ASSESSMENT OF SPLINE FUNCTIONS FOR ESTIMATING GROWTH CURVE PARAMETERS OF FUNAAB-ALPHA CHICKENS

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Abstract

The objective of this study was to fit four spline linear regression models to describe the growth of FUNAAB-Alpha Chickens (FAC). Body weight measurements of 300 FAC raised from day old till the 20th week were used to fit spline models of 3 (SP3), 4 (SP4), 5 (SP5) and 6 knots (SP6) using the REG procedure of SAS®. The data were first plotted to determine the most appropriate location of knots and they were placed at 4, 10 and 16th week of age for SP3, 4, 8, 12 and 16th week for SP4, 4, 7, 10, 14 and 18th week for SP5 and 3, 6, 9, 12, 15 and 18th week for SP6 respectively. The hatch weight predicted by SP3 were observed to be highest while SP6 predicted the lowest hatch weight for male and female FAC. For all the models, the greatest growth rates were predicted for the first 3-10 weeks after hatching. Based on Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC) as the goodness-of-fit selection criteria, SP3 had the lowest value of AIC and BIC for male while SP3 and SP4, with similar values, had the lowest value of AIC and BIC for the female FAC. It was concluded that the spline models of lower knots (SP3 and SP4) were the best fit to describe the growth of FAC.

Keywords: Spline models, FAC, Knots, hatch weight, Akaike Information criterion.

Introduction

The spline linear model (SLM) is a compound function consisting of a series of linear equations joined together with certain continuity conditions at various positions known as knots or junctions. The SLM is a nonparametric regression model that is fast gaining wide attention in statistical modeling due to its flexibility, good statistical interpretation, amenability to data that have no particular patterns, and very useful for modeling data that have changed patterns in sub-intervals such as growth curves with various distinct phases such as lag, log and stationary phases (Budiantara and Purnomo, 2011). Although most of the growth models available for poultry have been fitted using classical non-linear models, these models have their shortcomings. These include their inability to sometimes capture the inherent variability and considerable changes in growth over the course of the growth trajectory because they all assume that growth is sigmoidal throughout the lifetime of the animal (Meyer, 2005). Consequently, there is a need to explore alternative growth models using spline functions that will account for changes within each sub-phase of the growth trajectory. Aggrey (2002) and Meyer (2005) suggested that the spline linear regression models can be used as alternative to high order polynomials, complex and complicated non-linear models. The objective of this study was therefore to model the growth of FUNAAB-Alpha Chickens using spline functions of 3, 4, 5 and 6 knots.

Materials and methods

This experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Osun State Nigeria. Three hundred (300) day-old chicks of the FUNAAB-Alpha chickens (FAC) were obtained from the Hatchery Unit of the Federal University of Agriculture, Abeokuta. They were brooded for two weeks, wing tagged for identification and thereafter transferred to the deep litter pen. Data on body weight was taken from day old till the birds were 20 weeks old. PROC REG of SAS®(2003) was used to fit the linear spline models using 3, 4, 5 and 6 knots according to the following equation $W_t = W_0 + b_1(t-t_1) + b_2 (t -t_2) + b_3 (t-t_3)+\ldots\ldots. b_n (t -t_n)+e$ where W_t is the body weight at

time t, W_0 is the body weight at hatch, and t_1……t_n are the age at which the growth rate changes (knots); b_1……b_n are the growth rates of the specified periods that constitute the entire spline; and e the residual error which is assumed to be normally and independently distributed with mean = 0 and constant variance.

Results and Discussion

Table 1 shows the estimated hatch weights and regression coefficients for FUNAAB-Alpha chickens using spline functions of 3 (SP3), 4 (SP4), 5 (SP5) and 6 (SP6) knots. For both sexes, SP3 estimated the highest hatch weight while SP6 estimated the least values. The regression coefficients ranged from -38.47 to 47.46 for the male while it ranged from -39.40 to 40.47 for the female. The regression coefficients can be interpreted as the relative growth rates for the specific period in which they represent on the splines (Aggrey, 2002). The hatch weight predicted by SP3 for the male (74.71g) was higher than 32.80g reported by Aggrey (2002) that fitted linear splines of 3 knots at 6, 18 and 113 days of age to describe the growth patterns of Athens-Canadian chickens while 33.60g obtained by the same author for the female was similar to 34.40g obtained in this study. The range of linear regression coefficients are also much higher than 5.70-17.90 reported by Aggrey (2009). An important factor that may hinder direct comparison of the values of regression coefficients is the fact that the location of the knots in these chickens were different from the one used in the present study. The knots were placed at specific locations based on observed growth patterns so as to maximize the linear patterns in their growth trajectories. The greatest growth rates were predicted for the first 3-10 weeks after hatching. This is in agreement with the report of Aggrey (2002) that the greatest growth rate was attained between days 18 and 113 for the female while it was from hatch to day 6 for the males.

Table 1: Estimated Coefficients for Spline Regression model parameters in FAC raised under a deep litter system

	Male				Female			
Parameters	**SP3**	**SP4**	**SP5**	**SP6**	**SP3**	**SP4**	**SP5**	**SP6**
Hatch weight (β_0)	74.71	52.32	68.45	30.77	34.40	29.57	38.19	15.56
β_1	47.46	38.01	33.39	30.50	26.68	25.34	28.22	31.90
β_2	-38.39	35.07	35.52	33.52	-29.05	31.85	40.47	27.84
β_3	-21.81	-30.49	-38.47	-21.13	-15.35	-33.84	-27.88	-18.83
β_4	23.91	-28.60	-15.80	-23.00	34.33	-31.56	-29.14	-39.40
β_5		35.89	-39.44	-21.38		28.72	-24.35	-19.89
β_6			29.43	32.78			18.77	24.28
β_7				39.51				15.23

Table 2 shows the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) for the spline models fitted. For the male, SP3 had the lowest AIC and BIC and was adjudged the best fit model followed by SP5, SP4 and SP6 in that order. For the female, SP3 and SP4 had the lowest AIC and BIC values and were selected as the best fit model followed by SP3, SP6 and SP5 in that order. Overall, there seem to be a better fit to the data as the number of knots reduces. Stone (1986) concluded that fewer knots should be used unless the sample size is large enough and there is theoretical background to assume that the relationship being studied changes quickly.

Table 2: Best fit model selection criteria using Goodness-of-Fit tests

	Male		Female	
Model	**AIC**	**BIC**	**AIC**	**BIC**
SP3	**46.735**	**55.221**	**44.138**	**54.343**
SP4	50.167	61.256	**43.867**	**54.201**
SP5	49.204	59.544	45.867	56.425
SP6	54.660	65.298	46.623	57.188

Figures 1 and 2 depict the graphical representations of growth rate of male and female FAC respectively as predicted by spline functions of 6 (SP6), 5 (SP5), 4 (SP4) and 3 (SP3) knots. Generally, body weight increases with age but at different rate as predicted by different spline functions. There exists an overlap in the growth rate predicted by these functions from hatch till about 4th to 6th week for most cases.

For the male FAC, there was an overlap between SP4, SP5 and SP6 from hatch till the 14th week before the growth rate of the SP5 became higher than the rest. The growth rate predicted by the 3-knot function was found to be lowest. For the female, the growth rate predicted by the SP5 and SP6 functions were similar and highest and the growth rate predicted by SP3 was observed to be the lowest.

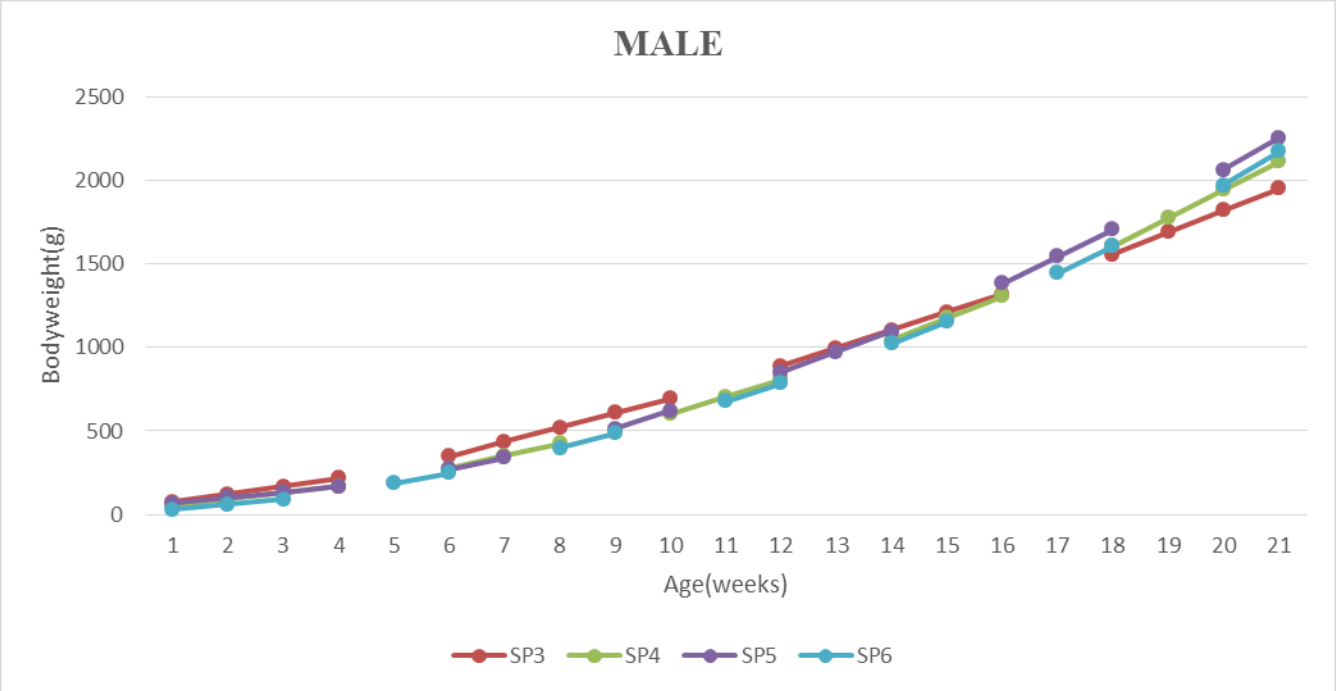

Fig 1: Growth curve of FAC as predicted by spline models (Male)

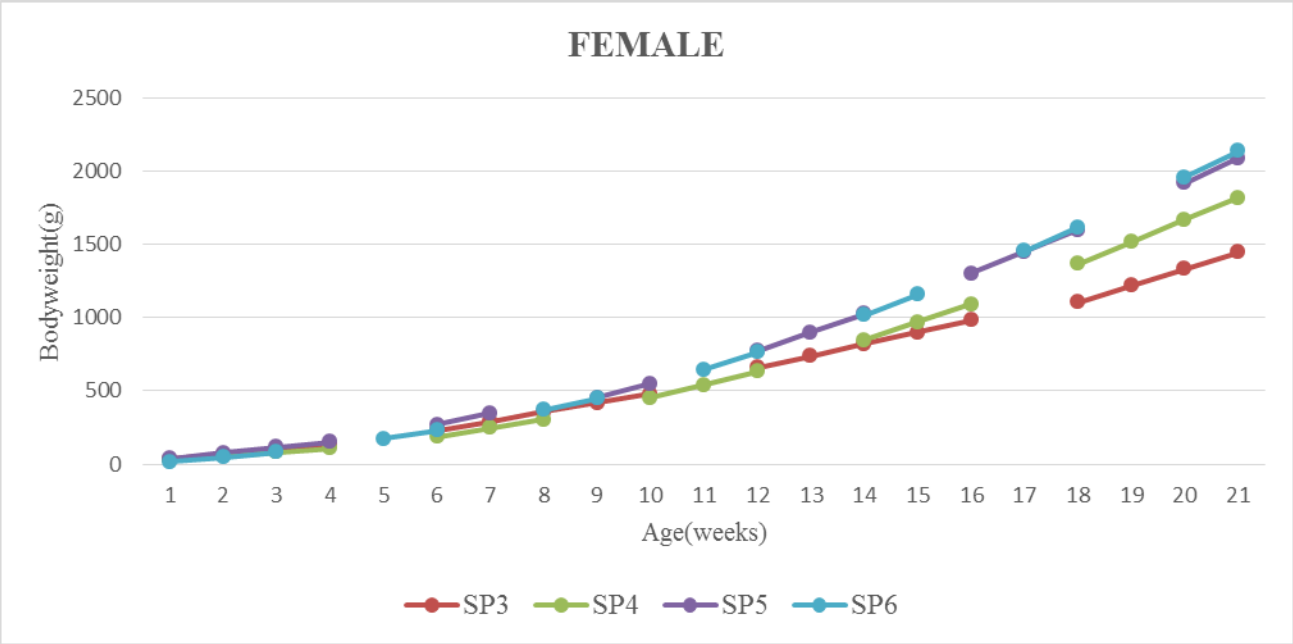

Fig 2: Growth curve of FAC as predicted by spline models (Female)

Conclusion

This study generated regression coefficients for growth rates for different periods of growth using spline models with different number and location of knots. The greatest growth rates were predicted for the first 3-10 weeks after hatching. The spline models of 3 and 4 knots were found to be the best fit for describing the growth performance of male and female FUNAAB-Alpha chickens respectively.

Acknowledgement

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HETEROSIS AND COMBINING ABILITY FOR BODY WEIGHT AND MORPHOMETRIC TRAITS IN A DIALLEL CROSS OF FUNAAB ALPHA CHICKENS

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Abstract

This study was carried out to evaluate heterosis and combining ability for growth traits in a diallel cross of two strains of FUNAAB Alpha chickens. Sixty hens comprising thirty white plumage and thirty black plumage colour aged between 17-18 weeks were used. The experiment which lasted for 5 months, considered such growth traits as: Body weight (BW), Body length (BL), Chest Girth (CG), Shank length (SL), Shank circumference (SC), Comb height (CH) and Comb length (CL). The study was based on heterosis and diallel cross of growth traits, (Hatch to 20 weeks of age). Data obtained were subjected to statistical analysis using IBM SPSS (Version 20, 2016). The result indicated that significant disparity ($P<0.05$) existed between White plumage and Black plumage chickens in all characters studied. White FUNAAB Alpha was 12.46% heavier than the Black FUNAAB Alpha. In the main cross of W♂ x B♀ and reciprocal cross of B♂ x W♀, the reciprocal (B♂ x W♀) cross was 6.82% heavier than the W♂ x B♀ at day old, although at 20 weeks of age, the W♂ x B♀ cross was 1.77% heavier than the B♂ x W♀ cross for body weight. The result of heterosis percentage revealed that heterosis estimates for body weight at hatch, 4 and 8 weeks of age was positive and higher in the black FUNAAB Alpha male x white FUNAAB Alpha female (B♂ x W♀). The main cross (W♂ x B♀) had superior heterosis for body length at hatch, 12 to 20 weeks of age.

Keywords: Diallel cross, general combining ability, heterosis, funaab alpha, growth traits.

Introduction

Indigenous chickens exist within the poultry population, and are extensively found under scavenging systems in most rural regions (Osei-Amponsah *et al*., 2010). These chickens are generally hardy and highly adapted to the various harsh environmental conditions of the tropics (Addisu, 2012). Within the past four decades there have been different breeding programmes aimed at genetic improvement of the Nigerian indigenous chickens. Genetic improvement of poultry is most often based on selection and crossbreeding (Adebambo *et al.*, 2011). Crossbreeding as a tool permits manipulation of genetic variation in order to modify the gene pool of the population in an attempt to obtain desired production traits (Soliman *et al.*, 2016). The FUNAAB Alpha breed is an improved Nigerian indigenous chicken developed from such breeding programme. These chickens have varied plumage colours, mostly white, black and barred. To sustain their use as breeding stock and development of different lines, it would be essential to assess their gene effects. Usually for identification of superior genotypes for production traits, it is imperative to carry out genetic analysis using diallel crossing, to estimate the nature and amount of genetic parameters as well as the general and specific combining abilities (Aly *et al.*, 2015; Khalil et al. 2018). The present study was undertaken to investigate the genetic effect of diallel cross (2×2) between two varieties of FUNAAB Alpha chickens.

Materials and Methods

Experimental Location and Study Period

This experiment was conducted at the Poultry Unit of the Teaching and Research farm of Rivers State University, Nkpolu Oroworukwo, Port Harcourt, Rivers State. The average rainfall in Port Harcourt is 200.45m (Uko and Tamunobereton-Ari, 2013). The study lasted for a period of 20 weeks, between June 2017 and October, 2017.

Experimental Birds

The birds used for this study were FUNAAB Alpha Strain. The FUNAAB Alpha birds are genetically improved Nigerian local chickens developed at Federal University of Agriculture Abeokuta (FUNAAB) Ogun State by a PEARL Project. Sixty FUNAAB Alpha improved Nigerian local chickens comprising thirty (30) black and thirty (30) white plumage hens between 17 and 18 weeks of age were sourced from the Poultry Unit of the Federal University of Agriculture (FUNAAB) Abeokuta, Ogun State. The birds were randomly allocated into 6 replicate deep litter pens/strain. The floor was littered with wood shavings. After acclimatization they were assigned into individual cages in a three tier battery cage at 19 weeks of age to ensure accurate collection of data on individual basis.

Selection of parents and diallel cross

Sire and Dam selection: Six cocks each were selected from the white and black FUNAAB Alpha population studied to serve as sires in the diallel crossing using semen quality traits (volume, morphology, concentration, motility) as selection criteria, whereas all sixty hens were mated due to the small size in population, thus no selection was practical.

Diallel cross: The selected birds were allocated randomly into four breeding groups as follows: WW (W♂ x W♀), BB (B♂ x B♀), WB (W♂ x B♀), and BW (B♂ x W♀) respectively. Each breeding group consisted of three sires and fifteen dams making a total of 72 chickens all together. For the mating procedure, artificial insemination method was used to inseminate the dams. A ratio of one sire to five dams in each group was used and this was replicated three times. The insemination was carried out using a micro-pipette set at 0.2µ. At the beginning of the experiment, semen was collected from the selected sire and inseminated into the oviduct of the dams in each breeding group. This was done thrice weekly to ensure high fertility.

Data Collection

Body weight and Morphometric Traits

Body weight and morphometric traits were measured and obtained from the progeny at intervals of 4 weeks (from hatch to 20 weeks of age). The variables among others measured include;

Body weight: The body weight of each bird was taken with the use of an electronic weighing scale in grams.

Chest Girth: This was measured as the width between two shoulder joints around the chest.

Body length: This was measured as the length between the lower ends of the rostrum maxillae (beak) to the caudal tail (coccygeal bone) without feathers from body surface.

The body measurements were done using the description of (Teguia *et al.*, 2008).

Data Analysis

Growth traits

Data were analyzed for variation between the crosses and within crosses (between progeny) using the multivariate analysis of general linear model procedure with genotype (WW, BB, WB, and BW) and Age (Hatch, 4, 8, 12, 16, and 20) as main effects. Interactions of these effects were also analyzed. Significant means at $P<0.05$ were separated using LSD.

Genetic parameter estimate

Heterosis: Heterosis was calculated on percentage of mid-parents

$F1 - \left\{(P1 + P2)/2\right\} \left| \left\{\frac{P1+P2}{2}\right\} \right. \text{x } 100$ Using mean, where F1 = the first cross and P1 or P2 is a parent in diallel and reciprocal crosses, (William *et al.*, 2002).

Heterosis % for cross $(W \text{ x } B) = \left\{(W \text{ x } B) - \frac{\{(WW+BB)\}}{2}\right\} / \{(WW + BB)\} /2 \text{ x } 100\}$

General Combining Ability (GCA): The general combining ability (GCA) values were calculated as the deviation of a specific genotype means from the overall mean for a trait estimated for the 4 diallel crosses. This implies that the GCA for (W x W) = {1/3*[(WW) + (W x B) + (B x W)] – 1/4* [(WW) + (BB) + (W x B) + (B x W)]}.

Results and Discussion

Results in Table 1 showed that at different weeks of age, body weight differed significantly (P<0.05) among the four genetic groups. The white FUNAAB Alpha strain had heavier day old weight in comparison with the black FUNAAB Alpha strain. In all crosses with white FUNAAB Alpha was used as a dam, heavier body weights at hatch and other age periods were noticed. The white FUNAAB Alpha (W x W parent genotype) was heavier (42.93g) than the Black FUNAAB Alpha parental genotype (37.80g) at day old. In the main cross of W♂ x B♀ and reciprocal cross of B♂ x W♀, the reciprocal (B♂ x W♀) cross was 6.82% heavier than the W♂ x B♀ at day old, although at 20 weeks of age, the W♂ x B♀ cross was 1.77% heavier than the B♂ x W♀ cross all for body weight. In all the growth traits studied, the White FUNAAB Alpha strain had better and higher significance than the Black FUNAAB Alpha strain. Furthermore, it may as well indicate that the underlying carotenoid pigmentation for white colour could possibly be linked with genes that favour the development of the various traits studied (Evans and Sheldon, 2015). Body length at different weeks of age was significantly different (P<0.05) among the four genetic groups, with the white FUNAAB Alpha (12.20cm) having a superior value. The main cross (W♂ x B♀) had higher value of 12.26cm than the reciprocal cross (B♂ x W♀) with value of 12.24cm, even though the disparity was very small. Similar trend was noticed in all other morphometric traits (CG, SL, etc).

Table 1 Mean SE for growth traits at different studied ages from the diallel crossing of White and Black FUNAAB Alpha strains

Trait	GG	Growth traits at different ages (weeks)						P-Value		
		Day Old	4	8	12	16	20	Strain	Age	S x A
BW	WW	42.93^{b}	187.86^{a}	578.07^{b}	991.50^{a}	1021.14^{a}	1024.14^{a}	0.000	0.000	0.005
	WB	41.00^{c}	169.70^{c}	548.67^{d}	833.40^{b}	844.10^{b}	848.10^{b}			
	BB	37.80^{d}	151.60^{d}	567.11^{c}	750.78^{d}	767.56^{d}	771.33^{d}			
	BW	44.00^{a}	184.70^{b}	612.80^{a}	819.00^{c}	828.60^{c}	833.10^{c}			
BL	WW	12.20^{c}	21.82^{a}	29.89^{a}	37.72^{b}	38.14^{b}	38.51^{b}	0.000	0.000	0.076
	WB	12.26^{a}	20.77^{c}	28.59^{c}	38.95^{a}	39.30^{a}	39.62^{a}			
	BB	11.77^{d}	20.03^{d}	29.00^{b}	33.23^{d}	33.57^{d}	33.76^{d}			
	BW	12.24^{b}	21.50^{b}	29.36^{b}	37.30^{c}	37.65^{c}	37.89^{c}			
CG	WW	9.92^{b}	15.61^{a}	22.47^{a}	29.29^{b}	29.73^{ab}	29.86^{b}	0.000	0.000	0.271
	WB	10.15^{a}	15.08^{c}	22.20^{c}	30.41^{a}	30.79^{a}	30.90^{a}			
	BB	9.35^{d}	14.76^{d}	22.40^{ab}	26.26^{d}	26.62^{c}	26.71^{d}			
	BW	9.82^{c}	15.25^{b}	22.26^{b}	29.12^{c}	29.52^{b}	29.60^{c}			
SL	WW	2.24^{c}	3.95^{b}	6.09^{ab}	7.54^{b}	7.75^{a}	7.84^{ab}	0.022	0.000	0.93
	WB	2.28^{a}	3.90^{c}	5.67^{c}	7.61^{a}	7.75^{a}	7.86^{a}			

	BB	2.20^{d}	3.59^{d}	6.02^{b}	6.84^{d}	7.02^{c}	7.12^{c}			
	BW	2.26^{b}	4.03^{a}	6.17^{a}	7.42^{c}	7.65^{b}	7.74^{b}			
SC	WW	1.85^{c}	2.76^{b}	3.54^{b}	7.02^{a}	4.44^{b}	4.48^{b}	0.315	0.000	0.787
	WB	2.05^{a}	2.65^{c}	3.64^{a}	4.44^{b}	4.52^{a}	4.60^{a}			
	BB	1.79^{d}	2.46^{d}	3.48^{c}	3.94^{d}	4.02^{c}	4.07^{d}			
	BW	1.94^{b}	2.86^{a}	3.45^{d}	4.02^{c}	4.08^{bc}	4.12^{c}			

GG = Genotype group, BW = Body weight, BL = Body length, CG = Chest girth, SL = Shank length, SC = Shank circumference, CL = Comb length, CH = Comb height, WW = White White, WB = White Black, BB = Black Black, BW = Black White, S x A = Interaction of Strain and Age

The result in Table 2 shows that heterosis estimates for body weight at hatch, 4 and 8 weeks of age was positive and higher in the black FUNAAB Alpha male x white FUNAAB Alpha female (B♂ x W♀). At 12 – 20 weeks of age, negative heterosis was obtained. Negative heterosis was obtained at 4 – 20 weeks of age for the main cross (W♂ x B♀). The main cross (W♂ x B♀) had superior heterosis for body length at hatch, 12 to 20 weeks of age. Similar observations were made with respect to chest girth, shank length, shank circumference, and comb length.

Table 2 Heterosis percentages of body weight and body morphometric for offspring at different studied ages from the diallel crossing of white (WW) and black (BB) FUNAAB Alpha Strain

Trait	**GG**	**Growth traits at different ages (weeks)**					
	♂ x ♀	**Day old**	**4**	**8**	**12**	**16**	**20**
BW	W x B	1.57	-0.02	-4.18	-4.33	-5.62	-5.53
	B x W	9.01	8.82	7.02	-5.99	-7.35	-6.54
BL	W x B	2.29	-0.74	0.03	9.76	9.61	9.64
	B x W	2.13	2.74	-0.29	5.14	5.01	4.86
CG	W x B	5.35	-0.69	-1.05	9.49	9.28	9.25
	B x W	1.92	0.42	-0.78	4.84	4.77	4.65
SL	W x B	2.70	3.45	-6.36	5.84	4.94	5.08
	B x W	1.80	6.89	1.89	3.19	3.59	3.48
SC	W x B	12.64	1.53	3.70	-18.98	6.86	7.60
	B x W	6.59	9.57	-1.71	-26.64	-3.55	-3.63

GG = Genotype group; BW = Body weight; BL = Body length; CG = Chest girth; SL = Shank length;
SC = Shank circumference; CL = Comb length; CH = Comb height; W♂ x B♀ = White male x Black female; B♂ x W♀ = Black male x White female.

The result for estimates of general combining ability (GCA) is presented in Table 3. GCA estimates were all positive for body weight in W♂ x W♀ for hatch, 4 to 20 weeks of age while they were all negative in B♂ x B♀ cross in all the ages. Similar trend was noticed in body length except for week 4 (0.263) that was positive for BB cross. Estimates of GCA for chest girth recorded positive estimates for W♂ x W♀ cross except week 8 (-0.023) that was negative; however, all the ages for B♂ x B♀ cross were negative.

Table 3 General and specific combining abilities of growth traits at different ages from the diallel crossing of white and black FUNAAB Alpha strains.

Trait	**GG**	**Growth traits at different ages (Weeks)**					
General Combining Ability (GCA)		**Day Old**	**4**	**8**	**12**	**16**	**20**
BW	WW	1.211	7.288	3.183	32.630	32.596	32.612
	BB	-0.502	-4.799	-0.470	-47.610	-51.93	-51.658
BL	WW	0.112	0.333	0.07	1.190	1.198	1.228
	BB	-0.028	0.263	-0.226	-0.306	-0.325	-0.355
CG	WW	0.153	0.138	-0.023	0.836	0.848	0.853

	BB	-0.036	-0.145	-0.046	-0.173	-0.188	-0.197
SL	WW	0.015	0.093	-0.011	0.171	0.174	0.173
	BB	0.001	-0.027	-0.033	-0.062	-0.068	-0.06
SC	WW	0.039	0.074	0.016	0.305	0.081	0.083
	BB	0.019	-0.026	-0.004	-0.722	-0.059	-0.054

GG = Genotype group, BW = Body weight, BL = Body length, CG = Chest girth, SL = Shank length, SC = Shank circumference, CL = Comb length, CH = Comb height, WW = White x White, BB = Black x Black, WB = White x Black, BW = Black x White.

Conclusion and Recommendation

The diallel analysis of the White and Black FUNAAB Alpha strain showed that body weight was affected by genetic group. There was negative heterosis observed in the crosses which could have been a result of the genetic closeness of the parents and also an interaction between genes of epistatic effect. Although crossing between white and black FUNAAB Alpha at varying ages lead to high body weight. With the white FUNAAB Alpha as dam (B x W) the offspring had superior body weight as compared to when the black FUNAAB Alpha was used as dam (W x B). The FUNAAB Alpha should be crossed with other strains that are genetically divergent from it so as to reduce inbreeding depression which may lead to low hybrid vigour.

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Up-grading indigenous chicken with sire line (SG-98) cocks of ShikaBrown® in villages around Zaria, Kaduna State

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Abstract
This study examines the effect of up-grading the indigenous chickens with sire line cocks of ShikaBrown parent chicken around Zaria. The study was carried out on small holder poultry farmers who keep and practiced domestic chicken production. Well-structured questionnaire were administered to obtain demographic data on the size of households and knowledge in keeping domestic chicken in the villages. Data were collected, pooled together and analyzed for average egg size, clutch number, percent hatch, mortality, and body weight at 20weeks from 2014 – 2017 on both pure indigenous chicken line (IC x IC) and cross between ShikaBrown sire line (SG) with indigenous chickens (SG x IC). Results showed that average egg weight increased significantly ($p<0.05$) from 35.11g (IC) to 41.08g (SG x IC), egg number per clutch (IC = 10; SG x IC = ≤11) and significant difference ($p<0.05$) for average body weight at 20weeks (IC = 1057g; SG x IC = 1350g). There was a change in the management system from extensive to semi intensive while most of the flock plumage started becoming homogenous while there were observed increase in shank length. There was no significantly difference ($p>0.05$) for mortality and percent hatchability. In conclusion therefore, the indigenous chickens in Nigeria can be improved by a well-planned cross breeding scheme with exotic chickens in villages which will gradually improve the living conditions of the farmers.

Introduction
The indigenous chickenwhich was not selected deliberately has been identified for their poor egg and meat production (Tadelle *et al*., 2003). However, well selected breed like the ShikaBrown®chickens which is adapted to adverse environmental and some diseases conditions produce higherbody weight, number of eggs and more meat than the indigenous chickentypes.At the moment, the genetic diversity of the indigenous and exotic chicken breeds can be utilized by cross breeding and up-grading schemes (Amao, 2017). The main purpose of crossing in chicken is to produce superior crosses (hybrid vigor): to improve fitness and also fertility traits and to combine different characteristics inwhich the crossed are valued for since crossbreeding exploits genetic variation (Amao, 2017). Results from studies conducted in Nigeria revels that both body weight and egg production at the smallholder level can be increased through intervention of up-grading or crossbreeding in a semi-scavenging poultry model (Egahi *et al.*, 2010). Furthermore, body weight at sexual maturity, egg number, egg weight and egg mass are better from offspring of crosses when compared with the pure strains (Amin, 2008).
Therefore, the objective of this study was to elucidate the performance of indigenous chicken and their crosses withShikaBrown®sire line on some performance traitsbased on the management system among smallholder farmers in villages around Zaria Metropolis of Kaduna State.

Materials and Methods
The study was carried out in Zaria, a major city in Kaduna State, Nigeria. It stands at a height of about 670m above sea level and about 640km away from the sea. It is located on latitude 11^0 04’

N and longitude 7^0 33' E. The climaticcharacteristic is that of tropical continental savannah climate with a distinct wet, dry and harmattansseason. The average annual temperature is 24.9^0c and an average annual rainfall of 1050mm (NIMET 2011).400 sexually matured ShikaBrown®sire line (SG-98) cocks were obtained from the breeding unit of the Poultry Research Programme, National Animal Production Research Institute, Shika, Zaria for distribution in October 2014. Before and after the distribution of the cocks, a survey was conducted from 2014 to 2017 using well-structured questionnaires to ascertain the size of households identified to be involved in the smallholder domestic chicken production system in the various villages. Subsequently, data were then collected for egg size, clutch number, fertility percent hatch, mortality, and management system and body weight at 20 weeks. Data on average egg weight and body weight at 20 weeks were analyzed using the general linear model procedure of Statistical Analysis System program (SAS, 2002). Significant means were separated using Duncan (1955) of the SAS package while simple descriptive statistics was used for the other traits.

Results and Discussions

Table 1 show the study area (participating villages) and number of cocks allotted to each house hold.The variation in number of cocks allotted wasinfluenced by the number keeping and practicing some level of poultry rearing. The study areas were close to those of Abdulrashid *et al*. (2018) that study some towns in Zaria metropolis which areclose to this present study.

Table 1: Villages and number of cock allotted

Name of village	Number of cocks allotted
Rafin Gora	40
Biye	52
Bijimi	29
Kurku	35
Karfe	27
Tisbiri	17
Salanke	11
Mahuta	36
UnguwarGaladima	41
HayinGada	53
MarabanGuga	56
Total	**397**

Table 2: Performance evaluation of indigenous chickens and their crosses with SG cocks

Traits	Pure line (IC x IC)	Cross line (SG x IC)
Average Egg weight (g)	35.11 ± 0.48^b	41.08 ± 0.55^a
Egg number per clutch (eggs)	10	≤11
Percent hatchability (%)	80	≤90
Mortality from 0 – 20 weeks (%)	80	75
Management system	Extensive	Semi-intensive
Plumage	Black, white, red, light brown, mottled and dark ash	Dark red, dark brown and golden
Shank length	Short	Long

Avg. body weight at 20 weeks (g)	1057±25.11[b]	1350±27.28[a]

IC = Indigenous chicken, SG = ShikaBrown sire line

Table 2 shows the performance evaluation of indigenous chicken and their crosses with SG ShikaBrown® sire line. The result showed that traits of interest increased significantly like the average egg weight (IC = 35.11g; SG x IC = 41.08g), egg number per clutch (IC = 10; SG x IC = ≤11) and the average body weight (IC = 1057g; SG x IC = 1350g). The result of average egg weight is similar to that of Amao, (2017) were the author reported 43.22g for Fulani ecotype (FE) crossed with Rhode Island Red (RIR) and attributed the improvement to cross breeding. This finding is in consonance with the reports of Fassill *et al.* (2010) and Ajayi (2010) who also attributed improvement in egg weight on crossing effects with exotic birds on local genotypes. Hatchability and mortality had slight numerical changes. The high level of mortality recorded was a major challenge which was attributed to predator's attack (snakes, wild birds and rats) at early age which is in agreement with the findings of Ajala *et al*. (2007) who revealed that predators account for large mortality in rural areas.The management system changed from extensive to semi-intensive while the plumage pattern changed to more homogenous colour of dark red, dark brown and golden which is due to dominance gene of the cocks. Also, there was increase in the shank length from short in the indigenous to longer shanks in their crosses. Similarly, the hatchability in this study was similar to 98.25% reported by Amao, (2017) and suggested that crossing local chicken with exotic breeds translates to up-grading of the unimproved local chicken.

Conclusion

In conclusion, the performance of indigenous chickens can be improved by a well-planned cross breeding scheme with exotic chickens in villages were large population of indigenous chickens resides. This is appropriate for the fact that it willcontribution in increasing meat and egg quantity.

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AUTO-SEXING POTENTIAL AND GROWTH PERFORMANCE IN RHODE ISLAND, NIGERIAN LOCAL CHICKENS AND THEIR RECIPROCAL CROSSES

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ABSTRACT
This study was conducted to determine auto-sexing potential in Rhode Island, Nigerian local chicken and their reciprocal crosses. A total of 241 eggs were set in the incubator to determine the fertility, hatchability, % Hatch, % dead in shell, % dead in cell and % deformed chicks in the four genotypes (Rhode Island Red (RIR) x Rhode Island White (RIW), Rhode Island Red (RIR) x Rhode Island White (RIW), Nigerian Local Red (NLR) x Rhode Island White (RIW) andNigerian Local Red (NLR) x Nigerian Local White (NLW). Only 94 eggs were hatched. Chi square analysis was used to test colour inheritance of chicks. The chi square (X^2) analysis revealed that both RIRxRIW and NLRxRIW crossbred chicks were autosexed. The study concluded that selection for plumage colour showed great potential in determining the probability of chicks being autosexed showed that the pure bred of RIRXRIW and reciprocal cross of NLRXRIW showed great potential of producing autosexed chicks, while the results on the direct of NLRXNLW and RIRXNLW suggest that the pattern of inheritance of plumage colour is not simple. The study recommends further investigation to further ascertain the mode of plumage colour inheritance in the Nigerian Local Chickens

Keywords: Auto-sexing, plumage

INTRODUCTION
In Nigeria, local Chicken production constitutes a significant portion of the chicken industry which is a major contributor of animal protein in the national diet (Ayorinde, 1986). Neither local, nor exotic chickens possess clear-cut superiority in the combination of productivity, adaptability, and resistance to local diseases which is desirable. The Nigerian Local Chicken exhibits higher fertility and hatchability under natural incubation, and better adaptation to the prevailing diseases, physical conditions and local management practices than exotic chickens. In addition, its meat is perceived to have superior gustatory qualities. It is however less productive (meat and eggs) than its exotic counterparts.

Reports have shown that the indigenous fowl possesses great potentials for genetic improvement through breeding programme such as selection and or cross breeding (Omeje and Nwosu, 1983; Nwosu*et al.*, 1985; Ikeobi*et al.*, 1996; Adebambo *et al.*, 1999; Peters, 2000; Adedeji *et al.*, 2008, Adebambo *et al.*, 2009). Cross breeding of the local stock with an exotic commercial stock could take advantage of artificial selection for productivity in the exotic birds and natural selection for hardiness in the indigenous birds (Adebambo *et al.*, 2009). Moreover, birds with better production performance can result from the combining ability of best performing exotic lines and the indigenous chicken. The constraints for improving productivity are related to breeds unsuitable for the environment and to diseases, bad management, lack of supplementary feeding and predators (Bagust, 1994). Crossbreeding of local stocks with exotic commercial stocks will take advantage of systematic scientific selection for productivity in the exotic birds and natural selection for hardiness in the indigenous birds.

With most animals it is relatively easy to tell the sex of the new-borns. The male reproductive organs are located on the outside of the body and are relatively easy to see, even in new-borns. This is not the case with poultry. In male birds the reproductive organs are inside the body cavity. This makes sexing newly hatched chicks difficult. Hence the sex of chick at hatching came into existence as a result of specialization in the poultry industry.

Sex identification is very important in poultry production; enormous benefits have resulted from the ability to sex day-old chickens, not only for hatcheries but for the poultry industry in general. The procedure has reduced the cost

of rearing chickens by 50% which in turn has reduced labour and feed expenses. The advent of feather sexing has allowed the meat chicken industry (broilers) to separate males from females for a quicker turn around. However mode of inheritance of plumage colour of our indigenous local birds that shared marked difference from their parents has not been reported in most indigenous birds and their reciprocal crosses with the exotic birds.

The inability to sex day old chicks of indigenous strains of chickens stands as a major huddle to their commercialization. Therefore early sexing of indigenous chicken will lead to improved productivity of indigenous chicken. Hence, the research was aimed to determine sex-linked colour sexing potential in Nigerian local chicken and to determine if the chicks can be auto-sexed.

MATERIALS AND METHODS

Location of the study

The rearing of parent birds and hatching of eggs were carried out using the poultry facilities at the Department of Animal Production, University of Ilorin. Ilorin is located between rainforest of the Southwest and Savannah grassland of Northern Nigeria with co-ordinates of 8° 30' 0" North, 4° 33' 0" East. It lies on an altitude of 305m, 1001' above sea level, with annual rainfall, relative humidity and day temperature of 600-1200 mm, 65-80% and 33-37^0 C, respectively.

Experimental animals and Management

A total of 241 eggs produced from different crosses of Rhode Island and Nigerian chickens (Table 1) were used for the determination of fertility, hatchability and analysis of un-hatched eggs. The parent birds from which eggs were obtained were kept in cages, the female birds were artificially inseminated with fresh semen and the eggs were hatched in electric incubator. A total of 94 chicks produced from the hatchability experiment were put in cages in a completely randomized design. The Nigerian local chicken used as parent stock was a mixed population of Yoruba and Fulani chickens. A commercial chick marsh with a calculated Crude Protein content of 21.09% (CP) and Metabolizable Energy (ME) of 2795 kcal/kg was fed to the birds for a period of 8 weeks and water was supplied *ad-libitum* to all the birds. Other management practices such as routine medication and sanitation were as recommended for chicken by NRC (1994).

Data collection

% fertility, Hachability of fertile eggs and hatchability of total eggs sets were calculated using the methods of Mauldin (2003). The breakout analysis of culled eggs was done by visual appraisal as described by Lourens *et al.* (2006). The identification of colour was done by visual appraisal.

Statistical analysis

Microsoft excel program was used to record all the data before preliminary statistical analysis were done. Chi square (X^2) analysis was used to test whether the result obtained in the colour of chicks differed from expectation.

Table 1: Mating plan and number of chicks produced from different crosses of Rhode Island and Nigerian local chickens

Sire	Dam	Number of eggs	Chicks
RIR (4)	RIW (8)	72	32
RIR (4)	NLW (8)	51	28
NLR (4)	NLW (8)	65	23
NLR (4)	RIW (8)	53	11
	Total	241	94

Number of birds in parenthesis, RIR = Rhode Island Red, RIW = Rhode Island White, NLR = Nigeria Local Red, NLW = Nigeria local White

RESULTS

Fertility, Hatchability and Hatch-out Analysis

The Fertility, Hatchability and Hatch-out Analysis of eggs from Rhode Island, Nigerian local and their reciprocal crossbreds are presented in Table 2. The fertility of eggs ranged from 72-89 percent while the hatchability of fertile eggs and hatchability of egg set were 24-65 and 19-57 percent, respectively. Eggs from Rhode Island Red x Rhode Island White chickens were better in fertility, hatchability of fertile eggs and hatchability of set eggs than those from purebred local and crossbred chicken. The lowest hatchability was obtained in the crossbred

NLRXRIW. The most common cause of un-hatched eggs was dead in cell; this was followed by dead in shell. Both % deformed and % banger accounted for only 6-22 percent of un-hatched eggs in the four genotypes (Table 2).

Table 2: Fertility, Hatchability and Hatch-out Analysis of eggs from Rhode Island, Nigerian local and their crossbreds

	Genetic groups			
Parameters	RIRXRIW	RIRXNLW	NLRXNLW	NLRXRIW
Number of eggs set	72.00	51.00	65.00	53.00
% Fertility	88.89	86.27	72.31	77.36
% Hatchability	51.56	65.19	51.06	24.39
% Hatch/egg set	45.83	56.86	36.92	18.87
% Dead in Shell	17.19	11.36	17.02	29.27
% Dead in Cell	28.13	15.91	31.92	43.33
% Deformed	6.06	10.34	20.85	0.00
% Banger	0.00	1.96	1.54	9.08

RIRXRIW = Rhode Island Red Male x Rhode Island White Female, RIRXNLW = Rhode Island Red Male x Nigeria local White Female, NLRXNLW= Nigeria Local Red Male x Nigeria local White Female, NLRXRIW = Nigeria Local Red Male x Rhode Island White Female

Plumage Colour Inheritance

Sex Linkage in Plumage Colour Inheritance

The results in table 3 shows that at a degree of freedom of 1 (*df =1*) and with an α level of 0.05 the crosses of both the direct and reciprocal crosses were segregated based on the decision rule.

The crosses between RIRXRIW (0.00) and NLRXRIW (1.66) were auto-sexed, while crosses between RIRXNLW (17.10) and NLRXNLW (9.56) are therefore rejected (H_1) since the cross group of the Chi Square calculated is greater than Chi Square Tabulated.

Table 3. Chi square table X^2 of pure bred and cross bred

	Chi Square	
Genotypes	**Calculated**	**Tabulated**
RIRXRIW	0.00	3.841
RIRXNLW	17.10	3.841
NLRXNLW	9.56	3.841
NLRXRIW	1.66	3.841

RIRXRIW = Rhode Island Red Male x Rhode Island White Female, RIRXNLW= Rhode Island Red Male x Nigeria local White Female, NLRXNLW= Nigeria Local Red Male x Nigeria local White Female, NLRXRIW= Nigeria Local Red Male x Rhode Island White Female

DISCUSSION

The fertility of eggs of the four genotypes were higher than 21.49-66.68 percent obtained by Bobbo *et al.* (2013) in their work on comparative assessment of fertility and hatchability traits of nine genotypes of pure and cross bred local chickens in Adamawa State. Fayeye *et al.* (2005) had obtained a fertility of 76 percent in an earlier work on Fulani-ecotype chicken. The hatchability of fertile eggs in this study was however higher than 48 percent obtained by Fayeye *et al* (2005) for Fulani-ecotype chicken. According to Brillard (2003), the fertility of an egg depends directly on the ability of the hen to mate successfully, store sperm, ovulate and support the formation and development of embryo. It also depends on the ability of cock to mate successfully and deposite adequate quantity of high quality semen (Wilson *et al.,* 1979). Such variation in results of fertility and hatchability is common in literatures because fertility and hatchability are influenced by a large number of genetic and non-genetic factors such as feed variation (Mussaddeq *et al.,* 2002; Lariviere *et al*., 2009), genotype of embryo (King,ori, 2011), egg size, age and shell quality (King,ori, 2011).

The hatch weight of RIRXNLW and NLRXNLW chicks in the present study were close to 27-28grammes obtained by Fayeye *et al.* (2005) in their work on Fulani ecotype chicken. However, Bobo *et al.* (2013) reported lower hatch weight of 7.00-25.62 grammes for straight and crossbred local chicks obtained from Adamawa state. Such a wide range in hatch weight is common with studies involving animals of different genetic groups. For instance, Khawaja *et al.* (2012) reported hatch weights of 20.9g to 31.3g in their work on Rhode Island, Fayoumi and their reciprocal crosses.

The result of direct cross of the Nigerian local chicken (NLRXNLW) is in line with earlier research of Nwosu and Ahana, (1987) that the local Nigerian chickens in Nigeria cannot be autosexed as autosexing characteristics has not been developed in them, however the cross between the Rhode Island Red male and Rhode Island White females can produce auto-sexed chicks at hatch as reported by ISA (2010). However the reciprocal cross (NLRXRIW) showed great potential to be autosexed and findings was similar to that reported by Pricop (2009) that new gene theory of sex determination based on the gene mechanism demonstrates that the females have the gene responsible for the inheritance of plumage colour located simultaneously in chromosome Z.

CONCLUSION

Collectively, the result showed that chickens with superior live weight were those which resulted from the cross between RIRXRIW and NLRXRIW respectively. The X^2 result used in determining the probability of chicks being auto-sexed showed that the pure bred of RIRXRIW and reciprocal cross of NLRXRIW showed great potential of producing auto-sexed chicks, while the results on the direct of NLRXNLW and RIRXNLW suggest that the pattern of inheritance of plumage colour is not simple. The study recommends further investigation to further ascertain the mode of plumage colour inheritance in the Nigerian Local Chickens.

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BULK DENSITY AND CRUDE PROTEIN COMPOSITION OF SOME PROTEIN FEED INGREDIENTS OBTAINED FROM OUTLETS IN OWERRI, NIGERIA

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ABSTRACT:
This study determined the bulk density (BD) and crude protein composition of protein feed ingredients from the feed outlets in Owerri, Nigeria. Protein feed ingredients samples were collected from three previously surveyed feed outlets (Fidelity, Elvon and Ceekings). Each sample was replicated thrice for bulk density determination and twice for crude protein determination. Bulk desity and crude protein composition values were analyzed using analysis of variance (ANOVA) Soya bean meal (SBM), full fat soya bean meal (FFSBM), groundnut cake (GNC), foreign fish meal (FFM) and local fish meal (LFM) were the available feed ingredients in these outlets. Bulk density values of these protein feed ingredients ranged from 0.55g/cm^3 for SBM from Ceekings to 0.85g/cm^3 for FFSBM from Fidelity. Crude protein (CP) values ranged from 40.13% - 49.58% and similar ($p>0.05$) CP values were recorded for FFSBM, GNC and FFM from all the feed outlets. It is recommended that appropriate standard physical composition be included alongside nutrient composition in the material listing of feed ingredients for livestock in Nigeria.

Keywords: protein, bulk, density, feed and outlets

INTRODUCTION

Feed ingredients are of high economic importance in the rearing of commercial poultry not only because it is primarily responsible for growth response of birds, but mainly because it represents the largest cost in the production cycle (Ávila *et al.*, 1992)**.** Types and sources of feed ingredients for poultry includes energy (maize, sorghum, millet,), proteins (soya bean meal, groundnut cake, full fat soya, fish meal, blood meal, cotton seed cake etc), fillers/industrial by-products (wheat bran/offal, palm kernel cake, rice husk etc) and micro-ingredients which includes amino acids (lysine, methionine), macro-minerals (bone meal, oyster shell, limestone, dicalcium phosphate etc), additives (toxin binders, etc), vitamins and micro-minerals. (NIAS, 2017). The nutritional composition, physical characteristics and form of feed offered to poultry at different ages and stages of growth have significant effect on the performance and subsequently economic output.

Proximate analysis provides the capability to rapidly measure dry matter, crude protein, fibre, fat, total ash and also the potential energy value (nitrogen free extract) of individual feed ingredients. (Poultry Hub, 2018). According to Okoli *et al.*, (2009), information on the proximate composition and sometimes toxicology of novel feedstuffs have been used routinely, especially during animal feeding trials. Similarly, the physical feed quality according to Jafanerjad *et al.*, (2010) is considered to have a very significant effect on broiler growth. Optimal feed intake is dependent on feed nutrient density and environmental temperature while growth is emphatically dependent of feed intake which is in turn influenced by feed form (Fasuyi and Odunoyo, 2015a). Biophysical characteristics such as bulk density (BD), water holding capacity (WHC), Particle size (PS) and Specific Gravity (SG) on the other hand play important roles in controlling feeding (Kryzakis and Emmans, 1995; Makinde and Sonaiya, 2007). Physical characteristics of feed or feedstuff might be one of the hidden reasons why animals eat so much and yet have little yield to the farmer or why some intensively kept animals eat below their productive requirement in the tropics (Omede *et al.*, 2011). According to Shelton *et al.*, (2005) feeds with low bulk density may result in gut fill before chicks can consume adequate feed to meet their nutrient needs. This reduced feed intake on a

weight, but not volume basis results in a reduced nutrient intake, which may be the cause of the reduced growth performance of chicks. In order words, nutritional content might be adequate but physical characteristic could pose a hindrance to efficient and profitable production. According to Omede *et al.,* (2012), the nutritional characteristics of finished ration is an aggregation of proximate, physical and toxicological characteristics of individual ingredients used in compounding the ration, therefore, proper understanding of all the raw materials and perhaps their relationships is imperative.

This study therefore, determined the crude protein and bulk density of protein feed ingredients obtained protein feed ingredients obtained in feed outlets in Owerri, Nigeria.

METHODOLOGY

The protein feed ingredient samples used for this study were obtained from previously surveyed feed ingredients outlets (Fidelity, Elvon and Ceekings) in Owerri in June, 2018. Two (2kg) of each protein feed ingredient was collected into previously labeled cellophane bags and labeled according to the outlet where they were obtained. Care was taken to ensure that samples were from stock that had not stayed beyond 7 days in the feed outlet. The protein feed ingredients collected were: Soya bean meal, Full fat soybean meal, Groundnut cake, Fish meal (foreign) and Fish meal (local). Each ingredient sample from each outlet was replicated three times for determination of bulk density and two times for the crude protein determination. Determination of the bulk density and crude protein composition of protein feed ingredients were carried out in the Laboratories of the Department of Animal Science and Technology, Federal University of Technology, Owerri, Imo State. However, crude protein determination was concluded after digestion at Jagee Laboratory, Ibadan, Oyo State, Nigeria. In analyzing bulk density, the method described by Makinde and Sonaiya (2007) and modified by Omede (2010).was adopted. The crude protein compositions were determined using the by the Kjeldahl's method as described by AOAC (1990). Means of data collected from the determined bulk density and crude protein composition of protein feed ingredients were subjected to Analysis of Variance (ANOVA) (Little and Hills, 1978) and where significant differences are observed, the means were separated using the Least Significant Difference (LSD) according to Obi (1990). These statistical analyses were done using the SPSS 20 (2011) package.

RESULTS AND DISCUSSION

Bulk density and crude protein composition data of protein feed ingredients from the three feed outlets surveyed are presented in tables 1and 2, respectively.

Bulk density of protein feed ingredients from outlets in Owerri: Bulk density ranged from 0.55g/cm^3 for soyabean meal sample from Ceekings to 0.85g/cm^3 for full fat soya bean meal from Fidelity outlet (Table 1). The bulk density values obtained in this study were higher than those reported by Omede *et al.,* (2011) perhaps as a result of the particle sizes of the ingredient samples. Similar ($p>0.05$) bulk density values were recorded for soya bean meal and local fish meal obtained from all the feed outlets. Ingredients samples from Ceekings produced the lowest bulk density values except for Foreign and Local fish meals. Only full fat soya bean meal produced higher bulk density values than groundnut cake. Full fat soya bean samples from the three outlets produced significantly ($p<0.05$) different bulk density values. According to Fasuyi and Odunayo (2015b), different feed raw materials even within the same group had different bulk density. Implication of this is that level of inclusion of each feed raw material in final feed formulation should be influenced by these variations in physical characteristic and would influence the ceiling of inclusion. (Omede *at al.,* 2011).

Table 1: Bulk density of protein feed ingredients from outlets in Owerri (g/cm^3)

Protein feed ingredients	Feed ingredient outlets surveyed in Owerri			SEM
	Fidelity	Elvon	Ceekings	

Soya bean meal	0.65	0.58	0.55	0.048^{ns}
Full fat soya bean meal	0.85^{a}	0.70$^{b.}$	0.63^{c}	0.009
Groundnut cake	0.75^{a}	0.58^{b}	0.57^{b}	0.009
Fish meal (Foreign)	0.63^{a}	0.56^{b}	0.56^{b}	0.025
Fish meal (Local)	0.56	0.62	0.59	0.039^{ns}

^{abc}Means in a row without a common superscript differ significantly (P<0.05).

Crude protein of protein feed ingredients from outlets in Owerri

Crude protein values of soya bean meal, full fat soyabean meal and groundnut cake ranged from 40.13% - 49.58% (Table 2). Aduku (2002) reported 44% and 45%, respectively as CP content of soyabean meal and groundnut cake which agreed with the trend observed in this study. Groundnut cake recorded slightly higher CP values than Soyabean meal from all the feed outlets. Full fat soya bean, local fish meal and groundnut cake recorded similar (p>0.05) CP values among the outlets. Soya bean meal and groundnut cake samples from Ceekings had the highest CP value. Crude protein values from this study were lower for groundnut cake, Soyabean meal and fish meal than those reported by FAO (2014). It was observed that foreign fish meals from the three feed outlets had very low crude protein values than those previously reported (Atteh, 2002; Aduku, 2004 and FAO, 2014).

Table 2: Crude protein of protein feed ingredients from outlets in Owerri (%)

Protein feed ingredients	**Feed ingredient outlets surveyed in Owerri**			**SEM**
	Fidelity	**Elvon**	**Ceekings**	
Soya bean meal	46.72^{a}	40.13^{b}	47.55^{a}	0.349
Full fat soya bean	41.18	41.54	40.88	0.194^{ns}
Groundnut cake	49.48	49.36	49.58	0.241^{ns}
Fish meal (Foreign)	25.66^{a}	20.27^{b}	25.54^{a}	0.130
Fish meal (Local)	40.9	41.04	40.78	0.173^{ns}

^{ab}Means in a row without a common superscript differ significantly (P<0.05).

CONCLUSION

Variation in bulk density and crude protein composition of same ingredient even among the feed outlets is indicative of the need to possible effect of processing and handling. It is recommended therefore, that physical characteristics (bulk density) of protein feed ingredients should be considered alongside the proximate composition (crude protein) in evaluating feed ingredients for poultry feeding.

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PREDICTION OF JAPANESE QUAIL EGG WEIGHT USING EGG COMPONENTS AS REGRESSORS

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ABSTRACT

This study was conducted on one hundred freshly laid eggs from Japanese quails with the purpose of predicting quail egg weight (EW) from some internal and external egg components, and also to have accurate and reliable models, for the prediction of egg weight without the use of sensitive scale. The following external (egg weight, egg width, egg length, shell thickness) and internal (yolk width, yolk length, albumen height and Haugh unit) components were measured and the level of relationships between them were determined. Level of affinity between egg components measured ranged from 0.054(Haugh unit vs. shell thickness) to 0.559 (Haugh unit vs. albumen height). Descriptive statistics for the eight egg components considered were computed. Intercept and slope of regression between variables were determined. Generated values were used in multiple, double and simple linear regression equations, respectively. A total of ten prediction equations comprising three multiple, six double and nine simple linear resulted from the data generated. All the equations developed can be used in egg type quail operations. Each prediction equation with egg weight as the dependent variable will assist poultry breeders and farmers in particular in determining the precise egg weight of eggs laid by birds on the farm.

Key words: Prediction, dependent variable, egg components, models, Japanese quail

Introduction

Egg is a major poultry product and mainly composed of albumen, yolk and egg shells (Abanikannda and Leigh, 2007). Compared to other sources of animal protein, egg is more affordable by the common man which gives poultry more advantage over other livestock. The eggs are cheap and readily available sources of protein in developing countries cannot be overemphasized and the contribution of major constituents of egg i.e. albumen and yolk to dietary intakes of humans have been well documented (Orji *et al*., 1998; Khurshid *et al*., 2005). Although chicken eggs are currently most commonly eaten by humans, the eggs from other birds are also used for daily consumption. For example Japanese quail eggs are gaining popularity in Europe and America, ostrich eggs in South Africa (Horbañczuk *et al.,* 2008). Quail eggs are the eggs laid by various species of quail, which are in the order *Galliformes*. Quail are mid-sized birds found in Europe, North Africa, the southern United States and some parts of Asia. (Horbañczuk *et al.,* 2008). Quail eggs are much smaller than average duck chicken egg, widely consumed and sold as novelty foods around the world and they range from white to brown in colour and mottled (black and brown spots). The weight of an egg is a direct proportion of albumen, yolk and shell it contains (Pandey *et al.,* 1986). Egg weight is an important egg trait, which influences egg quality as well as grading (Farooq *et al.,* 2001). In the egg processing enterprises, the weight of eggshell, albumen and the yolk that form the egg affect the amount and price of the product (Altan *et al.,1998*). In the context of egg production, the quality of an egg, which is not only known as the basic product in poultry activities by breeders, but also provided cheaply to consumers, is dependent on internal (albumen weight and yolk weight) and external (shell weight) quality traits. The use of prediction equations had been used by some researchers in poultry breeding, Abanikannda *et al*., (2007); Galal (2007); Raji *et al*., (2008) and Olowofeso (2009) carried out the development of some prediction equations which are useable in poultry production. Egg weight was easily predictable from egg length and width as positive association among these traits existed (Farooq *et al.,* 2001). This provides an indication for prediction of egg weight from both external (Egg width, egg

length, shell thickness) and internal (yolk width, yolk height, albumen height and haugh unit) egg components. Prediction of egg weight based on the level of relationship between both external and internal components means there is a need to compute correlation and regression estimates between these components.

Forecasting of egg weight without recourse to sensitive electronic scale has been a serious problem in egg production enterprise. The high cost of sensitive electronic scale has made it imperative to develop very simple and reliable mathematical relations for the prediction of egg weight based on the level of relationship between external and internal egg components (Olowofeso *et al.,* 2013).

Therefore, the objectives of this study were to estimate the relationship between internal and external components of quail eggs and to develop some reliable prediction equations to estimate Japanese quail's egg weight using both external and internal components.

Materials and methods

This study was carried out at the Quail unit, Obafemi Awolowo University Teaching and Research Farm, Ile-Ife, Osun state, Nigeria which lies between latitude $7^0 27' 59.99'' N$ and longitude $4^0 33' 59.99'' E$ (Androni TS GPS). 400 day old chicks were gotten from National Veterinary Research Institute Substation, Irewolede Local Government, Ikire and were taken to the Teaching and Research farm, where they were brooded from day old till 4 weeks of age. The quails were raised under favourable environmental condition and were fed *ad libitum* with quail's diet containing 24% protein and 2850 kcal ME/kg energy in the first 4 weeks period and later 20% protein and 2800 kcal ME/kg energy. These birds started laying at the age of 5 weeks. One hundred freshly laid quail eggs used for this study were collected in the morning from the Quail unit of the Teaching and Research Farm, which were obtained from one hundred and ninety female quails at 9 weeks of age. These freshly laid eggs were washed with clean water and dried with towel to remove dirts and contaminants from the shell. They were arranged on plastic egg trays, placed under fans to blow away tiny particle(s) which might be attached to the eggshell.

Data Collection

Data were collected on egg weight , egg length, egg width, albumen height, yolk height, yolk width, shell thickness and haugh unit to determine the relationship between the internal and external components and to develop prediction equations to estimate egg weight using both components.

Statistical Analysis

Correlation coefficient (R^2) and regression coefficient (b) between variables were estimated with SAS software (2002). Similarly, the prediction equations were developed using the linear function earlier defined by Glover and Mitchell (2001) and depicted as: $Y= (y- bx) + bX \Rightarrow Y= y + b(X-x)$

Where X and Y represent the independent and dependent variables respectively. When the values of these parameters were incorporated into the linear function defined above, a total of fifteen prediction equations were generated. Haugh unit (HU) was computed using: $HU= 100 \log (H+7.57- 1.7W^{0.37})$.

Results and Discussions

Descriptive statistics for the egg components measured is shown on table 1. The mean weight of quail egg (9.13g) in this study was lower than 11.28, 11.4, 10.2, and 10.34g reported by kul and seker (2004) and Dudusola (2010) and higher than 7.041g reported by Mudhar (2011). Mean egg weight, egg length, egg width, albumen height, , yolk height, yolk weight, shell thickness and Haugh unit were 9.13g, 2.97, 2.33, 0.57, 1.14, 2.18cm, 0.13mm and 100.57 respectively.

Table 1: Internal and external components of Japanese quail eggs

Parameters	Mean±SEM
Egg weight	9.13±0.06

Egg length	2.97±0.01
Egg width	2.33±0.05
Albumen height	0.57±0.09
Shell thickness	0.13±0.03
Yolk height	1.14±0.08
Yolk width	2.18±0.01
Haugh unit	100.57±0.01

SEM= Standard error of the mean

The level of affinity between egg components considered is shown on table 2. Egg weight correlate positively and significantly with egg width, egg length, yolk height and yolk width which implies that as each of these components increases, egg weight also increases. The correlation between Egg Weight and Egg Length (0.813), Egg Width and Egg Length (0.469) and Egg Weight and Egg Length (0.785) in this study were similar to Kul and Seker (2004) who reported correlation of 0.80, 0.76 and 0.35 respectively. The correlation between egg width and haugh unit was significant but negative. Egg width correlate significantly and positively with egg length but negatively with haugh unit. This means as egg length increases, egg width and haugh unit increase but egg width decreases. There was a positive correlation between egg length and yolk height and also with yolk width which was significant. The negative correlation between shell thickness and yolk width was significant. The correlation between albumen height and haugh unit was positive and significant and the correlation coefficient between these components for Japanese quail egg obtained in this study was not significantly different from the value reported for these variables for chicken by Olowofeso *et al*., (2013). Lastly, there was negative correlation between yolk width and haugh unit which was significant which implies that as haugh unit increases, the yolk width also decreases.

Table 2: Levels of affinity between all egg components

Traits	EW	EWD	EL	ST	YH	AH	YW	HU
EW		0.81*	0.79*	0.00007	0.25**	0.25**	0.49*	-0.67*
EWD			0.47*	-0.067	0.12	0.24	0.49*	-0.51*
EL				-0.004	0.29*	0.17	0.46	-0.54
ST					-0.08	-0.07	-0.20**	-0.05
YH						0.16	0.09	-0.097
AH							0.13	0.56
YW								-0.32*
HU								

*= Significant at p< 0.0001, **= Significant at p< 0.05; EW- Egg weight, EWD- Egg width, EL- Egg length, ST- Shell thickness, YH- Yolk height, AH- Albumen height, YW- Yolk width, HU- Haugh unit.

Ten prediction equations developed based on the data generated in this study are shown on table 3. The equations were ranked based on Akiake Information Criterion (AIC) and Cp statistics which are used for selecting the most appropriate models that best predict the egg weight. Thirty nine prediction equations were initially generated of which the best ten were selected using AIC. It was reported in the literature that these generated equations are of immense importance to poultry farmers especially those with interest in egg production (Olowofeso *et al*., 2013). The ten prediction equations for estimating quail's egg weight from egg components can be used by poultry breeders and farmers alike, however, use of single trait in *in vivo* prediction is usually imprecise and produces lower coefficient of determination (R^2) according to Wawro (1990) and Raji *et al.,* (2008), respectively. Based on the above assertion, multiple

regression equations may be used in predicting desired variable(s) at a particular instance in an egg type quail operation.

Table 3: Ten prediction equations developed for estimating Japanese quail's egg weight

Variable	Prediction equations for quail egg weight	Rank
$Y_{EW(EL,AH,ST,YH,YW)}$	-6.06+4.12EL+0.73AH+1.03ST+0.26YH+0.98YW	I
$Y_{EW(EL,AH,YH,STYW)}$	-5.91+4.18EL+0.76AH+0.96ST+0.96YW	II
$Y_{EW(EL,AH,YH,YW)}$	-5.84+4.16EL+0.72AH+0.22YH+0.91YW	III
$Y_{EW(EL,AH,YW)}$	-5.72+ 4.21EL+0.74AH+0.90YW	IV
$Y_{EW(EL,ST,YH,YW)}$	-6.03+4.19EL+0.92ST+0.36YH+1.01YW	V
$Y_{EW(EL,YH,YW)}$	-5.83+4.23EL+0.32TH+0.95YW	VI
$Y_{EW(EL,ST,YW)}$	-5.81+ 4.27EL+0.83ST+0.99YW	VII
$Y_{EW(EL,YW)}$	-5.66 +4.30EL+0.93YW	VIII
$Y_{EW(EL,AH,ST,YH)}$	-5.16+4.59EL+0.78AH+0.28ST+0.17YH	IX
$Y_{EW(EL,AH,ST,YH)}$	-5.80+4.63EL+1.37AH-0.65ST+0.13YH	X

EW- egg weight, EL- egg length, AH- albumen height, ST- shell thickness, YH- yolk height, YW- yolk width.

Conclusion and recommendation

It can be concluded from the study that the correlation between egg weight and egg width, egg weight and egg length were higher compared to others, meaning that they contributed more to the egg weight. Also, a total of ten prediction equations were developed for the estimation of quail's egg weight in this study, the first three multiple regression equations are of outmost importance in predicting the quail's egg weight at all times. Other equations developed, that is equations IV through X can also be used in the absence of sensitive electronic scale for egg weight determination.

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Phenotypic characterization of dactyl thoracic index of Nigerian indigenous sheep population

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Abstract

The study was conducted to evaluate phenotypic characterization of dactyl thoracic index of Nigerian indigenous sheep population. Four hundred indigenous sheep (of average age between 18- 24 months) were sampled in major small ruminant markets, with one hundred sheep from each of the four predominant breeds in Nigeria (Balami, Yankasa, Ouda, and WAD). Data were collected on body measurements of the sheep which were used to estimate the dactyl thoracic Index (DTI) of the sheep. The data were subjected to Univariate analyses using SAS (2004). Result revealed mean values which ranged between 1.05 ± 0.10 (dactyl thoracic index) and 78.23 ± 2.49cm (chest circumference). Result also revealed a relative high variability (coefficient of variation) with highest coefficient of variation obtained for rump width (29.80%) and the lowest was recorded for dactyl thoracic index (9.85%). There were significant effects (p<0.05) of breed on morphological traits of the sheep. However, the DTI was not significantly affected (p>0.05) by breeds of the sheep. Result revealed significant differences (p<0.05) between sex in all the variables, ram had higher values in all these variables. However, there was no significant effect of sex on DTI of these sheep population. Based on the result of the study, it is concluded that Nigerian indigenous sheep breeds are light meat type.

Keywords: Breeds, dactyl thoracic index, morphology, traits, variability

Introduction

Sheep have important social, cultural and structural roles in local communities particularly in developing countries. Indigenous sheep and goat contribute over 98% of the total small ruminant population in Africa (FAOSTAT, 2011). Sheep serve as on hand assets and are closely linked to the social and cultural life of resource poor family. The highest sheep population in Nigeria was recorded in the northwest zones where Kano was the highest population of about 2.6million heads and Zamfara recording the lowest population of about 857000 heads. The southwest zone had about 1.1million heads of sheep with Edo having the highest population 668410 heads (FMARI, 2002). Gefu *et al.,* (1994) in a survey of old Anambra state found that mean flock size was 2.4 million for sheep. Nigeria sheep population comprises of large breed of flocks managed extensively under harsh environment and traditional conditions with large variation in (Greoneveld *et al.,* 2010).

There are generally considered to be four breeds or races of sheep native to Nigeria viz: Balami, Uda, Yankasa and West African Dwarf (Ngere *et al*., 1979). Balami is the most predominant in the North eastern part of Nigeria. It is predominantly white and hairy breed with a pronounced convex heat and dull depression. Uda breeds occur throughout the Sahel Sudan vegetation zone of Nigeria. The coat colour is extremely brown or black from forehead anterior to the limber abdominal girth and white posterior. Yankasa breed is widely distributed in the Northern part of Nigeria. In size, it is the intermediate between Uda and the West African dwarf sheep. The coat colour of Yankasa is typically white with black patches around the eyes, ears, muzzle and sometimes feet. The West African dwarf is widely distributed in the south Nigeria, the is small compact hardy sheep with a wide range of coat colour which maybe white, black or brown or spotted black or brown or white coat. The breed is considered to be tolerant to trypanosomiasis (Adu and Ngere 1979).

One of the difficulties in conserving a genetic resource is the lack of its characterization and knowledge of the best production system for raising it (Edilberto *et al*., 2011). Phenotypic characterization of

livestock generally refers to the process of identifying distinct breed populations and describing their external and production characteristics within a given production environment (FAO, 2012). The phenotypic variation in a population arises due to genotypic and environmental effects, and the magnitude of phenotypic variability differs under different environmental conditions. Morphometric characters are continuous characters describing body shape (Cervantes *et al*., 2009). According to Solomon *et al*. (2007) morphological description is an essential component of breed characterization that can be used to physically identify, describe, and recognize a breed, and also to classify livestock breeds into broad categories. Thus, this study sought to evaluate the phenotypic characterization of dactyl thoracic index of Nigerian indigenous sheep population

Materials and Methods

The study was conducted in Ibadan, the capital city of Oyo State, Southwest Nigeria. For this study, four hundred indigenous sheep (of average age between 18- 24 months to ascertain sampling of animals that are well and fully grown and developed) were sampled in major small ruminant markets, with one hundred sheep from each of the four predominant breeds in Nigeria (Balami, Yankasa, Ouda, and WAD). Data were collected on body measurements of the sheep using flexible measuring tape following the standard procedure as described by FAO (2012). Traits measured were withers height, body length, rump height, rump width, chest circumference, chest depth, heart girth, hip width, chest width. These traits were used to estimate the dactyl thoracic Index (DTI) according to Alderson (1999). The DTI is thus estimated as: DTI = Chest circumference / Heart girth. Data were subjected to Univariate analyses using UNIVARIATE and FREQ of SAS (2004).

Results and Discussion

Result of summary statistics of morphology and dactyl thoracic index of Nigerian indigenous sheep population is presented in Table 1. Result revealed mean values which ranged between 1.05 ± 0.10 (dactyl thoracic index) and 78.23 ± 2.49cm (chest circumference). Result also revealed a relative high variability (coefficient of variation) with highest coefficient of variation obtained for rump width (29.80%) and the lowest was recorded for dactyl thoracic index (9.85%). Low values obtained for coefficient of variation for the result is an indication of good accuracy of the test low error in the results as reported by Acourene *et al*., (2001) that the smaller the coefficient of variation, the better the accuracy of the test and the smaller is the errors of the results. Low coefficient of variation had been reported in earlier studies on goat (Popoola *et al*., 2018), sheep (Popoola and Oseni, 2018).

Table 1: Descriptive statistics of morphological traits of the indigenous sheep breeds

Variables (cm)	Mean	Standard deviation	Coefficient of variation
Wither height	72.42	9.29	12.83
Chest circumference	78.23	12.49	15.97
Heart girth	74.81	9.90	13.24
Body length	62.53	8.88	14.21
Rump height	73.86	10.05	13.61
Rump width	22.13	6.59	29,80
Chest depth	20.05	5.88	29.31
Hip width	33.94	6.37	18.77
Chest width	75.37	11.98	15.89
Dactyl thoracic index	10.50	0.10	9.85

Table 2 shows the effect of breeds on the morphological traits and DTI of the sheep. There were significant effects ($p<0.05$) of breed on morphological traits of the sheep. Uda had highest values of

wither height, chest circumference, heart girth, body length, rump height, chest depth; highest value of rump width was recorded in Balami. However, the DTI was not significantly affected ($p>0.05$) by breeds of the sheep. Edilberto *et al.*, (2010) reported that DTI may not be more than 10.5 in light animals, up to 11.0 in light meat animal and up to 11.5 in heavy meat type. Results of DTI for Nigerian indigenous sheep (10.40-10.60) indicated that Nigerian sheep breeds are light meat type.

Table 2: Effects of breeds on morphological traits and dactyl thoracic index of indigenous sheep population.

Variables (cm)	Balami	Uda	WAD	Yankasa	SEM (±)
Wither height	73.78[b]	77.92[a]	66.77[c]	68.93[c]	0.41
Chest circumference	79.63[b]	84.41[a]	73.41[c]	73.92[c]	0.55
Heart girth	76.00[b]	80.04[a]	70.71[c]	71.19[c]	0.44
Body length	64.18[a]	64.91[a]	60.31[b]	60.38[b]	0.39
Rump height	75.50[b]	79.58[a]	67.05[d]	70.40[c]	0.44
Rump width	22.70[b]	25.09[a]	19.46[c]	20.23[c]	0.29
Chest depth	21.08[a]	22.11[a]	18.38[b]	18.34[b]	0.26
Hip width	34.04[b]	36.80[a]	32.33[c]	32.07[c]	0.28
Chest width	76.08[b]	81.93[a]	70.88[c]	71.05[c]	0.53
Dactyl thoracic index	10.50	10.60	10.40	10.40	0.11

Table 3 shows the effects of sex on morphological traits and DTI of Nigerian indigenous sheep population. Result revealed significant differences ($p<0.05$) between sex in wither height, chest circumference, heart girth, body length, rump height, rump width, chest depth, hip width, chest width. Ram had higher values in all these variables. However, there was no significant ($p>0.05$) effect of sex on DTI of these sheep population. The result of dactyl thoracic index of both sexes indicate that both ram and ewe are light meat type.

Table 3. Effect of sex on morphological traits and dactyl thoracic index of indigenous sheep population

Variables (cm)	Ewe	Ram	SEM (±)
Wither height	67.82[b]	74.17[a]	0.41
Chest circumference	74.12[b]	79.80[a]	0.55
Heart girth	71.60[b]	76.03[a]	0.44
Body length	60.03[b]	63.48[a]	039
Rump height	69.45[b]	75.53[a]	0.44
Rump width	20.64[b]	22.69[a]	0.29
Chest depth	18.44[b]	20.66[a]	0.26
Hip width	31.61[b]	34.83[a]	0.28
Chest width	69.93[b]	77.44[a]	0.53
Dactyl thoracic index	10.40	10.50	0.10

Conclusion

Based on the result of the study, it is concluded that there were significant effects of breeds on morphological traits of Nigerian indigenous sheep. The DTI of the sheep was not affected by breeds of the animals and Nigerian indigenous sheep breeds are light meat type.

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HYGIENIC FACTORS THAT INFLUENCE MEAT QUALITY; A REVIEW

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ABSTRACT

Animal-source foods are choice foods worldwide as they are relished for their tastes, aroma, texture and nutritional values in both human and animal diet. Livestock systems occupy about 30 per cent of the planet's ice-free terrestrial surface area. Animal source foods are rich in high quality protein and other bio-available micro-ingredients like iron, zinc and vitamins A and B12 that could be deficient in the diets of low-income and undernourished individuals. The amino acids in meat, milk and egg proteins are readily available and balanced to meet human requirements. They also contain lipids; hence contribute to dietary energy supply. Meat as an important source of protein in the diet of man cannot be overlooked. As a livestock product, the safety depends on the health of the animal and the factors affecting its production which include animal shed and environment, feeding and nutrition factors, slaughter house and slaughtering process with the equipment, water supply, etc. This paper discusses these factors from the perspective of hygiene and its safety for human consumption. It was concluded that ensuring on-farm health status of the animals is vital to the quality of their products entering the food chain.

INTRODUCTION

Livestock can be defined as farm animals such as cattle, sheep, goat and chicken that are kept on a farm as assets to a farmer with the aim of making profit or for domestic uses (Johannesen and Skonhoft, 2011). An animal product is any material derived from the body of an animal. Examples are flesh, blood, milk, eggs etc (Unklesbay, 1992). They are sources of animal protein for human nutrition. In general, hygiene according to the World Health Organization (WHO), "refers to conditions and practices that help to maintain health and prevent the spread of diseases (Buncic, 2006). Farm hygiene is the way of protecting the farm environment by preventing the introduction and spread of microbes and diseases which may adversely affect livestock.Optimising the health of animals increases productivity,and majorly protects human health by ensuring that food of animal origin are safe for consumption. Poor hygiene affects not only the farmer's productivity in terms of quantity and quality of product but it also negatively impacts the status of the country.Quality is expressed of as a degree of excellence; in terms of a product (farm product in this instance), it is referred to as a specification or set of specifications which are to be met, within given tolerance or limits, and which will make the product to be acceptable to the buyer at an economic cost to the producer (David, 2005).This write up thus reviews the hygienic factors that influence the quality of meat.

Keywords: animal products, meat, hygiene, quality

Meat and its Hygiene

Meat is defined as all parts of warm-blooded animals, in fresh or processed form, which are suitable for human consumption in the Regulation (EC) 853/2004. Usually, the muscles of healthy animals are essentially sterile at the point of slaughter (Krämer, 2002). However, during slaughtering and processing the meat surface is contaminated with a variety of microorganisms (Krämer, 2002; Olsson *et al*., 2003; Kleer, 2007). Meat hygiene programmes are primarily instituted to ensure that meat and meat products are "safe and wholesome". When meat is considered as spoiled, it is no longer acceptable for human consumption which is mainly attributed to sensory changes e.g. in colour, odour, flavour, aroma or texture (Mead, 2004; Singh and Anderson, 2004). Meat is among the most highly nutritious foods and a good source of protein, fat and minerals. It is also a highly perishable product because cooked and especially

raw meat is a good substrate for the growth and multiplication of harmful microorganisms. As a result, several diseases may be transmitted to humans through the consumption of infected meat or meat products.

Hygienic factors that influence the quality of meat

Building/ Facility (Housing)

Ideally the slaughterhouse should be located away from residential areas to prevent possible inconvenience to dwelling-places either by way of pollution from slaughter wastes or by way of nuisance from noise. There must be free access for animals to the site by road and the slaughterhouse should be situated in areas where flooding is unlikely to happen. The number of animals to be slaughtered should take into account the size of slaughter facility and the number of animals to be slaughtered is of great importance to avoid sanitary problems due to overcrowding. Materials that are absorbent and difficult to keep clean must not be used. Examples of unacceptable materials include wood, plasterboard and porous acoustic-type boards. Walls should be provided with suitable sanitary-type bumpers or sloped curbs to protect them from damage by hand trucks or lifters (Critical Design, Operational and Equipment Guidelines for Licensed Abattoirs, 2012).

Lairage is a place where livestock are kept temporarily (Critical Design, Operational and Equipment Guidelines for Licensed Abattoirs, 2012). This is a specific area inside the premises of a slaughter house where the animals are conveyed for rest. Rest is an important factor because when animals are stressed, carcasses of lower quality result from slaughter. There should be sufficient space for the animals and a good supply of potable water for drinking purposes.

Feeding and nutrition factors

Traditionally, feed is preferably withheld from ruminants immediately before and during periods of transporting to, and lairaging at, abattoir. However, water is offered to animals throughout the pre-slaughter period. The reasons for feed withdrawal include difficulties which overfilled guts would cause during dressing (evisceration) of slaughtered animals, as well as economic aspects (Gracey, *et al.*, 1999). Generally, the two main foodborne pathogens associated with beef, *Salmonella* and verocytotoxic*E. coli*, do not proliferate in the rumen environment, except under conditions of extended starvation, which leads to a reduction of the volatile fatty acids concentration (Rasmussen, *et al.*, 1993). The higher occurrence or levels of pathogens in rumen can increase their occurrence or levels in faeces, which increases microbial beef safety risks associated with those animals. On the other hand, it could be expected that some feeds (e.g. silage) increasing physical spread ability of the faecal excreta in the environment also could enhance spread of microbial hazards both on-farm and during transport-lairaging.

Animal cleanliness

Microorganisms including foodborne pathogens present in cattle faeces are frequently transferred, through direct or indirect routes to the hide, which is now recognised as the major source of microbial contamination with these organisms. Total viable counts of bacteria, occurrences of inoculated marker *E. coli* (Collis, *et al.*, 2004),and prevalence of *E. coli* O157 (Elder, *et al.*, 2000) on beef carcasses, all can be significantly affected by, and even correlated with those present on respective hides. Also, it has been demonstrated that degree of visual coat soiling has a significant effect on the contamination level of the finished carcass (Byrne, *et al.*, 2000; Hadley,*et al.*, 1997).

Hygienic status of cattle hides significantly depends on maintenance of clean stables, and is also influenced by type of their diet. It has been widely accepted that animal cleanliness is crucial to avoid the introduction of potentially pathogenic microorganisms in the beef processing line, so it is necessary to ensure that only clean cows are presented for slaughter (Bolton,*et al.*, 1998).

Water supply

Water is a vehicle for the transmission of several agents of disease and continues to cause significant outbreaks of disease in developed and developing countries (Kirby *et al*., 2003), several instances were purported to have been affiliated with poor quality water. Since slaughtering is a process which generates a lot of wastes, to cater for the good running of the processes and minimize contamination, there should be a good supply of water of drinking quality to allow processing and cleaning procedures which will

ensure hygienic quality products. Working routines should be planned in such a way as to economically use the consumption of water because of waste water disposal (Kirby *et al.,* 2003). It is also important to ensure that water storage vessels are properly covered, and cleaned regularly to maintain the water in a potable state.

Sanitation in the slaughter house

Sanitation may be defined as the process involved in the ensuring of good health by means of preventing human contact with the hazards of wastes. Such hazards can be physical, microbiological, biological or chemical agents of disease (Hui *et al., 2003*). The major goal for the food processing industries is to provide safe, wholesome and acceptable food to the consumer and control of microorganisms is essential to meet this objective (Baggen*et al*., 2003). In line with this, a slaughterhouse should be designed to ensure the flow of operations from the live animal holding area through to discharge areas. Meat products should, therefore, proceed progressively through cleaner areas of the operation, without backtracking to areas where the product was previously handled. Edible and inedible areas must be physically and operationally separate. Sources of meat contamination during slaughter may be classified as those associated with the animal, processing practices, abattoir facilities and employees.

Equipment

Equipment for undergoing slaughtering process, have to follow certain norms and regulations, it has been reported that such equipment have to be of non-corrosive materials, for example stainless steel. Structures like tables, hooks and machines should be positioned such that, they will be easy to relocate to facilitate cleaning and disinfection.

Slaughtering Processing

The hallmark for hygiene principle in processing is that the procedures considered as clean and unclean should be efficiently separated. This requires a well-structured plant layout, where the purpose of any structure should be the protection of the end product against accidental contamination (CAC, 1997).

Personnel

The personal hygiene of the workers is a primordial factor in slaughtering operations. The reason is simply that, contamination of food and disease transmission, depend upon the human factor as well as on the tools and mode of operation. Transfer of microorganisms by personnel particularly from hands is of vital importance (Bloomfield, 2003). During handling, bacteria are transferred from contaminated hands of workers to the food and subsequently to other surfaces.It is important to limit access into the premises during the time of slaughter. All personnel that are allowed access should also be dressed in the appropriate personal protective clothing, e.g. clean trousers and wearing appropriate waterproof aprons. Boots should be worn with the trousers neatly folded inside. The hallmark is that the workers must strictly abide to a formal code of hygiene.

Conclusion

Good hygienic practices (GHP) including provision of optimal animal health status in form of housing, feeding, water supply etc enhance the animals' resistance to infections, productivity and reduces on-farm spread of food safety hazards, such as poor growth, diseases and unwholesome meat and meat products.

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GENETIC DIVERSITY OF MITOCHONDRIAL DNA (MTDNA) D-LOOP SEQUENCES IN SIX IMPROVED TROPICALLY ADAPTED CHICKEN BREEDS (iTABS)

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Abstract
Improved tropically adapted chicken breeds (iTABs) are characterized as dual purpose, low-input high-output birds suitable for smallholder poultry (SHP). A 592-bp of mitochondrial DNA (mtDNA) D-loop region of 77 iTABs from six populations was amplified to assess the genetic differentiation of six iTABs introduced to smallholder poultry farmers in Imo State, Nigeria by the African Chicken Genetic Gains (ACGG) project. The specific objectives were to determine the level of polymorphism among and within the breeds, origin, phylogenetic relationship and evolutionary distance between and among these breeds. The haplotype diversity and nucleotide diversity of the iTABs were 0.80±0.025 and 0.391±0.013, respectively. 14 haplotypes were identified from 62 polymorphic sites. These haplotypes clustered into three clades with 99.7 % of the total maternal genetic variations occurring within population. Sasso and Shika Brown had the least (0.385) genetic distance. The results indicate the existence of three distinct maternal lineages from Southeast Asia, Indian subcontinent and Southwest China evenly distributed among the iTABs. The high genetic diversity observed within population can be utilized for the long term genetic improvement and stabilization of the breeds.

Keywords: mtDNA, smallholder-poultry, Phylogenetics, Polymorphism.

Introduction

The improved tropically adapted chicken breeds (iTABs) are low-input high-output chickens suitable for smallholder poultry (SHP). The establishment of an effective long-term genetic improvement, multiplication and delivery system is essential for the adoption and continuous supply of the iTABs to SHP farmers. Understanding the genetic diversity and phylogenetic architecture of the iTABs using mitochondrial DNA (mtDNA) will contribute to the development of the long-term genetic improvement program. MtDNA is an extremely variable genome which has unique characteristics that make it an ideal genetic marker (Avise, 2004).Therefore, this study was conducted to determine the level of mitochondrial DNA polymorphism, and establish phylogenetic relationships among the iTABs introduced to SHP farmers in Imo State, Nigeria.

Materials and methods

A total of 77 blood samples were collected from six populations of iTABs (Noiler (No), FUNAAB Alpha (Fu), ShikaBrown (Sb), Kuroiler (Ku), Sasso (Sa) and Fulani (Fi)) from three African Chicken Genetic Gains (ACGG) project sites in Imo State, Nigeria. Genomic DNA was extracted using standard phenol-chloroform method.

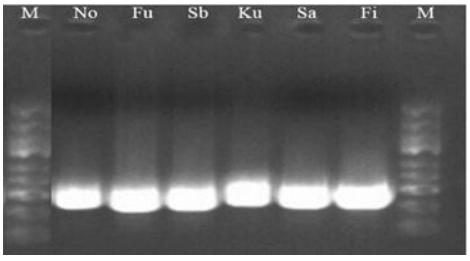

Figure 1**:** PCR Gel electrophoresis result of mtDNA D-loop region showing a 592-bp amplicon size for the iTABS: Noiler (No), FUNAAB Alpha (Fu), Shika Brown (Sb), Kuroiler (Ku), Sasso (Sa), and Fulani (Fi), M= 200-bp molecular –weight size marker.

PCR reactions were conducted at 96℃ for 15 mins, followed by 35 cycles consisting of 30 sec denaturation at 95℃, 30 sec annealing at 56℃ and 30 mins extension at 70℃, with final extension at 70℃ for 5 mins using a Gene Amp PCR System 9700 (USA). The PCR products were electrophoresed (120 V, 20 min) on 1.5% agarose gels, and purified before sequencing. A 592-bp of the mtDNA D-loop region was amplified, and sequenced (3730XL DNA Analyzer sequencer, Applied Biosystems) using primers from Mobegi *et al*. (2005): L16750 (5'-AGGACTACGGCTTGAAAAGC-3', accession No.: NC_001323, Desjardins and Morais, 1990) as the forward primers and H547 (5'-ATGTGCCTGACCGAGGAACCAG-3', Accession No.: AB098668, Komiyama *et al*., 2003) as the reverse primer.

Genetic analysis: A 315-bp sequence fragment was subsequently analysed. FinchTV version 1.4.0 (www.geospiza.com/finchtv) was used to assemble, view and edit the sequences. The MEGA 7.0 (Tamura *et al*., 2015) was used to align the D-loop sequence to the *Gallus gallus* RefSeq (Accession No:KX987152.1), following 1000 bootstrap replicates, a maximum Likelihood (ML) tree was generated. 3 D-loop sequences of *Galliformes*; *Meleagris gallopavo*, *Cortunix japonica* and *Anas platyrhynchos* (Accession No: EF153719, AP003195 and MF069250, respectively), were the out-groups. Eight RefSeq of *Gallus sp.* and two sub-species from the most common haplotypes of different clades found in Asian domestic chickens were included in the analysis. Genetic distances and diversities were analysed using Mega 7.0 and DnaSP 6.11.01 (Librado *et al*., 2017).

Results and Discussion

The 77 sequences from 6 iTABs populations generated 14 haplotypes from 62 polymorphic sites (Figure 2). All variable sites were due to substitution mutations, and 94.6% of these mutations were transitions.

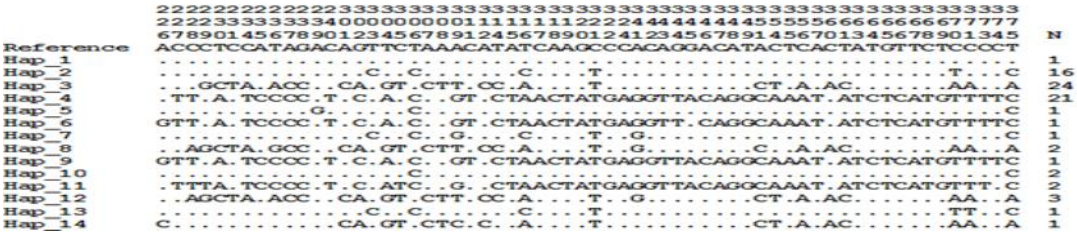

Figure 2**:** Nucleotide polymorphism and their frequencies (N) based on the haplotypes. Vertically oriented numbers indicate the RefSeq position, dots (.) indicate identity with the RefSeq, Hap 1-14are haplotype numbers.

Results in Table 1 showed that the highest (H=10) and the lowest (H=5) number of haplotypes were found within FUNAAB Alpha, and ShikaBrown/Noiler, respectively. The haplotype diversity (Hd) and nucleotide diversity (Pi) within population ranged from 0.731 (Sasso) - 0.970 (FUNAAB Alpha), and 0.383 (Sasso) – 0.471 (FUNAAB Alpha), respectively while the Hd and Pi among population were 0.796±0.025 and 0.386±0.013, respectively.

Table 1: Genetic diversity indices of iTABs in Imo State

	Among pop.	Within pop.					
Diversity indices		No	Fu	Sb	Ku	Sa	Fi
Number of sequences	77	12	12	14	13	13	13

Number of sites	618	618	618	618	618	618	618
Polymorphic sites	62	180	188	184	174	189	183
Number of Haplotype	14	5	10	5	6	7	8
Haplotype diversity	0.80	0.82	0.97	0.81	0.85	0.73	0.90
	(0.025)	(0.025)	(0.070)	(0.0454)	(0.065)	(0.113)	(0.067)
Nucleotide diversity	0.39	0.46	0.47	0.43	0.45	0.38	0.44
	(0.013)	(0.045)	(0.045)	(0.053)	(0.040)	(0.070)	(0.045)
Sequence conservation	0.22	0.23	0.23	0.21	0.23	0.29	0.24
	(22.3%)	(23.3%)	(23.1%)	(20.8%)	(23.1%)	(29.9%)	(23.8%)

Pop=Populations, No=Noiler, Fu=FUNAAB Alpha, Sb=ShikaBrown, Ku=Kuroiler, Sa=Sasso, Fi=Fulani, Number in parenthesis () are standard error of the mean.

In this study, Hd were higher than the values previously reported for African chicken populations by Adebambo *et al*. (2010) (Nigeria: 0.421), and Nwacharo *et al.* (2011) (Ethiopia: 0.374, Sudan: 0.413, Uganda: 0.322). Among the populations under study, Sasso showed the highest sequence conservation (29.2%) whereas FUNAAB-Alpha and Kuroiler both had the lowest sequence conservation (23.1%). Diversity indices Table 1 further revealed high mtDNA polymorphism within populations and low among populations. Table 2 shows that the highest genetic distance (0.457) was between Sasso and FUNAAB Alpha, and lowest (0.385) between Sasso and ShikaBrown. It was observed that all the breeds shared a common ancestry, with Sasso and ShikaBrown being more closely related. Furthermore, Analysis of Molecular variance shows that 99.67% of the maternal genetic variation occurred within populations while the remaining variation (0.38%) was found among populations.

Table 2: Genetic distance of the six iTABs in Imo State

	No	Fu	Sb	Ku	Sa	Fi
No		0.014	0.015	0.014	0.015	0.015
Fu	0.426		0.015	0.014	0.015	0.015
Sb	0.443	0.444		0.015	0.013	0.014
Ku	0.425	0.426	0.430		0.015	0.015
Sa	0.456	0.457	0.385	0.439		0.015
Fi	0.447	0.449	0.422	0.446	0.405	

Below diagonal represents distance estimate (d); above diagonal represents Standard Error of Mean (SEM). Analysis was computed in Bootstrap model. (No=Noiler, Fu=FUNAAB Alpha, Sb=ShikaBrown, Ku=Kuroiler, Sa=Sasso and Fi=Fulani).

The phylogenetic analysis (Figure 3) grouped the iTABs into three main clades (clade II, III and IV) out of the seven clades identified in Asian domestic chicken (Bjornstad *et al*., 2003). Mobegi *et al*. (2006) observed that the majority of haplotypes in West African village chicken populations cluster in clade IV,

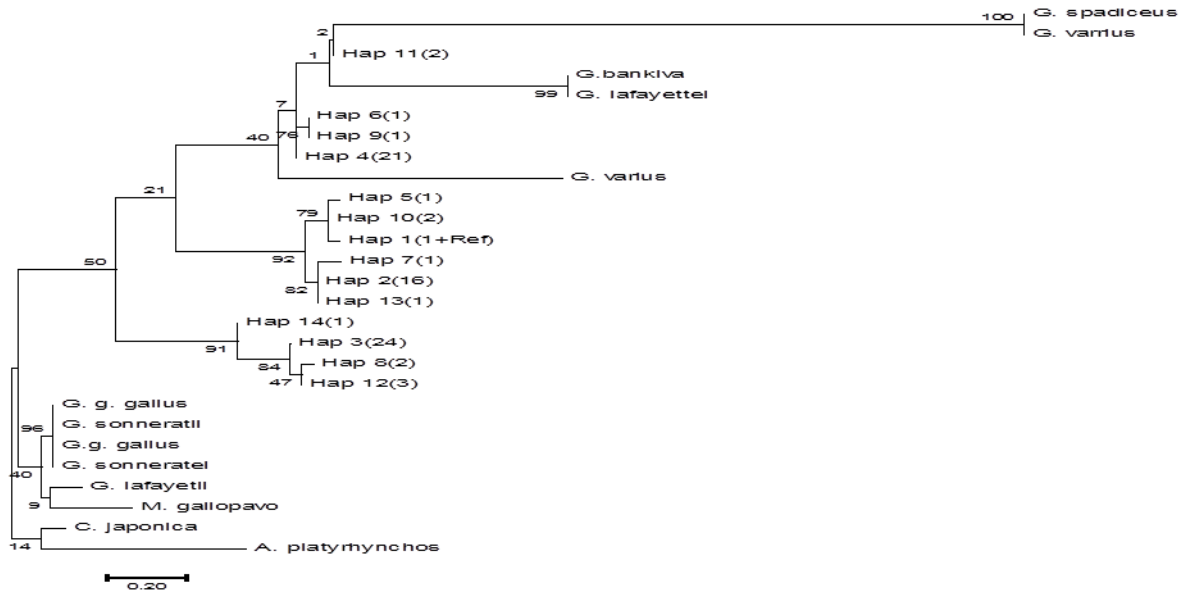

Figure 3.Phylogenetic relationship of the iTABS constructed using the haplotypes.

Muchadeyi *et al*. (2008) observed two distinct clades amongst both Zimbabwe and Malagasy chickens, while Adebambo *et al*. (2010) observed a single clade among Nigerian chicken populations, indicating a closer history of domestic chicken between West African village chicken and iTABs, but difference between Nigerian chicken and iTAB which suggests the absence of admixture. The phylogram revealed a shared ancient lineage between iTABs and the individuals of *Gallus species*. A recent common ancestor was observed between *G. varius* and iTABs haplotypes found in clade IV. Individuals in hap 11 (Sasso and FUNAAB Alpha) were found to have an intermixed lineage with *G. bankiva* and *G. lafayetii.* This distinct distribution patterns suggests that the divergent clades originated from divergent regions of Japan, Serbia and the Indian subcontinent, which supports the theory of multiple origins in South and Southeast Asia (Liu *et al.,* 2006; Kanginakudru *et al.,*2008).

Conclusion and Recommendation

The high genetic diversity within the population can be utilized for further genetic improvement of the breeds. This result can also guide in the conservation of the local germplasm, and evaluate the rate of admixture within the iTABs.

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THE NIGERIAN LOCAL CHICKEN HORMONAL FUNCTIONAL STATUS AS INFLUENCED BY AGE AND SEX FACTORS

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Abstract
A study was conducted to investigate the effect of age and sex on the hormonal status of the Nigerian Local Chicken raised in the Teaching and Research Farm of the Rivers State University Nkpolu-Oroworukwo, Port Harcourt. A total of forty (40) heterogeneous population of the Nigerian Local Chickens were used in a Completely Randomized Block Design (CRBD). Blood samples were collected from 10 males and 10 females from two different age groups (21 and 72 weeks). Hormonal assay was conducted to ascertain the values of some growth and reproductive hormones. These includes; thyroxin (T4), Triiodothyroxine (T3), Thyroid stimulating hormone (TSH). Prolactin (PRL), testosterone (TET), estrogen (E), luteinizing hormone (LH), follicle stimulating hormone (FSH) and progesterone (PROG). PRL, FSH, PROG and TET were significantly ($p<0.05$) affected by age while others were not significant ($p<0.05$). Prolactin had higher value for birds under the ages of 21 weeks than 72 weeks of age with a corresponding value of 28.35ng/ml and 8.64ng/ml respectively. Sex effect on hormones shown that, all hormones studied were significant except Tri-iodothyronine (T3). Testosterone as observed in this study was also influenced by age. Male birds unlike their female counterparts, 72 weeks of age recorded higher means value of 4.14 ± 0.52 than those of 21 weeks of age (1.11 ± 0.07). Therefore, the study was able to demonstrate the influence of age and sex on the status of hormones, particularly of those studied as present in the Nigerian Local Chicken investigated.
Keywords: Local chicken, age, sex, growth hormones, reproductive hormons

Introduction

Domestic fowl was found to have originated from the wild ancestor of jungle fowl *Gallus domesticus* from the Southeastern Asia around year (2000-3000 BC). During this period, four species of jungle fowl are found which includes red jungle fowl *(Gallus gallus),* Ceylonese Jungle fowl (*Gallus lafayetti*), gray jungle fowl (*Gallus sonnerati*) and the black or green jungle fowl (*Gallus varius*), and they are still in existence (Atteh, 2004). Adeleke *et al.,* 2011 reported that, the Nigerian local chicken is characterized phenotypically using their body structure (naked neck) plumage color (black, white etc.) and feathering pattern (normal, and frizzle feather). The Nigerian local chicken often possesses single comb and are usually self-reliant and capable of withstanding harsh environmental condition, minimal management and inadequate nutrition. They live largely on weed seeds, insects and feeds that would otherwise be a waste (Vetmeyer, 1991, Apuno and Ibrahim 2011). Also, the local male chicken (cockerels and cocks) are bigger in size than the hens (Ajayi and Agaviezor, 2009). The Nigerian local chicken is one of the major sources of protein to the Nigerian people even though it has been reported to be small in size and grows slowly but possesses good potential for egg and meat production (Omeje, 1983; 1985, Ogbonna *et al*., 2002). Sex, age, nutrition, housing, stress and other environmental factors have been identified as factors culpable of affect the hematological and biochemical parameter of animal (Balikei, 2007, Peters *et al.,*2011). However, the status of hormone and its effect and functionality on the performance and reproductive indices of the Nigerian local chicken in relationship with its exotic counterpart is still not detailed. Therefore, this study was aimed at investigating the hormonal status of the local chicken with a view of establishing its functionality with growth and reproduction.

Materials and Methods

This study was carried out at the Poultry Breeding Unit of Teaching and Research Farm of the Department of Animal Science. Rivers State University, Nkpolu-Oroworukwo, Port Harcourt. Port Harcourt lies between latitude 7°00" and 7°53"N and longitude of 4°35" and 4°51" (Uko and Tamunoberwton-Ari, 2013). A total of forty heterogeneous Nigerian local chickens were used for the experiment, comprising of ten male and ten female each from two different treatment age groups of twenty-one (21) weeks of age and seventy-two (72) weeks of age. The birds were raised in the Poultry Breeding Unit of the Department of Animal Science under intensive system were feeding rations were provided from commercial dealer and both the feed as well as water were given *ad libitum*. Blood samples were collected from 10 males and 10 females each from age groups of twenty-one (21) weeks and seventy-two (72) weeks of age. Blood collected was harvested into heparinized plastic tubes and the tubes were labeled accordingly. Hormones assay was done for thyroxin (T4), triiodothyroxine (T3), thyroid stimulating hormone (TSH), prolactin (PRL). Others include; testosterone (TET), estrogen (E), luteinizing hormone (LH), follicle stimulating hormone (FSH), progesterone (PROG). These were determined by enzyme immunoassay method, using commercial kits Stratus (DADE International Incorporation in immune fluorescence apparatus BAXTER STRATUS II). The experiment was a complete randomized block design (CRBD) in a 2x2 factorial arrangement. All data obtained were subjected to Analysis of variance (ANOVA), using the multivariate analysis in General Linear Models (GLM) of SPSS version 18. 2002

Results and Discussion

The hormone values of the Nigerian Local Chicken as affected by age are presents in Table 1. The result showed that tri-iodothyronine (T3), thyroxin (T4), thyroid stimulating hormone (TSH) were not statistically significantly ($p>0.05$). Among the hormones studied, only prolactin (PRL) and follicle stimulating hormone (FSH) that were statistically significant ($p<0.05$). It was noted that prolactin value was higher for birds under the ages of 21 weeks of age than 72 weeks of age birds with corresponding values of 28.35 and 8.64 respectively. Also, the same trend was noticed for FST, 21 weeks of age birds had higher values than 72 weeks of age birds, with corresponding values of 15.09 and 8.51 respectively. Results from this study replicate the possible impact of age as a factor on the survival and general performance of the Nigerian local chicken especially its reproductive capacities. This study confirms with earlier investigation by Hall *et al*. (1985) on the normal range of prolactin hormones (10-40ng/ml).

Table 1. Least square means ± SEM **for hormones as affected by Age in the Nigerian local Chicken**

PARAMETERS (nmol/l)	AGE		± SEM	SL
	21 weeks	72 weeks		
Tri-iodothyronine (T3)	0.56	0.64	0.04	NS
Thyroxin (T4)	1.11	1.15	0.02	NS
Thyroid Stimulating Hormone TSH)	18.08	16.13	2.62	NS
Prolactin (PRL)	28.35[a]	8.64[b]	6.38	*
Follicle Stimulating Hormone FSH)	15.09[a]	8.51[b]	0.97	***
Luteinizing Hormone (LH)	17.12	18.01	4.54	NS

Means in the row having different superscript are significantly different ($p<0.05$) NS = Non-significant**;** *P <0.05; *** P< 0.00

The hormone values of the Nigerian Local Chicken as affected by sex as presents in Table 2 revealed that, all hormones studied were significant ($p<0.05$) except for tri-iodothyronine (T3). From the means analyses table, thyroxin (T4) was observed to be significant ($p<0.05$) whereas prolactin (PRL) was highly significant ($p<0.01$). Very highly significant ($p<0.001$) was observed for thyroid stimulating hormone (TSH), follicle stimulating hormone (FSH) and luteinizing hormone. The result also recorded male birds having higher values than their female as showed in the table below. The categories of hormones studied (growth and reproductive hormones), male birds which were steadfastly noticed with higher values across

the hormones studied, speaks no doubt about the possibly gender factors attributed to governing differential physiological activities and status in higher animals. This result agreed with several authours reports on haematological indices and assay of the indigenous local chicken Chineke *et al.,* (2006), and Adass *et al.,* (2012). Kral and Suchy (2004), attributed male's higher values to gonadal and spermatogenetic development which occur during the period of sexual maturation and at the onset of reproductive activity in breeder cocks.

Table 2. Least square means for hormones as affected by Sex in the Nigerian local chicken associated by both male and female

Parameters	SEX		±SEM	SL
	MALE	FEMALE		
Tri-iodothyronine (T3)	0.65	0.542	0.04	NS
Thyroxin (T4)	1.17[a]	1.09[b]	0.02	*
Thyroid Stimulating Hormone (TSH)	25.3 [a]	8.89[b]	2.62	***
Prolactin (PRL)	30.48[a]	6.50[b]	6.38	**
Follicle Stimulating Hormone (FSH)	17.06[a]	6.55[b]	0.97	***
Luteinizing Hormone	32.82[a]	2.32[b]	4.54	***

Means in the column having different superscript are significantly different ($p<0.05$)
NS = Non-significant; *P <0.05; **P<0.01

The results of effect of age on the female sex hormone values of the Nigerian local chicken as presented on table 3. revealed that, progesterone was highly significant ($p<0.01$). Progesterone value was noted to be higher **(**0.34**)** in 21 weeks of age birds than those of 72 weeks of age (0.29). Estrogen, though the values were noted to be higher with birds of 72 weeks than those of 21 weeks of age but statistically not significant ($p>0.05$). The results of effect of age on the male sex hormone (testosterone) value of the Nigerian Local Chicken presented also in table 3. revealed that, testosterone was very highly significant ($p<0.001$). Male birds of 72 weeks recorded higher means value of 4.14 **±** 0.52 than those of 21 weeks of age (1.11 ± 0.07). The effects of age on female reproductive hormone (progesterone and oestrogen) has also established that, birds of the early age (21week of age) expresses greater values than those of 72 weeks of age for progesterone hormones in the Nigerian Local chickens as observed. The result was in tandem with other authors (Onagbesan *et al*., 1999; Onagbesan *et al*., 2006; Tonderai *et al.,* 2018). These authours noted that, birds that are attaining puberty and early stage of sexual maturity tend to have high reproductive hormones following the onset of follicular development and laying period, older bird on the other hand, hormone production decreases following reduced reproductive activities.

Table 3. Least square means ± SEM for Female hormones as affected by Age in the Nigerian indigenous chicken

Parameters	AGE		SL
	21 Weeks of age	72 weeks of age	
PROG	0.34 ± 0.01[a]	0.29 ± 0.01[b]	**
Estrogen	33.44 ± 4.30	49.86 ± 8.22	SN
Testosterone	1.11 ± 0. 07[b]	4.14 ± 0.52[a]	***

Means in the column having different superscript are significantly different ($p<0.05$)
NS = Non-significant; **P<0.01

Conclusion and Recommendations

From this investigation, it can be concluded that the production potential of domestic fowl is controlled by several parameters, including those related to their reproductive potential. Production of table and hatching eggs is crucial for poultry producers. The process in which egg number and egg components are formed, the rate of lay, egg fertility and hatchability are dependent on a multitude of synchronized

metabolic and physiological processes. The study therefore was able to demonstrate the influence of age and sex on the status of hormones particularly those studied in the Nigerian Local Chicken investigated. However, more hormonal research should be conducted in wider scope, probably in the molecular architectural levels.

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Principal Component Analysis of Morphological Characteristics of Indigenous Chickens in Borno State, Nigeria

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Abstract

Investigation on morphological characteristics of 198 normal feathered indigenous chickens of Central part of Borno State, North East Nigeria was carried out using Principal Component Analysis. Value for body weight (g), ornithological measurement (cm), wing span (cm), neck length (cm), back length (cm), keel length (cm), tail length (cm), thigh length (cm) and shank length (cm) were 1491.11, 60.80, 64.36, 13.39, 21.45, 11.99, 20.80, 13.10 and 9.34, respectively. Males were observed with higher values than the females. The first Principal Component (PC 1) accounted for the greatest percentage (46.67 %) and is a descriptor of body weight, ornithological traits and wing span; the second Component (PC 2) accounted for 17.35 % and is a descriptor of neck length, thigh length and shank length; the third Component (PC 3) accounted for 11.12 %, of the total variance and it described keel length.

Key words: Principal Component Analysis, indigenous chickens, morphological characteristics, body weight, ornithological measurement

Introduction

The indigenous chickens in Nigeria are good scavengers and foragers. They have good maternal qualities, harder when compared with exotic breeds and have high survival rate with minimal care and attention (Salako and Ige, 2006). To their credits as well, they are repositories of unique genes that could be used in other part of the world (Adebambo, 2004) thus, the need for their conservation. Morphometric measurements have been found useful in contrasting size and shape of animals (Mckracken *et al.,* 2000); Ajayi *et al.,* 2008). However, correlations between body dimensions may be different if the dimensions are treated as bivariates rather than multivariates. This could be traceable to the interrelatedness or lack of orthogonality of the explanatory variables. Multivariate analysis such as Principal Component Analysis would cater for this limitation (Yakubu *et al.,* 2009). Principal Component Analyses are a weighted linear combination of correlated variables, explaining a maximal amount of variance of the variables (Truxillo, 2003). This aids in data reduction, and breaks multicollinearity which may lead to a wrong inference in these variables. Despite the rich genetic nature of the indigenous chicken ecotypes, there is dearth of information on the description of their morphological traits in the North East, Nigeria using Principal Component Analysis. This study therefore aimed at investigating morphological characteristics of indigenous chickens in the Central part of Borno State, Nigeria using Principal Component Analysis.

Materials and Methods

Experimental site

Borno State lies between Latitudes 10^0-13^0 N and Longitudes 12^0 – 15^0 E. A greater part of the state lies on the Chad Formation. This State could be divided into broad relief regions; hilly/mountainous area of generally over 600 m above sea level, which cover the south and southeastern parts of the state; and plains of generally less than 600 m above sea level which dominate much of the central and northern parts of the State. The rainfall varies from 700 to 1000 mm in the southern part and 300 to 500 mm in the north (Ayuba *et al.,* 2003). Three seasons can be identified in the State: the cool dry (harmattan) season (October to March); the hot dry season (April - June); and rainy season (July - September). The hot season mean

temperatures ranging between 39^0 and 40^0 C. Droughts are endemic. Two vegetation zones identified are Sudan and Sahel savanna. Agriculture of both crops and animals is the mainstay of the economy (Mohammad and Ahmad, 2014).

Experimental birds and morphological measurements

198 (male = 107, female = 91) adult normal feathered indigenous chickens were collected from three Local Government Areas from the Central part of Borno State for the study. 71 chickens were collected from Jere, 60 from Maiduguri and 67 from Konduga Local Government Areas. Body Weight (BW) of the birds was determined using a measuring scale. Ornithological Measurements (OM) was measured from the tip of the beak to the end of the tail when the bird is laid down on its back. Wing Span (WS) is the distance between the ends of the longest primaries with wings stretched. Neck Length (NL) was taken as the distance between the nape and the insertion of the neck into the body. Back Length (BL) was taken as the length from the insertion of the neck in to the body to the saddle. Keel Length (KL) was the distance between both vertical of the sternum. Tail Length (TL) was measured from the tip of a central rectrix to the point where it emerges from the skin. Thigh Length (TL) is the length from the notch of the shin bone-femur joint, to shin bone tarsus joint. Shank Length (SL) was taken as the length from the notch of the shinbone-tersus joint until the other end.

Statistical analysis

Data on morphological characteristics were analyzed using Statistical Package for Social Sciences (SPSS) Version 20. The suitability of data for Principal Component Analysis (PCA) was tested using Bartlett's of sphericity and Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. Descriptive statistics of data was performed using the same software and PCA option of factor analysis was carried out. Factor loading was based on Eigen value of 1.00 and above, and the best descriptors were identified based on communality extraction factors closest to 1.00. The varimax option of orthogonal rotation was used in the rotation of the factor matrix.

Results and Discussion

The descriptive statistics of morphological characteristics of Borno State indigenous chickens was presented in Table 1. The mean value for body weight (g), ornithological measurement (cm), wing span (cm), neck length (cm), back length (cm), keel length (cm), tail length (cm), thigh length (cm) and shank length (cm) were 1491.11, 60.80, 64.36, 13.39, 21.45, 11.99, 20.80, 13.10 and 9.34, respectively. These values were higher in the males than females. The average body weight reported in this study (1491.1 g) is similar to 1.44±0.34 observed by Ige *et al.* (2012) in Frizzle feathered. However, the value is lower than 1.68±0.27 kg reported in Naked neck chicken (Ige *et al.,* 2012) and higher than 1.13 kg reported for normal feathered by Ikpeme *et al.* (2016). The ornithological measurement (60.80 cm) reported in this study is similar to 63.08±10 cm in Anak Titan (Ajayi *et al.,* 2012) and lower than body length of 54.3±0.046 obtained for normal feathered by Ajayi *et al.* (2012). The variations in values could not be unconnected with the variations in the climatic condition of the experimental environments.

Principal Component Analysis

The observed Bartlett's test (0.00) confirmed the suitability of the data for Principal Component Analysis. Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy observed (0.813) is higher than 0.60 considered adequate by Eydruran *et al.* (2010). The large communalities (0.631-0.856) are an indication that a large number of variance has been accounted for by the factor solution. A scree plot of Eigen values

Table 1: Descriptive statistics for morphological characteristics of indigenous chickens of Borno State

Trait	Mean	Standard Deviation	Male	Female
Body weight (g)	1491.11	284.165	1685.05	1263.08
Ornithological measurement (cm)	60.80	9.128	65.51	55.27
Wing span (cm)	64.36	8.59	68.53	59.45
Neck length (cm)	13.39	2.08	14.23	12.40
Back length (cm)	21.45	2.24	22.41	20.32
Keel lenth (cm)	11.99	1.71	12.34	11.59
Tail length (cm)	20.80	4.02	22.56	18.72
Thigh length (cm)	13.10	2.19	14.00	12.03
Shank length (cm)	9.34	1.62	10.05	8.51

against their Principal Components is shown in figure 1. Table 2 showed Rotated Component Matrix, Eigen values and percentage of variance. The Principal Components accounted for 75.14 %. The Principal Components had Eigen values of 4.20 (PC 1), 1.56 (PC 2) and 1.00 (PC 3) which accounted for 46.67 %, 17.35 % and 11.12 %, of the total variance, respectively. The three factors were characterized by high positive loadings. The first was on body weight (0.621), ornithological measurement (0.879), wing span (0.792), back length (0.797) and tail length (0.854). It is a descriptor of body weight, ornithological traits and wing span. The second was on neck (0.778), thigh (0.884) and shank lengths (0.629). Thus, it is a descriptor of neck, and leg traits. The third was on keel length (0.903), a descriptor of keel length.

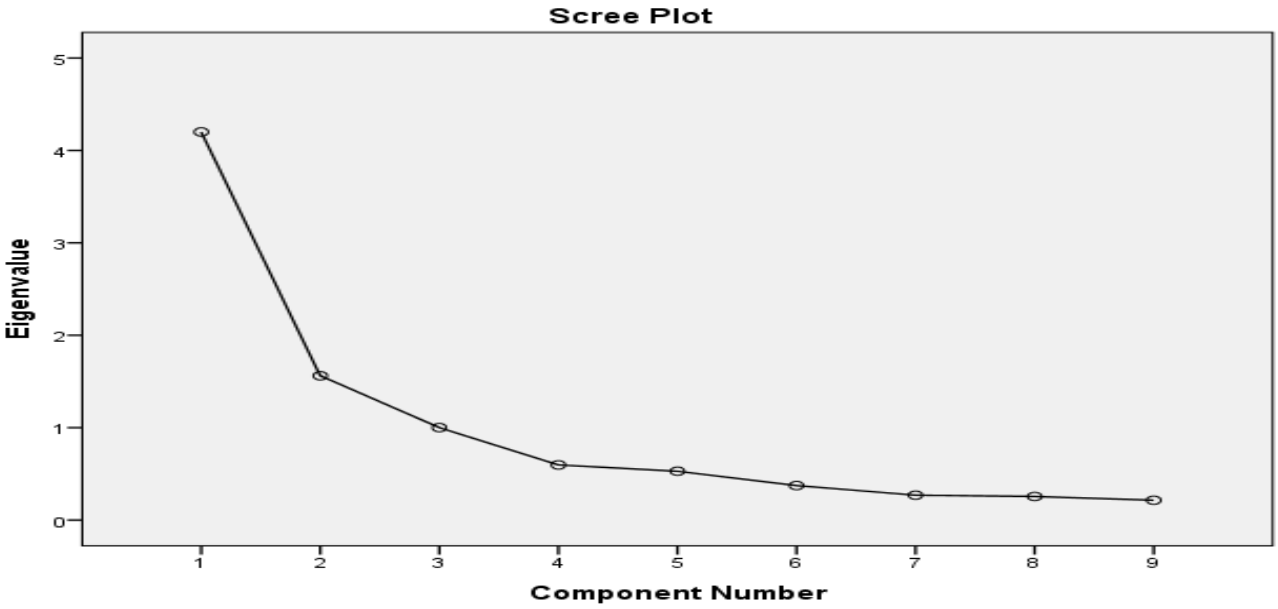

Figure 1

The first factor that accounted for the largest variance in this study maintains the usual trend in studies that used Principal Component Factor Analysis as reported by Yakubu *et al.*(2009) in chicken and Shahin and Hassan (2000) in rabbits. Ajayi *et al.*(2012) reported PC 1, PC 2 and PC 3 with high positive loadings, respectively for similar morphological traits in indigenous chickens as reported in this study.

Conclusion

The three principal components (PC 1, PC 2 and PC 3) obtained in this study could be useful in

Table 2: **Rotated Component Matrix, Eigen values and percentage of total variance of Borno State indigenous chickens**

	Component			
Trait	**1**	**2**	**3**	**Communality**
Body weight	0.621	0.585	0.110	0.740
Ornithological measurement	0.879	0.189	0.035	0.810
Wing span	0.792	0.223	0.244	0.736
Neck length	0.274	0.778	-0.233	0.735
Back length	0.797	0.050	0.233	0.691
Keel lenth	0.181	0.086	0.903	0.856
Tail length	0.854	0.043	-0.015	0.731
Thigh length	-0.067	0.884	0.214	0.832
Shank length	0.214	0.629	0.435	0.631
Eigen values	4.200	1.562	1.000	
% of Total variance	46.67	17.35	11.12	

evaluating these indigenous chickens for breeding and selection purposes. The selection of these chickens for Principal Components will not cause a correlated response in terms of other Principal Components since correlation between Principal Components is zero.

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POLYMORPHISM OF OVOCALYXIN-32 GENE AMONG SIX NIGERIAN CHICKEN POPULATIONS

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Abstract
Ovocalyxin-32 (OCX-32) is a matrix protein found within the outer layers of the eggshell. Numerous reports in the literature have identified association between variants in the gene encoding this protein OCX-32 and various eggshell quality traits. Thus, OCX-32 is a candidate gene for eggshell traits in commercial poultry populations. Sequencing of exon 1 and 2 of the OCX-32 gene in six Nigerian chicken populations revealed 2 SNPs. Two polymorphic sites (-162T and T229G) were identified in broiler (a commercial line) and Abuja populations respectively. However, SNPs T229G present in exon 2 caused an amino acid change indicating that the polymorphic sites identified in the ABJ population probably represent a small fraction of a more common polymorphic site found in the chicken populations. Commercial broiler had unique variants indicating that more polymorphic site could possibly be found in further study. High heterozygosity within a local Nigerian chicken and commercial broiler chicken indicates selection pressure for certain variants both in the natural environment and during the breeding program. The study also revealed absence of variants (low heterozygosity) within four Nigerian chicken populations and the presence of Hardy- Weinberg equilibrium. This indicates that the three Nigerian native chicken populations (Nsukka, Ogun and Abuja) had undergone little selection and random mating. However, broiler, layer and heavy ecotype could be limited in SNPs due to small sample size. The T229G polymorphism detected in Abuja chicken could be useful in genomic selection and expedite improvement of meat production and egg production traits in Nigerian native chickens.
Keywords: OCX 32, SNPs, Diversity, Chicken, Populations

INTRODUCTION

Egg quality remains an important requirement for today's market to guarantee the integrity of the egg and to reduce the numbers of eggs lost on the way to the consumer. Approximately 6 to 8% of the total egg production is not usable or marketable due to the poor quality of shells (Harms *et al.,* 1996). Major financial losses during routine handling and transport from producer to retail outlets have been recorded (Hunton, 1995). The shell is the most obvious structure related to the safety and integrity as well as the appearance of the egg and has been the focus of most attention for genetic selection. Indeed it is observed that when comparing across traditional and commercial breeds, eggshell traits have been maintained in comparison to other traits suggesting the breeding goals have been successful (Hocking *et al.,* 2003). Therefore, eggshell stability traits play a major role because only eggs with an intact shell are considered salable. Thus, if egg quality, and specifically, eggshell stability, is guaranteed, the layer industry could increase the number of salable eggs produced by each hen housed. Selection for egg quality has therefore been an important component of the breeding strategy of companies marketing egg laying-type hens.

The eggshell is a highly ordered structure resulting from the deposition of calcium carbonate and an organic matrix from the acellular uterine fluid (Nys *et al.,* 2004). Ovocalyxin-32 (*OCX-32*), a 32-kDa protein, is present at high levels in the uterine fluid during the terminal phase of eggshell formation and is localized predominantly in the outer eggshell (Gautron *et al.,* 2001). The timing of *OCX-32* secretion into the chicken uterine fluid suggests that it may play a role in the process of mineral deposition and in the completion of the eggshell (Hincke *et al.,* 2003). SNP in the intron region of the *OCX-32* gene was associated with the thicknesses of the mammillary layer (Dunn *et al.,* 2008). Low egg production strains

of Taiwanese country chickens expressed more transcripts of the *OCX-32* gene compared with high strains at egg-laying stages and suggested that the *OCX-32* gene is a potential molecular marker associated with different rates of egg production (Yang *et al.,* 2007). These results indicate that the *OCX-32* gene might have a direct effect on egg quality traits. The objective of the present study was as to identify a polymorphism of the chicken *OCX-32* gene in different indigenous Nigerian chicken populations.

MATERIALS AND METHODS

Collection of blood samples and DNA extraction

Blood samples were collected from the wing vein of a total of 180 Nigerian chickens (30each) consisting of the Abuja, Nsukka, Ogun, Heavy ecotype, Layers and Broilers type chicken. The blood samples were stored at -20°C until DNA extraction. Total genomic DNA was extracted using Quick-gDNA Mini Prep kit of Norgen Biotek Corporation following the manufacturer's protocol.

Primers and PCR amplification

Two pairs of primers were used for selective amplification of cOCX-32 gene based on the chicken *OCX-32* mRNA information (accession no. NM_204534) and genome sequences (accession no. AADN02021077) on chromosome 9 in GenBank. The primers were synthesized by Integrated DNA Technology (USA). The primer sequences were:

F'- 5'GGCAGGACCCGAGCGAGGAGTT-3'; R'-5'GGCTAAGGCGTGAGGACCGAAACC-3'

F'-5'GCCCACTGGTCAGAAAAGAA-3'; R'-5'CCTGCAGAGGAAAAGAGCTG-3'

Selective amplification of different regions of OCX-32 gene was performed using thermocycler GeneAmp PCR System 9700 (Applied Biosystems, Foster City, CA, USA) and PCR reagents synthesized by Norgen Biotek corporation Canada. PCRs were performed in a programmable thermocycler with the following protocol: 94°C for 5 min; followed by 30 cycles of 94°C for 30 s, 55°C for 30 s and 72°C for 1 min; with a final extension step of 72°C for 10 min. Amplification of the different segments of cOCX-32 gene was confirmed by running the PCR products on 1% agarose gel and visualizing under UV rays. Thirty microliters of each PCR product was purified and sequenced using the Big Dye Terminator v3.1 Cycle Sequencing Kit by standard protocol.

Sequence analysis

Chromatographs generated from sequencing were processed using Cluster W and sequence trimming was carried out on BioEdit. Both forward and reverse primer sequences were then aligned using the ClustalW multiple sequence alignment program (http://www.ebi.ac.uk/clusatlw/) to determine the presence of genetic polymorphisms. Sequences were blasted against database on NCBI and reference sequences acquired (NC_006096.5 and NP_989865.1).

RESULT AND DISCUSSION

DNA polymorphism

The intron/exon location (Loc), the affected cDNA and position of SNP in OCX 32 locus of the Nigerian chicken are shown in Table 1. Variants were numbered according to their order of occurrence in the gene sequence. Following the May, 2006 chicken genome build (WUGSC 2.1/gal Gal 3) at UCSC (http://genome.UCSC.edu) the position of individual variant was determined.

Table 1: The affected cDNA and position of SNP in OCX 32 locus of the Nigerian chicken

Name	Loc	Position	JF	NSK	OG	ABJ	HE	LA	BRL
OCX 32-1	I_1	22596162	-	-	-	-	-	-	T
OCX 32-2	E_2	22596229	T	T	T	G	T	T	T

Note; JF (Jungle Fowl), NSK (Nsukka), OG (Ogun), ABJ (Abuja), HE (Heavy Ecotype), LA (Layers) and BRL (Broiler)

The Populations of Nigeria Chicken differed slightly in terms of number of variants found within and between populations. Only two polymorphic sites were found among the populations used in the study. The two polymorphic sites (-162T and T229G) were identified in BRL (a commercial line) and ABJ populations respectively, however only SNPs T229G present in exon 2 caused an amino acid change indicating that the polymorphic sites identified in the ABJ population probably represent a small fraction of the more common polymorphic site found in the chicken populations. Commercial broiler had unique variants indicating that more polymorphic site could possibly be found in further study.

SNP Detection

SNPs and their locations in OCX 32 gene sequence among population of Nigerian native and commercial chicken are shown in table 2. One novel SNP (-162T) was found in this study. The novel SNPs (-162T) discovered in this study differed from those reported earlier, while the other SNPs (T229G) had been reported earlier (Takahashi *et al.*, 2010). SNP T229G found in ABJ brought about change in amino acid (leu83Arg), while SNP – 162T also found in commercial broiler did not cause change in Amino acid. SNP T229G had been reported earlier to be in linkage disequilibrium (LD) with five other variants present in exon 2 (Fulton *et al.*, 2012). Those six variants always appeared together. Hence the SNP T229G can be used alone to identify the genotype of the entire cluster. For the size of 305 bp analysed in this study, there is one SNP in an average of 152 bp sequence of chicken OCX 32.

Table 2: SNPs and their locations in OCX 32 gene sequence among population of Nigerian native and commercial chicken

Position	Location	N.N.change	Codon and AA change
22596162	Intron 1	g - > T	None
22596229	Exon 2	T > G	CTT>CGT:p.leu83Arg

CONCLUSION AND RECOMMNDATION

The result suggested that very low heterozygosis was observed between populations. In conclusion only three chicken populations (Nsukka, Ogun and Abuja) followed the Hardy Weinberg equilibrium, indicating that the three Nigerian native chicken populations (Nsukka, Ogun and Abuja) had undergone little selection and random mating. However, Broiler, Layer and Heavy ecotype chicken with selection pressure, could be limited in SNPs due to small sample size. The T229G polymorphism detected in Abuja chicken could be associated with meat production and egg production traits in Nigerian native chickens and therefore should be a subject for further enquiry.

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PROSPECTS IN THE UTILIZATION OF ASSISTED REPRODUCTIVE TECHNOLOGIES (ART) TOWARDS IMPROVED CATTLE PRODUCTION IN NIGERIA

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Abstract
Nigeria has a huge potential for cattle production but sadly this has been poorly developed. This is partly attributable to the poor utilization of assisted reproductive technologies (ART) in dairy and beef cattle breeding and production. These technologies generally include artificial insemination (AI), multiple-ovulation, embryo transfer, *in vitro* fertilization (IVF), sex determination, cloning and genetic engineering. ARTs have been applied extensively in the yearly production of millions of cattle in many developed and developing countries worldwide. This review highlights the applications and potentials of ARTs in cattle production and suggests how stakeholders in the Nigerian cattle industry can exploit these potentials. It is clear that the utilization of ARTs will enhance national livestock productivity so the Nigeria can feed her growing population and possibly increase her foreign exchange earnings by becoming a livestock-exporting country.

Keywords: assisted reproductive technologies, cattle production

Introduction
Nigeria has a current estimated human population of 198 million based on figures released by the National Population Commission (National Population Commission, 2019). On the other hand, the National Agriculture Sample Survey in Nigeria reported an estimated national cattle population of 19 million (National Agriculture Sample Survey, 2011). This is considered to be grossly inadequate in meeting the national human demand for meat, milk and other cattle products or in contributing to the gross domestic product (GDP). For instance, Nigerian's production of 0.6 million tons of milk per annum is comparatively one of the lowest in the world. This meets about 34% of the estimated annual milk consumption of 1.7 million tons. Consequently, Nigeria has to spend an average of 480 million US Dollars on the importation of milk annually (PricewaterhouseCoopers Report, 2017). Furthermore, the National Bureau of Statistics reported that about 63% of Nigerians live below the poverty line (National Bureau of Statistics, 2016). Therefore, the low availability and high cost of livestock and animal products means that many Nigerians are unable to meet their minimum daily animal protein intake.

High reproductive efficiency is essential for profitable beef and dairy cattle production. In Nigeria, poor nutrition, prevalence of cattle diseases, and the practice of nomadic pastoralism have been associated with low cattle productivity (Ducrotoy et al., 2016; PricewaterhouseCoopers Report, 2017). Furthermore, more than 99% of dairy cattle reared in Nigeria are the local indigenous breeds such as Bunaji, Rahaji and Sokoto Gudali whereas foreign breeds including Friesians, Jerseys and Brown Swiss, and cross breeds account for less than 1% (PricewaterhouseCoopers Report, 2017). Although these local breeds are genetically adapted to the tropical environment (Mwai et al., 2015), they produce far less milk than their foreign counterparts which has been attributed to genetic composition and to some extent management practices by dairy cattle farmers (Saleh et al., 2016). For instance, the average liters

of milk produced per day was 30.15 and 1.57 for the Friesian and Bunaji breeds, respectively (Saleh et al., 2016). This low productivity is worsened by poor use of modern reproductive techniques, and the lack of planned and selective breeding for improved genetic potential and maximal productivity. Instead, there is indiscriminate breeding in cattle herds resulting in decreased reproductive potentials and the spread of diseases. Therefore it is overdue for an increase in the exploitation of modern methods of animal breeding and reproduction, if ever Nigeria hopes to overcome her shortcomings in cattle and other livestock productivity.

Assisted reproductive technologies (ART)

Assisted reproductive technologies (ART) are applied extensively in many parts of the world in humans and animals to advance our knowledge of reproductive processes and to promote reproductive efficiency. These technologies generally include artificial insemination (AI), multiple-ovulation, embryo transfer, *in vitro* fertilization (IVF), sex determination, cloning and genetic engineering (Ball and Peters, 2004). In the cattle industry, ARTs were initially developed to increase the production of calves from parent cattle with high genetic potentials, but now offer many opportunities for beef and dairy cattle production.

Oestrus synchronization

Synchronization of oestrus involves the use of pharmacologic means to control oestrus and ovulation in farm animals. Generally the techniques are based on either the artificial induction of premature luteolysis using luteolytic agents, or the administration of progestagens to temporarily suppress ovarian activity. Synchronization offers several management advantages and facilitates the maximal and batch managements of AI and calving in cattle herds, thereby increasing productivity and decreasing costs in dairy and beef cattle production (Pineda, 2003).

Artificial insemination (AI)

Artificial insemination is the introduction of live spermatozoa into the genital tract of the female to cause fertilization by means other than natural mating. Semen from bulls can be extended and preserved at 4-5 °C for a few days or frozen in liquid nitrogen at -196°C for years or decades. Semen from a few high-performance bulls can be used to breed large numbers cows leading to rapid genetic improvement and dissemination of new breeds within cattle populations (Ball and Peters, 2004). Movement of preserved semen instead of live bulls would also improve trade, reduce production cost and also decrease the spread of cattle diseases usually transmitted by direct contact between cattle.

Multiple ovulation and Embryo transfer (MOET)

Multiple-ovulation (superovulation) is a pharmacologic technique applied to increase the number of oocytes released at ovulation, usually by 2 to 10 fold, thereby increasing the potential number of embryos. On the other hand, embryo transfer (ET) refers to the techniques by which embryos are collected from a female (donor) and transferred into the uterus of another female (recipient) where they develop to term. Typically, a cow ovulates a single oocyte during each reproductive cycle, and therefore may produce only 8 to 12 calves in her reproductive lifetime. However, utilizing the technology for MOET, it is possible to obtain 30 to 40 calves from a single cow over a period of a year (Pineda, 2003). Through ET, the numbers of imported highly valuable and scarce cattle breeds could be multiplied rapidly, leading to increased genetic improvement of cattle populations (Thomasen et al., 2016). Highly valued cows that are injured or too old to carry normal pregnancy could also be made to continue producing calves via ET, rather than these animals being culled or sold for slaughter. Natural twinning ranges from 1-2% in beef

cattle, but the efficiency of beef production could be also be increased in intensively managed farms by inducing twinning using ET. This technology also offers commercial advantage to farmers via a lower cost of importation of cryopreserved embryos compared to live cattle.

In vitro fertilization (IVF)

In vitro fertilization (IVF) is a technology via which oocytes are matured and fertilized outside of the female. The resulting embryos are then transferred back to the same or different females for development. Mature oocytes can be collected by flushing the oviducts shortly after ovulation. Alternatively, immature oocytes can be obtained from abattoir ovaries or by aspiration of pre-ovulatory follicles via ovum pick up (OPU) from live cows (Ball and Peters, 2004). The technology offers the potential for large numbers of *in vitro* produced embryos together with exciting opportunities for other technologies in cattle reproduction such as sex determination, cloning and genetic engineering.

Sex determination

This technology is useful when calves of a particular sex are considered to be more valuable than those of the opposite sex. For instance, dairy farmers would prefer most of their calves to be female (replacement heifers for the milking herd) whereas beef farmers would prefer bull calves for their higher body mass and beef production potential. Sex could be determined either by semen sexing or embryo sexing. Sexed semen could be applied in farms to inseminate cows with the aim of producing calves of the required sex, or for the fertilization of oocytes *in vitro* to produce embryos of the required sex. Sexed embryos could also be transferred to recipient cows to produce calves of the required sex (Pellegrino et al., 2016).

Cloning

These technologies involve embryo splitting or the use of nuclear transfer to produce genetically-identical twins or large numbers of cloned cattle. In the nuclear transfer technique, a cleavage stage embryo is split into individual blastomeres, which are then fused individually to enucleated oocytes. The resulting zygotes are then cultured and transferred to recipient cows for development to term. This offers the potential for the production of large numbers of genetically-superior cattle to drive increased dairy and beef production (Pineda, 2003).

Genetic engineering

This technology involves transferring a selected gene into an embryo so that the resulting offspring carry and express that gene later in life. Animals that carry a copy of a desired foreign gene are referred to as being transgenic (Pineda, 2003; Carlson and Lancto, 2016). In Africa, and particularly Nigeria, genetic engineering of bovine embryos may offer opportunities for the production of cattle that retain the genetic predisposition to hardiness, adaptation to the tropical environment and tolerance to tropical diseases while incorporating genetic potential for rapid growth and increased milk and beef production (Mwai et al., 2015).

Potential Interventions

There has been a significant increase in the utilization of ARTs, particularly AI and MOET, in the production of millions of cattle in many developed and developing countries worldwide. This has led to a tremendous increase in both dairy and beef cattle production in several countries such as the United States and Brazil. In Nigeria, AI has been routinely performed since 1978 at the national animal production research institute (NAPRI), Zaria. AI is also performed in a few private commercial cattle farms. Unfortunately, these efforts impact a small proportion of cattle population in Nigeria. A recent study in Northern Nigeria also revealed poor extension contact

among dairy farmers, blocking the farmers from access to sources of improved dairy cattle technologies (Saleh et al., 2016). Tertiary institutions in Nigeria also present platforms for the utilization of ARTs in research that can improve animal reproduction and productivity. Many of these institutions have made considerably efforts in some areas of animal production, and in the treatment of reproductive diseases. Regrettably, there is a low potential for the application of ART, partly due to the absence of a number of equipment and facility but mainly due to shortage of human skill or training.

Clearly, an intensive application of ARTs will assist in the improvement of reproductive efficiency and productivity in dairy and beef cattle farming in Nigeria through several approaches. Skills in ARTs should be incorporated and exploited in both teaching and research in veterinary and animal science institutions. Subsequent research findings should also be utilized by the stakeholders in the cattle industry (government agencies and cattle farmers) to improve cattle productivity. In addition, there should be provision of adequate trainings, workshops and extension services in the use of ARTs to both the public and private sector participants in the cattle industry. Finally, the Nigerian government should discourage nomadic pastoralism with its attendant human conflict, while encouraging cattle ranching and the application of ARTs in cattle production.

In conclusion, it is important to note that whilst the focus here is on cattle, the principles and skills of ARTs are equally relevant to other livestock and animal species including sheep, goat, pig, horse, dog, cat, poultry and wildlife. Nigeria has a huge potential for cattle and other livestock production but sadly this has been poorly developed. It is clear that the utilization of ARTs will enhance national livestock productivity so the Nigeria can feed her growing population and possibly increase her foreign exchange earnings by becoming a livestock-exporting country.

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AGE ESTIMATION IN SAHELIAN GOAT USING HORN DISTANCE AND BODY LENGTH IN NIGERIA

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Abstract
The study involving age estimation using horn distance and body length was carried out on 200 normal sahelian goat of different age groups Group 1(0 – 6 Mouth), Group 2 (6 months –1 year), Group 3 (1 – 2 years), Group 4 (2 – 3 years) and Group 4 (above 3 years) and sexes group A (80 Males) and group B (120 Females), collected from the different regions of the Sokoto state, in winter season, using standard animal ethics approved by the government. The collected data were then taken to the Veterinary Anatomy laboratory of Usmanu Danfodiyo University; for analysis. The body length-measured as the distance from the external occipital protuberance to the base of the tail, while the horn distance; is measured at the greatest distance between base to base of the horns. Result have shown that in male the horn distance decreases with increase in age but slightly increases with increase in age in female sahelian goat. In male the body length geometrically increases with increase in age but arithmetically increases with increase in age in female sahelian goat. Result have shown that in male there is a reciprocal increase in the horn distance and body length with increase in age but linear increases in the horn distance and body length with increase in age in female sahelian goat. Based on this findings, it was concluded that horn distance and body length can be used to predict the age of this species of animal considering the need in establish the knowledge of estimating the age of our domestic animal at easy, cheep and simpler way using physical anatomical features, such as Horn, tail comb etc.
Keywords: Age estimation, Anatomical features, Body length Sahelian goat, Horn distance

Introduction
Goat a hardy domesticated ruminant mammal they has backward curving cylindrical horns especially in the male kept for milk and meat and noted for its lively behavior. There uses to humans includes, provision of milk, manure, fiber and then meat and hide (Akpa *et. al.,* 1998). Goat is significance livestock species in developing countries of the world. For example in Nigeria, Four hundred and Seventeen Millions goats accounting for Sixty five percent and ninety five percent respectively are located in developing countries. Goats are harder and well adopted to hash climate due to their gazing habit and physiological Characteristic. They are able to browse on the plants that would normally not be eaten to a broad range at production system (Hirst, 2008). This is the most common system throughout the developing countries. Involved either the existence system will large herder and or Flocks grazing on arid or seminar and range land on the intensive system with similar herd and or flocks kept in confinement mostly in the hummed tropics (Adedeji, and Gbadamosi, 1999).

Age estimation using various anatomical features in domestic animals are possible but, required some experience and skills; mainly because, it is sometimes difficult to distinguish clearly between there comparative structures as there was no marked difference in size and shape of the stage of development within their family (Hart, *et. al.,* 1982; Hirst, 2008; Noran and Mukherjee 1997). Age simply refers to the length of time that an animal has existed and the duration of the animal's life at a point in time. The only way to age an animal accurately, is to know the date of delivery but where these records are not available various anatomical features are used to estimate age (Hart, *et. al.,* 1982). The most convenient anatomical features of ageing are the phenotypic anatomical structures (Bello *et al*., 2013).

Horns are Skin associated structures that serve a particular function including sensitization contractile, lubricant and heat loss. In human some of the more common skin appendages are not (sensation Heat loss, fitter for breathing protection), arrest glands in to hair follicle, which also the hair) sweet glands (can be sweet secreted with strong odour (apocrine) or with a plant odour (eccrine) and Hails (protection) (Bratte *et. al.,* 1999). A horn is a permanent paired projection on the head of various animals consisting of a covering of Keratin and other proteins, surrounding a care of live bone. Horns are distracted from antlers, which are not permanents. Some time it is found dangerous to open the month of an animal (goat) because it may bile you. In ability to differentiate between the permanent and temporary teeth take it documentation in our local goat. There is need to establish the knowledge of estimating the age of our domestic animal at easy, cheep and simpler way using physical anatomical features, such

as Horn, tail comb etc. The knowledge acquired from the research will half in education farmers and student in estimating the age of Red Sokoto goat using horn length. The aim is to estimate the age of our local domestic Sahelian goats using horn length with the objective of relating the estimation age using teeth body and horn length

MATERIALS AND METHODS

Study Area

The study was carried out on 200 normal sahelian goat of different age groups Group 1(0 – 6 Mouth), Group 2(6m –1 years), Group 3(1 – 2 years), Group 4(2 – 3 years) and Group 4(above 3 years) and sexes group A (80 Males) and group B (120 Females), collected from the different regions of the Sokoto state, in winter season, using standard animal ethics approved by the government. The collected data were then taken to the Veterinary Anatomy laboratory of Usmanu Danfodiyo University; for analysis.

Body length-measured as the distance from the external occipital protuberance to the base of the tail

Horn distance; is measured at the greatest distance between base to base of the horns (Adedeji, and Gbadamosi, 1999)

Aging procedure

All domestic animals have two successive sets of teeth; deciduous teeth or milk teeth as the first set of teeth in young animals and permanent teeth as in aged animal. The knowledge of teeth eruption, wearing and labeling was employed as adopted by Douglas, (201 6). The data obtained from the study will be analyzed using statistical software for social science (SPSS); values will be presented in form of tables and figures as mean ± SEM.

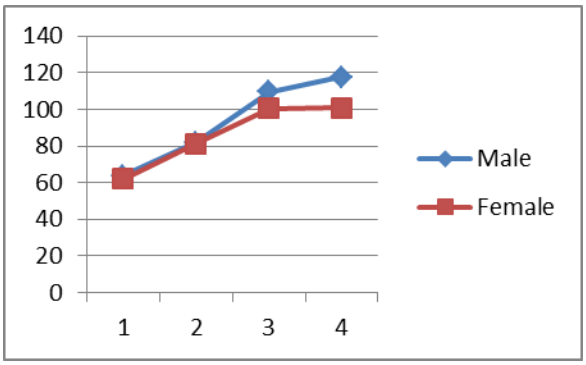
RESULTS AND DISCUSION

Result have shown that in male the horn distance decreases with increase in age but slightly increases with increase in age in female sahelian goat as shown in table 1and figure3 and 4.the above findings is in line with the finding of Adedeji, and Gbadamosi, (1999), Bratte *et. al.*, (1999) in West African dwarf goat, Gizaw, (1995) in Mongolian goat and Gajbhonya, and Johar, (1985) in East African mountain goat. Based on the result obtained, in male the body length geometrically increases with increase in age but arithmetically increases with increase in age in female sahelian goat as shown in table 1and figure2 and 5. The above findings in agreement with the finding of Noran and Mukherjee (1997), Hassan and Ciroma, (1992) in West African dwarf goat, Gizaw, (1995) **i**n South African bushy goat and Gajbhonya, and Johar (1985), Akpa *et. al.* (1998) of East African mountain goat and Ethiopian Harro sheep.

Results have shown that in male there is a reciprocal increase in the horn distance and body length with increase in age but linear increases in the horn distance and body length with increase in age in female sahelian goat as shown in figures 2, 3 and 4.

Table 1: Age related changes of body length and horn distance in Sahelian goats

	BODY LENGTH		HORN DISTANCE	
	Male	Female	Male	Female
Group 1(0 – 6 Mouth)	63.65±3.64	62.11±3.50	3.65±0.25	3.17±0.35
Group 2(6m –1 years)	82.06±4.06	81.39±4.00	3.33±0.15	3.20±0.20
Group 3(1 – 2 years)	109.56±3.80	100.36±4.50	3.36±0.35	4.65±0.25
Group 4(2 – 3 years)	117.67±4.00	100.70±4.85	2.72±0.15	5.21±0.75
Group 4(above 3 years)	130.50±3.50	118.80±5.25	2.35±0.25	5.30±0.65



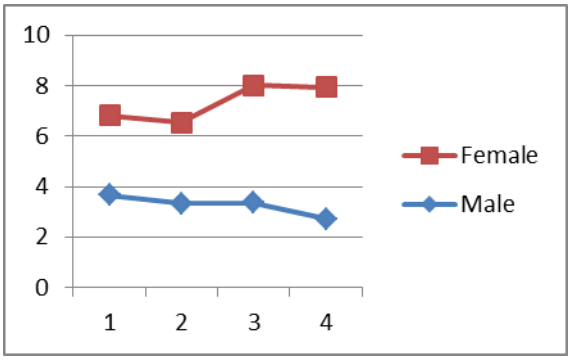


Fig 1:- Relationship of between age and sex of body length in Sahelian Goat
Fig 2:- Relationship of between age and sex of Horn distance in Sahelian Goat
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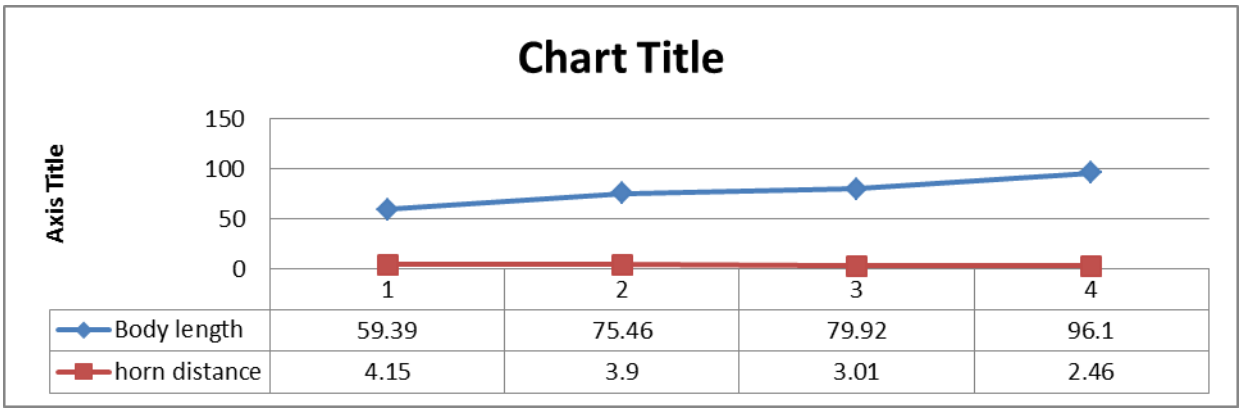

Fig 3:- Relationship of between body length and Horn distance in male Red Sokoto Goat

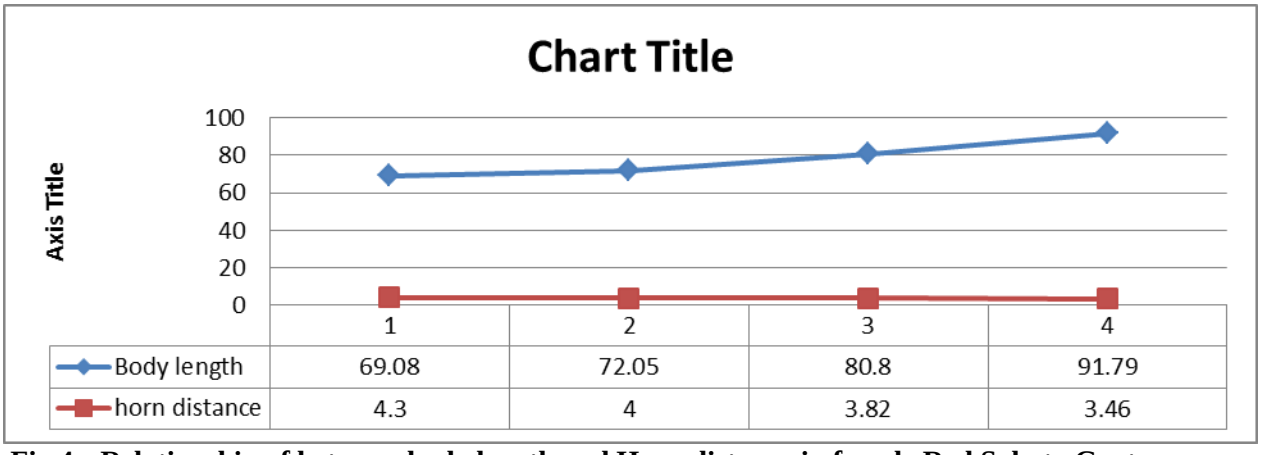

Fig 4:- Relationship of between body length and Horn distance in female Red Sokoto Goat

CONCLUSION AND RECOMMENDATIONS

The review has been able to provide reasonable documentary facts to support and encourage the production of small ruminant animals in Nigeria. The production of goats will provide meat, milk, skin and wool for the farmers and a good source of revenue to the state government. In view of the economic advantage associated with goat production coupled with the availability of local feedstuffs in the zone, the

farmer should be provided with loan facilities for commercial production of small ruminant animals. The local breeds of goat should be upgraded by experts in the zone for optimum productivity.

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PHENOTYPIC CORRELATION OF MORPHOMETRIC TRAITS IN NEW ZEALAND WHITE RABBITS REARED UNDER TROPICAL CONDITION

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ABSTRACT
A total of 48 New Zealand White (NZW) rabbits were used for the study. Morphometric traits such as Fore Limb (FL), Hind Limb (HL), Body Length (BL), Thigh Girth (TG), Abdominal Circumference (AC) and Leg Length (LL) in NZW rabbits were measured using measuring tape in centimetre (CM) at 4, 8 and 12 weeks of age. The data were analysed using the simple linear correlation procedure of SAS analytical package to obtain the phenotypic correlations among the various morphometric traits studied. From the study, the phenotypic correlations obtained were all positive and ranged between moderate (0.47) and high (0.89) for all ages considered for the NZW rabbit. This shows that as the animal grows, there is a positive relationship between the various morphometric traits and further implies that even growth is expected in NZW rabbits.

Key words: New Zealand rabbit, morphometric traits, correlations, hind limb, fore limb

INTRODUCTION
Improvement of rabbits genetically, is a vital scope on the way to increasing their contribution to the much needed animal protein in developing countries (Okoro *et al*., 2010). However, the importance and efficacy of rabbit production in Nigeria has not been fully harnessed with respect to the profitability and their impact in meeting the much needed animal protein in Nigeria. In other to reduce the production cost and increase the profitability of rabbit production, genetic improvement of the adapted breed has to be undertaken. One of the pre-requisites for genetic improvement is the knowledge of genetic parameters for important economic traits (Akanno and Ibe, 2006). Towards value addition in rabbit production, rabbit producers are more interested in the various parts of the animal body in relation to others to optimize returns on production, as it has direct impact on their feed efficiency and performance. Thus, breeders need to establish the relationship that exists between these morphometric traits and to organize the breeding programmes so as to achieve an optimum combination of bodyweight and good conformation for maximum economic returns (Khalil et al., 1987). This makes the work of the breeders easier and faster as effects can then be concentrated on traits that are easier to measure. Breeds such as New Zealand White, Dutch and Chinchilla remain the most commonly identified ones which have peculiar characteristics in terms of body weight that distinguish them from one another (Okoro *et al*,. 2010). Therefore, this study aimed at identifying the phenotypic correlation coefficients among the morphometric traits of New Zealand White (NZW) rabbits at ages 4, 8 and 12 weeks.

MATERIALS AND METHODS
Study site
The study was carried out at the Rabbitary Unit of the Directorate of University Farms, Federal University of Agriculture, Abeokuta, Nigeria. The farm lies on the Latitude within the rain forest belt of Western Nigeria, Latitude $7^0$10´North, Longitude $3^0$2´East and altitude 76 masl. The climate is humid

with a mean annual rainfall of 1,037mm, mean temperature of 34.7°C and mean relative humidity of 82 %. The vegetation interplays between tropical rainforest and derived savannah.

Experimental animals and management

A total of 48 New Zealand White rabbits kittens were used for the phenotypic parameters' estimation study. The kittens after birth were allowed to stay with their mother till 28 days before being weaned. After weaning, the rabbits were housed in wooden cages with wire mesh floor (40 × 50 × 60 cm) and were provided with concrete feeders and watering system. Four rabbits were kept per cage. After two weeks of birth, the kittens were introduced to commercial grower mash (CGM) and lasted till the end of the study. The animals were fed solely on the commercial grower mash diets with the following characteristics; 17.5% crude protein, 16% crude fibre and 2500 kcal/kg diet digestible energy *ad libitum*.Water was provided freely. Routine management was observed and drugs were applied as when necessary.

Data collection and Statistical analysis

The linear body measurements of individual rabbits were taken at 4, 8 and 12 weeks of age with the aid of a measuring tape in centimetres (cm). Traits studied were Fore Limb (FL), Hind Limb (HL), Body Length (BL), Thigh Girth (TG), Abdominal Circumference (AC) and Leg Length (LL). The phenotypic correlations of the morphometric traits at different ages were estimated using the simple linear correlation procedure of SAS (2000) analytical package to examine the linear relationship between the traits at different ages. The correlation coefficients between the different weights were derived as:

$$r = \frac{\sum XY}{\sqrt{\sum X \sum Y}} \qquad i = 1,\ldots,N$$

Where r = pearson correlation

X_i = first random variable of the ith body weight

Y_i = second random variable of the ith body weight

The Pearson correlation is defined between -1 and +1 ($-1 \leq r \leq 1$) where -1 indicates a perfect decreasing (negative) linear relationship, +1 indicates a perfect positive (increasing) linear relationship and some values between -1 and +1 in all other cases indicate the degree of linear relationship between the X and Y parameters.

RESULTS AND DISCUSSION

The results of the phenotypic correlations are as presented in Tables 1, 2 and 3 for 4, 8 and 12 weeks of age, respectively. As observed from the Tables for all ages considered, the phenotypic correlation coefficient values, among the morphometric traits in all the ages, ranged from moderate to high correlation, and were all positive, which means that as any one morphometric trait is increasing; a corresponding increase is expressed in the other. This shows that morphometric growth in NZW rabbit is symmetrical with other body parts. It is also indicative that as this breed of rabbit grows, all the other parts are growing concurrently. High phenotypic correlation between the studied morphometric traits agreed with the report of Janssens and Vandepitte (2004) and that of Oke *et al*. (2004) where they found positive, and highly significant ($p<0.01$) correlations between the morphometric traits of interest. The highest phenotypic correlation coefficient value of 0.82 was obtained between TG and HL while the lowest of 0.54 was obtained between LL and TG at 4 weeks of age. This indicated that the thigh and the hind limb are highly correlated since they are on similar proximity of the animal. At 8 weeks of age (Table 2), TG and HL were highly correlated (0.89) among other morphometric traits. The lowest phenotypic correlated value of 0.47 was obtained between TG and FL (Table 2). In Table 3, HL and FL were lowly correlated phenotypically followed by LL and AC. However, HL was highly correlated with TG (0.82) and LL (0.82).

Table 1: Phenotypic correlation of morphometric traits in NZW rabbit at 4 weeks of age

Parameters	FL	HL	BL	TG	AC	LL
FL						
HL	0.55					
BL	0.78	0.62				
TG	0.68	0.82	0.75			
AC	0.77	0.68	0.70	0.63		
LL	0.65	0.75	0.70	0.54	0.63	

FL = Fore limb, HL = Hind limb, BL = Body length and TG = Thigh girth, AC = Abdominal circumference, LL = Leg length

Table 2: Phenotypic correlation of morphometric traits in NZW rabbit at 8 weeks of age

Parameters	FL	HL	BL	TG	AC	LL
FL						
HL	0.68					
BL	0.53	0.76				
TG	0.47	0.89	0.50			
AC	0.72	0.77	0.55	0.75		
LL	0.82	0.66	0.69	0.65	0.80	

FL = Fore limb, HL = Hind limb, BL = Body length and TG = Thigh girth, AC = Abdominal circumference, LL = Leg length

Table 3: Phenotypic correlation of morphometric traits in NZW rabbit at 12 weeks of age

Parameters	FL	HL	BL	TG	AC	LL
FL						
HL	0.55					
BL	0.78	0.62				
TG	0.68	0.82	0.75			
AC	0.77	0.68	0.70	0.63		
LL	0.65	0.82	0.68	0.61	0.59	

FL = Fore limb, HL = Hind limb, BL = Body length and TG = Thigh girth, AC = Abdominal circumference, LL = Leg length

CONCLUSION AND RECOMMENDATION

This study revealed that positive, and moderate to high phenotypic correlation values exists between morphometric traits in NZW breed of rabbits. This is an indication that growth in this breed of rabbit is evenly and well distributed around the body. This is however, a good indicator for rabbit breeders and producers who aimed at morphometric traits for optimizing their production process.

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ON-STATION PERFORMANCE EVALUATION OF IMPROVED TROPICALLY ADAPTED CHICKEN BREEDS FOR SMALLHOLDER POULTRY PRODUCTION SYSTEMS IN NIGERIA

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Abstract
Availability of appropriate genetics is important for the development of Smallholder Poultry (SHP). The biological potential of improved dual purpose chicken germplasms was evaluated in Nigeria. A total of six breeds (*Fulani*, *FUNAAB Alpha*, *Kuroiler*, *Noiler*, *Sasso, and Shika Brown*) were tested on-station, in deep litter houses at two test centres (Public and Private facility) for 504 days. Birds were fed *ad libitum* for the first 140 days after which restricted feeding was practised. Lowest and highest hatchability of eggs set was 55% (*FUNAAB Alpha*) and 89% (*Sasso*), respectively. At 140 days, male live weights were 200 % - 300 % higher than the local chickens (975g) except *ShikaBrown* (152%) and *Fulani* (135%). Lowest ($p<0.05$) age at first egg were 119 days for *ShikaBrown* and 120 days for *FUNAAB Alpha* and *Kuroiler.* Highest hen-housed egg production was 192 for *ShikaBrown,* and feed intake per dozen eggs was lowest ($p<0.05$) for *ShikaBrown* (3.0 kg) and *FUNAAB Alpha* (3.1 kg). Mortality rate of the breeds was significantly different ($p<0.05$) during brooding, growing and laying. The genotype by environment interaction effect on the performance of the breeds was largely due to management practices at the test centres. Results from this study indicate that all the breeds are more suitable as dual-purpose birds compared to the local chickens.
Keywords: Germplasms, Nigeria, smallholder-poultry, on-station, dual-purpose

Introduction
Smallholder poultry (SHP) is defined as poultry keeping by households using family labour, locally available feed resources obtained largely through scavenging by a flock of less than 100 birds, of unimproved or improved breed. (Sonaiya, 1990). The low productivity of the SHP production systems (as characterized by high mortality, low egg numbers, and poor live performance) has resulted in the demand by SHP producers for "better and bigger" birds in Nigeria (ACGG Nigeria baseline data 2016, http://data.ilri.org/portal/dataset). Such "better" birds are best provided not by commercial/industrial poultry germplasms, but by SHP-specific hybrid germplasms (SHP-SHG) which are improved dual purpose birds that incorporate genes for higher productivity and performance into the hardiness of locally adapted chickens.
The introduction of SHP-SHG has been successfully tested in Bangladesh for the Sonali chickens (FAO, 2015) and in Uganda with the *Kuroiler* (Galukande *et al.,* 2016; Sharma *et al.,* 2015). The objective of this study was to evaluate the growth performance, egg production and survivability of selected, improved SHP-SHG for the SHP production systems in Nigeria.

Material and Methods
Study locations: The on-station test was replicated at two centres located within the derived savanna: Fol-Hope Farms, Ibadan, Oyo State, and Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State. The testing of the birds commenced in May 2016.
Experimental birds and management: A total of 1,939 day old chicks of both locally sourced breeds (*Fulani*, *FUNAAB Alpha*, *Noiler* and *ShikaBrown*) and imported breeds (*Kuroiler* and *Sasso*) were brooded from 0 to 42 days (d). The chicks were hatched on-station, from hatchable eggs sourced from the respective breeder farms. The birds were sexed at 42d, and grown separately until 140d for males, and

504d for females. The population density was 10 chicks/m^2, 7 birds/m^2, and 5 birds/m^2 during brooding, growing and laying phases, respectively. Commercial feed (Chick mash: 2,993 kcal ME/kg, 22.3% CP; Grower mash: 3,013 kcal ME/kg, 17% CP) and water were available *ad libitum* during brooding and growing phases. During the laying phase (Layer mash: 2,500 kcal ME/kg, 16.5% CP, 3.6% Ca), hens were restricted to a maximum of 120g feed/hen/day. Standard biosecurity measures and vaccination schedules were observed at the test centres.

Data collection and analysis: Fertility and hatchability percentages were determined from hatchery performance record taken at day 1 (eggs set), day 18 (candling), and day 21 (hatching)**.** Data on feed intake, egg production, and mortality were taken daily. Body weights were measured every 14d. For males, bodyweights were taken until 140d when they were exited from the test. For females all measurements were taken up till 504d. The study was conducted independently in each of the test stations as a completely randomized design with a minimum of 4 replicates per strain. Growth rate, feed conversion ratio (FCR), hen housed egg production (HHEP), hen day egg production (HDEP), and mortality rate were analysed using analysis of variance of SAS student edition. Differences between breed means and stations means were separated using Duncan Multiple Range test.

Results

Table 1 shows the hatchery performance. Hatchability of fertile eggs (HFE) was over 70% in all the breeds with *Noiler* being the highest (89%).

Table 1. Hatchability of eggs of the six breeds

Breeds	Eggs Set*	Number Fertile	Hatchability % of eggs set (HES)	Hatchability % of Fertile eggs (HFE)
Fulani	8,187	6,275	55	72
FUNAAB Alpha	13,688	9,153	55	82
Kuroiler	24,480	20,521	67	80
Noiler	11,905	11,190	84	89
Sasso	93,992	79,629	71	84
ShikaBrown	23,157	20,911	77	85

*Total number of eggs set for both on-station and on-farm test.

Table 2 shows the live weight performance of the breeds. Bodyweight gain and FCR of the breeds differed ($p<0.05$) significantly during brooding, growing and laying. *Noiler* had the lowest FCR at brooding (2.2) but did not differ from *Sasso* during growing for males. Male bodyweight gain for *Sasso* (2,962g) and *Kuroiler* (2,894g) were higher ($p<0.05$) than *Noiler* (2,599g), while *FUNAAB Alpha* (2,097g) differed ($p<0.05$) from *ShikaBrown* and *Fulani*. At 504d, *Sasso* had the highest ($p<0.05$) live weight.

Table 2. Body weight and feed performance (LSM±SEM) of the six breeds tested on-station

Parameters	Fulani	FUNAAB Alpha	Kuroiler	Noiler	Sasso	Shika Brown
Brooding	Both Sexes (70)	Both Sexes (353)	Both Sexes (408)	Both Sexes (310)	Both Sexes (408)	Both Sexes (400)
Day-old BW,g	24±0.9^{d}	31±0.9^{b}	40±0.6^{a}	37±0.7^{ab}	39±0.9^{a}	28±0.3^{c}
42-d BW, g	202±14.8^{d}	378±11.7^{c}	598±22.3^{b}	744±10.6^{a}	494±8.9^{b}	279±4.5^{cd}
42-d FI, g/bird	777±9.7^{e}	1093±9.1^{d}	1735±18.4^{a}	1575±9.2^{b}	1385±21.1^{c}	1047±8.0^{d}

FCR	4.4±2.1[d]		3.2±1.7[b]		3.1±1.8[b]		2.2±0.5[a]		3.0±1.2[b]		4.2±1.4[c]	
Growing	M	F	M	F	M	F	M	F	M	F	M	F
	(20)	(46)	(113)	(180)	(130)	(141)	(148)	(151)	(190)	(181)	(194)	(197)
56-d BW, g	366±25.8[e]	325±10.5[c]	685±18.3[c]	594±15.8[b]	970±22.3[b]	834±25.5[a]	1179±19.8[a]	978±15.5[a]	921±15.4[b]	855±11.7[a]	502±8.9[d]	472±6.4[bc]
140-d BW, g	1321±84.7[e]	1028±63.4[c]	2097±62.6[c]	1635±54.5[b]	2894±51.0[a]	2421±38.6[a]	2599±51.0[b]	2071±38.3[a]	2962±48.9[a]	2353±15.2[a]	1688±27.3[d]	1340±8.3[bc]
84-d FI, g/bird	10660±32.1[e]	9131±28.2[c]	15868±35.7[b]	15162±41.7[a]	17598±25.2[a]	15448±38.4[a]	11609±53.3[d]	10307±40.0[b]	16943±62.7[b]	14490±78.5[a]	13432±33.3[c]	10962±19.3[b]
FCR	11.2±3.8[c]	13.0±3.2[cd]	11.2±2.2[c]	14.6±4.6[d]	9.1±1.3[b]	9.7±3.7[b]	8.2±1.8[a]	9.4±2.1[a]	8.3±1.6[a]	9.7±3.4[b]	11.3±4.0[c]	12.6±2.7[c]
Laying	F		F		F		F		F		F	
	(31)		(161)		(130)		(141)		(179)		(191)	
504-d BW, g	1740±48.2[d]		2131±22.6[c]		2422±30.1[b]		2332±25.9[b]		2635±34.0[a]		2045±18.6[c]	

BW=Bodyweight, FI=Feed Intake, FCR=Feed conversion ratio, M=Male, F=Female, ( )=Figures in parenthesis are number of observations at the start of the phase. [a-e]Means with different superscripts on the same row were significantly different at P < 0.05, LSM=Least square mean, SEM=Standard error of the mean

Table 3 shows the laying performance. The mean age at first egg, egg weight and HHEP in 364 days were 125 days, 52g and 141, respectively. *ShikaBrown* had the lowest (p<0.05) age at first egg (119 days). *Noiler* and *ShikaBrown* had the highest (p<0.05) egg weight (56g) which was not significantly different from that of *Kuroiler* and *Sasso*. The lowest and highest HDEP was observed in *Sasso* (35%) and *FUNAAB Alpha* (75%), respectively. Feed intake per dozen eggs was lowest (p<0.05) for *ShikaBrown* (3.0 kg) and *FUNAAB Alpha* (3.1 kg).

Table 3. Age at first egg, egg weight, hen housed egg production, hen day egg production and feed intake per dozen eggs (LSM±SEM) of all the breeds tested on-station

Parameters	Breed					Station		
	Fulani	FUNAAB Alpha	Kuroiler	Noiler	Sasso	Shika Brown	Fol-Hope	FUNAAB
Age at first egg, d	126±1.1[c]	120±0.9[b]	120±1.3[b]	130±1.8[d]	133±0.6[d]	119±0.3[a]	128±0.9[a]	120±0.8[b]
Egg weight, g	40±0.9[c]	49±0.4[b]	54±1.0[a]	56±0.7[a]	55±1.2[a]	56±0.4[a]	52±0.3[a]	52±0.3[a]
HHEP, count	88±3.4[d]	190±2.8[a]	127±4.2[c]	173±2.1[b]	75±5.6[e]	192±0.7[a]	140±1.8[a]	107±2.1[b]
Maximum HDEP, % (days)	68±0.8 (175)	75±0.5 (182)	60±0.5 (175)	61±0.6 (238)	35±0.8 (182)	71±0.9 (245)	63±1.1 (203)	53±1.4 (238)
Feed/dozen eggs, kg	4.6±2.1[c]	3.1±1.3[a]	4.6±1.8[c]	3.6±0.9[b]	8.5±1.1[d]	3.0±1.8[a]	6.6±1.7[b]	4.1±1.2[a]

HHEP=Hen housed egg production, HDEP=Hen day egg production. [a-e]Means with different superscripts on the same row were significantly different at P < 0.05, LSM=Least square mean, SEM=Standard error of the mean.

Table 4 shows the mortality rate of the breeds. Mortality during brooding ranged from 3.6% (*Noiler*) to 33.6% (*Kuroiler*). *Noiler* (13.5%), *Kuroiler* (18.5%) and *Sasso* (25.8%) had higher male mortalities during growing than *Fulani* (0%), *ShikaBrown* (2.6%) and *FUNAAB Alpha* (7.9%), but for females, *Fulani* had the highest mortality (32.6%) while *Sasso* was lowest (1.1%). *FUNAAB Alpha* had the highest

(24.8%) mortality during laying, followed by *Sasso* (24%), *Noiler* (21.7%), *Fulani* (19.4%), *Kuroiler* (19.2%), and *ShikaBrown* (16.8%).

Table 4. Mortality rates (LSM±SEM) of the six breeds tested on-station

Phases	Breed						Station	
	Fulani	FUNAAB Alpha	Kuroiler	Noiler	Sasso	Shika Brown	Fol-Hope	FUNAAB
Brooder, Mortality %	5.7±0.7[c]	16.9±1.0[e]	33.6±2.9[f]	3.6±0.6[b]	9.1±1.8[d]	2.3±0.1[a]	8.4±1.3[a]	15.6±1.7[b]
Grower, Male Mortality, %	0[a]	7.9±1.4[c]	18.5±4.2[e]	13.5±2.1[d]	25.8±3.6[f]	2.6±0.8[b]	11.4±1.9[b]	7.9±1.0[a]
Grower, Female Mortality, %	32.6±0.9[e]	10.6±2.5[d]	10.6±4.9[d]	6.6±1.8[c]	1.1±0.1[a]	3.1±0.0[b]	10.8±2.4[a]	9.6±2.0[a]
Layer, Mortality, %	19.4±1.3[a]	24.8±4.4[c]	19.2±4.0[a]	21.7±3.1[b]	24.0±2.2[c]	16.8±1.1[a]	33.9±3.8[b]	27.3±2.7[a]

[a-e]Means with different superscripts on the same row were significantly different at $P < 0.05$, LSM=Least square mean, SEM=Standard error of the mean.

Discussion

The HFE of all the breeds, except *Fulani* is within the range (80-90%) reported by MALDM (1993) for dual purpose chicken breeds. The fertility and HFE of *Fulani* were low compared to the report by Adedeji *et al.* (2015) for *Fulani* chickens tested on station (Fertility 85%, HFE 84%), but it was similar to that reported by Dunya *et al*. (2014) for local chickens. The growth performance of the breeds, shows the group of *Kuroiler*, *Noiler* and *Sasso* to have better performance than the group of *FUNAAB Alpha* and *ShikaBrown* when compared with *Fulani*. At 42d, *Noiler* was the most efficient at converting feed to muscle with 50% reduction in FCR compared to *Fulani*. Comparing the male live weights of the breeds with the mean male live weight (975g) of the Nigerian local chickens raised on-station (Ajayi, 2010; Nwosu and Asuquo, 1984; Akinokun, 1975), *Sasso*, *Kuroiler*, *Noiler*, *FUNAAB Alpha*, *ShikaBrown* and *Fulani* were higher by 304%, 297%, 267%, 215%, 173% and 135%, respectively. This shows a cluster of fast (*Sasso*, *Kuroiler*, *Noiler* and *FUNAAB Alpha*) and slow (*ShikaBrown* and *Fulani*) growing breeds. There was a 22% reduction in the mean age at first egg of the improved breeds compared with the locals (160 days) and a 39-50% increase (*Noiler*, *FUNAAB Alpha* and *ShikaBrown*) in HHEP over the local chickens (128 days) reared on-station (Ajayi, 2010; Adedokun and Sonaiya, 2002). *ShikaBrown* and *FUNAAB Alpha* were the most efficient at converting feed to eggs. Overall, the locally sourced breeds had a lower mortality rate than the imported breeds which suggests that the locally sourced breeds were more adaptable to the environment than the foreign breeds.

Conclusion and Recommendation

All the breeds performed comparably better than the local, unimproved chickens. At 140d, *Kuroiler* and *Sasso* had over 200% increase in bodyweight while *Noiler* had over 150% increase compared with the local chickens. *ShikaBrown* had the highest (50%) increase in HHEP compared with the local chickens. The overall ranking (i.e. highest to lowest) of the breeds based on hatchability, growth and laying performance, and survivability is *ShikaBrown/Noiler*, *Kuroiler/Sasso*, *FUNAAB Alpha* and *Fulani*.

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MALE-SPECIFIC REGION (MSY) GENES - POTENTIAL FERTILITY MARKERS FOR SELECTION OF INDIGENOUS BULLS FOR ARTIFICIAL INSEMINATION

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Abstract
Molecular marker-based selection is a novel tool for unbundling complexities associated with thorough understanding of animal breeding and can contribute to full exploitation of animals' potential for food production. An integrative application of this technologies with artificial insemination can lead to increased productivity of livestock production systems in Nigeria; however, careful selection of animals especially bulls which are the focal animal in artificial insemination since they donate the semen and again determine their offspring productivity is a big task due to possible implication of infertility and sub-fertility. Apart from genetic and biological importance of the bulls, highly fertile semen will economically compensate for high cost involved in the practice of the artificial insemination. In Nigeria where livestock production is more extensive than intensive, and records of animal performance is hard to come-by hence, the need to develop field level non-invasive and fast technique of identifying high fertile bull is necessary. This paper present male-specific region genes assessment as such method because these genes are potential molecular markers for determining whether a bull is fertile or not in order to determine its suitability for breeding programmes using artificial insemination technology.

Keywords: Male-specific (MSY) region genes, molecular marker, Nigeria indigenous cattle

Introduction

Reproductive technology with excellent potential for increasing herd level productivity in cattle is artificial insemination because semen from a single bull can sire multiple calves far and wide within and outside a given geographical location; but selection and recruitment of highly fertile bull is the key to successful implementation of artificial insemination especially in the tropical poor resources countries. Lack of adequate records keeping and poor breeding programme are limiting factors for identification of highly fertile indigenous bull in the tropics such as Nigeria therefore, the need for field level molecular fertility markers is a worthy application of molecular biology for increasing livestock productivity as a way of fighting food insecurity in Nigeria where population is currently growing at alarming rates. Expression of MSY genes are potential marker of bull fertility and their mechanisms of action are relatively unexplored hence the need to investigate them becomes highly imperative for the purpose of establishing expression of these genes as field level fertility marker in bulls selection for improved productivity (Hamilton, *et al*, 2012).

Bulls fertility is a major cause of economic loss in cattle production because healthy bulls are at many times confused with fertile bulls meanwhile lots of bulls even when they are healthy may either be infertile or sub-fertile (David *et al*, 2014). Several factors including nutrition, genetics, environment, infectious diseases, and management may be responsible cause of infertility or sub-fertility in bulls but what matters is identification of infertile or sub-fertile in order to prevent their use in breeding programmes especially in artificial insemination because this can imply huge improvement on overall herd output. Annotation of genes which have been shown to regulate fertility in cattle holds significant promise for understanding the regulation of fertility in bulls because these genes when expressed in cattle reproductive tracts will be expressed in the semen hence will ensure successful conception. Therefore

exploration of genetics behind bull fertility is a powerful tool that can aids farmers profits because identifying superior animals as the parents of the next generation cows will contribute to yield in both milk and beef enterprise (Noirin *et al*, 2014).

Potential of Male-specific region (MSY) genes as marker of fertility in cattle breeding

In herd level productivity improvement; identification and recruitment of good animals into breeding is a key for successful breeding programme because the discovery of genes and markers influencing traits of economic interest for the livestock industry is an ongoing process with commercial applications (Fortes *et al*, 2013). Identification of genes for desirable traits unlike in traditional selection can improve accuracy of introducing desirable genes into animals next generations. This selection approach is a paradigm shift in animal production science with umatched accuracy for improving productivity compared with traditional selection which is primarily based on phenotypic traits and it will allow optimum application of reproductive technologies for improvement of indigenous low productive breeds (Meuwissen *et al*, 2016). The male-specific region of the mammalian Y chromosome (MSY) contains clusters of genes essential for male reproduction; the region of MSY have highest gene density in the genome of bovine, the genes are predominantly expressed and are differentially regulated during the testicular development, and it is a region of genomic niche regulating male reproduction (Chang *et al*, 2013).

Apart from their predominance in testicular development, genes in MSY region are highly expressed in the testis of fertile mammals which supports their potentials as molecular markers of fertility (Paria *et al*, 2011). Again some of the genes within the region in bovine were reported to be highly expressed (upregulated) during testicular development which is an indication that they are important for reproductive performance. Meiotic recombination which is an essential biological process that generates genetic diversity were reported to be more for bulls compared with cattle in a large genome-wide association study involving up to a million cattle; and this diversity primarily occurs near the subtelomeric regions of all bovine autosomes which is an indication that most genetic richness of cattle are closely associated with bulls (Ma *et al*, 2015). Considering the growing population and increasing demand for cattle products (milk and beef), application of reproductive technologies such as artificial insemination is highly desirable but in order to eliminate the use of sub-fertile and infertile bulls from breeding programme; molecular identifcation using MSY region genes in indigenous cattle of Nigeria can speed up selection and improve productivity.

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SEXUAL DIFFERENTIATION AND PHENOTPIC CORRELATIONS AMONG BIOMETRIC TRAITS OF NIGERIAN LOCAL TURKEY (*Meleagris gallopavo*)

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Abstract
One- hundred and twenty four (124) Nigerian local turkeys at age of six months were used for this study. Data were collected on growth traits to determine the effect of sex and phenotypic correlations among growth traits. Sex had significant effect (P<0.05) on all the variables in favour of male. The body weight, shank length, thigh length, body length, wing length, wing span and breast girth for males were 3.80 kg, 9.01 cm, 21.68 cm, 63.00 cm, 32.44 cm, 72.86 cm and 40.17 cm respectively, while the corresponding values for female were 2.93 kg, 7.27 cm, 17.96 cm, 55.37 cm, 28.18 cm, 63.92 cm and 36.14 cm. The correlation coefficients between body weight and the linear measurements in the two sexes were positive and mostly significant in males. It ranged between 0.291 and 0.561 in males and 0.233 and 0.721 in females. Sexual dimorphism was obvious in all the traits considered in favour of males and in similar trend the positive correlations between body weight and the linear body measurements in the two sexes indicate pleiotropy which means improvement in any of the traits will lead to improvement in the body weight.

Keywords: Nigerian local turkey, sex, wing length, body length and breast girth

Introduction

The first approach in livestock characterization apart from evaluation of its production performance is the evaluation of body size and conformation (Ibe, 1989). A quantitative measure of conformation will no doubt enable reliable genetic parameters for the traits to be estimated but also make it possible to include conformation in breeding programme. Body weight has been commonly used to measure body size. Assessment of body weight and linear body measurements has been found useful in quantifying body size and shape (Ibe and Ezekwe, 1994).

Phenotypic characterization of Animal Genetic Resources (AnGR) is the process of identifying distinct breed populations and describing their external and production characteristics in a given environment and under given management, taking into account the social and economic factors that affect them. The information provided by characterization studies is essential for planning the management of AnGR at local, national, regional and global levels. The *Global Plan of Action for Animal Genetic Resources* (FAO, 2007) recognizes that "A good understanding of breed characteristics is necessary to guide decision-making in livestock development and breeding programmes".

The developmental processes of males and females are governed by partially different hormonal and physiological controls (Nestor *et al*., 2000). Such sex differences in physiological parameters may translate into sex-specific responses to selection among males and females of the same age and, ultimately, can lead to a rapid change in sexual size dimorphism even under constraints of shared gene pool (Rhen, 2000). Therefore, the aim of this study was to determine the effect of sex on growth traits and the phenotypic correlations among the growth traits.

Materials and Methods

The experiment was carried out in a farm at Ibadan in Oyo State. Ibadan is located on latitude 07^0 23N and longitude $03^0$54E and has a semi-hot equatorial climate characterized by seven or more uninterrupted humid months and one to three dry months. One- hundred and twenty four turkeys were raised from day-old to six months of age in a deep litter system, where they were fed with commercial feed and water supplied *ad libitum.* At the sixth month of age, the turkeys were weighed individually and linear body measurements taken as follows:

Linear body measurements were as suggested by Solomon (1996) and Gueye *et al*. (1998) . The weights of the birds were obtained using a 20 kg weighing scale, while a measuring tape was used for body measurements in centimeter. Wing Length (WL) was taken from the shoulder joint to the extremity of terminal phalanx while Shank Length (SL) was measured from the hock joint to the spur. Thigh Length (TL) was taken as the distance between the hock joint and the pelvic joint. Body Length (BL) is the length between the tip of the *rostrum maxillare* (beak) and that of the *cauda* (tail, without feathers). Breast girth (BG) was taken under the wing at the edge of the sternum while wing span (WS) is length between tips of right and left wings after both arestretched out in full. To ensure accuracy, each measurement was taken twice and the mean was used in subsequent analysis. All the measurements were taken by the same person.The data collected were subjected to analysis of variance to determine the summary statistics and sex effect on the growth traits using SAS (1999). Pearson correlation was used to determine the correlation coefficients among the traits on sex basis.

Results

Table 1 shows the summary statistics of the body weight and linear body measurements on the basis of sex. Sex had significant effect ($P<0.05$) on all the variables considered. Higher values were recorded in favour of males.

Table 1: Summary statistics of body weight and linear measurements of Nigerian local turkey

SEX	VARIABLE	MEANS	STD.DEV.	N	NIN.	MAX.	CV
	BWT	2.93±0.06	0.46	81	1.5	3.5	15.74
	SL	7.27±0.11	0.78	81	6.0	9.0	10.76
	TL	17.96±0.19	1.33	81	16.0	22.0	7.38
FEMALE	BL	55.37±0.44	3.17	81	47.0	63.0	5.73
	WL	28.18±0.28	1.99	81	24.0	34.0	7.09
	WS	63.92±0.51	3.65	81	56.0	73.0	5.71
	BG	36.14±0.48	3.40	81	28.0	42.0	9.41
	BWT	3.80±0.06	0.38	43	3.0	4.5	9.95
	SL	9.01±0.08	0.49	43	8.0	10.0	5.38
	TL	21.68±0.19	1.18	43	19.0	24.0	5.43
MALE	BL	63.00±0.52	3.12	43	57.0	70.0	4.95
	WL	32.44±0.40	2.42	43	25.0	36.0	7.46
	WS	72.86±0.90	5.41	43	57.0	80.0	7.42
	BG	40.17±0.51	3.05	43	34.0	45.0	7.59

Bwt-body weight,Sl-shank length,Tl-thigh length; Bl-body length;Wl-wing length;Ws-wing span;Bg-breast girth

The correlation coefficients between the body weight and linear measurements for male and female birds are shown in Table 2. The upper diagonal shows the correlations for males while the lower diagonal is for the females. The correlations between body weight and the linear measurements were positive in the two sexes but not significant with wing length. It was also not significant with shank length (0.263) and thigh length (0.228) in the female. The correlations among the linear measurements in the male ranged between -0.057 and 0.559 while in the female were between 0.050 and 0.779.

Table 2: Phenotypic correlation between body weight and linear measurements

	BWT	SL	TL	BL	WL	WS	BG
BWT	1.000	0.366*	0.561**	0.466**	0.291	0.397*	0.516**
SL	0.263	1.000	0.470**	0.387*	0.506**	0.431**	0.008
TL	0.228	0.637***	1.000	0.673***	0.562**	0.559**	0.266
BL	0.495**	0.545***	0.588***	1.000	0.504**	0.588**	0.153
WL	0.233	0.467**	0.531***	0.633***	1.000	0.749***	-0.057
WS	0.325*	0.445	0.562***	0.639***	0.779***	1.000	0.09
BG	0.721***	0.188	0.050	0.447**	0.205	0.338*	1.000

Bwt-body weight,Sl-shank length,Tl-thigh length; Bl-body length;Wl-wing length;Ws-wing span;Bg-breast girth

Discussion

The significant effect of sex on the body weight and other variables considered in this study was in favour of males which had higher values on all the variables. The higher values observed in males indicate sexual dimorphism. This is in agreement with the observation of Ogah (2011) who reported body weight of 3.38±0.07 kg for males and 2.65±0.02 kg for females in Nigerian indigenous turkey at five months of age. The 3.80±0.06 kg for males and 2.93±0.06 kg for females observed in this study are lower than the 6.01 kg and 3.97 kg reported by Kodinetz (1940) and Muzic (1990) for Zagorje turkey at five months of age. The higher values observed in the variables compared with the values reported by Ogah (2011) for the same breed could be attributed to age differences. The relatively low body weight in the present study compared to the respective traits found in temperate region may be due to the unfavourable environmental conditions such as temperature, feed supply and unselective nature of tropical animal genetic resources. The positive correlations between body weight and other body measurements observed in both male and female turkey indicate that improvement in any of the variables correspond to improvement in body weight which could be explained by pleiotropy. Similar observations were reported by Ogah (2011) and Bachev (1990).

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EVALUATION OF FOUR CLASSICAL NON-LINEAR MODELS TO DESCRIBE THE GROWTH CURVE OF FUNAAB-ALPHA CHICKENS

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Abstract

The objective of this study was to evaluate four non-linear models (Gompertz, Logistic, Bertalanffy and Richard's) to describe the growth performance of FUNAAB-Alpha chickens (FAC). Three hundred (300) FAC chicks of both sexes were raised from day old till the 20th weeks of age. Body weight records were taken weekly and the NLIN procedure of SAS® was used to fit four non-linear growth functions. For all the models, parameter A (or asymptotic weight) ranged from 2050.8 to 3716.6g for the male and 1591.7 to 3330g for the female chicken respectively, while parameter B (constant of integration) ranged from 0.7541 to 15.441. Similarly, parameter K (maturity index) ranged from 0.0463 to 0.2002.The parameter A (asymptotic weight) was highest for Bertalanffy model while the Logistic model estimated the highest value of parameter B (the scaling parameter) and parameter K (maturity index). For all the models fitted, age at inflection point ranged between 13.30 and 17.63 weeks for male chickens and 14.23 and 19.94 weeks for female chickens, while the corresponding body weight at inflection point ranged between 754 and 1528 g and 586 and 1261 g for male and female chickens respectively. Using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) as the goodness-of-fit criteria, the Bertalanffy and Gompertz growth models were adjudged as the best fit models for evaluating the growth of FAC.

Keywords: Non-linear models, Growth curve parameters, FUNAAB-Alpha chickens, Point of Inflection.

Introduction

Growth can be defined as body weight gain or weight gain of body parts with age. The process of growth, measured as body mass or body weight on a longitudinal time frame has often been summarized using mathematical equations fitted to growth curves and the objective of this curve fitting is to describe the course of body weight increase over time or age with mathematical parameters that are biologically interpretable (Aggrey, 2002). These parameters have biological interpretation in terms of growth process and their values, as well as their relationships with other parameters, provide a genetic basis for understanding growth process and to develop breeding strategies to alter or modify the trajectory of growth.

Many mathematical models have been applied for the study of growth performance in poultry research. These include Gompertz, Bertalanffy, Logistic and Richard's functions. These models are non-linear and they fitted curves that relate the age of the bird with its weight, characterized the different phases of growth of the bird, allowed the estimation of the animal's growth rate, the age at which the animal stops growing and when it reaches sexual maturity (Galeano-Vasco *et al*., 2014).

Funaab-alpha chickens is a new breed of chickens described as an improved, indigenous, tropically adapted and dual-purpose breed developed through crossbreeding and intensive selection over many generations for improved meat and egg production without sacrificing adaptation to the tropical environment (Adebambo, 2015). Knowledge about jts growth curve parameters will be useful in making effective management decisions relating to feeding, maximization of the growth period and evaluating the influence of environmental stress on growth. The objective of this study was therefore to compare Gompertz, Logistic, Bertalanffy and Richard's growth models for describing the growth trajectory of Funaab-alpha chickens.

Materials and Methods

Three hundred (300) day-old chicks of the FUNAAB-Alpha chickens (FAC) were obtained from the Hatchery Unit of the Federal University of Agriculture, Abeokuta. They were brooded for two weeks, wing tagged for identification and thereafter transferred to the deep litter pens. A sensitive digital scale was used to take the weekly body weight of the individual chicken from day old till the 20th week when the experiment was terminated. Four non-linear growth functions including Gompertz, Logistic, Bertalanffy and Richard's model were fitted using the NLIN procedure of SAS®(2003) using the following equations: $W_{t=A*exp\ (-B*\exp(-K*t)}$; $W_t = A\ (1 - B * e^{-K*t})^3$; $W_t = \frac{A}{1+B*exp(-k*t)}$ and $W_t = 1 + B * exp(-k * t)^{1/d}$ respectively.

A is asymptotic weight, B = scaling parameter, K= maturity index while d is shape parameters for Richard's model.

Results and Discussion

Table 1 shows the estimated growth model parameters for male and female FUNAAB-Alpha chickens (FAC) reared intensively under a deep litter system using Gompertz, Logistic, Bertalanffy and Richard's growth functions. For all the models, parameter (A) which is the asymptotic weight (maximum stationary weight) ranged from 2050.8-3716.6g for the male and 1591.7-3330g for the female chicken respectively while parameter (B), the scaling parameter (constant of integration) ranged from 0.7541-15.441. Likewise, parameter K, which is the maturity index ranged from 0.0463-0.2002. The Bertalanffy model estimated the highest asymptotic weight while the Logistic model estimated the least. The asymptotic weight estimated in this study by the Gompertz model is consistent with the findings of Zhao *et al.* (2015) and Al-Samarai (2015) on some improved indigenous chickens of China and meat-type chickens of Iraq respectively but higher than the values obtained by Aggrey (2002), Osei-Amponsah *et al.* (2014) and Ngeno *et al.* (2010) for Athens-Canadian chickens and local chickens in Ghana and Kenya respectively. The values of parameter A obtained for Logistic model is consistent with the values reported by Aggrey (2002) and Al-Samarai (2015) but lower than the values reported by Eleroglu *et al.*(2014) for some Turkish indigenous chickens. Parameter A obtained in this study for Richard's model in this study is consistent with the findings of Aggrey (2002) but higher than those reported by Rizzi *et al.*(2013) and Osei-Amponah *et al.*(2014) for chickens in Italy and Ghana respectively. The variations in the asymptotic weight of these chickens could be attributable to genetic differences, the system of management and the prevailing climatic conditions of the environment in which these chickens were raised as well as the various interactions which ultimately influence the growth trajectory.

Table 1: Estimated growth model parameters for FUNAAB-Alpha chickens

	Male				Female			
Model	**A**	**B**	**K**	**D**	**A**	**B**	**K**	**D**
Gompertz	3056.3	3.5503	0.0860	-	2521.0	3.5813	0.080	-
Logistic	2050.8	15.441	0.2002	-	1591.7	15.718	0.1964	-
Bertalanffy	3716.6	0.7541	0.0463	-	3330.6	0.7672	0.0417	-
Richards	3056.2	2.521	0.150	0.343	2520.9	2.852	0.147	0.352

Where A,B,K and D are the asymptotic weight, the scaling parameter, maturity index and the shape parameter for Richard's model respectively

Table 2 shows the body weight and age at inflection point for FAC as estimated by Gompertz, Logistic, Bertalanffy and Richard's models. For all the models fitted, age at inflection point for FAC ranged between 13.30 and 17.63 weeks for male chickens and 14.23-19.94 weeks for female chickens while the corresponding body weight at inflection point ranged between 754 and 1528 g and 586 and 1261 g for male and female chickens respectively. For both sexes, the Gompertz model estimated the highest body weight at inflection while the Logistic model estimated the least. Similarly, the Richard's model predicted the earliest age at inflection point while the Bertalanffy model estimated the highest age at inflection. For all the models, the males had higher body weight at inflection than females. However, the females had higher ages at inflection point than the corresponding males for all the models.

The goodness-of-fit tests for the Gompertz, Logistic, Bertalanffy and Richard's growth models are presented in Table 3. These included the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). The lower the values of AIC and BIC, the better fit is the data (Kaps and Lamberson, 2004). For both sexes, the Bertalanffy model had the lowest AIC and BIC and was adjudged the best fit model followed by Gompertz model, Richard's model and logistic model in that order. This is in agreement with the conclusion of Aworetan and Oseni (2018), Eleroglu *et al.*(2014), Ngeno *et al.*(2010) and Osei-Amponsah *et al.*(2014) that reported Bertalanffy as the best fit nonlinear models for some indigenous chickens in Nigeria, Turkey, Kenya and Ghana respectively while Darmani *et al.*(2003) selected the flexible Richard model as the best fit. The lesser fit of the Richard's model observed in this study may be due to the extra parameter in the model, for which it was penalized by the model selection criteria. It has also been reported as inadequate in providing good fit to data patterns and observation (Meng *et al*., 1997). Aggrey (2002) suggested that the addition of the fourth parameter may represent an over-parametarization of the growth model.

Table 2: Body weight (g) and age (weeks) at inflection point

	Male		Female	
Model	**T_i (weeks)**	**W_i(g)**	**T_i (weeks)**	**W_i(g)**
Gompertz	14.73	1528	15.95	1261
Logistic	13.67	754	14.03	586
Bertalanffy	17.63	1101	19.94	987
Richards	13.30	1294	14.23	1070

Where T_i is the age (weeks) and W_i is the body weight (g) at inflection point.

Table 3: Best fit model selection criteria using Goodness-of-Fit tests

	Male		Female	
Model	**AIC**	**BIC**	**AIC**	**BIC**
Gompertz	50.42	61.528	44.46	55.102
Logistic	53.23	64.488	47.10	58.342
Bertalanffy	**49.42**	**60.122**	**44.21**	**54.154**

Richards	50.42	61.778	46.76	57.813

Where AIC and BIC are Akaike Information Criterion and Bayesian Information Criterion and Bayesian Information Criterion respectively.

Graphical representations of the growth rate patterns of FAC are depicted in Figures 1 and 2. The growth curves showed the non-linear dependency of body weight on age. Body weight increased with age but at different rates which differed slightly from one model to the other.

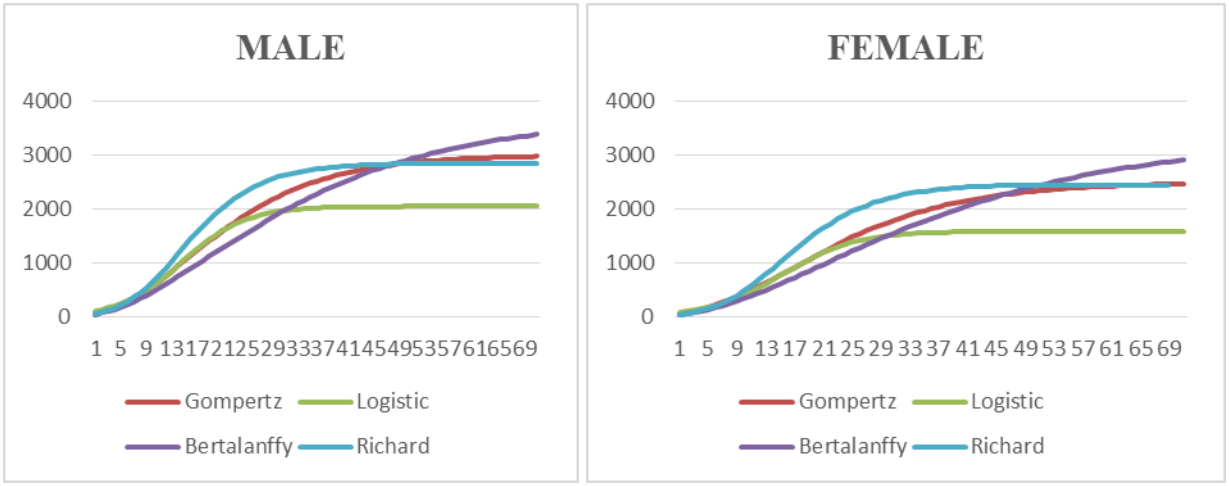

Fig 1 and 2: Growth curves for FAC predicted by Richards, Gompertz, Logistic and Bertalanffy growth models

Conclusion

The present study generated growth curves and growth parameters such as asymptotic weight (A), maturity index (K) and the constant of integration (B) for FAC. The predicted body weight from hatch till age at maturity were also generated. Among the non-linear models fitted, Bertalanffy and Gompertz models were found to be the best fit models.

Acknowledgement

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ESTIMATE OF DIRECT AND PERCENTAGE HETEROSIS OF BODY WEIGHT AND LINEAR BODY MEASUREMENTS OF RABBITS

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ABSTRACT
A total of 93 kittens produced from six (6) sires mated to twenty eight (28) dams of the New Zealand White (NZW) and Chinchilla (CHA) breeds of rabbit in a Completely Randomized Design were used for the estimation of heterosis. Positive direct and percentage heterosis were observed for all the growth traits measured in weeks 4, 8 and 12 (week 4- BW+74.32 & 25.22%, week 8- BW+89.72 & 12.69%, week 12- BW+45.22 & 4.14%) except in week 8 where negative direct and percentage heterosis occurred for EL (-0.38 , - 3.92) and week 12 where negative direct and percentage heterosis was observed for HS (-0.15, -1.32) and TL (-0.13, -1.44). It is therefore concluded that the NZW x CHA rabbits should be used for growth purposes because they had the highest performance in their growth parameters measured when compared with the other crosses: NZW x NZW, CHA x NZW, and CHA x CHA.

INTRODUCTION
Rabbit is a micro livestock producing about 47kg of meat per doe per year, which is enough to solely meet the animal protein requirement of a medium sized family under small scale rural farming systems (Hassan and Owolabi, 1996; Adedeji *et al*., 2012). Besides, rabbit meat is rich in vitamin B and extremely low in cholesterol and sodium levels (Jithendran, 2000; Omole *et al*., 2005). Starting a rabbit project requires minimal initial capital outlay. Additionally, a rabbit can be easily sold when a small amount of money is needed to meet immediate family needs. Rabbit production is a veritable way of alleviating animal protein deficiency in Nigeria (Ajala and Balogun, 2004). Crossbreeding offers two distinct advantages over pure breeding: heterosis and breed complementarity. Heterosis is the difference in performance between crossbred offspring and their purebred parents. This can be positive or negative. Mathematically, heterosis is the percentage increase in a specific trait that progeny have over the average performance of their parents (El-Bayomi *et al*., 2012). Positive heterosis or "hybrid vigour" is the superiority of the heterozygote above the average value for the two parents (Fayeye, 2013). The percent superiority depends on the magnitude of non-additive genetic variation in the trait under consideration (Nagpure *et al*., 1991). El-Bayomi *et al*. (2012) reported that Californian crossed with New Zealand White rabbits had the best positive estimates of heterosis for body weights at all ages (22.69, 17.60, 6.76, 4.50, and 7.60% for weaning, 6th, 8th, 10th and 12th week of age; respectively). Abdel-Hamid (2007) estimated positive heterosis % for Californian x New Zealand White rabbits for body weight at weaning and 6th week of age. On the other hand, Zaghlool (1997) and Eman (2011) estimated negative heterosis % for Californian x New Zealand White rabbit at weaning. Khalil and Afifi (2000) reported a negative and low heterosis for post-weaning body weights (weeks 4, 6, 8, 10 and 12) in a cross between NZW and Gabali (Desert Egyptian breed). Nwakpu *et al*. (2015) reported a positive % heterosis for body weight (g) from birth to 8th week for all the crossbred kits measured. Percent heterosis effects were highly significantly ($P<0.01$) different among the crossbreds from birth to weaning. Egena *et al*. (2014) reported a positively significant ($P<0.01$) direct heterosis only for nose-to-shoulder with a percentage of 5.16 in favour of NZW strain. Production traits affecting milk yield and growth (for instance, season of kindling, lactation length, body weight) showed about 5% heterosis and a moderately high heritability (Hansen, 2006). The highest level of individual heterosis is always seen in the F_1 generation, but unfortunately the level always decreases in subsequent generations. An alternative to maintain the level of heterosis after

creating a two way cross is to produce a three way cross because in the third generation (F_3) or fourth generation (F_4) there is no further decrease in heterosis, as long as no inbreeding exists (Wakchaure *et al*., 2016). Therefore , the objective of this study was to estimate the direct and percentage heterosis of body weight and linear body measurements of a cross between New Zealand White and Chinchilla breeds of rabbits.

MATERIALS AND METHODS

Experimental site

This experiment was carried out at the Rabbitary Unit, Teaching and Research Farm, Michael Okpara University of Agriculture, UmudikeUmuahia, Abia State. The farm is located at latitude 05^0 29^1 North and longitude 07^0 33^1 East. The farm lies in the altitude of 122m and within the rainforest zone of south-east Nigeria, which has bimodal rainfall pattern and total annual rainfall range of 1700-2100mm, maximum ambient temperature of 27 to 36^0C during the hot dry season of the year (November – March) and minimum ambient temperature range of 20^0C-26^0C during the cold rainy season (April-October). The relative humidity ranges from 57-91% and is located in warm humid tropics (NRCRI, 2004)

Experimental animals and their management

Ninety-three (93) kittens produced from six (6) sires and twenty-eight (28) dams of the NewZealand White and Chinchilla breeds of rabbit were used for this study to estimate heterosis. The animals were housed in hutches. Feed (concentrate and forages-*Panicum maximum* and *Centrosema pubescens*) and water were given to the animals *ad libitum*. The diet fed to the animals consisted of 18% CP, 2600 ME (Kcal/kg), and 8% CF as analyzed. Routine management operations were carried out on daily basis. The animals were given Ivomec injections against Endo- and Ecto- parasites.

Data collection and analysis

Data on growth performance were collected bi-weekly from the progeny starting from the 2nd week to their 12th week of age. The body weight was taken using a sensitive scale and a toploading Hana power 5kg scale with sensitivity of 25g, while the morphometric traits were measured using a measuring tape graduated in centimeters.

Estimates of direct heterosis were obtained as follows (Dickerson, 1992)

Direct heterosis = Mean of crossbreds – Mean of purebreds

$$= \frac{[(NZWxCHA + CHAxNZW) - (NZWxNZW + CHAxCHA)]}{2}$$

The percent (%) heterosis was calculated as follows: $\frac{\text{Heterosis (H) in units}}{\text{Mean of purebred}} \times 100$

$$= \frac{[(NZWxCHA + CHAxNZW) - (NZWxNZW + CHAxCHA)]}{[NZWxNZW + CHAxCHA]} \times 100$$

The experiment was a Completely Randomized Design. The statistical model of the design is as shown in expression 3.1.

$Y_{ij}=\mu + G_i + e_{ij}$ . . . 3.1

Where,

Y_{ij} = Single observation, e.g body weight, ear length, packed cell volume, etc

μ = Overall mean

G_i = Effect of genotype (i =1,…,4)

e_{ij} = random error, assumed to be independently, identically and normally distributed with zero mean and constant variance (ii n d $(0, \sigma^2)$).

RESULTS AND DISCUSSION

Table 1 gives estimates of direct and percentage heterosis of body weight and linear body measurements of rabbits in weeks 4, 8 and 12. In week 4, the direct and percentage heterosis for body weight and linear body measurements were positive. This agrees with El-Bayomi *et al.* (2012) who reported positive estimates of heterosis for body weight at all ages in a cross between California and New Zealand White rabbits. This also agrees with Nwakpu *et al.* (2015) who reported a positive percent heterosis for body weight from birth to 8th week for all the crossbred kits measured. Egena *et al.* (2014) also reported a positive and highly significant ($P<0.01$) direct heterosis only for nose-shoulder with a percentage of 5.16 in favour of NZW strain. In week 8, the direct and percentage heterosis for body weight and linear body measurements were positive except for EL. In week 12, the direct and percentage heterosis for body weight and linear body measurements were positive except for HS and TL. The negative heterosis observed for HS and TL partly agrees with Egena *et al.* (2014) who reported that heterotic effect was significant ($P<0.01$) but negative for all the linear body measurements in a cross between New Zealand White and Chinchilla rabbits. The negative heterosis observed is also in agreement with Zaghlool (1997) and Eman (2011) who estimated negative percent heterosis for California x New Zealand White rabbits at weaning. Khalil and Afifi (2000) reported a negative and low heterosis for post weaning body weight (weeks 4, 6, 8, 10 and 12). Positive heterosis (hybrid vigour) indicates the superiority of the heterozygote over the average value for the two parents. The implication is that crossbreeding is effective in improvement of the traits, which are largely influenced by non-additive genes. The positive estimate of heterosis also implies that the rabbits (progeny) were able to receive and combine the trait genes from both parents. The negative heterosis implies that the performance of the progeny is lower than the average performance of their parents.

CONCLUSION

The estimates of heterosis for growth traits were positive for body weight in all the ages estimated and positive for most of the linear body parameters measured. This is an indication that the rabbits (progeny) used for this study were able to receive and combine the traits (genes) of both parents. This study showed that crossbreeding is very important in the improvement of rabbits for the traits studied. It is recommended that the NZW x CHA genotype be selected and used by farmers for optimum improvement.

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Table 1: Estimate of direct and percentage heterosis of body weight and linear body measurements of rabbits in weeks 4, 8 and 12

Age(weeks)	Heterosis	BW	BL	EL	HG	HS	LBH	LFB	TL	TG
4	Direct	74.32	1.54	0.24	1.00	0.09	0.95	0.76	0.41	0.58
	Percentage(%)	25.22	7.01	3.43	7.35	1.26	7.10	8.89	9.21	10.64
8	Direct	89.72	1.93	-0.38	1.79	0.38	0.62	0.92	0.44	0.52
	Percentage(%)	12.69	6.96	-3.92	9.87	4.38	3.53	8.74	6.52	6.92
12	Direct	45.22	2.12	0.18	1.16	-0.15	0.72	0.38	-0.13	0.75

Percentage(%)	4.14	6.28	1.64	5.46	-1.32	3.21	2.73	-1.44	8.23

BW – Body Weight, BL – Body Length, EL – Ear Length, HG – Heart Girth, HS – Head to Shoulder, LHB – Length of Hindlimb, LFB - Length of Forelimb, TL – Tail Length, TG – Thigh Girth

Table 2: Mating scheme for the production of offspring

Mating Type	Number of Sires	Number of Dams	Number of Progeny
NZW X NZW	3	6	25
NZW X CHA	3	6	20
CHA X CHA	3	7	18
CHA X NZW	3	9	30

FARMERS' CHOICE OF BREEDING STOCK AND TRAIT PREFERENCES IN TROPICALLY-ADAPTED CHICKENS IN FIVE AGRO-ECOLOGICAL ZONES IN NIGERIA

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Abstract

This study aimed at determining chicken genotypes of choice and traits preference in chickens by smallholder farmers in Nigeria. Data were obtained from a total of 2,063 farmers using structured questionnaires in five agro-ecological zones in Nigeria. Chi square ($\chi 2$) statistics was used to compare categorical variables. Ranking of the six genotypes and twelve traits of preference was carried out using the non-parametric Kruskal–Wallis H and Friedman tests. Categorical principal component analysis (CATPCA) was used to assign farmers into groups. With the exception of Shika Brown, preferences for chicken genotypes were significantly ($P \leq 0.01$) influenced by agro-ecological zone. Overall, FUNAAB Alpha, Sasso and Noiler chicken were ranked 1st, followed by Kuroiler (4th), Shika Brown (5th) and Fulani birds (6th), respectively. Across genotypes, preferences for traits varied significantly ($P \leq 0.005$ and $P \leq 0.01$). Traits of preference for selection of chicken breeding stock were body size, egg number, egg size and meat taste. The two PCs extracted, which explained 65.2% of the variability in the dataset, were able to assign the farmers into two groups based on preference for body size of cock and hen and the other ten traits combined. The present findings may guide the choice of appropriate chicken genotypes while the traits of economic importance may be incorporated into future genetic improvement and conservation programmes in Nigeria and in Sub-Saharan Africa.

Keywords: Chicken, traits, non-parametric, multivariate analysis, Nigeria

Introduction

Smallholder poultry sub-sector in Sub-Saharan Africa is beset with myriad of problems among which are poor nutrition, limited technical know-how, vagaries of climatic factors, slow-growth, low meat yield, small size/number of eggs, low-input and high mortality. In order to address the factors militating against high chicken production and productivity at the smallholder level, research efforts in the area of genetics and breeding amongst others have been made in the past three decades (Sonaiya, 2016). One of such is the development of chicken genotypes that are adapted to the prevailing tropical conditions (Adebambo *et al*., 2018). However, it has been reported that the proper identification of appropriate chicken breeds that will be suitable to a particular environment or agroecological zone in Nigeria is required for the growth and development of the poultry industry. Such decision is expected to be based on farmers' choice especially at the smallholder level using the bottom-top approach. This, coupled with farmers' traits of preference, may be valuable inputs for appropriate design and implementation of agro-ecologically friendly and sustainable genetic improvement programmes. Under the African Chicken Genetic Gains (ACGG) project, Kuroiler and Sasso birds (foreign, but tropically-adapted genotypes) alongside the

genotypes developed in Nigeria (Fulani, FUNAAB alpha, Noiler and Shika Brown) were tested in five agroecological zones of Nigeria. This paper reports a study aimed at evaluating choice of chicken genotypes and trait preferences by ACGG participating smallholder chicken farmers in Nigeria. This may assist in future research efforts on genotypes and traits of economic importance by private and public intervention programmes geared towards boosting smallholder chicken production.

Materials and Methods

The post on-farm data collection study was conducted in five agro-ecological zones under the ACGG project in Nigeria. The birds (Sasso, Kuroiler, Fulani, Shika Brown, Noiler and FUNAAB alpha) given to the farmers were managed under the traditional poultry scavenging system in all the five zones. Each zone was represented by a State (Kwara, Rivers, Imo, Nasarawa and Kebbi) and involved a total of 2,063 rural chicken keepers. In each zone, twelve villages, 2 per local government area (LGA) in each of the 3 senatorial districts were randomly selected. Structured questionnaires were used to elicit information on the choice of chicken genotypes and traits of preference in a post on-farm data collection survey. The traits Body Size–Cock (BSC); Body Size–Hen (BSH); Supplementary Feed Consumption–Cock (SFC); Supplementary Feed Consumption–Hen (SFH); Egg Number–Hen (ENH); Egg Size–Hen (ESH); Scavenging Ability–Cock (SAC); Scavenging Ability–Hen (SAH); Meat Taste–Cock (MTC); Meat Taste–Hen (MTH); Ease of Sales–Cock (ESC) and Ease of Sales–Hen (ESH) as perceived by the respondents were ranked on a scale of 1 (Like very much), 2 (Like), 3 (Not Important), 4 (Dislike), 5 (Dislike very much), 6 (Not Applicable). Percentage distribution of chicken genotype of choice by the farmers across zones and gender was obtained using Pearson's Chi square. Ranking of the five genotypes in order of preference by farmers and of the traits of economic importance was carried out using the non-parametric Kruskal–Wallis H and Friedman tests followed by Mann–Whitney U and Wilcoxon Signed-rank tests for Post hoc analyses. In order to explore hidden patterns of trait preferences for appropriate grouping of the respondents, categorical principal component analysis (CATPCA) procedure was used. SPSS (2015) statistical package was employed in the analysis.

Results and Discussion

The preference for a chicken genotype was significantly ($P \leq 0.01$) influenced by agroecological zone with the exception of Shika Brown (Table 1) with FUNAAB Alpha, Sasso and Noiler chicken ranked 1st, followed by Kuroiler (4th), Shika Brown (5th) and Fulani (6th), respectively (Table 2). The high preference for FUNAAB Alpha, Sasso and Noiler birds in the present study could be due to their desirable performance in the field. This could have been influenced mainly by their body size and egg number (Table 3). Although Kuroiler was ranked fourth, it was able to compete well with Sasso and Noiler chicken. This implies that in the case of non-availability of the latter, Kuroiler could be a good substitute. The low ranking of Shika Brown might be attributed to the fact that the breed was developed mainly for egg production unlike others that are dual-purpose. The least preference for Fulani chicken could be as a result of its low productivity compared to other genotypes. However, this genotype is renowned for its high adaptability to the prevailing hot-dry tropical environment of Nigeria (Yakubu and Ari, 2018) and good scavenging ability. Some of the merits indicated by farmers for the choice of a particular genotype in the current study are similar to the egg productivity and body size traits reported by Sisay *et al*. (2018). Gender differences (Table not shown) in the present study as regards the choice of Sasso chicken may be attributed to poultry keeping objectives and varied importance attached to the chicken genotype by both male and female farmers. Traits of preference for selection of breeding stock in the present study were body size, egg number, egg size and meat taste. The observations on body size and egg yield are in consonance with the findings of Mahoro *et al*. (2018) that they are important economic traits to select in the indigenous chicken. Meat quality in form of good taste is an important trait in the poultry industry. It has been recommended that breeding strategies should aim not only at the growth and performance of chicken, but also put into consideration the qualitative aspects of meat (Paiva *et al*., 2018).Two PCs were extracted which explained 65.3% of the variability in the dataset and revealed that irrespective of gender and agro-ecological zone, the farmers in Nigeria can be grouped into two: Those that emphasize BSC and

BSH and those that attach more importance to SFC, SFH, ENH, EZH, SAC, SAH, MTC, MTH, ESC and ESH.

Conclusion

The present study revealed equal ranking of FUNAAB Alpha, Sasso and Noiler, followed by Kuroiler, Shika Brown and Fulani chicken across five agro-ecological zones in Nigeria. Traits of economic importance that appeared consistent in selecting breeding stock were body size, egg number, egg size and meat taste. The chicken farmers were distinctly assigned into two groups (body size and non-body size traits) using categorical principal component analysis. These findings when combined with quantitative on-farm data have implications for future breeding programs geared towards increased chicken production and productivity in the tropics using bottom-top approach.

Acknowledgement

This research was carried out under the International Livestock Research Institute (ILRI) led African Chicken Genetic Gains (ACGG) project sponsored by Bill and Melinda Gates Foundation. The support of Dr. Tadelle Dessie (ACGG International Program Leader) and his team at ILRI is acknowledged.

Table 1. Chicken genotype preference by farmers across zones in Nigeria

	Zone						
	Kwara	Rivers	Imo	Nasarawa	Kebbi		
Factor	No (%)	No (%)	No (%)	No (%)	No (%)	Chi-square	P-value
Genotype							
Shika Brown							
Liked	49 (59.0)	40 (52.6)	60 (72.3)	48 (57.1)	52 (61.9)		
Not Liked	34 (41.0)	36 (47.4)	23 (27.7)	36 (42.9)	32 (38.1)	7.342	0.119^{ns}
FUNAAB Alpha							
Liked	38 (79.2)	40 (90.9)	30 (62.5)	43 (89.6)	42 (87.5)		
Not Liked	10 (20.8)	4 (9.1)	18 (37.5)	5 (10.4)	6 (12.5)	17.671	0.01**
Fulani							
Liked	17 (47.2)	16 (48.5)	3 (8.3)	2 (5.6)	14 (38.9)		
Not Liked	19 (52.8)	17 (51.5)	33 (91.7)	34 (94.4)	22 (61.1)	30.433	0.01**
Kuroiler							
Liked	68 (81.0)	64 (83.1)	74 (88.1)	58 (69.0)	52 (64.2)		
Not Liked	16 (19.0)	13 (16.9)	10 (11.9)	26 (31.0)	29 (35.8)	18.743	0.01**
Sasso							
Liked	62 (73.8)	66 (88.0)	77 (91.7)	67 (79.8)	50 (60.2)		
Not Liked	22 (26.2)	9 (12.0)	7 (8.3)	17 (20.2)	33 (39.8)	30.246	0.01**
Noiler							
Liked	67 (79.8)	47(61.0)	73 (86.9)	74 (88.1)	67 (79.8)		
Not Liked	17 (20.2)	30(39.0)	11 (13.1)	10 (11.9)	17 (20.2)	22.675	0.01**

** Significant at $P \leq 0.01$; ^{ns}Not significant

Table 2. Ranking of preferred chicken genotypes by farmers in Nigeria

Genotype	Liked	Not Liked	Mean Rank[v]	Kruskall-Wallis Test	Position
	No (%)	No (%)			
Shika Brown	297 (64.8)	161 (35.2)	1496.65^{c}		5th
FUNAAB Alpha	303 (87.6)	43 (12.4)	1194.98^{a}		1st
Fulani	72 (36.5)	125 (63.5)	1872.32^{d}		6th
Kuroiler	410 (81.3)	94 (18.7)	1277.59^{b}		4th
Sasso	502 (85.1)	88 (14. 9)	1228.00^{ab}		1st
Noiler	475 (84.8)	85 (15.2)	1231.50^{ab}	292. 970**	1st

**Significant at $P \leq 0.01$; Means in columns followed by different letters are different significantly ($P \leq 0.05$)

[v]The lower the mean rank, the more important the genotype

Table 3. Mean ranks of traits preference across six chicken genotypes and their significance level according to Kruskall-Wallis test[v]

	Genotype						
	Shika Brown	FUNAAB Alpha	Fulani	Kuroiler	Sasso	Noiler	
Traits	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Kruskall-Wallis Test
BSC	1082.90^{b}	971.94^{a}	1351.16^{c}	1018.16^{ab}	1010.99^{ab}	1012.96^{ab}	40.292**
BSH	1088.59^{b}	974.47^{a}	1230.45^{c}	1023.56^{ab}	1010.54^{a}	1002.51^{a}	21.008**
SFC	1013.94^{b}	991.78^{b}	975.38^{ab}	1014.69^{b}	1096.48^{c}	911.83^{a}	28.286**
SFH	1005.98^{b}	971.39^{ab}	939.06^{ab}	1001.40^{b}	1102.78^{c}	910.31^{a}	32.361**
ENH	801.83^{a}	878.48^{b}	1059.23^{c}	982.83^{bc}	1042.54^{c}	925.90^{b}	49.808**
EZH	821.92^{a}	924.11^{b}	1197.42^{d}	936.70^{bc}	1007.94^{c}	951.92^{bc}	39.894**
SAC	965.69^{ab}	946.06^{a}	885.13^{a}	1033.12^{b}	1068.86^{c}	1021.86^{bc}	16.406**
SAH	982.42^{ab}	912.29^{a}	883.56^{a}	1013.05^{b}	1077.72^{c}	1016.14^{bc}	22.065**
MTC	911.95^{a}	1029.04^{b}	1059.87^{b}	1000.97^{b}	1018.89^{b}	1055.10^{b}	14.402*
MTH	877.24^{a}	970.45^{b}	1012.48^{bc}	1010.54^{bc}	999.60b^{c}	1056.98^{c}	21.744**
ESC	938.38^{a}	973.57^{a}	1164.73^{b}	1015.77^{ab}	1016.11^{ab}	957.03^{a}	14.225*
ESH	933.71^{a}	927.94^{a}	1094.91^{b}	982.25a	1028.14^{b}	926.91^{a}	16.222**

*, ** Asymptotic significance at $P \leq 0.005$ and $P \leq 0.001$, respectively

Means followed by different letters in rows are different. [v]The lower the mean rank, the more important the trait

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EFFECT OF DOSAGE OF VITAMIN E ON PHYSIOLOGICAL AND BLOOD PARAMETERS IN GROWING *Arbor acres* PULLETS UNDER HUMID TROPICAL CONDITIONS

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Abstract

One hundred and forty four growing *Arbor Acres* broiler breeder pullets were used to determine the effect of vitamin E (dL-α-tocopheryl acetate; VE) on the physiological and blood responses.The birds aged 21d were randomly assigned to 4 treatments consisting 0, 50, 100, 150mgVE/kg of diet, with 3 replicates per treatment till d84.Data obtained for rectal temperature (RT), heart rate (HR), respiratory rate (RR), skin temperature under wing (STW) and on the breast (STB), haematology and plasma biochemistry were subjected to analysis of variance.In female chickens, VE significantly ($p<0.05$) affected HR, STW, WBC, heterophil, lymphocyte and H/L ratio but did not affect RT, RR, STB, PCV, RBC, Hb concentration, eosinophil, monocyte, basophil, MCV, MCH, MCHC and biochemical parameters.Only pullets on 100mg/kg VE had lower HR than the control group. For STW, 50mg/kg VE had lowervalue than the control. VE, irrespective of dosage, increased ($p<0.05$) WBC and lymphocyte in pullets compared to control group. Except in 100mg/kg feed group, heterophil and H/L ratio in 50 and 150mg/kg feed recorded lower values than the control. VE administration of at least 50mg/kg feed in the diet of growing broiler breeder chickens might help in decreasing skin temperature, improving immunity and reducing stress under hot conditions.

Keywords:*tocopherol; heat stress; broiler breeder; blood; haematology; plasma biochemistry*

Introduction

It is well established that stress has detrimental effects on growth, immunity and performance of poultry species (Ajakaiye*et al.*, 2010). Heat stress (HS), which ensues under high environmental temperature, leads to economic losses. Reports on detrimental effects of HS on different classes of chickens are commonly found in literatures.However, growing broiler breeder chickens had received little attention among others classes of chickens.Broiler breeder chickens are known to be more susceptible to HS than strains of chickens.HS generates a lot of free reactive oxygen species (ROS) called radicals.Free radicals react with polyunsaturated fatty acids (PUFAs) in biological bi-layered membranes to initiate achain-reaction process known as lipid peroxidation in living systems thereby compromising the membrane integrity (Estévez, 2010).Vitamin E, a good chain-breaking natural antioxidant is reputed for scavenging the ROS that cause oxidation in the biological membranes.Unlike other vitamins, it is not synthesized in chickens. Its use has been reported in various classes of chickens (Sahin *et al.*, 2010; Guetchom *et al.*, 2012), but little is known of its effects in young broiler breeder chickens reared under tropical environment. Therefore, the present study aimed at determining the effect of dietary vitamin E on physiological and blood parameters in growing broiler breeder chickens under humid tropical conditions.

Materials and methods

Experimental location and meteorological observations:

The study was carried out at the Poultry Unit of University Farms, Federal University of Agriculture, Abeokuta, Nigeria (latitude 7° 13'N; longitude 3° 26'E (Google Earth, 2017) and altitude 76 m above sea level). Data on pen temperature and relative humidity in different units were monitored using thermo-hygrometer at 08:00, 13:00 and 17:00h daily. Temperature-humidity index (THI) and effective temperature were calculated.

Animals and management:

One hundred and forty fourfemale 21d-old *Arbor acres*broiler breeder birds managed according to the manual from the industry were allotted to four treatment groups. Birds in Treatment I received diet containing no vitamin E (dL-α-tocopheryl acetate; VE) while Treatment II, III and IV received dietary treatment with 50, 100 and 150mg VE/kg feed respectively in an experiment that last till d84.There were three replicates and 12 birds per replicate. Commercial diet was used for the birds at different stages of growth. Water was made available *ad libitum*.

Data collection:

Physiological responses

Rectal temperature (RT) of birds (n=2) from each replicate was measured with *Jorita* digital thermometer (model: ECT-5; 0.1°C accuracy).Respiratory rate (RR) of the birds was taken as the number of breaths per minute by counting the flank movement. Stethoscope was used to take the heart rate (HR) of the birds. Non-contact infra-red thermometer was used to take the skin temperature under wings (STW) and on the breast (STB) within 15cm from the bird. All measurement of physiological responses was taken twice weekly from d21 – d84 between 14.00 and 16.00 h.

Blood sampling and analyses

Blood samples were obtained from the chickens on d28, 56 and 84 via the wing web into heparinized and blank tubes for haematology and plasma biochemistry respectively. Parameters determined include PCV, RBC, Hb concentration, WBC, differential count, H/L ratio, total plasma protein, albumin, globulin, uric acid, creatine kinase and creatinine. MCV, MCH and MCHC were calculated.

Statistical analyses:

Data collected on body temperature, respiratory, heart rates, haematological and plasma biochemical parameterswere subjected toone-way analysis of variance using SAS (2002) computer statistical package. Means that are significantly different were separated with Tukey'sStudentized range test.

Results

Table 1 shows the summary of the meteorological observations during the experiment. The average pen temperature, relative humidity, THI and effective temperature was 28.2°C, 79.6%, 80 and 33°C respectively. Result of physiological responses in growing broiler breeder pullets as affected by vitamin E treatment is presented in Table 2. VE did not significantly ($p>0.05$) affect RT, RR and STB in pullets. However, HR in pullets was significantly ($p<0.05$) affected by VE. Pullets on 100mg/kg VE had lower HR than the CONTROL group. Birds on 50mg/kg VE had lower STW than the CONTROL and 150mg/kg VE in pullets, though similar to 100mg/kg VE.

Table 1:Summary of meteorological observations during the experiment

Climatic factor	**0800h**	**1300h**	**1700h**	**Average**
Ambient temperature (°C)	25.7±1.76	30.9±2.57	28.8±2.81	28.2±3.20
Relative humidity (%)	80.3±7.48	62.6±7.65	66.3±9.41	79.6±8.41
Temperature-humidity	75.8	81.2	78.9	80.0

index				
Effective temperature (^oC)	27	35	32	33

Table 3 shows the effect of vitamin E on haematologicaland biochemical parameters in growing breeder pullets. WBC, heterophil, lymphocyte and H/L ratio were significantly ($p<0.05$) affected by vitamin E in female birds. VE increased ($p<0.05$) WBC and lymphocyte in pullets compared to CONTROL group.Except in 100mg/kg feed group, heterophil and H/L ratio in 50 and 150mg/kg feed groups recorded higher values than the CONTROL. Plasma biochemical responses were not significantly ($p>0.05$) affected by different dosages of vitamin E. Similar results were obtained in broiler breeder pullets for plasma biochemistry.

Table 2: Effect of vitamin E on the physiological parameters in growing broiler breeder pullets under humid tropical conditions

Parameter	**Vitamin E (mg/kg feed)**				**sem**	**p**
	0	**50**	**100**	**150**		
Female						
Rectal temperature (^oC)	41.2	41.1	41.1	41.1	0.05	0.627
Heart rate (beats/min)	238.8[a]	234.5[ab]	230.3[b]	235.1[ab]	1.86	0.015
Respiratory rate (breaths/min)	42.7	43.4	40.9	42.5	0.86	0.203
Skin temperature on breast (^oC)	37.0	37.0	37.3	37.1	0.14	0.526
Skin temperature under wings (^oC)	40.5[a]	40.1[b]	40.3[ab]	40.5[a]	0.04	0.011

[a,b]Means within the same row with similar superscripts differ significantly ($P<0.05$)

Table 3: Effect of vitamin E on the haematologicaland biochemical parameters in growing broiler breeder pullets under humid tropical conditions

Parameter	**Vitamin E (mg/kg feed)**				**sem**	**p**
	0	**50**	**100**	**150**		
Packed cell volume (%)	34.2	35.1	36.2	35.3	0.90	0.903
Red blood cell ($x10^{12}/l$)	3.17	3.30	3.33	3.54	0.10	0.634
Haemoglobin conc. (g/dl)	11.6	12.0	12.0	12.0	0.29	0.968
White blood cell ($x10^9/l$)	1.93[b]	4.24[a]	4.40[a]	4.18[a]	0.80	0.016
Heterophil (%)	49.4[a]	38.6[b]	40.9[ab]	39.5[b]	1.02	0.037
Lymphocyte (%)	49.4[b]	56.7[a]	53.6[ab]	56.4[a]	2.31	0.036
H-L ratio	0.99[a]	0.72[b]	0.80[ab]	0.73[b]	0.01	0.023
Eosinophil (%)	1.83	2.28	2.28	1.82	0.120	0.327
Monocyte (%)	2.67	2.33	3.00	2.29	0.141	0.255

Basophil(%)	0.11	0.11	0.17	0.12	0.053	0.979
MCV (fL)	112.3	127.3	120.8	107.9	6.86	0.767
MCH (pg)	38.0	45.3	39.1	33.2	2.48	0.412
MCHC (g/dl)	34.1	35.0	34.1	34.0	0.69	0.951
Total protein (g/dl)	5.3	5.8	5.1	5.8	0.23	0.622
Albumin (g/dl)	3.9	4.4	3.6	4.2	0.22	0.536
Globulin (g/dl)	1.4	1.4	1.5	1.5	0.05	0.829
Uric acid (mg/dl)	6.4	6.9	5.8	6.3	0.43	0.837
Creatine kinase (U/l)	0.76	0.86	0.83	0.80	0.062	0.950
Creatinine (mg/dl)	1.49	1.45	1.65	1.58	0.157	0.974

[a,b]Means within the same row with similar superscripts differ significantly (P<0.05)

Discussion

The mean climatic measurements during the experimental period showed that the birds were continually under stressful conditions. Broiler chickens have the thermal comfort zone within 18 and 22^{o}C (Charles, 2002). Meanwhile, the present study was carried out under mean temperature which is 6.2^{o}C above the upper critical limit. A good pointer is the heterophil-lymphocyte ratio ranging from 0.72 and 1.17. Birds with heterophil to lymphocyte ratio of about 0.2, 0.5 and 0.8 are known to be under low, optimal and high degrees of stress respectively in chickens(Gross and Siegel, 1983).

Vitamin E supplementation in diet reduced the heart rate in growing female breeder chicken. Birds on 100mg VE per kg feed recorded 3.7% lower heart rate than the group that received no VE. Vitamin E is a major chain-breaking anti-oxidant in living systems, functioning in biological membranes (Surai *et al.*, 2016). Its involvement in thermoregulation and the cardio-vascular responses in growing breeder chickens have not been fully understood.However, it has been reported that accumulation of free radical may lead to endothelial damage in cells of the heart (Arab *et al.*, 2006), causing the heart to work more.It is known as well that one of the responses of chicken to heat stress is the stimulation of cardiovascular system, leading to vasodilatation. Skin temperature under wings is closely related with the core body. Lowered skin temperature in birds fed vitamin E is an indication of efficient thermoregulation in female birds that received 50mg VE/kg feed.

Supplemental vitamin E had no effect on PCV, RBC, Hb concentration, red blood cell derivatives, and some differential counts eosinophil, monocyte and basophil of both pullets and cockerels. Similar results were obtained in broiler chickens by other authors (Tras *et al.*, 2000).WBC, heterophil, lymphocyte and H:L ratio were affected by vitamin E. Vitamin E is known to reduce cytotoxic action caused by free radicals in the living cells and improves the phagocytic activity of macrophages in broiler chickens (Leshchinsky and Klasing, 2001).Leukocytes and the differentials are usually affected by high temperature and immunity of chickens is compromised under heat stress episodes. Heterophil in avian class, as neutrophil in mammals, has the phagocytic function (Qureshi et al., 1998). This multiplies and proliferates during heat spell while lymphocyte decline in number. The use of vitamin E in the present study reduced heterophil count and increase lymphocyte, thereby lowering the H:L ratio. In another study similar to the present one, VE raised WBC and lymphocyte, and lowered heterophil, H:L ratio, in Control group of layer hens (Ajakaiye et al., 2010).HS promotes the release of catecholamines and corticosteroids that induce lipid peroxidation of membranes, including membranes of T and B lymphocytes (Silva et al., 2011). Antioxidant supplementation in the diets stimulates immunity in avian class.In the present study, VE did not affect any of the plasma biochemical parameters considered. This is contrary to the previous reports. However, most of the reports were not in growing breeder chickens.

Conclusion

Vitamin E supplementationof at least 50mg/kg feed in the diet of growing broiler breeder chickens increased WBC and lymphocytes and decreased skin temperature, heterophil and H:L ratio and so may help improved immunity during hot period in the humid tropical environment.

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OESTRUS BEHAVIOUR AND HORMONAL CHARACTERISATION OF THE OESTROUS CYCLE OF JENNIES SYNCHRONIZED WITH SINGLE TREATMENT OF PGF2α (LUTALYSE®) AND JENNIES NOT SYNCHRONIZED, IN ZARIA NIGERIA

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ABSTRACT

This study was carried out to evaluate oestrus behaviour and hormonal changes during the oestrous cycle of Jennies synchronized with single treatment of PGF2α (lutalyse®) and Jennies not synchronized, in Zaria Nigeria. Eight (8) cycling Jennies aged 3.2±1.0 years were used for this study. The jennies were randomly assigned to 2 groups of 4 jennies each; Group 1 (n=4) Jennies not treated with any synchronizing agent; Group 2 (n=4) Jennies treated with a single injection of 10mg of Lutalyse®. The treated and untreated group were observed for behavioural oestrus three times daily (8-10 am, 12-2 pm and 4-8 pm) for two oestrous cycles. Blood was collected from the jennies for extraction of serum, for progesterone and oestradiol estimation using Enzyme-linked Immunosorbent Assays (ELISA). One-way ANOVA and T-test were used to analyze the results. The characteristic oestrus behaviour of jennies was; tail raising from the perineum, opening and closing of mouth (mouth clapping), flehmen and winking of the vulva. From this study it was established that the average oestrus period of Nigerian indigenous jennies was 8.0 ± 0.5 days and their average oestrous cycle length was 30.0 ± 5.0 days. It was concluded from this study that synchronization of Jennies is possible using exogenous PGF2α. This study has shown that, plasma progesterone and oestradiol analyses is a valuable tool for the study of fundamental reproductive endocrinology in Nigerian indigenous jennies.

Keyword: Nigerian Jennies, Oestrus behaviour, Hormonal characterization. Oestrus synchronization, Lutalyse.

INRODUCTION

Donkeys are one of the ancient domesticated livestock species and are valued for their ability to survive under harsh conditions (Blench et al., 1990; Swai and Bwanga, 2008). However, they are often regarded as animals of low social status and neglected by research and developmental organizations (Starkey, 1995). There are 41.5 million donkeys worldwide (Desalegne et al., 2011), with a population of 0.8 million donkeys in Nigeria (Mabayoje and Ademiluyu, 2004). Cross-border movements by the pastoral Fulani from Niger, Chad, Burkina Faso, Mali and Cameroon, have increased the number of donkeys in Nigeria (Blench, 2004). In Nigeria, donkeys are concentrated mainly in the northern states because of the savannah type of vegetation and fewer disease vectors such as tsetse flies (RIM, 1992). Synchronizing oestrus is usually achieved by using luteolytic agents such as prostaglandin F2α or one of its analogues. Examples of these products are sold under the trade names of Lutylase ®, Estrumate ® and Prostamate® (Howey et al., 1983). This study was carried out to evaluate oestrus behaviour and hormonal changes during the oestrous cycle of Jennies synchronized with single treatment of PGF2α (lutalyse®) and Jennies not synchronized, in Zaria Nigeria.

MATERIALS AND METHOD

Experimental animals and management

This study was carried out at the donkey farm of the Equine and Camel Research Programme of the National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika Zaria. Eight (8) cycling Jennies aged 3.0 ± 1.0 years with mean body weight of 90.6 ± 6.5kg and mean body condition score of 3.5 ± 0.2 were used for this study. Cyclicity was determined based on two rectal palpations (30 days apart), ultrasound scans done twice and two blood samples were also obtained twice (30 days apart)

to confirm cyclicity. The jennies were kept outdoors in a group and fed Digitaria smutsii (woolly finger grass), concentrate rations at 1.2kg/jennies/day and hay as basal diet, water was provided ad libitum.

Experimental design

The animals were randomly assigned to 2 groups of 4 jennies each

Group 1: Four jennies were used to detect natural oestrus and were not synchronized

Day 0 oestrus observation

Group 2: Four jennies were synchronized with a single treatment of 10mg of PGF2α (Dinoprost tromethamine- Lutalyse®) intramuscular injection.

Day 0 (PGF2α IM Injection) oestrus observation

Oestrus detection

Following the administration of the injections of PGF2α, treated and untreated jennies were observed for behavioral oestrus beginning from day 0 when the experiment commenced. Jennies were observed for oestrus behaviors for two hours, three times daily (8-10 am, 12-2 pm and 4-8 pm) for the period of the experiment. Parameters evaluated were; lowered head with neck extended forward, opening and closing of the mouth, ears back against the neck, standing to be mounted, tail raised from the perineum, vulva winking, mucous discharge and presentation of the perineum toward the jack. In addition, Jennies were exposed to a jack to aid oestrus detection

Blood Sampling

Five (5) ml of blood was obtained from the jennies via jugular veni-puncture using a 5 ml syringe (18 Gauge needle) on the day of synchronization, then twice weekly for 8 weeks, to determine the progesterone and estradiol concentrations. The blood samples were decanted into vacutainers and transported to the laboratory. Blood samples collected were centrifuged at 2000×G and serum harvested. Serum samples obtained were appropriately stored at -20˚C until analysis for determining progesterone and estradiol concentrations using an Enzyme-linked immunosorbent assays (ELISA) technique.

Data analysis

Chi square was used to compare between the physical manifestations of oestrus and the different groups. Frequency of oestrus characteristics were expressed in percentage. Data on progesterone and oestradiol profile values were expressed as Mean ± S.E.M. Comparisons between the groups were carried out using one-way ANOVA and T- test. The differences were considered significant when $P < 0.05$, highly significant when $P<0.01$ and not significant when $P > 0.05$. SAS system for windows 9.0 was used for the analysis.

RESULT AND DISCUSION

Percentage frequency of oestrus characteristics in jennies treated with PGF2α

Parameters	Grp1 (NT)(%)	Grp2 (1LT)(%)	LS
Head lowering	60	40	**
Mouth clapping	70	50	**
Ears backward	60	50	*

Standing to be mounted	60	50	*
Tails raising	70	50	**
Vulva winking	60	40	**
Mucous discharge	20	10	*
Presentation of perineum	10	0	*
Flehmen	70	60	*

LS= Level of Significance.

Progesterone and Oestradiol Profiles for Group 1 (Not treated group)

The serum progesterone (P4) and oestradiol (E2) profiles for group 1 (jennies that served as control) to detect natural oestrus as shown in Figure 1.1. Mean P4 concentration rose from 1.35±1.08 ng/ml on day 0 to 2.01±1.80 ng/ml on day 3 then declined to 0.18 ± 0.07 ng/ml on day 10 increasing to 2.44 ± 2.22 ng/ml on day 18, while E2 concentration decreased from 11.81 ± 4.94 pg/ml on day 0 to 8.55 ± 1.63 pg/ml on day 14 then increasing to 11.10 ± 3.05 pg/ml on day 25.

Figure 1.1 Progesterone and oestradiol profiles of jennies not treated.

Progesterone and Oestradiol Profiles for Group 2 (Single treatment lutalyse)

The serum progesterone (P4) and oestradiol (E2) profiles for group 2 (Single treatment lutalyse)as shown in Figure 4.8. The progesterone and oestradiol concentrations were inversely related. Mean serum P4 concentration at the start of the study day 0, was 0.88 ± 0.61 ng/ml and mean serum E2 concentration was 63.2 ± 49.94 pg/ml. The P4 concentration rose to 6.45 ± ng/ml on day 3 after PGF2α treatment and E2 declined to 62.71 ± 45.79 pg/ml.

Figure 1.2 Progesterone and oestradiol profiles of jennies treated with a single injection of 10 mg of PGF2α

Key: Day 0= Day of first injection of 10mg of Lutylase

It was observed that tail raising, opening and closing of mouth (mouth clapping), flehmen and winking of the vulva were the most consistently observed signs of oestrus in jennies from all the groups, corroborating the works of Vandeplassche et al., (1981), Henry et al., (1991) and Taberner et al., (2008).

It was established from this study that the oestrus period of groups 1 and 2 were both 8 days, respectively. The oestrus cycle length of groups 1 and 2 was 25 and 35 days respectively. these findings are similar to the work of Henry et al., (1987), established that the oestrus period can occur between 6 to 8 days, and the oestrus cycle from 25 to 26 days.

CONCLUSION AND RECOMMENDATION

Synchronization of jennies is possible using exogenous PGF2α. However, it is recommended that single injections of Dinoprost tromethamine (Lutalyse®) can be used for oestrus synchronization in jennies but, there was no significant difference in the oestrus behaviors and hormonal profiles between the synchronized and un synchronized jennies.

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THE EFFECTS OF AQUEOUS GINGER *(ZINGIBER OFFICINALE*) EXTRACT ON SPERM QUALITY AND HAEMATOLOGY IN LEAD ACETATE TREATED MALE ALBINO RATS

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Abstract
This study was carried out to determine the ameliorative effects of aqueous ginger extract on sperm quality and haematology in lead acetate treated male albino rats. Twenty four male albino rats used for this study were randomly assigned into four groups (n = 6). Rats in group 1 served as normal control. Rats in group 2 were treated for 6 weeks with only lead (4 mg/kg). Rats in group 3 were treated with lead (4 mg/kg) and ginger (300 mg/kg) simultaneously for 6 weeks. Rats in group 4 were treated with lead (4 mg/kg) for 6 weeks and then with ginger (300 mg/kg) for another 6 weeks. Results obtained showed significant decreases ($P < 0.05$) in sperm motility and sperm viability in group 2 when compared to groups 1 and 3. There was no significant difference ($P > 0.05$) in sperm motility and viability of animals in group 3 when compared to group 1. There was no significant difference ($P > 0.05$) in sperm motility and sperm viability of animals in group 4 when compared to group 2. For haematological parameters, there was a significant decrease in RBC level of animals in group 2 when compared to those in groups 1 and 3. There was a significant increase in WBC of group 2 when compared to groups 1, 3 and 4. From the results, aqueous ginger extract showed protective potentials on sperm quality and haematology in lead acetate treated male rats.
Keywords: Ginger, Lead acetate, sperm quality, haematology

Introduction

Lead (Pb) is one of the most abundant heavy metal pollutants in the environment, and is well documented as a dangerous and insidious poison (White *et al*., 2007) Research has shown that lead toxicity causes severe damage to the reproductive system and haematology, interfering with spermatogenesis and reduces sperm production and quality (Biswas and Ghosh, 2006; Hamadouche *et al*., 2009). Oxidative stress induced by lead toxicity is the main cause of changes in sperm characteristics and haematology (Ashry *et al*., 2010). Ginger (*Zingiber officinale)* has been reported to have antioxidants properties (Prakash *et al*., 2010). Hence, the objective of this study was to determine the ameliorative effects of aqueous ginger extract on sperm quality and haematology in lead acetate treated male albino rats.

Materials and methods

The lead (Pb) acetate used was from Joe Chem Ventures Ltd, University of Nigeria, Nsukka, Enugu State.
Ginger: The ginger rhizome was purchased from Ogige market in Nsukka, Enugu State.

Extraction of Ginger *(Zingiber Officinale)* extract

The ginger rhizome was crushed using mortar and pestle. It was then filtered using Wattman no. 1 filter paper. The filtrate was concentrated in a hot air oven at 37^0C and stored at 4^0C during its use.

Experimental Design

Twenty four mature male albino rats were randomly assigned into four (4) groups of six rats each and treated once daily as follows:
Group 1: Rats in this group served as the normal control and were given distilled water as placebo.
Group 2: Rats in this group were treated, daily with lead alone at 4 mg/kg *per OS* [6] for six weeks
Group 3: Rats in this group were treated daily with lead at 4 mg/kg and ginger extract at 300 mg/kg *per OS* [11] from day one for six weeks
Group 4: Rats in this group were treated daily with lead at 4 mg/kg *p*
er OS for 6 weeks and then with ginger extract at 300 mg/kg *per OS* for the another 6 weeks.

Determination of testicular weight

After 30 days of treatment (end of study period), rats from each group were euthanized using chloroform. The testis from each rat was carefully dissected out, extraneous tissues removed and then weighed.

Determination of sperm motility

A drop of sperm from the cauda epididymis was placed on a warmed slide and observed using a light microscope. Sperm cells moving in a straightforward unidirectional motion were counted while sperm cells moving in circles, in backward direction or showing pendulous movement were excluded (Zemjanis, 1977)

Determination of sperm viability

One drop of semen was mixed with one drop of eosin-nigrosin stain on a warm slide. A thin smear was then made from the mixture of semen and stain. The smear was then air-dried and viewed under the microscope. The live and the dead sperm cells were separately counted and the ratio of the live to dead sperm cells was calculated in percentage. The sperm cells that appeared clear (white) were counted as live while those that picked up the stain (appeared pink/red) were counted as the dead cells (Zemjanis, 1977).

Determination of packed cell volume (PCV)

This was determined by the hematocrit method (Coles 1986). Values were expressed in percentage.

Determination of white blood cell (WBC) and red blood cell (RBC) counts

These were estimated using the improved Neubauer counting chamber (Coles 1986). Values were expressed as number of counts x 10^6/µl of blood.

Determination of hemoglobin (Hb) concentration

This was done using cyanomethaemoglobin method (Coles 1986) and values recorded in g/dl

Differential Leukocyte count

Lieshamann Technique (Coles 1986) was used. Each type of white blood cell was expressed as a percentage of the total count and converted to the absolute value per microlitre of blood.

Statistics

Data obtained from the study was statistically analysed using one way analysis of variance (ANOVA). The variant means were separated using Duncan Multiple Range Test. Level of significant was accepted at $p < 0.05$.

Results and Discussion

Table 1: Mean values of the testicular weight, sperm motility and viability.

PARAMETER	GROUPS			
	1 (normal control)	2 (lead only)	3 (lead + ginger)	4 (lead 6 weeks, then ginger 6 weeks)
Testicular Weight (grams)	1.10 ± 0.00	0.90 ± 0.16	0.90 ± 0.10	1.07 ± 0.03
Sperm Motility (%)	76.68 ± 8.82^a	30.00 ± 5.77^b	73.33 ± 3.33^a	40.00 ± 5.77^b
Sperm Viability (%)	76.67 ± 8.82^a	40.00 ± 5.77^b	66.67 ± 3.33^a	46.67 ± 3.33^b

Key: a, b = different superscripts indicating differences between the mean ($p<0.05$)

Table 2: Mean values of Packed Cell Volume, Haemoglobin concentration and Red Blood Cell count.

PARAMETER	GROUPS			
	1 (normal control)	2 (lead only)	3 (lead + ginger)	4 (lead 6 wks, then ginger 6 weeks)
Packed Cell Volume (%)	49.67 ± 2.03^{a}	41.67 ± 0.67^{b}	47.33 ± 1.45^{a}	46.33 ± 0.88^{a}
Haemoglobin conc. (g/dl)	10.70 ± 0.31^{a}	7.27 ± 0.88^{b}	9.10 ± 0.23^{c}	8.43 ± 0.26^{c}
Red Blood Cell count (10^6/µl)	28.17 ± 1.09^{a}	24.00 ± 0.58^{b}	26.00 ± 0.58^{ac}	24.33 ± 0.33^{bc}

Key: a, b, c = different superscripts indicating differences between the mean ($p<0.05$)

Table 3: Mean values of different cells of the leukocytic series

PARAMETERS	GROUPS			
	1 (normal control)	2 (lead only)	3 (lead + ginger)	4 (lead 6 weeks, then ginger 6 weeks)
Total WBC	70.00 ± 1.15^{a}	82.00 ± 2.00^{b}	68.66 ± 0.67^{a}	72.00 ± 1.15^{a}
Neutrophil	40.67 ± 0.67^{a}	30.67 ± 0.67^{b}	46.00 ± 1.15^{c}	30.00 ± 0.00^{b}
Lymphocyte	58.00 ± 1.54^{a}	68.00 ± 1.15^{b}	52.00 ± 1.15^{c}	68.00 ± 1.15^{b}
Monocyte	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00
Eosinophil	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00

Key: a, b, c = different superscripts indicating differences between the mean ($p<0.05$)

There were no significant differences ($P > 0.05$) in the mean testicular weight of animals among the groups. This was however not in line with the study that reported atrophy of the testes of rats treated with lead acetate (Chowdhury,2009). The significant decrease ($P < 0.05$) in sperm motility and viability observed in group 2 (lead only) animals when compared to animals in groups 1 (normal control) and 3 (lead + ginger) may be as a result of lead-induced oxidative stress (Auger *et al*., 2001). Lipid peroxidation destroys the structure of lipid matrix in the membranes of spermatozoa, and it is associated with loss of sperm motility and viability (Sharma and Agarwal, 1996). There was no significant difference ($p > 0.05$) in sperm motility and viability of animals in group 3 (lead + ginger) when compared to group 1 (normal control). This may be due to antioxidant properties of ginger (Ahmed *et al.*, 2000). There was no significant difference ($p > 0.05$) in sperm motility and viability of animals in group 4 (lead 6 weeks, then

ginger 6 weeks) when compared to group 2 (lead only). This may be because the toxic effect of lead had occurred before commencement of treatment with ginger. This suggests that it is better to prevent lead toxicity with consumption of ginger than allowing the toxicity to occur before treatment with ginger. For haematological parameters, there was a significant decrease ($p < 0.05$) in packed cell volume (PCV) and haemoglobin (Hb) concentration of group 2 (lead only) animals when compared to groups 1 (control), 3 (lead + ginger) and 4 (lead 6 weeks and then ginger 6 weeks). There was also a significant decrease in red blood cell (RBC) count of group 2 animals when compared to those in groups 1 and 3. These decreases in PCV, Hb and RBC of group 2 were in line with previous studies (Alsaleh, 1994). Red blood cells have a high affinity for lead. Lead has a destabilising effect on cellular membrane and RBCs, decreasing cell membrane fluidity and increasing the rate of RBC haemolysis. Haemolysis appears to be the end result of ROS-generation and lipid peroxidation in the RBC membrane (. Lawton and Donaldson, 1991). In the total white blood cell (WBC) count, a significant increase ($p < 0.05$) in group 2 animals when compared to groups 1, 3 and 4 was observed. This may be as a result of the body's immune response to lead toxicity, hence the increased production of WBCs. There was a significant decrease ($p < 0.05$) in the number of neutrophils of animals in groups 2 and 4 when compared to groups 1 and 3 but all the values fell within the normal range reported for this specie. There was a significant increase ($p < 0.05$) in the number of lymphocytes of animals in groups 2 and 4 when compared to groups 1 and 3 but all the values fell within the normal range reported for this specie.

Conclusion and recommendation

In conclusion, ginger extract demonstrated a significant protective potential on sperm quality (motility and viability) and haematology in lead acetate treated male rats. The study also showed that ginger may be more effective when supplemented in animals diet rather than used as a therapeutic agent after the occurrence of lead toxicity. Hence, supplementation of ginger (*Z. officinale*) in animal's feed is recommended. This may be effective in reducing the toxic effect of lead on sperm quality and hematology, hence improving fertility in male animals.

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CHICKEN GROWTH HORMONE POLYMORPHIC VARIATION AND ITS ASSOCIATION WITH ECONOMIC TRAITS– A REVIEW

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ABSTRACT
The classical approaches to the detection of genetic differences in farm animals have been mostly based on the use of blood proteins (protein in blood plasma and serum) and blood groups. More recently, DNA polymorphisms have become popular in the genetic characterization of farm animals. This has helped in the study of polymorphism of the genes encoding hormones and their receptors, as well as their association with economic traits. The chicken Growth Hormone (GH) gene plays a crucial role in controlling growth and metabolism, leading to potential correlations between GH polymorphism and economic traits in animals. The allelic variants of functional genes are a result of different modifications of nucleotide composition such as point mutations (Single Nucleotide Polymorphism-SNP), insertions/deletions and soon. Polymorphism identification and subsequent study of its relationship with productivity characters will provide a basis for further targeted breeding which is fully applicable to the poultry farming and other farm animal species. This correlation could be used as a basis for selection and genetic improvement of farm animals.
Keywords: Polymorphic, Chicken, Growth Hormone, Chicken Growth Hormone and Economic traits.

INTRODUCTION

Growth performance and carcass traits are very significant economic traits in broiler chickens production, and are controlled by sets of complex genes. Growth is a complicated procedure regulated by a wide variety of neuroendocrine pathways (Zhang *et al.*, 2008). For this reason, it is very difficult to make rapid progress using conventional methods of genetic selection within breeds (Zhang *et al.*, 2008). Recent advances in molecular technology have provided new opportunities to evaluate genetic variability at the DNA level (Kaya and Yildiz, 2008). Growth Hormone (*GH*) is secreted by somatotropic cells of the anterior lobe of the pituitary. The growth hormone gene, which is located on chromosome 27, contains 5 exons and 4 introns with a total length equal to 4.35kbp. *GH* influences animal processes such as growth, lactation, reproduction and metabolism (Breier, 1999). Therefore, the *GH* gene, with its functional and positional potential, has been widely used as a marker for example, caprine *GH* gene have been being correlated with milk traits and its possible usage for selection of both dairy and meat type goats. Growth hormone affects growth traits in broiler chickens production such as growth rate, body weight maturation, metabolism rates, egg production, reproduction, appetite control and aging. Growth hormone promotes muscle and bone growth and development, as well as regulation of fat content and its metabolism (Zhang *et al.*, 2007).

Chicken Growth Hormone

The chicken Growth Hormone (*c*GH) is a 22-kDa protein, containing 191 amino acid residues (Hrabia *et al.,* 2008). In poultry, *cGH* consists of 4,101 base pairs, having five exons and four introns (Kansaku *et al.,* 2008). A polypeptide, the hormone is produced and secreted by the pituitary gland. *cGH* affects a variety of physiological functions and growth performance (Apa *et al.,* 1994) and has been reported to be one of the most important genes affecting chicken performance traits playing critical roles in both growth and metabolic rates. It also plays a crucial role in controlling growth and metabolism, leading to potential correlations between *cGH* polymorphisms and economic traits. *cGH* is involved in the processes of sexual differentiation, pubertal maturation and participates in gonadal steroidogenesis, gametogenesis and ovulation. It plays an important role in a variety of secondary functions such as egg production, aging and reproduction (Kansaku *et al.,* 2008).

Polymorphism of Chicken Growth Hormone

Genetic diversity in the *cGH* gene has been reported to exits in native chicken breeds when compared to commercial breeds (Nie *et al.,* 2002). This could be due to the genetic diversity of the native chickens. Thakur *et al.* (2009) in Kadakanath chicken of India observed three genotypes of the chicken growth hormone; AA, AB and BB at the *cGH1* locus. Bhattacharya *et al.* (2010) reported also reported three genotypes AA, BB and AC in White Leghorn chickens. Wenming *et al*. (2010) investigated the mutation characteristics of growth hormone (*GH*) gene in five Chinese indigenous goose populations. All the exons and introns of the gene were amplified by 20 pairs of primers and genotypes of all the primers were observed by PCR-SSCP; they observed six SNPs per 1000 nucleotides in exons compared to two SNPs per 1000 nucleotides in intron regions. Four SNPs were detected by two primers and four genotypes AA, BB, CC and DD were generated among the five populations evaluated. Tanmankaur *et al.* (2008) analyzed 776 bp amplicon of chicken *GH* gene digested with *Msp*1 with the results revealing three different patterns (AA, AC and CC) created by a combination of polymorphic *Msp*1 cut sites present in exon-1 (one site) and in intron-1 (one site). Polymorphism in intron 4 of the *cGH* gene was studied by Nie *et al*. (2002) in Chinese native chickens. A total of eight restriction digestion profiles were identified within the 1170 bp amplified PCR product, by *Msp*I restriction endonuclease. Among 20 populations, distinctly different allele numbers and fragments of intron 4 RFLPs between Chinese native chickens were observed. A new allele D was identified at a high frequency in the slow growing Taihe Silkies and Beijing Fatty strains.

In their study of a native chicken population by Makhsous *et al.* (2013) in Iran, a total of 142 chicken blood samples were collected and a specific primer set was used to amplify a fragment of the growth hormone locus using PCR. PCR products were then digested with *SacI* and *MspI* restriction endonucleases. Their results revealed the existence of three genotypes of the amplified fragment digested with *SacI* enzyme (+/+, +/- and -/-) controlled by two "+" (wild type) and "–" (normal type) alleles with allelic frequency of 0.898 and 0.102, respectively while the genotype frequency for the three genotypes were 0.817, 0.162, and 0.021, respectively. The amplified fragment digested with *MspI* enzyme revealed three alleles A, B and C with frequency of 0.599, 0.102, and 0.299, respectively; six genotypes AA, AB, AC, BB, BC, and CC were observed with genotype frequency of 0.338, 0.113, 0.409, 0.007, 0.070, and 0.063, respectively. Anh *et al.* (2015) studied crosses involving broiler breeder, PS with four Thai chicken breeds (Kaen Thong; KT, Khai Mool Esarn; KM, Soi Nin; SN, and Soi Pet dam line; SP) with regard to the

association of growth hormone polymorphism with growth performance and carcass trait. The authors observed the existence of three genotypes (AA, AG and GG) in all the crosses with the following gene frequencies for the A and G alleles: 0.20 and 0.80 for the PSxKM, 0.30 and 0.70 for the PSxKT, 0.29 and 0.71 for the PSxSN, and 0.27 and 0.73 for the PSxSP crosses, respectively.

Association between Chicken Growth Hormone and Economic Traits

Chicken growth hormone gene has been used as a candidate gene for marker assisted selection for improved performance (Muhammed *et al.,* 2018). The results showed that c*GH* gene could be linked to a major gene significantly affecting the growth and carcass traits in chicken. Fotouhi *et al*. (1993) observed significant ($p<0.05$) correlation of alleles of the growth hormone gene and growth hormone receptor gene with juvenile body weight, age at first egg, the hen-day rate of egg production, egg specific gravity and egg weight in a strain of White Leghorns. Refraction fragment length polymorphisms characterized in the introns of *cGH* gene of White leghorn has been associated with egg production phenotype, resistance to Marek's disease and avian leukosis. In various populations of Chinese native chickens, an allele present in intron 1 had been linked to laying performance (Mou *et al.,* 1995). Lei *et al.* (2007) reported that an SNP with G and A substitution of *cGH* was associated with abdominal fat pad weight, abdominal fat pad ratio and crude fat content of the breast muscle. Makhsous *et al.* (2013) reported no significant ($p>0.05$) effect of the six *cGH* genotypes on egg number, laying % and mean egg weight (g) at 28, 30 and 32 days weeks of age in Iranian native chickens; the three *Sacl*-RFLP generated genotypes however, affected ($p<0.05$) egg number and laying % with chickens having +/+ genotype laying more eggs. Laying rate was however similar in chickens having +/+ and -/- genotypes. In their study, Anh *et al.* (2015) observed no significant ($p>0.05$) effect of the genotypes on body weight (except at between week 2 and 4, and week 4 and 6 which were significant, $p<0.05$); birds carrying the AG and GG genotypes were observed to have better body weight ($p>0.05$) over those having AA genotype ($p<0.05$). Average daily gain was significant ($p<0.05$) only at 0-2 weeks, and 0-6 weeks again with birds carrying AG and GG genotypes having better performance ($p<0.05$) compared to those having the AA genotype.

CONCLUSION

Polymorphism of chicken growth hormone exists which is adduced to genetic diversity. This kind of diversity is a useful tool for characterization and improvement of the chickens as the various polymorphic forms could be used as candidates for marker assisted selection. It is interesting to search for polymorphism in the gene, the products of which are involved in the regulation of many functions, primarily those associated with support of growth and differentiation.

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Blood profile of Finisher broiler chickens fed diets supplemented with melon and walnut seed meal

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Abstract
This study was aimed at assessing the effect of dietary supplement of melon and walnut seed meal on haematology and serum biochemical indices of broiler chickens. Seven isonitrogenous (19.0% crude protein) and isocaloric (2931.5kcal/kg Metabolizable energy) diets were formulated. Basal diet (T1) had no walnut or melon seed meal supplementation. However, other diets contained 2 (T2), 4 (T3) and 6g/kg (T4) walnut seed meal, while diets T5, T6, and T7 had 2, 4, 6g/kg supplemental melon seed meal, respectively. Arbor Acre broiler chickens (n= 400) weighing 500±21.3g aged 28days were allotted in a completely randomised design to the diets for four weeks. Except for mean cell haemoglobin concentration, all haematological indices were significantly higher (P<0.05) for chickens on dietary treatments compared with those on T1 (control). Heamoglobin (g/dL) of chicks on T1 (7.9) was significantly lower (P<0.05) than T2 (9.6), T3 (10.0), T4 (10.2), T5 (10.3), T6 (9.1) and T7 (10.4). Also, serum glucose, aspartate aminotransferase, alanine aminotransferase, total cholesterol, albumin and total protein increased significantly (P<0.05) in chickens on supplemental diets compared with those on T1(control).Serum urea nitrogen (mg/dL) were 4.7, 5.1, 7.5, 11.0, 4.4, 8.5 and 10.6 in chickens on T1, T2, T3, T4, T5, T6 and T7 respectively differed significantly (P< 0.05). Blood profiles of broiler chickens on various treatments were enhanced by dietary supplement of both melon and walnut seed meal. These condiments could be considered as additives in finisher broiler chicken diets.

Keywords: Haematology, Serum biochemical indices, Broiler finisher, Dietary supplement

INTRODUCTION

Melon (*Citrullus colocynthis*), is reported to have hepatoprotective activity (Dar *et al.*, 2012), good physiochemical and fatty acid profile (Oluba *et al.*, 2008).Walnut (*Tetracarpidium conophorum)* seeds are good source of essential unsaturated fatty acid (linoleic and alpha linoleic acid), tocopherol and potent antioxidant hormone, melatonin. (Grace *et al*., 2014, Akbari *et al* 2015).Dietary supplementation of such condiment in diets of broiler chickens could assist in enhancing the blood profile.

The numerous blood constituents has always been the effective media both for clinical investigations and nutritional evaluation of the organism (Aderemi, 2004). Nutrition, age, sex, genetics, physiological status, housing, starvation, environmental factors, stress, disease and transportation can affect haematological and biochemical indices of animals (Opara *et al*., 2006). Packed cell volume, red blood cell, white blood cell and haemoglobin content of chicken blood are factors of their health status and nutrient utilization (Aderemi and Alabi, 2013).

This study was therefore aimed at assessing the effect of dietary supplementation of both melon and walnut seed meal on haematology and serum biochemical profiles of finisher broiler chickens.

MATERIALS AND METHODS

Experimental site
The study was carried out at the Poultry Unit, Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria, located on Latitude $7^{o}\,26^{'}\,35.1^{''}$ N and Longitude $3^{o}\,53^{'}\,32.3^{''}$ E and Central Laboratory, Department of Animal Science.

Dietary Treatments

Seven isonitrogenous (19.0% crude protein) and isocaloric diets (2931.5kcal/kg Metabolizable energy) were formulated. Each treatment comprised a replicate of five birds each. Feed and water were supplied *ad libitum*. These treatments were: 1-Basal diet (no supplemental melon/walnut meal). 2 – Basal diet + 2g walnut seed meal / kg**,** 3 – Basal diet + 4g walnut seed meal / kg**,** 4 – Basal diet + 6g walnut seed meal / kg**,** 5 – Basal diet + 2g melon seed meal / kg**,** 6 - Basal diet + 4g melon seed meal / kg and 7 – Basal diet + 6g melon seed meal / kg.

Management of Experimental Chicken

Arbor Acre broiler finisher birds (n=400) weighing 500±21.3g aged twenty eight days were allotted in a completely randomised design to diets for four weeks. Prior to the stocking, the pen had been cleaned and disinfected. Thereafter, the chicks were randomly assigned to seven treatments consisting of ten birds per replicate.

Blood Analysis

At week eight of the experiment, blood samples (5 mL each) was collected from three birds per replicate. The packed cell volume (PCV) was determined using Micro haematocrit method as described by Kelly (1979). Red blood cell (RBC) and white blood cell (WBC) were determined using Neubauer haemocytometer after appropriate dilution. Haemoglobin (Hb) concentration was determined by a Cyanomet haemoglobin method using Drabkin's solution as diluents. Mean corpuscular volume (MCV), Mean corpuscular haemoglobin (MCH) and Mean corpuscular haemoglobin concentration (MCHC) were determined using appropriate formulae by Van Beekvelt *et al*. (2001).

MCHC (%) = Hb/PCV,

MCV (fL) = Hb/RBC and

MCH = PCV/RBC.

The other tubes were covered, centrifuged and serum harvested for analysis. Total protein was determined by Biuret method as described by Kohn and Allen (1995) while albumin was determined using Bromocresol green (BCG) method as described by Peters *et al*. (1982). Urea was determined using dimethyl monoxide and measured in a spectrophotometric at 450nm as described by Watt and Chrisp (1954).

Statistical Analysis

Data were subjected to descriptive statistics analysis of variance (SAS, 2002) while means were separated using Duncan multiple range test (Duncan, 1955)at $\alpha_{0.05}$.

Result and Discussion

Tables 1 shows the haematological parameters of broiler finishers fed experimental diets The haematological parameters were within the reported normal range (Tewe, 1985:Awoniyi *et al*., 2000). The normal values obtained in the present study are indications of the good qualities of the experimental diets and they were well tolerated by the chicks. There were significant differences ($P<0.05$) in haematological values across the treatments for chicks on dietary treatments when compared with those on T1 (control) for all parameters except MCHC. The treatments were however within the reported normal range (Awoniyi, *et al*., 2000; Akinmutimi, 2004)

Table 1:Haematological indices of broiler chickens fed graded level of walnut and melon

Parameters	T1	T2	T3	T4	T5	T6	T7	SEM
PCV(%)	24.30^{b}	27.30^{ab}	31.70^{a}	31.30^{a}	32.00^{a}	26.70^{ab}	31.70^{a}	0.87

Hb(g/dL)	7.90^{b}	9.60^{ab}	10.00^{a}	10.20^{a}	10.30^{a}	9.10^{ab}	10.40^{a}	0.27
RBC(10^{6}µl)	2.10^{c}	2.40^{bc}	3.50^{a}	3.60^{a}	3.40^{ab}	3.00^{abc}	3.60^{a}	0.16
WBC(10^{9} µl)	17.20^{a}	12.2^{b}	14.2^{ab}	17.3^{ab}	17.00^{a}	12.20^{b}	15.40^{ab}	5.95
MCV(fL)	122.70^{a}	127.50^{a}	89.70^{b}	87.98^{b}	79.22^{b}	106.04^{ab}	88.14^{b}	5.07
MCH(pg)	39.40^{ab}	46.20^{a}	28.30^{b}	28.50^{b}	27.10^{b}	35.05^{ab}	28.87^{b}	1.91
MCHC(%)	3.20	3.50	3.20	3.30	3.42	3.23	3.28	0.05

^{abc}*Means with different superscripts along the same row are significantly different (P<0.05); SEM- Standard Error of Means: PCV; Pack cell volume: Hb; haemoglobin: RBC; Red blood cell: WBC: white blood cell: MCV; mean corpuscular volume: MCHC; mean corpuscular haemoglobin concentration: MCH: mean corpuscular haemoglobin*

Table 2 shows the serum biochemical indices of broiler chicks fed diets supplemented with melon and walnut seed meal. There were significant differences (P<0.05) in the values obtained for the parameters across the treatments. Values obtained for the chicks on treatments were higher (P<0.05) than the control (T1). Total protein increased across the treatment with dietary supplementation of both melon and walnut seed meal. This could be due to increased dietary protein intake or improved protein digestibility, since high serum protein is an indicator of protein adequacy (Ahamefule *et al*., 2006). Uric acid metabolism is influenced by the level and quality of protein in the diet (Ward *et al.*, 1974). Serum uric acid levels are influenced by the diet, hydration status, and species (Lumeij, 2008). The varying sera uric acid values compared favourably with the reported reference values (Simaraks *et al*. 2004).

Table2: Serum biochemical indices of broiler chickens fed supplemental walnut and melon seed meal

Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**SEM**
Glu(mg/dL)	145.00^{c}	146.60^{c}	197.90^{a}	131.30^{d}	154.20^{c}	171.10^{b}	185.50^{a}	5.14
AST(i.u/L)	45.00^{b}	45.40^{b}	48.80^{b}	53.30^{b}	51.90^{b}	53.50^{b}	70.90^{a}	2.42
ALT(i.u/L)	3.60^{b}	3.80^{b}	4.40^{ab}	5.30^{ab}	5.90^{ab}	6.20^{ab}	7.30^{a}	0.42
TCHOL.(mg/dL)	67.80^{d}	107.90^{bc}	115.20^{b}	155.20^{b}	101.80^{c}	112.30^{bc}	119.90^{b}	5.50
ALB(g/dL)	1.70^{c}	1.80^{bc}	2.30^{a}	2.30^{a}	2.10^{ab}	2.10^{abc}	1.90^{bc}	0.06
T.P(g/dL)	4.40^{c}	5.90^{b}	6.00^{ab}	7.30^{a}	6.20^{ab}	6.60^{ab}	5.20^{bc}	0.23
UR(mg/dL)	4.70^{c}	5.10^{c}	7.50^{bc}	11.00^{a}	4.40^{c}	8.50^{ab}	10.60^{a}	0.65

^{abc}*Means with different superscripts are significantly different (P<0.05) ; SEM – Standard Error of Means: GLU; Glucose: T.CHOL; Total cholesterol: ALT; Alanine aminotransferase: AST; Aspartate aminotranferase: ALB; Albumin: UR; Uric acid*

Conclusion

In conclusion, blood profile of broiler chickens was enhanced by dietary supplements of melon and walnut seed meal. These condiments could therefore be considered as additives in finisher broiler chicken diets.

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EXTERNAL EGG QUALITY CHARACTERISTICS OF SEVEN-CHICKEN STRAINS FROM SOUTH-WESTERN NIGERIA

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Abstract
The study was conducted to determine the effect of strain on external egg quality characteristics of seven-chicken in South-Western Nigeria using a total of 195 point of lay hens. Each of the seven strains used was replicated three times at 10 birds per replicate, making a total of 30 hens per strain except for the frizzle feather that were 15 in number. Completely randomized design was used for the trial that lasted for 22 weeks. A total of 936 eggs were collected between weeks 30–37 from the hens for external quality studies. The birds were fed experimental diets during the period of the study. Results of this study showed that egg weights, shell thickness and colour were significantly different ($p<0.05$) among the seven strains. Hubbard strain eggs had the highest egg weight (50.53g). Also, eggs of indigenous chickens are generally small/peewee in size (37.11g–43.23g) and the eggs of Fulani ecotype chickens weighed heaviest (43.23g) with thinnest shell (0.31mm) among the indigenous chickens. Brownish colour eggs are more pronounced in exotic chickens than the indigenous population. It can be concluded that normal feather chickens possessed good shell thickness and Fulani ecotype chickens possessed the greatest potential for laying large size eggs. Shell colour which could appeal to consumers in indigenous chickens should be improved upon. Fulani ecotype chicken is recommended for improvement and incorporation as indigenous layer bird while normal feather chickens are recommended because of their egg shell strength. Researches on Nigeria Indigenous Chickens for improvement in egg shell colouration to attract consumers are highly advocated.

Keywords: Egg measurements, egg shell, improvement, indigenous and exotic chickens

Introduction
Indigenous chickens, such as naked neck, frizzle feather, Fulani ecotype and normal feather, constitute about 80% of the 120 million poultry birds found in Nigeria (RIM, 2002). Among these species, naked neck possesses good egg laying characteristics (Udoh *et al.,* 2012). This breed of chicken contains genes and alleles pertinent to their adaptation to a particular environment and breeding goals (Romanov *et al*., 1996). Indigenous chickens are self-reliant and hardy birds with the capacity to withstand harsh weather conditions and adapt to adverse environment (Chin, 2003). They are known to possess qualities such as the ability to hatch their own eggs, brood, scavenge for major parts of their food and possess appreciated immunity from endemic diseases (Duguma, 2006). Their products are preferred by the majority of Nigerians because of the pigmentation, taste, leanness and suitability for special dishes (Horst, 1989). These products (egg and meat) are readily available to villagers and people in the urban and semi-urban areas at relatively cheaper rates, thus, serves as a good source of income and protein in their diets (Ibe, 1992).
Therefore, the objectives of the study are to determine the external quality characteristics of eggs from seven-chicken strains in South-western Nigeria. This will also help to generate baseline data on the egg quality characteristics of some Nigerian indigenous chickens and make appropriate recommendations necessary for theirimprovement to increase the protein intake of Nigerians.

Materials and Methods
The study was carried out between September – December, 2016 at the Teaching and Research Farm, Livestock Section (Poultry Unit) of the Federal University of Technology, Akure, Ondo State, Nigeria with Latitude 07° 16¹ and 07° 18¹N and Longitude 05° 09¹ and 05° 11¹ E. There is a unimodal rainfall pattern which starts from April to October with an average of 1556mm per annum. The average ambient

temperature was about 30 - 32°C and relative humidity was 80%.A total of 195 laying hens of different strains were obtained from FUNAAB hatchery, Ogun state and Foresight Farm hatchery, Oyo State, Nigeria. The seven chickenstrains used for the experiment were: Normal feather, Fulani ecotype, Frizzle feather, and Transylvania and Naked neck indigenous strains while Hubbard and Marshall were meat-type exotic chickens. Each strain was replicated three times at 10 birds per replicate making a total of 30 hens per strain except for the Frizzle feather that were 15 in number. The study which lasted 22 weeks had the birds distributed into seven treatments according to their genotypes in a completely randomized design (CRD) arrangement. The diet used for the experiment was formulated at the Federal University of Technology, Akure Teaching and Research Farm Feed mill. The diet was fed to the birds at 125g/bird/day for the period of the experiment. The calculated analysis of the diets' crude protein (CP) and metabolizable energy (ME) used were grower's mash (16.66% CP and 2798.56Kcal/kg ME) and layer's mash(18.17% CP and 2995.95Kcal/kg ME).A total of nine hundred and thirty-six (936) eggs at18 eggs per strain and 9 eggs for Frizzled feather were collected every Friday for 8 weeks from 30 – 37 weeks of age from the experimental hens for external egg qualities. The external egg quality characteristics determined as described below were egg weight, width and height, shell thickness, colour and weight.

a. Egg and egg shell weights

The eggsand egg shells were weighed (g) using the sensitive scale (5kg max) while the vernier caliper was used to determine the egg length and egg width and the micrometer screw gauge which was used to determine the egg shell thickness after 72hours. The egg shell colour was determined by visual observation of its colour and comparison was done using the Roche colour fan.

b. Shell thickness

The internal egg membranes of freshly collected eggs were pulled off the shells immediately after being broken. The shell thickness was determined by taking the thickness of the egg shell at three different places (the narrow end, the broad end and the side) by using a micrometer screw gauge calibrated in millimeters. The average of the three values was then recorded.

c.Egg height

This was determined by using the vernieer caliper. The caliper was place at the narrow and broad end of the egg and held firmly but not too tight to prevent cracking of the egg. The readings on the two scales were recorded.

d.Egg width

This was determined by the use of the venire caliper. The instrument was placed at the equatorial plane of the egg and held firmly round the egg. The dimension was read off in centimeters.

Data Analysis

All data generated were subjected to one way analysis of variance (ANOVA) using SAS, 2008 Version 13 statistical software. Duncan Multiple Range Test (DMRT) was used to separate the means where significant differences existed using the same statistical package.

Results and Discussion

This study revealed that egg weights were significantly different ($p<0.05$) among the seven strains with Hubbard strain eggs being heaviest (50.53g) and the lightest in naked neck (37.11g). This result disagreed with the report of Udoh *et al.* (2012) who reported that naked neck had heaviest egg weight among the exotic and indigenous strains. The differences observed could be attributed to variations in their genotypes. Egg weight variations in different genetic groups have been reported by many authors (Padhi *et al.*, 1998 and Chatterjee *et al.*, 2007).The study showed that eggs of indigenous chickens are generally small or peewee in size as their weights ranged between 37.11g – 43.23g and chicks from the chicks are presumed to be small as such. Among the indigenous chickens, the eggs of Fulani Ecotype chickens weighed heaviest (43.23g) with thinnest shell (0.31mm).Birds with big body ate more feed to maintain their body size and therefore, the size of their eggs is greater (Alex, 2001). This confirmed the findings of this study in which the exotic birds ate more, weigh heavier and had bigger/heavier egg weights than their indigenous counterparts.

The variation in height of the eggs among the strains, in which Hubbard (HB) and Transylvanian (TB) had higher egg height, could be due to their genetic makeup. Environmental factors such as diet, water intake, temperature, humidity and management practices may also contribute to the variability observed in external egg quality parameters (Isihahomen *et al.,* 2014). The differences observed in the shell thickness and weight among all the strains is a reflection of high genetic value for shell strength and weight which could make it withstand environmental stress. The low value (<0.33mm) observed in Fulani ecotype, frizzled feather, Hubbard, naked neck and Transylvanian strains for shell thickness showed that eggs of these strains are more prone to breakage and microbial spoilage compared to normal feather and Marshall broiler and could largely determine the fertility and hatchability of indigenous chicken eggs. Chineke (2001) observed that egg shell thickness below 0.33 mm is considered too thin with the attendant risk of breakage and ease of entry by micro-organisms. The consumer's acceptability of an egg is a function of its colour which invariably affects saleability and profitability. The shell colour were significantly different ($p<0.05$).The characteristics brown colour eggs is more pronounced in exotic chickens. This could be probably due to their genetic composition for melanocortin synthesis and deposition on their egg shells than in the indigenous species. Variation observed in shell colour among the strains could be as a result of strain difference. Shell colour is a strain characteristic, although there are often variations among individual hens in a particular flock even when all are of the same breed or strain. Jacob *et al.* (2000) further explained that, shell colour comes from pigments in the outer layer of the shell. The shell colour of the indigenous chickens was clearly different from that of broiler chickens except for naked neck and Transylvanian chickens. This shows the characteristic brown and white shell colours of exotic and indigenous chickens respectively. However, few brown eggs were found in NN and TB chickens.

Table 1: Effect of strains on external egg quality characteristics of experimental birds

Parameters	NF	NN	FF	FE	TB	MB	HB	±SEM
BWT (g)	1391.11^{d}	1451.76^{d}	1404.95^{d}	1840.99^{c}	1966.80^{b}	3559.73^{a}	3569.73^{a}	184.70
EWT (g)	40.39^{f}	37.11^{g}	41.98^{e}	43.23^{d}	47.36^{c}	48.92^{b}	50.53^{a}	0.42
EHT (cm)	4.99^{d}	5.00^{d}	5.14^{c}	5.14^{c}	5.40^{a}	5.27^{b}	5.46^{a}	0.03
EWH (cm)	4.37	3.73	3.84	3.95	4.16	4.04	4.13	0.03
STK (mm)	0.34^{a}	0.31^{c}	0.28^{d}	0.31^{c}	0.29^{d}	0.33^{b}	0.31^{c}	0.01
SWT (g)	4.16^{c}	3.81^{d}	3.95^{d}	4.41^{b}	4.48^{b}	4.83^{a}	4.95^{a}	0.06
Shell colour	1.97^{a}	1.61^{b}	1.97^{a}	1.85^{a}	1.55^{b}	1.08^{c}	1.00^{c}	0.04

$^{a, b,, c, d , e, f, g}$ =means on the same row but with different superscripts are statistically ($p<0.05$) significant,BWT = Body weight, EWT = Egg weight, EHT = Egg height, EWH = Egg width, STK = Shell thickness, SWT = Shell weight,cm = Centimeter; g = Gram; FE = Fulani Ecotype; FF = Frizzled Feather; HB = Hubbard Broiler; MB = Marshal broiler; NF = Normal Feather; TB = Transylvanian Breed; NN= Naked Neck; ±SEM = Standard Error of Mean.

Conclusion and Recommendations

The findings of this study indicated that strain had significant effect on egg weight and height, shell thickness, weight and colour. Most of the external egg quality investigated revealed that exotic strains were superior to indigenous species on egg weight as their eggs were heavier in weights with good heights and shell thicknesses. The study also showed that eggs of indigenous chickens are generally small/peewee in size and chicks from them would probably be small as such. Among the indigenous chickens, the eggs of Fulani Ecotype chickens weighed heaviest with thinnest shell. The low shell thickness observed in some strains showed that eggs of these strains are more prone to breakage and microbial spoilage. The characteristics brown colour eggs is more pronounced in exotic chickens in this

study than the indigenous population. It can be concluded that normal feather chicken eggs had good shell thickness that favour its handling and reduction in microbial spoilage. Fulani ecotype chickens possessed the greatest potential for improvement as egg producing indigenous chickens in Nigeria. Brown eggs shell colour formation of indigenous chickens is poor. Fulani ecotype chicken is recommended for improvement and incorporation as indigenous layer bird because of its potential in laying heavy weight eggs. Normal feather chickens are also recommended because of their egg shell strength. Researches on NICs for improvement in egg shell colouration to attract consumers and increase saleability and profitability of produces is highly advocated.

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Response to reviewer's comments on the manuscript titled: **EXTERNAL EGG QUALITY CHARACTERISTICS OF SEVEN-CHICKEN STRAINS FROM SOUTH-WESTERN NIGERIA**

S/N	Page	Reviewer's comment	Author's response
		REVIEWER	
I		***Author***	
		The author modified name of authors	**Adebayo, O.T**. added as the last author
II		***Abstract***	
	L 13	The review noted a floating statement	Statement linked up appropriately
III		***Methodology***	
	L 10	The reviewer noted a variation in the number of birds used	Generally, Frizzled feather indigenous chickens have lethal gene. Hence, very poor hatchability. This accounted for the number variation.
IV		***Results and Discussion***	
	L 1	The reviewer wanted a sign of significant difference	sign of significant difference **($p<0.05$)** inserted
	L 9 & 11	The reviewer wanted a change of eat to past tense	Corrections effected

GROWTH PERFORMANCE OF SIX TROPICALLY-ADAPTED CHICKEN BREEDS IN BACKYARD FLOCKS ACROSS KEBBI STATE, NIGERIA

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Abstract
On-farm growth assessment of six tropically-adapted breeds of chicken was conducted in six locations in Kebbi state, Nigeria. The birds were distributed by the African Chicken Genetic Gains (ACGG) project. The study was designed to generate baseline data that could be used in the chicken selection and improvement program in the study area. A semi-structured questionnaire and field observation were used for data collection. Data were collected from 208 households, each with one of the six chicken breeds randomly distributed in batches at six weeks of age covered growth of birds from week 7-18. General Linear Model (GLM) of the SPSS was used for analyzing the data. Mean body weight at 18 weeks was similar and higher for Noiler, Sasso, Kuroiler and Funaab alpha (1383g, 1374g, 1339g and 1303g) than that of Fulani (1116g) which is higher than that of ShikaBrown (817g) respectively across the locations ($P<0.05$). Expectedly, Cocks recorded higher mean live weight than the pullets (1338 versus 1104g) in all the breeds and across the locations ($P<0.05$). The significance of interaction between location and breed on the overall growth performance of the birds was underlined.

Keywords: Growth, On-farm, Chicken breed, Location, Sex

Introduction

Chickens are regarded as the most important and widely spread avian species among poultry birds (Dutta *et al.,* 2013). They are said to be one of the important animal genetic resources used as weapons for fighting poverty and malnutrition, especially in rural areas of most developing countries, which results in the growing interest on the use of chicken as a tool for poverty alleviation in villages throughout the world (Dunya *et al.,* 2015). However, chicken growth and development is a complicated life process and is subject to a significant amount of control by genetic and non-genetic factors (Pourtorabi *et al.,* 2017; Zhenqiang *et al.,* 2013).

Chicken consumption in the rural areas of Nigeria is reserved for special occasions due to the low level productivity of free range birds (Adene, 2006). There is also no comprehensive list of the breeds and varieties of chickens kept by rural smallholders and their characterization becomes difficult due to cross-breeding with the exotic breeds and random mating within the flock (Sonaiya and Swan, 2004). Most performance evaluations of chicken stains were usually conducted under intensive system of management (Sonaiya and Swan, 2004), hence true reflection of their performance under extensive or backyard extensive systems is lacking.

If production from family poultry is to remain sustainable, it must emphasize the use of adapted breeds, family labour, and better management of stock and local feed resources among other factors (Sonaiya and Swan, 2004). This therefore suggests the need to study different chicken breeds with the aim of determining their appropriateness under the local environment and the prevailing production system.

Materials and methods

Study area

The study was conducted in six villages: Alwasa and Lailaba in Argungu Local Government Area (LGA); Senchi and Kwendo in Zuru LGA and Jiga and Sabiyal in Aliero LGA. The three LGAs represent Kebbi North, Kebbi South and Kebbi Central Senatorial Districts of Kebbi State, Nigeria. Kebbi state experiences two alternating seasons: the short wet (rainy) season; which starts from May/June and ends in September/October, and the long dry season; which completes the remaining part of the year. The mean annual rainfall is about 841mm, mean temperature varies from 16.4°C to 39.5°C recorded in December

and April respectively (Climate-Data.Org, 2017). The open Savanna vegetation pattern in the state provides opportunity for extensive livestock rearing and cultivation of short duration arable crops. Thus, most of the people in the state are agro-pastoralists: rearing livestock alongside arable crop production.

Sampling technique and birds' allocation

Multi-stage sampling procedure was employed for selecting respondents. At first stage, one LGA was selected from each senatorial district. In the second stage, purposive sampling was used to select two villages from each of the selected LGAs and the third stage involved random selection of 35 households in each village. Each household was randomly allocated one of the six chicken breeds (Kuroiler, Sasso, Fulani, Funaab alpha, Noiler and ShikaBrown) which makes 208 flocks.

Collection and analysis of data

Monthly body weight data on all the ACGG birds in each household were recorded according to breed and location. The data were collected using a semi-structured questionnaire designed to collect information on birds' performance and management practices in each household. The collected data were subjected to the GLM of SPSS (2013) for analysis. Means were compared using Duncan's Multiple Range Test (DMRT). The following general linear model was used:

$Y_{ijk} = \mu + B_i + G_j + T_k + e_{ijk}$

Where, Y_{ijk}= Dependent variable BW@WK 6… MBW@WK 18)

μ = Overall population mean for a given variable;

B_i = Fixed effect of i^{th} sex (1, 2);

G_j = Fixed effect of j^{th} location (1, 6)

T_k = Fixed effect of k^{th} breed (1, 6)

e_{ijk} = Random residual error associated with Y_{ijk} observation.

Results and discussion

Growth performance of the birds

The mean final body weights of all the birds according to breed, location and sex are presented in Table 1. Significant differences were observed for mean body weight at 18 weeks across the study villages ($P<0.05$). The respective mean final body weight (1383g, 1374g, 1339g and 1303g) of Noiler, Sasso, Kuroiler and Funaab-alpha were statistically similar, but higher than that of Fulani (1116g) which was higher than 817g of ShikaBrown.

Similarly, location had significant effect on the overall growth performance of the breeds ($P<0.05$). Aggregate mean final body weight of the birds was highest in Lailaba (1674g), followed by Alwasa with 1309g, which was higher than 1192g and1166g recorded in Jiga and Kwendo, respectively. The aggregate mean final body weights recorded in Jiga and Kwendo were similar ($P>0.05$), Kwendo and Senchi in Zuru LGA recorded no significant difference in the aggregate mean final body weight (1166g versus 1099g; $P>0.05$). The least performance was recorded in Sabiyal with 857g.

Table 1: Mean values for final body weight of birds according to breed, location and sex

Breed		Sex/Breed		Location		Sex	
Noiler	1383.10^{a}	M	1500.58^{a}	Lailaba	1673.72^{a}	M	1904.57^{a}
		F	1290.53^{b}			F	1456.44^{b}
Sasso	1374.30^{a}	M	1491.34^{a}	Alwasa	1308.56^{b}	M	1491.23^{a}
		F	1254.10^{b}			F	1151.08^{b}
Kuroiler	1339.27^{a}	M	1509.98^{a}	Jiga	1192.46^{bc}	M	1251.19^{a}
		F	1172.82^{b}			F	1141.82^{b}
F-alpha	1302.98^{a}	M	1511.83^{a}	Kwendo	1166.11^{c}	M	1246.90^{a}
		F	1122.60^{b}			F	1087.84^{b}

Fulani	1115.88[b]	M	1172.55[a]	Senchi	1098.64[c]	M	1214.11[a]
		F	1062.35[b]			F	989.76[b]
S-Brown	816.59[c]	M	862.69[a]	Sabiyal	857.43[d]	M	900.05[a]
		F	774.12[b]			F	816.27[b]

The Growth Curve

The average monthly body weight performance of all the breeds is shown in figure 1. The growth pattern from the age of introduction (6weeks) was steady during the first month of the study. The growth continues at an increasing rate with Noiler having recorded the highest mean body weight all through which sharply declined from 14 to 18 weeks. This change in normal growth pattern could be due to the interaction of genetic (breed) and non-genetic factors (farm, season, feeding systems, flock management, housing, vaccination etc) affecting growth (Hossen, 2010; Desha et al., 2016). Sasso breed appeared to have outweighed Kuroiler and F-alpha at 18 weeks of age and almost attained the same weight with Noiler. The growth of Funaab alpha and Kuroiler followed a similar pattern, one (Kuroiler) slightly higher than the other (F-alpha). The growth of Fulani and Shikabrown is less than the rest of the breeds due to the disparity in their genotype. The Fulani being natives of the research locations with no selection records, exhibited a more stable growth pattern and grew faster than ShikaBrown.

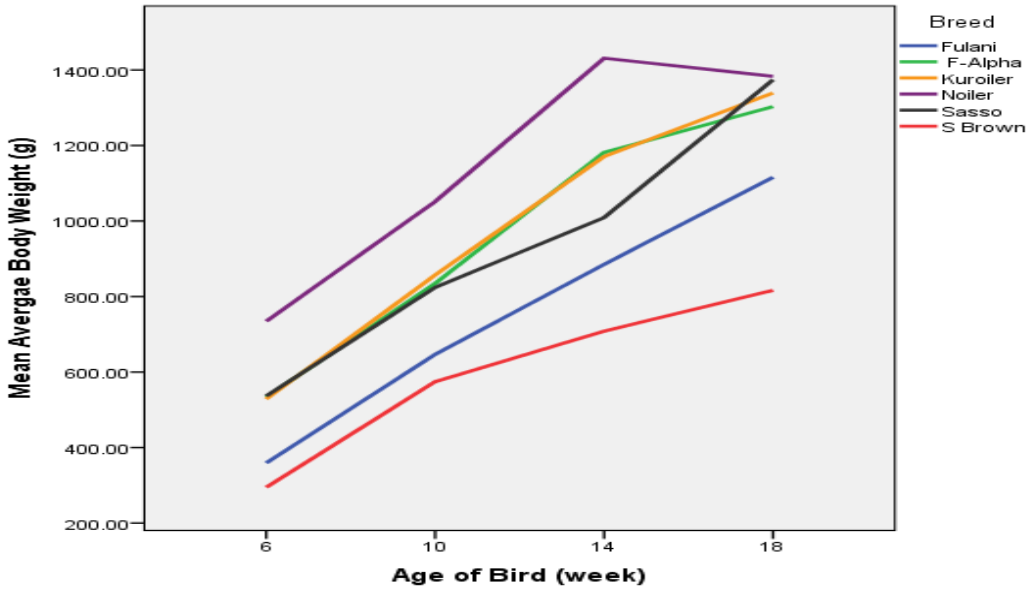


Figure 1: Growth curve of six tropically-adapted chicken breeds

Genotype × Environment Interaction on Growth of Chickens

Lailaba village proved to be the most favourable environment for almost all the breeds. The farmers in Lailaba had wider range of choice of chicken breeds, since all the breeds performed relatively better when compared with the other villages. Similarly, Alwasa supported a relatively good growth performance, similar to Jiga. There was no significant difference ($P<0.05$) between the overall growth performance of the breeds in Jiga and Kwendo and Senchi. The lowest overall growth performance was recorded in Sabiyal.

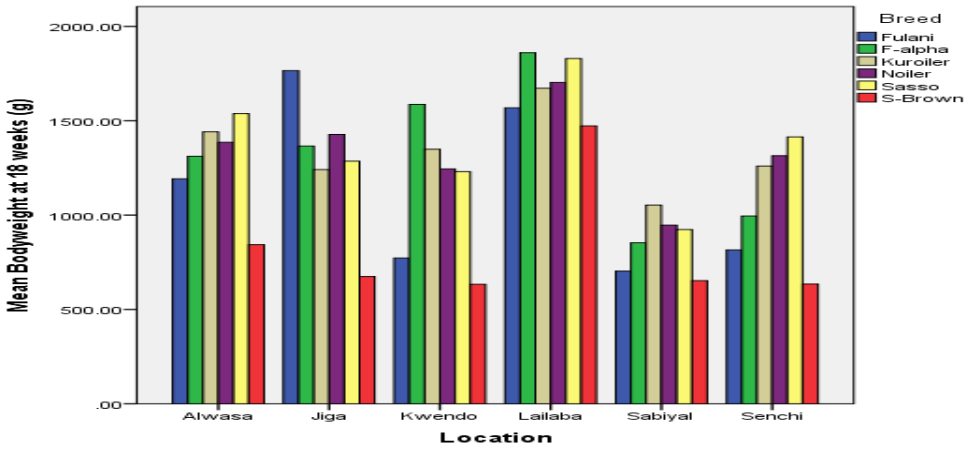
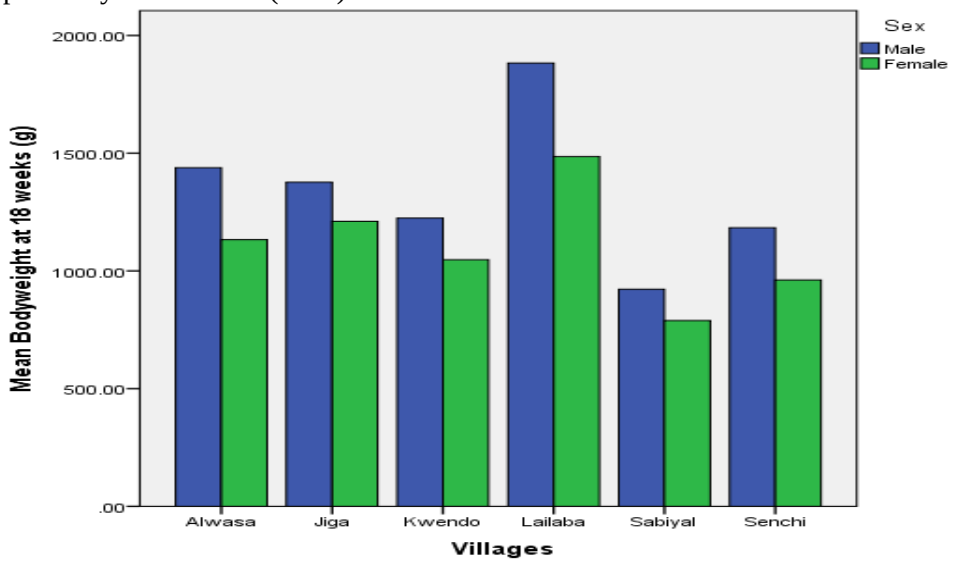


Figure 2: Genotype × Environment Interaction on Growth of Chickens

Sex ×location effect on growth of chickens

Figure 3 shows mean body weight of cocks been higher than that of the pullets (P<0.05) which proves that, regardless of breed and location cocks attain heavier body weight than pullets. A similar finding was reported by Desha *et al*. (2016).



Conclusion and recommendation

From the results of this study, it can be deduced that on-farm growth performance of chicken is affected by genetic factors peculiar to breed(s). Non-genetic factors which include sex, age, location and varying flock management practices in different locations exert great influence on growth. Farmers in the study locations ought to choose breed(s) suitable to their location and give preference to cocks for better growth performance.

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SEMEN INDICES AND SEMINAL ZINC CONCENTRATION OF MALE RABBITS FED DIETS SUPPLEMENTED WITH ZINC

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ABSTRACT

An experiment was carried out to assess the effect of dietary levels of zinc on semen indices and seminal zinc concentration of rabbit bucks. Twenty male rabbits aged 6 months old were randomly allocated to four groups and fed diets containing 0, 50, 100 and 150 mg of zinc gluconate per kg diet respectively for eight (8) weeks with five bucks per group. Semen was collected from the bucks weekly using an artificial vagina. Samples of fresh semen were assessed for semen volume (ml), spermatozoa motility (%) and sperm concentration ($x10^8$/ml). The number of spermatozoa per ejaculate ($x10^8$) was also calculated. Seminal plasma was separated from the semen by centrifugation and seminal zinc concentration was determined using atomic absorption spectrophotometry. Data obtained were subjected to statistical analysis. The result showed that all semen parameters assessed were not significantly influenced by zinc levels fed to the bucks. Seminal zinc concentration was higher in bucks administered dietary zinc levels ($Z_{50,}$ Z_{100} and Z_{150}) compared to those on the control (Z_0). Bucks fed 100mg/kg diet had the highest seminal zinc concentration while the least was recorded in bucks on the control. It was concluded that dietary level of zinc gluconate as observed in this study may not enhance semen quality of rabbit bucks. However, supplemental levels of zinc gluconate may result in increased seminal zinc concentration in rabbit bucks.

Keywords: Zinc gluconate, Male reproduction, Seminal plasma

INTRODUCTION

Poor semen production is a factor that hinders efficient reproductive performance in males. In the tropics, male rabbits are used for breeding purposes from about 6 months of age and expected to produce semen consistently from this age. This is not so in many tropical breeds and their crosses; as their performance is influenced by several factors among which diet play a significant role. Diets low in micronutrients contributes to inefficient spermatogenesis as they are essential for growth and development. Microelements are often provided to animals in diets as a component of the premix added and supplemented in diet or water as necessary. Certain microelements may be present in sufficient quantities in feed but their deficiency symptoms may still be observed in the animals due to their varying bioavailability or forms that cannot be utilized in the body (Wang *et al*., 2010). Salts of minerals are often used in oxides, carbonates, chlorides, and sulphates forms and the use of chelate forms is on the increase (Wang *et al*., 2010, Chrastinova *et al*., 2015). Zinc gluconate is a chelated form of dietary zinc and it has been used extensively in human. Zn is vital for growth and development, sexual maturation and reproduction, dark vision adaptation, olfactory and gustatory activity, insulin storage

and release and for a variety of host immune defenses (Biswajit *et al*., 2013). The presence of Zn in the proper concentration in the diet of the animals is of immense importance not only for the well-being of the animals but also for optimizing the overall performance of the animals and to enhance their production potential (Shinde *et al*., 2006). Improvement in the sperm production and fertility has been achieved following the supplementary feeding of Zn (Biswajit *et al*., 2013). Zinc functions as a cofactor of numerous enzymes and is involved in cell division processes; higher levels are required for reproduction and fur production than for maintenance and meat production (Halls, 2010). The zinc requirements for rabbits vary from 25 to 60 mg/kg diet (Mateos *et al.,* 2010). Oliveira *et al.* (2004) affirmed that the inclusion of zinc in the diet of breeding animals can influence spermatozoa concentration. Zinc is essential for the development of sex organs and spermatogenesis in the males. In order to select bucks on the basis of high fertility for breeding purpose, there is need to assess their semen quality especially at the age they are termed matured and supplement for zinc where necessary. Hence, this study aimed at evaluating semen characteristics and seminal zinc concentration of rabbit bucks fed supplemental levels of zinc in chelated form (zinc gluconate).

MATERIALS AND METHODS

A total of twenty (20) bucks aged 6 months with an average weight of 1.88kg were used for this experiment. The study was conducted at the rabbitry unit of the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria. Rabbits were housed individually in cages and fed same diet for two weeks for acclimatization. They were randomly allotted into 4 groups of 5 bucks per group and fed the experimental diet containing 0, 50, 100 and 150 mg zinc gluconate per kg diet for 8 weeks. The groups were designated as Z_0, Z_{50}, Z_{100} and Z_{150} respectively. The experimental diet was presented in a pelletized form and clean water was supply daily. The experimental diet contained 16.13% crude protein, 2396.6kcal/kg digestible energy and 10.38% crude fibre. Semen was collected from the bucks weekly using an artificial vagina. Samples of semen were assessed for semen volume, spermatozoa motility and sperm concentration. The number of spermatozoa per ejaculate was calculated as the product of semen volume and spermatozoa concentration. Seminal plasma was separated from the semen by centrifugation at 4000 rpm for 15 minutes and assessed for seminal zinc concentration using atomic absorption spectrophotometry. Data obtained were subjected to statistical analysis of variance procedure using Statistical Analytical System (SAS, 2009). Treatment means were compared using Duncan Multiple Range Test of the same software.

RESULTS AND DISCUSSION

Improvement in the sperm production and fertility has been achieved following the supplementary feeding of Zn (Biswajit *et al*., 2013). Table 1 shows the result on semen indices of rabbit bucks fed dietary levels of zinc. All the semen parameters assessed were not significantly influenced by supplemental levels of zinc fed to the bucks. The values obtained for the semen indices assessed are semen volume (1.38 – 1.69 ml), spermatozoa motility (80.31 - 89.88 %) and sperm concentration (3.78 – 5.05 $x10^8$/ml). This study therefore showed that dietary supplementation of chelated form of zinc as zinc gluconate may not improve semen production in male rabbits. The result from this study corroborates the report of Chrastinova *et al*. (2015) who observed a weak influence of Glycinoplex-Zn in young

rabbit's performance. Egwurugwu *et al*. (2013) reported a significant effect of oral zinc administration on sex hormones and sperm quality in wistar rats. However, findings from this study is at variance with that of Moce *et al*. (2003) who reported a significantly higher total sperm production in adult male rabbit administered 100mg/kg dietary levels of zinc sulphate. Ogbu and Herbert (2018) reported a significant decrease in follicle stimulating hormone and interstitial cell stimulating hormone when dietary levels of zinc gluconate was fed to two (2) months old rabbits. Based on the relationship between reproductive hormones and semen production, it implies that supplementing rabbit diet with zinc gluconate within this age range (2 – 6 months old) may not result in improve semen production. The result on seminal zinc concentration (mg/l) is presented in figure 1. The values obtained was significantly higher in bucks fed Z_{100} (1.09) and Z_{150} (0.95) than those fed the control diet Z_o (0.33) however the values were not significantly different from that of bucks fed Z_{50} (0.61). The increase in seminal plasma concentration of zinc shows that dietary levels of zinc influenced the activity of the accessory sex gland (prostate gland). This may help to enhance prostate health as Bentley and Grubb (1991) reported that apart from red and white blood cells; zinc is also stored in the prostate gland.

Table 1: Semen Indices of Rabbit Bucks Fed Supplemental Levels of Zinc

SEMEN INDICES	Z_0	Z_{50}	Z_{100}	Z_{150}	±SEM
Semen Volume (ml)	1.67	1.69	1.38	1.50	0.09
Spermatozoa Motility (%)	89.88	84.70	80.31	87.20	2.00
Sperm Concentration ($x10^8$/ml)	4.07	3.78	5.05	4.08	0.31
Number of spermatozoa /ejaculate ($x10^8$)	6.80	6.39	6.97	6.12	0.54

Z – Zinc

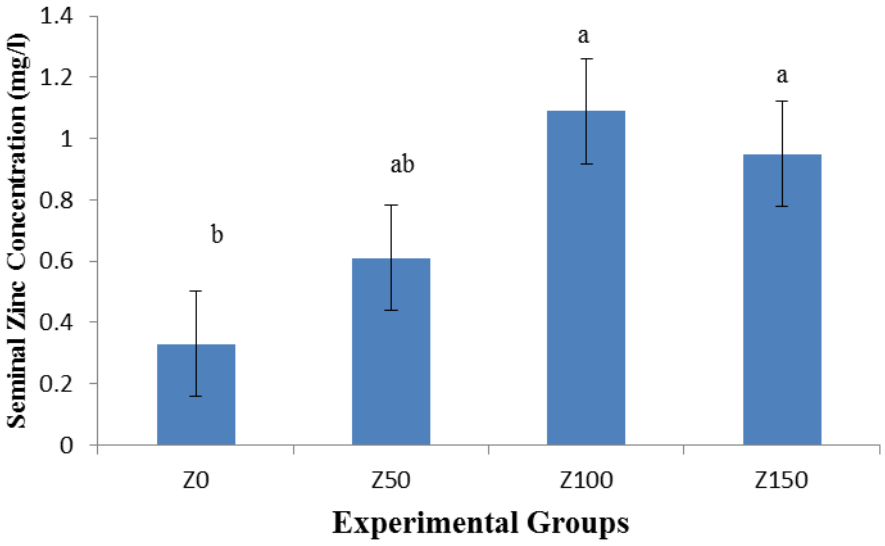

Figure 1: Seminal zinc concentration of male rabbits fed dietary zinc levels

CONCLUSION

It was concluded from the study that dietary levels of chelated form of zinc (zinc gluconate) may not improve semen quality of rabbit bucks. However, supplemental levels of zinc gluconate may result in increased seminal zinc concentration in rabbit bucks which is indication of improved prostate health.

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COMPARATIVE HISTOMORPHOLOGICAL STUDY OF THE ONE HUMPED CAMEL (*Camelus dromedarius*) THYROID GLAND

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ABSTRACT

A histomorphological comparative study of the thyroid glands of 55 healthy adult (8-15 years) camels (C*amelus dromedarius*) of different sexes group A (28 Males) and group B (27 Females), were investigated under gross and microscopic anatomical differentiation. Gross studies revealed that thyroid glands of both sexes were located in between the third ring of trachea and the laryngopharynx portion of the pharynx and had two lobes, connected by an isthmus. They female gland appeared to be deeply reddish brown than the male in colour. The values of weight, length, width and diameter of both sexes glands were shown to have significant difference with the male been greater than the female (P>0.05). Histological observation revealed that the male thyroid gland consisted of more connective tissue capsule than the female and traberculae were found extending from the capsule deep into the parenchyma of the gland in the female than in the male, which divided it into lobules. These shown that lobation is more pronounced in female than in male with each lobule consisted of two sized follicles in variable numbers, the large and small. The large follicles predominate in the male and were lined by low cuboidal epithelium, while the small follicles predominate in the female were lined by high cuboidal to columnar epithelium. The follicles had colloid material in their lumen, probably an apocrine secretion from the lining epithelial cells of both sexes.

Keywords: Comparative anatomy, Columnar epithelium, Sex, C*amelus dromedarius*, Thyroid gland

INTRODUCTION

The endocrine system is a global system that works through release of chemical messages called hormones (Bello *et al*., 2012). The thyroid is an endocrine gland which secretes thyroglobulin, triiodothyronine and thyroxin hormones (Malie *et al*., 1987; Banks, 1993). Thyroxin plays an important role in metabolism of the animal body. Thyroid gland consists of follicles lined by follicular cells. The interfollicular space has been reported to be filled with connective tissue (Asari *et al*., 1985; Bello *et al*., 2012). The most outstanding feature of the vertebrate thyroid gland is its ability to concentrate large amount of iodine for the synthesis of thyroxin (Georgieva and Gerov, 1975).

The normal anatomy and physiology of dromedarian camel is least understood when compared to Llama, Guanaco, Cattle, Sheep, Goat and Pig (Bello *et al*., 2012). The description of dromedarian camel is usually made as if it is identical with Llama specie (Bello *et al*., 2012, Franco *et al*., 2004). Though, they are seasonal breeders (Belknap, 1994; Bello *et al*., 2012 that are closely related anatomically to the South American Camelids (Georgieva and Gerov, 1975; Wilson *et al*., 1990; Belknap, 1994; Umaru and Bello, 2012) little is known on the anatomy and physiology of the thyroid gland.

The present study was conducted to investigate the sexes related differences (male and female) of normal microscopic anatomy of thyroid gland of one humped camel (C*amelus dromedarius*) with the aim of understand the teaching of comparative anatomy and physiology of the gland of the dromedarian Camel in the world.

Materials and Methods

The study was carried out on 55 normal Adult (8-15 years) one-humped camel of different sexes group A (28 Males) and group B (27 Females), collected from the metropolitan abattoir, Sokoto in winter season, using standard animal ethics approved by the government. The collected samples were then taken

to the Veterinary Anatomy laboratory of Usmanu Danfodiyo University; where the gross and biometric values were determined.

$1cm^2$ thick of sample from each segment was collected and fixed in 10% formalin solution. After fixation was achieved, the tissue sample was processed for paraffin blocks preparation. The sections of 5µm were subjected to haematoxylin and eosin for routine morphology (Luiz and Jose, 2005). The standard sections were examined under light microscope and micrographs taken using Sony digital camera(x5) with 12.1 mega pixel.

RESULTS AND DISCUSSION

Gross observations

Gross studies of thyroid gland of camel revealed that the gland of both sexes were located in between the third ring of trachea and the laryngopharynx portion of the pharynx and had two lobes, connected by an isthmus. They female gland appeared to be deeply reddish brown and the male gland appeared to pale reddish brown in colour. An isthmus connected these lobes to each other was observed in all the sexes and was reddish brown in colour too. This finding is similar to other large animals like cattle and buffaloes (Getty *et al.,* 1986) i.e., with the first ring of trachea and consisted of two lobes on both side and an isthmus connecting these lobes. In some desert reptiles, the colour of the gland is in concordance with the findings of Schwartz and Dioli (1992).

The values of weight, length, width and diameter in camels of different sexes groups via male and female are presented in Table 1. The mean weight was 50.55 ± 0.26g and 45.70 ± 0.35g, the mean length 6.36 ± 0.33cm and 5.36 ± 0.46cm; the mean width 3.53 ± 0.21cm and 3.35 ± 0.29cm and the mean diameter 1.05 ± 0.14cm and 0.97 ± 0.13cm in two groups respectively, which was showing significantly higher in male than in the female. The result showed slightly lower than previously reported value of 52.7 gm in camel (Abdel-Wahab and Hamza, 1970). It has been reported that in summer the size of the gland increases (Yagil *et al*., 1978). The mean diameters recorded were 0.97 and 1.05 cm which fell in the range of 0.5 in female to 1.5 cm in male adult camels (Schwartz and Dioli, 1992). The mean length recorded was 5.36cm in female and 6.36 cm in male, and is in contrary to the range of 3cm in female to 8 cm in male as reported by Abdel-Wahab and Hamza, (1970) in llama. Similarly, the width of gland recorded was 3.35cm in female and 3.53cm in male which was contrary to the range of 2cm in female and 4.5cm in male as reported earlier in this species (Schwartz and Dioli, 1992). The statistical analysis revealed non-significant difference in various parameters between the two sexes groups. However, the values of all the parameters were relatively higher in male camels compared with female group.

Table 1: Values (Mean ± SD) of different parameters in camels of two Sexes groups

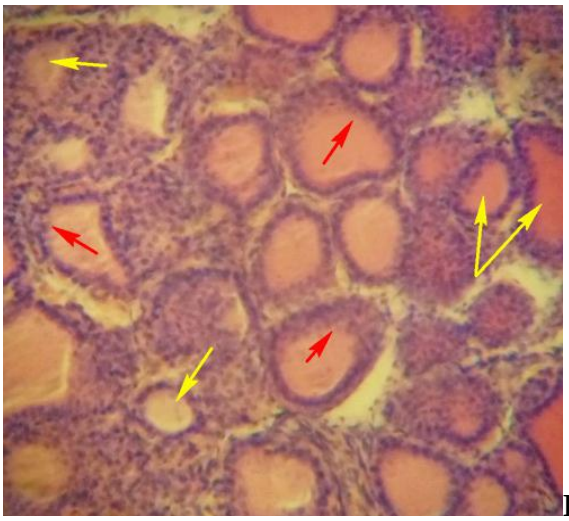
Parameters	FEMALE	MALE
Weight (g)	45.70 ± 0.35^a	50.55 ± 0.26^b
Length (cm)	5.36 ± 0.46^a	6.36 ± 0.33^b
Width (cm)	3.35 ± 0.29^a	3.53 ± 0.21^b
Diameter(cm)	0.97 ± 0.13^a	1.05 ± 0.14^b

Histological findings

Histologically, the thyroid gland of both sexes consisted of a connective tissue capsule composed of coarse and fine collagenous fibers with scattered fibroblast and small blood vessels all over the capsule (Fig.1, 2 and 3). The traberculae of the female gland were seen extending from the capsule into the parenchyma of the gland and dividing it into lobules (Fig.1and 2). Blood vessels were also present in the connective tissue of the traberculae. Each lobule consisted of aggregation of follicles as shown in figures1and 2. Three types of follicles were identified in sexes, large (A), medium (B) and small (C) (Fig. 3). The large follicles (A) were lined by low cuboidal epithelium having flattened nuclei and were assumed to be inactive cells while the medium follicles (B) were lined by columnar epithelium having oval nuclei. The small follicles (C) were lined by cuboidal epithelium with rounded nuclei, these were active cells. Each follicle was filled with a gel-like material called colloid (Fig. 3). The colloid is a storage form of follicular epithelial secretion. There is no evidence of para-follicular or C-cells in thyroid glands

of camel of both sexes. This result shown similar observations as reported previously in camel (Abdel-Magied *et al*, 2000; Atoji *et al.*, 1999) i.e. the gland consisted of follicles of variable sizes with smaller lined by low cuboidal to semi squmaous epithelium, while the larger ones were lined by high cuboidal to columnar epithelial cells. The parafollicular or C-cells were found missing but has been reported in cattle and buffaloes (Miyandad, 1973). Similar observations have been recorded by Abdel-Magied *et al*. (2000).

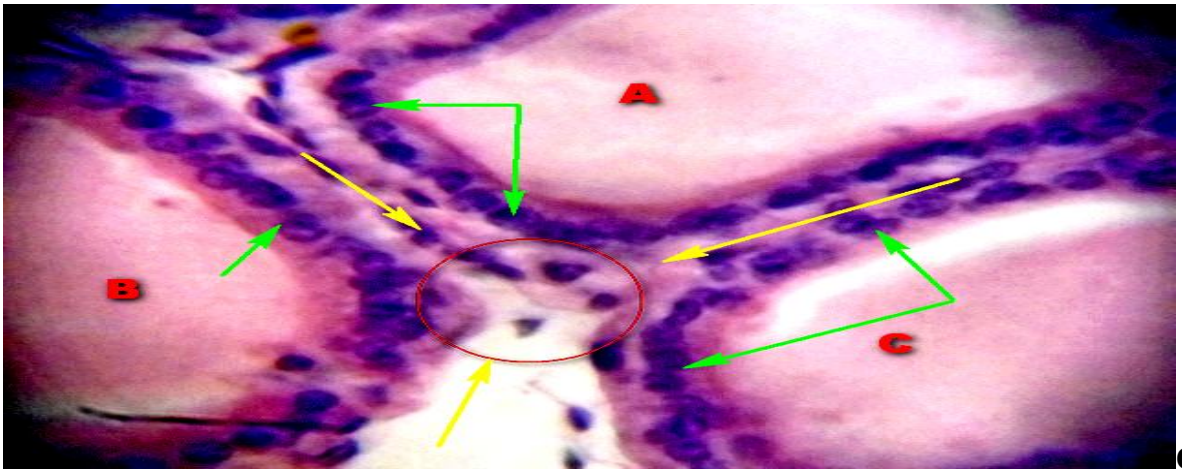

A


B

Key:-

A: - Photomicrograph showing male thyroid gland follicle with tall cuboidal epithelium (**H and E X150**)

B: - Photomicrograph showing female thyroid gland follicle with short cuboidal epithelium (**H and E X150**)



C

Key:- Photomicrograph showing female thyroid gland follicle (A,B,C) with cuboidal epithelium (green arrow), inter follicular connective tissue (yellow arrow) and zone of blood vessels (red circle) (**H and E X150**)

CONCLUSION

Base on the above findings, it can be concluded that thyroid gland of male dromedarian camel is larger, thicker and heavier than the female dromedarian camel. Histological observation further revealed that, the male thyroid gland consisted of more connective tissue capsule than the female and traberculae were found extending from the capsule deep into the parenchyma of the gland in the female than in the male, which divided it into lobules. These shown that lobation is more pronounced in female than in male with

each lobule consisted of two sized follicles in variable numbers, the large and small. The large follicles predominate in the male and were lined by low cuboidal epithelium, while the small follicles predominate in the female were lined by high cuboidal to columnar epithelium.

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"POINTED-END" AND "BLUNTED-END" EGG SHAPE BIASED SEX OF JAPANESE QUAILS AT NATIONAL VETERINARY RESEARCH INSTITUTE, VOM

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Abstract
Following sex determination at about 3 to 6 weeks old in Japanese quail, several undesired growers are often culled from the convoy. Thus, it becomes pertinent to predetermine only the desired sex during egg incubation. Many techniques and ideas have been developed to identify Japanese quail sex at day old but to no avail. Therefore, this study was aimed at investigating the claims and speculations by many Nigerian traditions and beliefs that "pointed-end" and "blunted-end" eggs produce male and female hatchlings respectively in poultry species. To achieve this, a total of 1,100 Japanese quail eggs were carefully sorted and distributed based on the shape into 550 "pointed-end" eggs and 550 "blunted-end" eggs. Data were collected on incubation period, hatchability and sex ratio. In the "pointed-end" eggs, incubation period was between 17 and 18 days, hatchability was 50.7% and more cocks (207) representing 74.2% compared to only 72 hens (representing 25.8%) were recorded with a sex ratio of 1 hen: 2.9 cocks. Whereas, among the "blunted-end" eggs, chicks emerged on the 18th day of incubation, 59.5% hatchability was observed and more hens (238 representing 72.8%) relative to 89 cocks representing 27.2% were recorded with a sex ratio of 2.7 hens: 1 cock. Consequently, the claims and speculations by many Nigerian traditions and beliefs that egg shape could determine the sex of poultry species appeared to be correct. At the moment, in-depth research findings are required, to elucidate this preliminary finding before its adoption.

Keywords: Egg shape, Japanese quails, NVRI, sex determination, sex ratio.

Introduction

Japanese quail like fowls, pheasants and partridges belong to the family *Phasianoidea* of Order *Galliformes* of the Class *Aves* of the Animal Kingdom. Species or subspecies of the Genus *Coturnix* are native to all continents except the Americas. The domesticated subspecies *Coturnix coturnix japonica* was called Japanese quail also known as Common quail, Eastern quail, Asiatic quail, Stubble quail or Pharaoh's quail. Meanwhile, the correct popular nomenclature for *Coturnix coturnix japonica* was given as Japanese quail or *Coturnix* and not *Coturnix* quail because the Latin word "*Coturnix"* may be translated as quail (Fah, 2009; Howes, 1964). According to Haruna *et al*. (1997), Japanese quail (*Coturnix coturnix japonica*) was introduced into Nigeria in 1992, where it has gradually gained popularity over other poultry species. Japanese quail is believed to be a veritable source of nutrients that can satisfy human requirements for healthy living (Boni *et al*., 2010; Raji *et al*., 2015). In particular, the eggs have been reported to be rich in minerals and vitamins that could meet the recommended daily requirements of human beings irrespective of the age. Essentially, quail products have been reported to be low in fats and cholesterol contents and as such very medicinal as they help against digestive tract disorder, anaemic, diabetic and hypertensive conditions (Jean, 2009; Musa *et al*., 2007; Sati *et al*., 2012).

Since quails mature at 30 – 60 days old, weighing between 100 – 220g with potency of laying 250 – 320 eggs per year (Jean, 2009), its products would be readily available to meet human demands. It is believed

that if fertile eggs are needed in quail convoy, 1 male: 1 or 2 female(s) ratio should be maintained and quail egg fertility may continue for up to 14 days even when the male is withdrawn from the convoy (Woodward *et al*., 1973). The quest for fertile egg production has resulted in undue pressure on quail chicks demand and supply but sexing at day old is impossible. Although, Fah (2009) reported that quail sex identification is possible at 3 weeks of age using plumage pattern, it requires reaffirmation at 6 weeks old. Unfortunately, there is little or no reliable information on quail chick sexing at day old, even with the Japanese vent examination hi-tech facilities and the sex-linked colour auto-sexing recently developed. Many Nigerian traditions and beliefs have it that "pointed-end" and "blunted-end" eggs produce male and female hatchlings respectively in poultry species. Thus, this study was targeted at investigating the influence of egg shape on Japanese quails sex.

Materials and methods

The study was conducted at the National Veterinary Research Institute (NVRI), Vom, Jos. Jos is a city in Plateau State in the Middle Belt of Nigeria located on latitude 9° 55' 42.56"N and longitude 8° 53' 31.63"E. The altitude is about 1,264.5m (4,148.62 Feet) above sea level with about 1,400mm (55 inches) of rainfall annually. Average monthly temperatures of 21 – 25°C (70 – 77°F) and hailstones sometimes fall during the rainy season because of the cooler temperature at high altitude (Wikipedia, 2018). A total of 1,100 Japanese quail eggs were collected from a convoy at the peak of lay in the Breeding Unit, Poultry Division NVRI. The eggs were carefully sorted and distributed based on the shape into 550 "pointed-end" eggs and 550 "blunted-end" eggs (See plates 1 and 2).

Plate 1: "Pointed-end eggs"

Plate 2: "Blunted-end eggs"

All the eggs were incubated in 8 clutches in an automated incubator, regulated at 38^{o}C with relative humidity set appropriately at 60 – 70% depending on the incubation day. Incubation period represented the time between egg incubation and chick emergence, hatchability was determined by dividing the number of hatched chicks with the number of incubated eggs and death of the birds was recorded as mortality. At 3 weeks old, sex of the birds was identified using breast plumage and at 6 weeks old, the identified sex was reaffirmed using breast plumage. Cocks population relative to the hens represented the sex ratio. The data collected were analysed using simple descriptive statistics as prescribed by Adesoye (2006).

Results and discussion

Table 1 shows the effect of "pointed-end" egg shape on hatchability and sex ratio in Japanese quails. The incubation period of 17 – 18 days was in consonant with the reports of Romao *et al*. (2009). The hatchability value was relatively lower than 69.6 – 72.7% reported by Farghly *et al*. (2015) in Japanese quail except in the 5th and 7th egg clutch where 66% and 76% were recorded. This could be largely due to infertility level of the eggs incubated and partly due to bias selection of the eggs used in the study. More cocks (207) representing 74.2% were recorded in all the egg clutches incubated. This probably indicated that "pointed-end" egg shape may influence Japanese quail sex. More importantly, the sex ratio was

biased to more cocks in the convoy, suggesting that the excess cocks could be slaughtered for meat production. Though mortality was apparently higher (41) in cocks compared to 36 in hens, it was recorded in both sexes. Therefore, "pointed-end" or blunted egg shape may not determine survivability rate in Japanese quail.

Table 1: Influence of "pointed-end" egg shape on hatchability and sex ratio in Japanese quails

Parameters		Egg clutches incubated								
		1	2	3	4	5	6	7	8	Grand total
No. of eggs incubated		100	100	100	50	50	50	50	50	550
Incubation period		18	17	18	18	18	17	17	18	-
No. of hatched eggs		43	51	50	22	33	20	38	22	279
Hatchability (%)		43	51	50	44	66	40	76	44	50.7
No. of hens		14	13	14	6	7	5	10	3	72 (25.8%*)
No. of cocks		29	38	36	16	26	15	28	19	207 (74.2%*)
Hen : cock ratio		1:2.1	1:2.9	1:2.6	1:2.7	1:3.7	1:3	1:2.8	1:6.3	1:2.9
Mortality	Hen	3	8	4	2	8	1	7	3	36
	Cock	6	7	6	4	3	3	9	3	41

*: Percentage values grand total number of hatched eggs; embryo physiological status of the unhatched eggs was not evaluated.

Table 2 presents the effect of "blunted-end" egg shape on hatchability and sex ratio in Japanese quails. The incubation period was uniformly 18 days in all the egg clutches incubated throughout the study period. This agreed with the observation of Romao *et al*. (2009) that Japanese quail eggs hatch normally between 16 and 18 days of incubation. In a total of 550 eggs incubated in 8 egg clutches, 327 eggs (representing 59.5%) hatched. This value was similar to the observations of Mani *et al*. (2008) and Romao *et al*. (2009) in Japanese quail. Out of this, 72.8% (238) were hens and 27.2% (89) were cocks, corroborating Nigerian traditions and beliefs that "pointed-end" eggs produce male hatchlings in poultry species. Even when more mortality (41) was observed among the cocks, it occurred in both sexes thus, the observation may not be due to the "pointedness" or "bluntness" of the egg shape.

Table 2: Influence of "blunted-end" egg shape on hatchability and sex ratio in Japanese quails

Parameters		Egg clutches incubated								
		1	2	3	4	5	6	7	8	Grand total
No. of eggs incubated		100	100	100	50	50	50	50	50	550
Incubation period		18	18	18	18	18	18	18	18	-
No. of hatched eggs		69	53	57	29	43	23	25	28	327
Hatchability (%)		69	53	57	52	86	46	50	56	59.5
No. of hens		44	42	48	16	32	17	17	22	238 (72.8%*)
No. of cocks		25	11	9	13	11	6	8	6	89 (27.2%*)
Hen : cock ratio		1.8:1	3.8:1	5.3:1	1.2:1	2.9:1	2.8:1	2.1:1	3.7:1	2.7:1
Mortality (%)	Hen	9	5	5	4	7	3	2	4	39
	Cock	12	8	9	2	3	5	1	1	41

*: Percentage values grand total number of hatched eggs; embryo physiological status of the unhatched eggs was not evaluated.

More essentially, the sex ratio was observed to skew towards more hens indicating that "blunted-end" egg shape apparently influenced sex determination in Japanese quail. This observation apparently lent more credence to the observations of Göth and Booth (2005) and Eiby *et al*. (2008) that more hens hatched in

avian species in Japanese quail but contradicted the observations of Idahor *et al*. (2015a; b; c; d) in some poultry species.

Conclusion

Since "pointed-end" egg shape apparently hatched more cocks and "blunted-end" egg shape yielded more hens, this study seemingly elucidated the claims and speculations of many Nigerian traditions and beliefs on the influence of poultry egg shape on sex determination in poultry species. However, repeated in-depth research should be conducted in this regard, before the adoption of this preliminary finding.

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Effect of Bitter Leaf Meal (*Vernonia amygdalina*) on Haematological Indices and Blood Glucose Level of Rabbits

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ABSTRACT

In a ten-week feeding trial, fifty six mixed breeds of rabbits were used to evaluate the effect of bitter leaf meal (BLM) on the haematological indices and blood glucose level. Four concentrate mash diets were compounded with inclusion of BLM at 0%, 5%, 10% and 15% . Data obtained were statistically analyzed with the General Linear Model of SAS and means were separated using the Duncan Multiple Range Test. The proximate composition in this study showed that bitter leaf had DM (94.70%), CP (20.48%), CF (11.15%), EE (7.05%) and Ash (13.30 %). The DM decreased as the inclusion level of BLM increased in the diets while the Ash content was highest in 15% BLM (34.35, followed by 10% BLM (32.25), 0% BLM (29.90) and 5% BLM (29.50) while the CP content of diets 5% BLM, 10% BLM and 15% BLM were higher than 0% BLM diet. However, the ME content of the experimental diets decreased as the inclusion level of BLM increased in the diets. The rabbits fed diets 0% BLM (8.77) and 5% BLM (8.03) had significantly higher ($p<0.05$) RBC counts than diets 10% BLM (6.74) and 15% BLM (6.67) diets while the MCV and MCH counts were higher in rabbits fed diets 10% BLM and 15% BLM than other diets. However, there were no significant differences ($p>0.05$) in the MCHC, WBC, PCV and Hb values of rabbits fed the experimental diets. Furthermore, there were no significant differences ($p>0.05$) among the blood glucose levels of rabbits fed the experimental diets. Therefore, it could be concluded that inclusion of bitter leaf meal (BLM) in the diets of rabbits up to 15% had no deleterious effect on the haematological indices and blood glucose level.

Key words: Bitter leaf, haematological, blood, glucose level

INTRODUCTION

Rabbits play a very important role in the supply of animal protein to Nigerians especially in the rural and peri-urban areas. They are efficient converters of feed to meat and can utilize up to 30% crude fibre as against 10% by most poultry species (Egbo *et al* 2001). However, the quality and quantity of available feed resources pose a major problem to animal production especially during the dry season when forages are scarce and limiting in essential nutrients. This leads to search for forages that are cheap and available all year round such as bitter leaf. It is an indigenous Africa plant species; which grows in most parts of sub-Sahara Africa. The leaf meal is a proteinous feed resource 20 – 34% CP (Owen *et al.*, 2009) and can serve medicinal purposes. Olosunde and Odeyinka (2018) observed that bitter leaf can be included up to 15% in the diets of WAD goats without negative effect on performance. However, limited information is available on its utilization as dry season forage feed source in the diets of rabbits. Thus, this study evaluated the haematological indices and blood glucose level of rabbits fed bitter leaf meal (BLM).

MATERIALS AND METHODS

The experiment was conducted at the Rabbit Unit of the Teaching and Research farm, Obafemi Awolowo University. The experiment lasted for a period of 10 weeks. Four concentrate mash diets were compounded with BLM at 0%, 5%, 10% and 15% graded levels (Table 1). Fifty-six rabbits of both sexes, comprising of different crosses of breeds of rabbit were used in this experiment. The animals were 6 weeks old (550-1000g). They were randomly allotted to four treatments in a completely randomized design. One animal each were housed in a cage with a dimension of 23 x 18 x 15 inches. The rabbits were provided

with the moist mash experimental diets and clean water ad libitum daily. The *Vernonia amygdalina* leaves were harvested from the Teaching and Research Farm, Obafemi Awolowo University and air dried for one week as established by Olosunde and Odeyinka (2017). Proximate analysis of processed bitter leaf sample and experimental diets were determined by standard methods (AOAC, 2000). The haematological parameters were determined using the procedure of Baker and Silverton (1976) while blood glucose level was measured using glucometer.

RESULTS AND DISCUSSION

The proximate composition in this study showed that bitter leaf (BL) (Table 2) had DM (94.70%), CP (20.48%), CF (11.15%), EE (7.05%) and Ash (13.30 %). The CP and EE of BL in this study were lower than 44% and 9.20% respectively for pulped BL (Sodamade, 2013). The CF in this study was comparable to report of Asaolu *et al.* (2012) for sun dried BL. Furthermore the Ash content was lower than 15.2% (Udochukwu *et al.,* 2015) for air-dried BL. The differences in the proximate composition might be attributed to the different processing methods adopted in these studies. The DM decreased as the inclusion level of BLM increased in the diets while the Ash content was highest in 15% BLM (34.35, followed by 10% BLM (32.25), 0% BLM (29.90) and 5% BLM (29.50) while the CP content of diets 5% BLM, 10% BLM and 15% BLM were higher than 0% BLM diet. However, the ME content of the experimental diets decreased as the inclusion level of BLM increased in the diets. The CP of diets in this study fell within 12-16% reported by Mmereole *et al.* (2011) for growing rabbits. The CF decreased with increasing level of BLM and was observed to fall within 11.0-16.0% reported by Ayandiran and Odeyinka (2016) for diets containing bread waste and *Moringa oleifera* leaf. The metabolizable energy of all the experimental diets in this study was lower than 2588-2995kcal/kg reported by Mufwa *et al.* (2011) for growing rabbits fed diets containing graded levels of brewers dried grain. Thus BLM might not be regarded as a total energy source in the diets of rabbits. The rabbits fed diets 0 % BLM and 5% BLM had significantly higher ($p<0.05$) red blood cell (RBC) counts than diets 10% BLM and 15% BLM diets while the mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) counts were higher in rabbits fed diets 10% BLM and 15% BLM than other diets (Table 3). However, there were no significant differences ($p>0.05$) in the mean corpuscular haemoglobin concentration (MCHC), white blood cell (WBC), packed cell volume (PCV) and haemoglobin (Hb) values of rabbits fed the experimental diets. Furthermore, there were no significant differences ($p>0.05$) among the blood glucose levels of rabbits fed the experimental diets. Esonu *et al*. (2001) stated that, haematological constituents reflect the physiological responsiveness of the animal to its internal and external environment, feed and feeding inclusive. The result obtained in this study shows that PCV of rabbits were within the normal range reported by Burns and Lannoy (1966) who considered the normal PCV of a healthy rabbit to be between 30-50%. The red blood cells indices (MCH, MCV, and MCHC) are important morphological characteristics of anaemia (Campbell, 1988) which also fell within the normal range reported by Mitruka and Rawnsley (1977). The Hb in this study was lower than 11.82-13.60 stated by Terzungwe *et al*., (2013). The blood glucose values observed across all the levels of BLM inclusion were within the recommended range (80 - 150 mg/dl) reported by University of Pennsylvania School of Veterinary Medicine (2002).

CONCLUSION

It could be concluded that inclusion of bitter leaf meal (BLM) in the diets of rabbits up to 15% had no deleterious effect on the haematological indices and blood glucose level.

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Table 1: Gross composition of experimental diets

Ingredient (%)	0%BLM	5%LBM	10%BLM	15%BLM
Maize	25	23.75	22.50	21.25
BLM	-	1.25	2.50	3.75
Corn bran	26.00	26.00	26.00	26.00
Brewer's dried grain	35.00	35.00	35.00	35.00
Soybean meal	5.00	5.00	5.00	5.00
Groundnut cake	5.00	5.00	5.00	5.00
Bone meal	1.50	1.50	1.50	1.50
Oyster shell	1.00	1.00	1.00	1.00
Palm oil	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25

Table 2: The proximate composition of experimental diets fed to rabbits

Parameter	BL	0%BLM	5%BLM	10%BLM	15%BLM
Dry matter (%)	94.70	96.05	95.40	94.95	94.05
Crude protein (%)	20.48	13.03	14.08	14.20	14.50
Crude fibre(%)	11.15	16.55	16.15	15.20	14.75
Ether Extract (%)	7.05	7.65	8.30	8.55	8.70
Ash(%)	13.30	29.90	29.50	32.25	34.35
Nitrogen Free Extract (%)	42.72	28.92	27.37	24.75	21.75
ME (kcal/kg)	2845.35	2131.42	2164.90	2096.58	2013.33

Table 3: Haematolological indices and blood glucose of rabbits fed BLM

Parameter	0%BLM	5%BLM	10%BLM	15%BLM	SEM	PROB
RBC ($\times 10^6/mm^3$)	8.77^a	8.03^a	6.74^b	6.67^b	0.26	0.001
MCV (fl)	25.80^c	27.11^c	35.48^a	34.57^a	1.57	0.04
MCH (pg)	8.61^b	8.92^b	11.86^a	11.76^a	0.53	0.02
MCHC (g/dl)	33.33	32.97	33.50	34.02	0.20	0.27
WBC ($\times 10^3/mm^3$)	10.52	9.84	9.78	9.97	0.14	0.20
PCV (%)	22.40	21.80	23.80	22.40	0.66	0.78
Hb (g/dl)	7.48	7.18	7.96	7.62	0.22	0.69
Blood Glucose (mg/dl)	96.40	143.80	129.20	107.80	10.81	0.44

EFFECTS OF LOCATIONS ON PHENOTYPIC CHARACTERISTICS OF FULANI CHICKEN ECOTYPES

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Abstract

The experiment was conducted using 250 matured birds from 5 different locations in 2 phases. The first phase was carried out using fifty birds each from the five randomly selected locations. The birds were used to determine body linear measurements such as body length, shank length, wing length, beak length and breast girth. However, for the second phase, fifty (50) hens and five cocks were purchased from each location. This comprised of ten hens and 1 cock from each locality and bred using a mating ratio of 1 cock to 10 hens. Data collected on all the parameters of body linear measurement, egg production and egg quality characteristics were analyzed using analysis of variance (ANOVA) and correlation procedure of SPSS Statistical software (2011).

The result obtained indicated that location had significant (P≤0.05) effects on body weight, body linear measurements, egg production and correlations among these parameters. However, location had no significant (P>0.05) effects on external and internal egg quality characteristics except for egg weight and egg shell weight. HDEP was consistently higher than HHEP across location. Correlations between body weight and body linear measurements were generally high, positive and non significant. From the findings of this research it was recommended that selection of Fulani chicken should be location driven. Also, shank length and breast girth should be used to determine body weight of Fulani chickens than any other body measurements.

Keywords: body linear measurement, hen-day egg production, hen-housed egg production,

Introduction

The ever increasing human population in African especially Nigeria has led to high demand for the available but insufficient animal and poultry products in the country. Poultry particularly chicken are very important genetics resources among the avian species ((Pimm and Lawton, 1988). Native chicken production is vital in the livelihood of many house-hold members in the country, especially as a source of resources for rural farmers providing nutrition for the family (good source of protein), a small cash flow reserve for times of celebrations or need and in some areas contribute to religious ceremonies and recreation (Gwaza *et al.*, 2015). Fulani chicken ecotype is one of the best preserved local chickens in Nigeria because of the cultural lifestyle of the Fulani poultry keepers. A comparism of the Fulani chicken ecotype within and between locations could provide useful information on superior performance and physical characteristics. The objective of the study was to investigate the effects of locations on phenotypic characteristics of Fulani chicken ecotypes.

Materials and Methods

The experiment was carried out at the Livestock Teaching and Research Farm of the Faculty of Agriculture, Shabu-Lafia Campus Nasarawa State University, Nasarawa State. The experiment was conducted in 2 phases. The first phase was linear body measurement while the second phase was the egg production and egg quality characteristics. For the first phase, fifty birds comprising of 25 cocks and 25 hens) were randomly selected from 5 location (Lafia, Akurba, Adogi, Asakio and Namu) making a total of 250 birds. Body linear measurements such as body length, shank length, wing length, beak length, tail length and breast girth were measured from the birds using measuring tape. However, for the second phase, fifty (50) hens and 5 cocks were purchased from each location. This was comprised of ten hens and 1 cock from each randomly selected locality. The birds were housed separately according to location and allowed to breed at a mating ratio of 1 cock to 10 hens. The birds were allowed to lay eggs for a period of three months to monitor their egg production. First 5 eggs laid in each month were collected base on location and used to determine external and internal egg quality characteristics. The external egg quality characteristics such as egg length and egg width were determined using venial caliper, shell

weight were determined using sensitive electronic scale while shell thickness was determined using micrometer screw gauge. The internal egg quality characteristics were determined using destructive techniques method. By this method, eggs were gently broken and poured on a flat container. Vernial caliper was used to determined albumen length, albumin height, york height and york width. Egg shape index and york index were determine by a formular. The part time egg production lasted for three months. During this period, birds were fed formulated layers marsh. The following measures of egg production were determined.

(a) Percent part-lay Hen Housed egg production (% HHP): This will be expressed as:

$$\% \text{ HHP} = \frac{Total\ egg\ laid}{No.of\ birds\ housed \times No\ of\ days\ since\ housed} \times \frac{100}{1}$$

(b) Percent Hen day egg production (% HDP)

$$\% \text{ HDP} = \frac{Total\ egg\ laid}{No.of\ birds\ alive \times No\ of\ days\ since\ hen\ laid} \times \frac{100}{1}$$

Experimental Design and Data Analysis

The design of the experiment was Completely Randomized Design (CRD). Data collected on all the parameters were analyzed using analysis of variance (ANOVA) and correlation procedure of SPSS Statistical software (2011).

Result and Discussion

This research has demonstrated that location had significant effects body weight and body linear measurements of Fulani chicken ecotype (table 1). The observed significant effects of location on body parameters measured except body weight and breast girth strongly agrees with the report of (Gwaza *et al.,* 2015) who observed that there are variations within and between chicken ecotypes. The mean value observed in this research for matured body weight strongly agree with 1375g and range of 1310g to 1760g reported by Ayorinde *et al.* (2012) and Ukwu *et al.* (2017). Body length observed in this study is higher than 23.97cm with a range of 22.66cm to 25.85cm reported by Mbap and Zakar (2000) as body length for indigenous chicken in Yobe State. Okon *et al* (1997) reported 25.00±0.21cm for mean body length of local chicken in Calabar. Mancha (2004) also reported 17.95±0.18cm as mean body length for chicken in Jos Plateau. Badubi *et al.* (2006) observed that the average body length of male and female chicken in Botswana as 18.1±2.3cm and 20.2±2.9cm respectively. The significant effects of location on shank length in this study disagree with the report of Halima (2007) who reported a non significant effect of location on shank length. However, the mean value obtained in this study for shank length strongly agree with the value of 8.58±0.12cm and 10.31±0.16cm reported by Ukwu *et al.* (2017) for North Central Nigerian chicken. Halima (2007) reported a lower value of 7.50cm for Ethiopian chicken (male and female). Badubi *et al.* (2006) reported the shank length of the Tswana indigenous females and males as 7cm and 8.5cm respectively. Wing length value of 27.15±0.86cm to 31.14±0.53cm is far higher than 14.20±0.21 and 16.36±0.25cm reported by Ukwu *et al.* (2017). The significant variation in tail length observed in this study strongly agree with the report of Badubi *et al.* (2006) who reported that tail length was significantly ($p \leq 0.05$) different among three location of Botswana. The tail length obtained in this study is very similar to 17.9±8.7cm, 12.7±10.1cm and 22.1±9.2cm for males but higher than 13.3±3.9cm, 11.4±5.6cm and 14.3±2.2cm for females as reported for Central, Moun and Western regions of Botswana (Badubi *et al.,* (2006).

Table 1: Effect of Location on Body Weight and Body Linear Measurement of Fulani Chicken Ecotype

L	BWT	BL	SL	BG	WL	BKL	TL
1	1390.90±82.38	46.54±1.78^{b}	8.30±0.40^{b}	12.20±0.39	27.15±0.86^{b}	2.89±0.11^{b}	15.02±0.92^{b}
2	1527.27±73.97	52.09±1.47^{a}	9.59±0.33^{a}	12.68±0.39	29.45±0.72^{a}	3.15±0.08^{ab}	18.00±1.00^{ab}
3	1550.91±62.31	51.73±1.29^{a}	9.36±0.33^{a}	12.73±0.38	29.73±0.86^{a}	3.14±0.98^{ab}	17.41±0.47^{ab}
4	1600.00±58.39	51.73±1.47^{a}	9.55±0.32^{a}	12.77±0.16	31.09±0.71^{a}	3.24±0.78^{a}	18.50±1.48^{a}
5	1627.27±94.48	52.09±1.28^{a}	9.50±0.23^{a}	12.73±0.43	31.14±0.53^{a}	3.21±0.8^{a}	16.91±0.81^{ab}

LOS	**NS**	*****	*****	**NS**	*****	*****	*****

LOS = level of significant, * = significant at 5 percent probability, L = location, BWT = body weight, BL = body length, SL = shank length, WL = wing length, BG = breast girth, BKT = beak length and TL = tail length.

Location had no significant effects on both external and internal egg parameters except egg weight and egg shell weight (table 2). The mean egg weight in the present study strongly agrees with the value of 41.6 g reported by (Msoffe *et al,* 2001). The mean egg length obtained in the present study fairly agrees with the value (5.15) reported by Momoh (2005) in Nigerian local chicken but lower than 4.83cm reported for Bangladesh indigenous chicken (Islam and Nishibori, 2009). The mean value of egg width obtained in this study is slightly lower than the value (4.10±0.01) reported by Halima (2007). Egg shape index in this study is slightly higher than 72.60% reported by Momoh (2005) for normal feathered indigenous chickens in Nigeria. Egg shape index is an indicator of external egg quality. Egg shell weight obtained in this study fairly agree with the value of 5.82 ± 0.16 reported by Halima (2007). The slightly lower shell weight recorded in this study could probably be due to the efficacy of the weighing scale used, weight of the eggs and/or the method/period of drying of the shell. Shell thickness in this current study is higher than the value reported by Momoh *et al.* (2007). The albumen height in the current study strongly agrees with the value of 0.651cm reported by Badubi *et al.* (2006). However, the mean value of albumen width in this current study is slightly lower than the value (6.25) reported by Badubi *et al.* (2006) for egg quality characteristics of three phenotypes of local chickens in Adamawa state. Variation in internal characteristics of egg could be due to the freshness of the eggs and the type of feed given.

Table 2: Effect of location on external and internal egg characteristics on fulani chicken ecotype

LOCATION	1	2	3	4	5	LOS
EWT (g)	42.67±0.32^{c}	42.29±0.55^{c}	45.73±0.85^{b}	45.43±0.80^{b}	49.30±0.63^{a}	*
EL (cm)	5.24±0.02	8.63±2.37	5.35±0.39	5.45±0.08	5.36±0.05	NS
EW (cm)	3.93±0.02	3.96±0.05	4.05±0.05	3.99±0.06	4.07±0.02	NS
ESI (%)	75.62±0.61	75.95±1.13	75.82±1.09	73.61±1.60	75.97±0.64	NS
ESW (g)	5.00±0.16bc	4.71±0.15c	5.20±0.14ab	5.14±0.12^{ab}	5.50±0.11^{a}	*
EST (mm)	30.11±0.66	30.36±0.51	29.80±0.45	30.79±0.52	30.20±0.60	NS
AL (cm)	7.49±0.19	7.56±0.16	7.54±0.15	7.61±0.17	7.59±0.19	NS
AH (cm)	0.68±0.39	0.68±0.03	0.67±0.03	0.67±0.03	0.67±0.04	NS
AW (cm)	5.66±0.17	5.60±0.13	5.75±0.13	5.67±0.14	5.70±0.16	NS
YH (cm)	1.57±0.02	1.55±0.02	1.55±0.01	1.55±0.02	1.55±0.02	NS
YW (cm)	3.82±0.02	3.82±0.02	3.83±0.02	3.83±0.02	3.83±0.02	NS
YI (%)	41.16±0.60	40.78±0.60	40.65±0.48	40.71±0.61	40.64±0.65	NS

LOS = level of significant, * = significant at 5 percent probability, NS = non significant, L = location, EWT = egg weight, EL = egg length, EW = egg width, ESI = egg shape index, ESW = egg shell weight, EST egg shell thickness, AL = albumen length, AH = albumen height, AW = albumen width, YH = York height, YW = York width and YI = York index.

Egg production

Location had significant effects on the entire egg production parameters studied (table 3). The hen day egg production (HDEP) was consistently higher than the hen housed egg production (HHEP) across locations. The result obtained for HDEP and HHEP is lesser than average of 38.56 eggs reported by Momoh *et al.* (2007) as the short-term egg number of the light ecotype chicken for the short term (90 days from first lay) egg production. The egg production of the local chicken is a result of many genes acting on a large number of biochemical processes, which in turn control a range of anatomical and physiological traits.

Table 3: Effects of Location on Hen Day Egg Production and Hen House Egg Production

LOCATION	HDP	HHP
1	19.27±1.91^{ab}	19.04±1.50^{a}
2	18.22±1.79^{ab}	16.02±0.68^{bc}
3	21.08±1.70^{a}	18.80±0.58^{a}
4	16.11±0.60^{b}	14.94±0.06c
5	17.67±0.19^{ab}	17.61±0.06ab

LOS	*	*

LOS = level of significant, * = significant at 5 percent probability, EGNO = egg number, HDP = hen day production, HHP = hen house production

Correlation of different egg quality parameters

The correlations between body weight and body linear parameters were generally non significant, positive and high (table 4). Relationships between body weight and body linear measurement varied across locations as similarly reported Ukwu *et al.* (2017). The mostly positive correlation obtain in this study is similar to the report of Alabi *et al.* (2012) for three indigenous chicken breeds of South Africa and Ukwu *et al.* (2017) for matured female local chickens in Benue State of Nigeria. The implication of this correlation is that increases in body weight will results to concomitant increase in body linear measurements of local chicken. Thus any selection programme aimed at improving body weight will lead to corresponding improvement in linear body measurements of birds.

Table 4: Phenotypic, correlation between body weight and body linear measurement on Fulani local chicken ecotype base on location.

	BWT	BL	SL	BG	WL	BKL
Location 1						
BL	0.329					
SL	0.652**	0.662**				
BG	0.410	0.294	0.101			
WL	0.559	0.883**	0.652**	0.305		
BKL	0.292*	0.685**	0.814**	0.164	0.527*	
TL	0.574**	0.631**	0.556*	0.205	0.759**	0.379
Location 2						
BL	0.573**					
SL	0.550**	0.881**				
BG	0.629**	0.664**	0.722**			
WL	0.567**	0.814**	0.848**	0.420		
BKL	0.138	0.042	0.033	0.420	-0.044	
TL	0.310	0.861**	0.744**	0.563**	0.568**	-0.241
Location 3						
BL	0.184					
SL	0.322	0.570**				
BG	0.355	-0.107	-0.313			
WL	0.298	0.262	0.741**	-0.160		
BKL	0.299	0.479*	0.644**	0.074	0.375	
TL	0.346	0.621**	0.335	0.139	0.468*	0.485*
Location 4						
BL	0.069					
SL	0.463*	0.702**				
BG	0.349	-0.107	-0.070			
WL	0.499*	0.697**	0.650**	-0.104		
BKL	-0.150	0.272	-0.208	0.218	-0.105	
TL	0.000	0.818**	0.646**	-0.483*	0.632**	0.051
Location 5						
BL	0.888**					
SL	0.494*	0.458*				
BG	0.962**	0.920**	0.454*			
WL	0.468*	0.575**	0.604**	0.516*		
BKL	0.298	0.294	0.391	0.308	0.129	
TL	0.373	0.249	-0.085	0.230	-0.273	0.194

LOS = level of significant, * = significant at 5 percent probability, ** = significant at 1 percent probability, BWT = body weight, BL = body length, SL = shank length, WL = wing length, BG = breast girth, BKT = beak length and TL = tail length.

Conclusion and Recommendation

The study revealed that location had significant ($P \leq 0.05$) effects on body weight, body linear measurements, egg production and correlations among these parameters. However, location had no significant ($P > 0.05$) effects on external and internal egg quality characteristics except for egg weight and egg shell weight. HDEP was consistently higher than HHEP across locations. Correlations between body

weight and body linear measurements were generally non significant, positive and high. From finding of this research work, it is recommended that, selection of Fulani chicken should be location driven. Shank length and breast girth should be used to select body weight of indigenous chickens than any other body measurements. This becomes necessary due to the fact that these parameters had the highest relationship with body weight.

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Hypo and hyper thermic stress effects on *Moringa* extract extender from male turkeys administered *Moringa* leaves and seeds extracts.

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Abstract

The thermic effects on semen samples of male turkeys administered *Moringa* leaves and extracts were examined after being diluted with *Moringa* extract as an extender at di levels (0%, 50% and 100%). A total of 36 male local turkeys were used for the exper The male turkeys were administered aqueous extract from *Moringa olerifera* seeds and The turkeys were assigned into four treatment groups consisting of T1 (0% extrac (100%seed extract) T3 (50%seed and 50%leaf extract) and T4 (100% leaf extract treatments was replicated three times. Each treatment had nine turkeys with three turke replicate. Semen collection was done using locally fabricated tools. The collected semer subjected to thermal stress at 37^0C (hypo) and 46^0C (hyper) for a period of 90m Progressive motility was evaluated very 30minutes with an aliquot of each treatment s under a warm microscope. The semen was combined with the extender at the rate (semen: extender). The result showed that there were no significant ($p > 0.05$) on the ext as well as the temperature variation effect from the water bath. However there were sign difference ($P<0.05$) on sub group effect of on hyper thermic conditions, which is an ind that the administered extract had a significant positive effect on the motility rate of sperr of local turkeys in the hyper thermic (46^0C) condition. The leaves extracts alone (T4 significantly highest, while the seeds extracts (T2) was better than the combination effe when compared with the control (T1). Therefore since there were no significant diff among the extenders (B, C) and the control (A). It then becomes imperative to conclude t reduce cost and use locally available materials, using *Moringa* leaves and seeds extracts a long way to boost local turkey production by an average Nigerian farmers at the rate o *Moringa* extract to real extender at 46^0C.

Key words; Local turkey, Semen, Extender, *Moringa olerifera* extract, Thermic stress.

Introduction

Low fertility and poor hatchability due to poor semen quality resulting from semen oxidative stress affects turkey production in Nigeria (Bucak-Louis *et al*. 2010). Sexual dimorphism in the size of turkeys contributes largely to their low fertility rate. Therefore artificial insemination (AI) is an option yet to be explored at large. Storage which is an integral part of AI is affected by temperature, as fertility levels of turkey semen drops after 6 hours of storage at refrigeration temperature and those of chicken after 24 hours (Donoghue and Whishart, 2000). Besides, turkey semen are active only in aerobic conditions whereas chicken spermatozoa are active in anaerobic conditions. This makes turkey semen more efficient because it has higher oxidation rate and lower lactic acid accumulation in the presence of oxygen which is the major difference in terms of their metabolism (Douard *et al*., 2000). The use of various plant extracts in animal feeding trails has over the years witnessed increased exploitation due to many health benefits which are well documented (Chia *et al*., 2018). These phytobiotics or phytogenic

including herbs and spices and plant extracts are safe and available substitutes to synthetic antibiotics, they are well known for their pharmacological effects and used as feed supplements or medicines in poultry industry (Morna *et al.,* 2017). *Moringa oleifera* is one of such plants that has been used in this regard over the years due to its rich nutritional composition (Moyo *et al.,* 2011). Hence using the leaves and seeds extracts from *Moringa olerifera* as an extender at various temperatures was geared towards improving local productivity of turkeys among rural famers in the least possible way.

MATERIALS AND METHOD

Experimental materials

The *Moringa olerifera* leaves and seeds were procured from the metropolis of Owerri. The leaves and seeds were handpicked, shade dried in an open air room for about one week at room temperature. The leaves seeds were grounded separately into powder. The ground leaves and seeds were stored in their various designated air-right containers. 1 gram of *Moringa* was diluted in 1000mls of clean water over night. Cheese cloth was used to sieve of the plant particles in the morning and future diluted with 4000ml of clean water. This served as drinking water for each replicate.

Experimental birds and management

A total of thirty six (36) six (6) weeks old male local turkey were purchased from a reputable farm and were quarantined for 2 weeks to enable them adapt and stabilize. The local male turkeys were assigned to 4 treatment groups replicated three times with nine local turkeys per treatment and three turkeys per replicate. The turkeys were separated in each replicate in a deep litter pen spread with wood shavings. The feed and water were given ad-libitum throughout the period. The experiment lasted for seven months (196 days).

Experimental treatments

Treatment one (TI) had no *Moringa* extracts. Treatment two (T2) had only 1 gram of *Moringa* seed powder. Treatment three (T3) had a combination of leaf and seed powder (500 mg of each powder) while treatment four (T4) had only 1 gram of leaf powder.

Preparation and use of the extender

This involved collection of semen from each treatment. The collected semen was pool and divided into six (6). The pooled semen samples were gradually subjected to higher (46^0C) and lower (37^0C) temperature for a period of 1hour. The semen trait was assessed after every 30 minutes. Semen samples from turkey toms was diluted with egg yolk extender in the ratio of 1:5 (semen : extender) The egg-yolk extender consisted of penicillin (0.028g), 1g of glucose, egg yolk (20ml) and distilled water made up to 100ml as control. After dilution, the semen samples were drawn into Eppendorf tubes sealed and maintained at 46^0C for one (1) hour. 50mls of *Moringa* leaves and seeds aqueous extracts were collected in separate test tubes and centrifuged at 3000 revolution per minutes for ten (10) minutes. The clear supernatant fluid of these extract was decanted into a clean beaker. The extender was supplemented at 0% (A), 50% (B) and 100% (C) respectively, and each of the test tube was subjected to hyper (46^0C) and hypo (37^0C) thermic conditions in a water bath. Examined after, zero (0), thirty (30) and sixty (60) minutes at 46^0C and 37^0C, the samples were assessed for progressive motility.

Data collection

At about of twenty six (26) weeks of age, all the male turkey from each treatment group were trained for semen collection using the abdominal massage techniques as was described by Burrows and Quinne (1937) and Baskst and Long (2010). This involves massaging the cloacae region to achieve phallic tumescence. After which the region surrounding the cloacae is gently squeezed (Cloacal stroke) to express the semen (Kalamah *et al.,* 2002). The collected semen was examined for both physical and

microscopic parameters. Prior to collection of semen, turkey toms were denied of feed and water for some hours to avoid faecal and urea contamination.

Data evaluation

An aliquot of each sample from extender A (0%), B (50%) and C (100%) was evaluated for progressive motility after every 30minutes.

Sperm motility

The motility of the collected semen was evaluated immediately after collection by taking a normal saline solution with the aid of micropipette on a clean warm (38^{O}C) glass slide. A clean glass rod was then used to take a very small dab of the whole semen and dropping it on the buffer. A clean cover slip was placed on the drop, then it was allowed to spread under the cover slip but not beyond it. The slide was then viewed under electronic microscope with low magnification ($\times$ 400). The observed view was scored in percentage.

Statistical analysis

The 2x3x4 factorial in completely randomized design (CRD) experiment was analyzed using simple T-test and netted design described by Ogbeibu (2014).

Result and Discussion

Table 1; shows the effect of standard extender (A) and *Moringa* leaves and seeds augmented extenders (B and C) on the motility rate of turkey semen over time, under hyper thermic (46^{0}C) and hypo thermic (37^{0}C) conditions. The progressive motile sperm of the *Moringa* administered treatment groups was in line with the observations of Zaharadden *et al.,* (2005) 80.17±2.63 – 84.25±2.23 in local turkey breeds. It was observed that there were no significant (P>0.05) effect of extender on the hypothermic and hyper thermic conditions on motility rate of the sperm cells. Although numerically the extender B (50% *Moringa* extract) and C (100% *Moringa* extracts) subgroup effects were far better than the control under both hypo and hyper thermic stress conditions. Best motility rate was observed in extender B under effect of seeds extracts in hypo thermic condition. While extender B with male turkeys administered leaves extracts thrived better in hyper thermic conditions. This may imply that *Moringa* extract really improved the motility rate at both higher and lower body temperatures. There were no significant difference (P>0.05) on both thermic conditions on which the samples were subjected. However there were significant difference (P<0.05) on sub group effect of on hyper thermic conditions. This indicates that the administered extract had a significant positive effect on the motility rate of sperm cells of local turkeys in the hyper thermic (46^{0}C) condition. The leaves extracts alone (T4) were significantly highest, while the seeds extracts (T2) was better than the combination effect (T3) when compared with the control (T1). These findings are in line with those of Alemade *et al.,* (2014) on use of *Moringa* leaves on rabbit reproductive response. Therefore since there were no significant difference among the extenders (B, C) and the control (A). It then becomes imperative to conclude that, to reduce cost and use locally available materials and enhance productivity, using *Moringa* leaves and seeds extracts will go a long way to boost local turkey production by an average Nigerian farmers at the rate of 50% *Moringa* extract to real extender at 46^{0}C.

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Temperature	Extract	Extender			Extract subgroup effect
		A	B	C	
Hypo thermic	T1	67.28±17.70	71.02±13.92	69.95±15.01	**69.62^{a}±14.63**
$\overline{X}$ = 67.57^{NS}	T2	56.17^{a}±31.85	76.17^{a}±15.82	66.50^{a}±23.37	**66.28^{a}±24.56**
	T3	65.80^{a}±25.79	71.50^{a}±20.07	64.67^{a}±25.38	**67.41^{a}±22.44**
	T4	60.20^{a}±26.24	72.43^{a}±16.98	66.43^{a}±23.30	**67.00^{a}±21.32**
	Extender subgroup effect	**62.31^{a}±24.4**	**72.91^{a}±15.77**	**66.87^{a}±20.84**	
Hyper thermic	T1	55.25^{a}±21.42	55.00^{a}±21.82	56.00^{a}±22.35	**55.43^{c}±20.16**
$\overline{X}$ = 65.59 ^{NS}	T2	67.75^{a}±23.89	73.40^{a}±18.05	72.40^{a}±19.37	**71.43^{ab}±18.80**
	T3	49.25^{a}±30.70	62.75^{a}±15.76	61.75^{a}±17.58	**57.92^{bc}±21.22**
	T4	73.75^{a}±23.89	76.17^{a}±17.98	75.00^{a}±18.95	**75.13^{a}±18.51**
	Extender subgroup effect	**61.50^{a}±24.6**	**67.50^{a}±19.28**	**66.95^{a}±19.82**	
					Extract main effect
Harmonized main effect	T1	62.47^{a}±19.12	64.06^{a}±18.83	63.61^{a}±19.12	**63.41^{a}±18.41**
	T2	60.80^{a}±28.10	74.91^{a}±16.05	69.18^{a}±20.80	**68.53^{a}±20.04**
	T3	58.44^{a}±27.61	68.00^{a}±18.08	63.50^{a}±21.52	**63.48^{a}±22.07**
	T4	66.22^{a}±24.69	74.15^{a}±16.81	70.39^{a}±21.00	**70.71^{a}±20.22**
	Extender main effect	**61.97^{a}±24.2ss**	**70.50^{a}±17.42**	**66.90^{a}±20.16**	

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Means with different superscripts $^{a, b, c}$ or ^{d} on the same row are significantly different (P<0.05).

NS: Non-significant independent sample T-test (2-tailed, p < 0.05) effect.
Values are mean ± standard deviation of replicated determinations; a-c: means with same superscripts are not significantly (p > 0.05) different. For every extract and extender subgroup effect under each thermal condition, means in the same rows bearing same superscript are not significantly (p > 0.05) different (n = 6 and 24, respectively). For extract subgroup effect, means in the same column bearing different superscripts are significantly (p < 0.05) different (n = 18). For every extract, and the extender main effect, means in the same rows bearing same superscript are not significantly (p > 0.05) different (n = 12 and 48, respectively). For extract main effect, means in the same column bearing different superscripts are significantly (p < 0.05) different (n = 36).

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EVALUATION OF FOUR CLASSICAL NON-LINEAR MODELS TO DESCRIBE THE GROWTH CURVE OF FUNAAB-ALPHA CHICKENS

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Abstract

The objective of this study was to evaluate four non-linear models (Gompertz, Logistic, Bertalanffy and Richard's) to describe the growth performance of FUNAAB-Alpha chickens (FAC). Three hundred (300) FAC chicks of both sexes were raised from day old till the 20th weeks of age. Body weight records were taken weekly and the NLIN procedure of SAS® was used to fit four non-linear growth functions. For all the models, parameter A (or asymptotic weight) ranged from 2050.8 to 3716.6g for the male and 1591.7 to 3330g for the female chicken respectively, while parameter B (constant of integration) ranged from 0.7541 to 15.441. Similarly, parameter K (maturity index) ranged from 0.0463 to 0.2002.The parameter A (asymptotic weight) was highest for Bertalanffy model while the Logistic model estimated the highest value of parameter B (the scaling parameter) and parameter K (maturity index). For all the models fitted, age at inflection point ranged between 13.30 and 17.63 weeks for male chickens and 14.23 and 19.94 weeks for female chickens, while the corresponding body weight at inflection point ranged between 754 and 1528 g and 586 and 1261 g for male and female chickens respectively. Using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) as the goodness-of-fit criteria, the Bertalanffy and Gompertz growth models were adjudged as the best fit models for evaluating the growth of FAC.

Keywords: Non-linear models, Growth curve parameters, FUNAAB-Alpha chickens, Point of Inflection.

Introduction

Growth can be defined as body weight gain or weight gain of body parts with age. The process of growth, measured as body mass or body weight on a longitudinal time frame has often been summarized using mathematical equations fitted to growth curves and the objective of this curve fitting is to describe the course of body weight increase over time or age with mathematical parameters that are biologically interpretable (Aggrey, 2002). These parameters have biological interpretation in terms of growth process and their values, as well as their relationships with other parameters, provide a genetic basis for understanding growth process and to develop breeding strategies to alter or modify the trajectory of growth.

Many mathematical models have been applied for the study of growth performance in poultry research. These include Gompertz, Bertalanffy, Logistic and Richard's functions. These models are non-linear and they fitted curves that relate the age of the bird with its weight, characterized the different phases of growth of the bird, allowed the estimation of the animal's growth rate, the age at which the animal stops growing and when it reaches sexual maturity (Galeano-Vasco *et al*., 2014).

Funaab-alpha chickens is a new breed of chickens described as an improved, indigenous, tropically adapted and dual-purpose breed developed through crossbreeding and intensive selection over many generations for improved meat and egg production without sacrificing adaptation to the tropical environment (Adebambo, 2015). Knowledge about jts growth curve parameters will be useful in making effective management decisions relating to feeding, maximization of the growth period and evaluating the influence of environmental stress on growth. The objective of this study was therefore to compare Gompertz, Logistic, Bertalanffy and Richard's growth models for describing the growth trajectory of Funaab-alpha chickens.

Materials and Methods

Three hundred (300) day-old chicks of the FUNAAB-Alpha chickens (FAC) were obtained from the Hatchery Unit of the Federal University of Agriculture, Abeokuta. They were brooded for two weeks, wing tagged for identification and thereafter transferred to the deep litter pens. A sensitive digital scale was used to take the weekly body weight of the individual chicken from day old till the 20th week when the experiment was terminated. Four non-linear growth functions including Gompertz, Logistic, Bertalanffy and Richard's model were fitted using the NLIN procedure of SAS®(2003) using the following equations: $W_{t=A*exp\ (-B*\exp(-K*t)}$; $W_t = A\ (1 - B * e^{-K*t})^3$; $W_t = \frac{A}{1+B*exp(-k*t)}$ and $W_t = 1 + B * exp(-k * t)^{1/d}$ respectively.

A is asymptotic weight, B = scaling parameter, K= maturity index while d is shape parameters for Richard's model.

Results and Discussion

Table 1 shows the estimated growth model parameters for male and female FUNAAB-Alpha chickens (FAC) reared intensively under a deep litter system using Gompertz, Logistic, Bertalanffy and Richard's growth functions. For all the models, parameter (A) which is the asymptotic weight (maximum stationary weight) ranged from 2050.8-3716.6g for the male and 1591.7-3330g for the female chicken respectively while parameter (B), the scaling parameter (constant of integration) ranged from 0.7541-15.441. Likewise, parameter K, which is the maturity index ranged from 0.0463-0.2002. The Bertalanffy model estimated the highest asymptotic weight while the Logistic model estimated the least. The asymptotic weight estimated in this study by the Gompertz model is consistent with the findings of Zhao *et al.* (2015) and Al-Samarai (2015) on some improved indigenous chickens of China and meat-type chickens of Iraq respectively but higher than the values obtained by Aggrey (2002), Osei-Amponsah *et al.* (2014) and Ngeno *et al.* (2010) for Athens-Canadian chickens and local chickens in Ghana and Kenya respectively. The values of parameter A obtained for Logistic model is consistent with the values reported by Aggrey (2002) and Al-Samarai (2015) but lower than the values reported by Eleroglu *et al.*(2014) for some Turkish indigenous chickens. Parameter A obtained in this study for Richard's model in this study is consistent with the findings of Aggrey (2002) but higher than those reported by Rizzi *et al.*(2013) and Osei-Amponah *et al.*(2014) for chickens in Italy and Ghana respectively. The variations in the asymptotic weight of these chickens could be attributable to genetic differences, the system of management and the prevailing climatic conditions of the environment in which these chickens were raised as well as the various interactions which ultimately influence the growth trajectory.

Table 1: Estimated growth model parameters for FUNAAB-Alpha chickens

	Male				Female			
Model	**A**	**B**	**K**	**D**	**A**	**B**	**K**	**D**
Gompertz	3056.3	3.5503	0.0860	-	2521.0	3.5813	0.080	-
Logistic	2050.8	15.441	0.2002	-	1591.7	15.718	0.1964	-
Bertalanffy	3716.6	0.7541	0.0463	-	3330.6	0.7672	0.0417	-
Richards	3056.2	2.521	0.150	0.343	2520.9	2.852	0.147	0.352

Where A,B,K and D are the asymptotic weight, the scaling parameter, maturity index and the shape parameter for Richard's model respectively

Table 2 shows the body weight and age at inflection point for FAC as estimated by Gompertz, Logistic, Bertalanffy and Richard's models. For all the models fitted, age at inflection point for FAC ranged between 13.30 and 17.63 weeks for male chickens and 14.23-19.94 weeks for female chickens while the corresponding body weight at inflection point ranged between 754 and 1528 g and 586 and 1261 g for male and female chickens respectively. For both sexes, the Gompertz model estimated the highest body weight at inflection while the Logistic model estimated the least. Similarly, the Richard's model predicted the earliest age at inflection point while the Bertalanffy model estimated the highest age at inflection. For all the models, the males had higher body weight at inflection than females. However, the females had higher ages at inflection point than the corresponding males for all the models.

The goodness-of-fit tests for the Gompertz, Logistic, Bertalanffy and Richard's growth models are presented in Table 3. These included the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). The lower the values of AIC and BIC, the better fit is the data (Kaps and Lamberson, 2004). For both sexes, the Bertalanffy model had the lowest AIC and BIC and was adjudged the best fit model followed by Gompertz model, Richard's model and logistic model in that order. This is in agreement with the conclusion of Aworetan and Oseni (2018), Eleroglu *et al.*(2014), Ngeno *et al.*(2010) and Osei-Amponsah *et al.*(2014) that reported Bertalanffy as the best fit nonlinear models for some indigenous chickens in Nigeria, Turkey, Kenya and Ghana respectively while Darmani *et al.*(2003) selected the flexible Richard model as the best fit. The lesser fit of the Richard's model observed in this study may be due to the extra parameter in the model, for which it was penalized by the model selection criteria. It has also been reported as inadequate in providing good fit to data patterns and observation (Meng *et al*., 1997). Aggrey (2002) suggested that the addition of the fourth parameter may represent an over-parametarization of the growth model.

Table 2: Body weight (g) and age (weeks) at inflection point

	Male		Female	
Model	**T_i (weeks)**	**W_i(g)**	**T_i (weeks)**	**W_i(g)**
Gompertz	14.73	1528	15.95	1261
Logistic	13.67	754	14.03	586
Bertalanffy	17.63	1101	19.94	987
Richards	13.30	1294	14.23	1070

Where T_i is the age (weeks) and W_i is the body weight (g) at inflection point.

Table 3: Best fit model selection criteria using Goodness-of-Fit tests

	Male		Female	
Model	**AIC**	**BIC**	**AIC**	**BIC**
Gompertz	50.42	61.528	44.46	55.102
Logistic	53.23	64.488	47.10	58.342
Bertalanffy	**49.42**	**60.122**	**44.21**	**54.154**

Richards	50.42	61.778	46.76	57.813

Where AIC and BIC are Akaike Information Criterion and Bayesian Information Criterion and Bayesian Information Criterion respectively.

Graphical representations of the growth rate patterns of FAC are depicted in Figures 1 and 2. The growth curves showed the non-linear dependency of body weight on age. Body weight increased with age but at different rates which differed slightly from one model to the other.

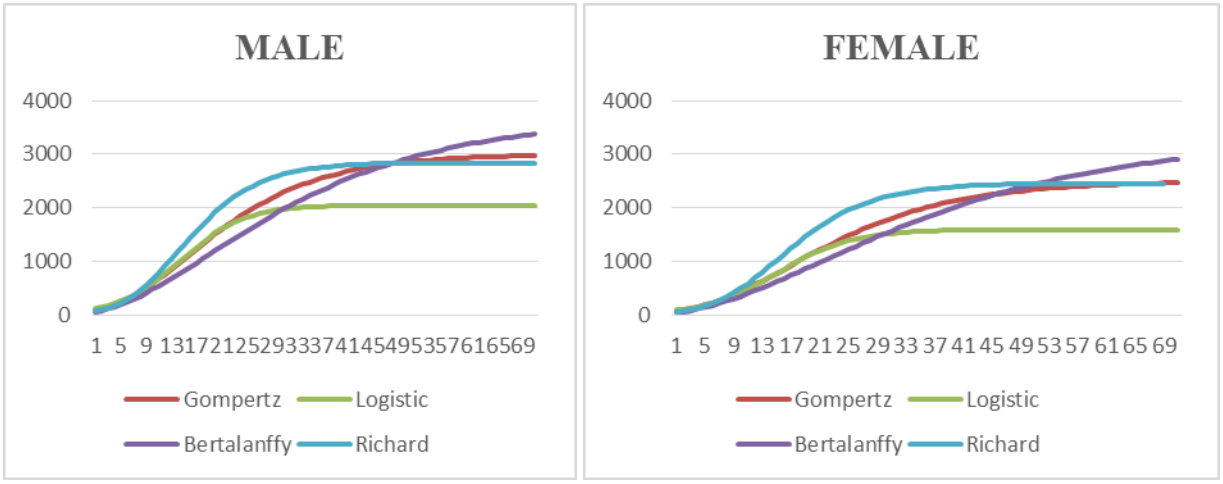

Fig 1 and 2: Growth curves for FAC predicted by Richards, Gompertz, Logistic and Bertalanffy growth models

Conclusion

The present study generated growth curves and growth parameters such as asymptotic weight (A), maturity index (K) and the constant of integration (B) for FAC. The predicted body weight from hatch till age at maturity were also generated. Among the non-linear models fitted, Bertalanffy and Gompertz models were found to be the best fit models.

Acknowledgement

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EFFECT OF VITAMIN C LEVELS ON PERCENTAGE SPERM ABNORMALITIES OF CHILLED BULL SEMEN IN EGG YOLK EXTENDER

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Abstract

An experiment was conducted to evaluate the effect of Vitamin C levels on spermatological parameters of chilled bull semen in chicken and quail egg yolk extender at different storage periods. Semen was collected from three bulls between 2 – 3 years of age weekly with the aid of artificial vagina.Extenders were prepared from the egg yolk of chicken and quail and three inclusion levels of Vitamin C (0, 3 and 6mg/ml), respectively. Abnormal spermatozoa percentages were counted using a hand counter, and recorded as ratios. The results shows that the inclusion levels of Vitamin C on chicken and quail egg yolk extender had significant effect ($P<0.05$) on abnormal cells of bull spermatozoa on semen pH at 0, 24, 48 and 72 hours respectively.

Keywords: Bull semen, Friesian x Bunaji, Sperm abnormalities, Vitamin C, Egg yolk.

Introduction

Some techniques of reproductive physiology have been applied to animal breeding for the achievement of faster genetic improvement. These techniques include artificial insemination, oestrus synchronization, induction of multiple ovulation, anti-steroid immunization, long term storage of gametes and embryo transfer (Gordon, 2004). Using Artificial insemination (AI) as the first biotechnology widely implemented in practice is important for selection and breeding of cattle (Gravance et al., 2009). The process of AI involves semen collection, evaluation, processing, preservation and final introduction into the genitalia of an oestrous female (Thibier and Wagner, 2002). The role of vitamin C in ameliorating the adverse

effects of reactive oxygen and nitrogen radicals has been well established (Padayatty et al., 2003). The addition of vitamin C in an extender improves the optimal sperm performance by reducing cell damage through its continuous radical scavenging action. The antioxidant effect of vitamin C is related to direct vitamin E regeneration by reducing the tocopheroxyl radical in the one electron redox cycle (Dalvit et al., 1998).The use of chilled (liquid) semen has been said to be a cheap solution to the decline fertility of frozen semen and is more effective and efficient (Sri et al., 2012) without the need for liquid nitrogen and the incidence of fertility decline compared to frozen semen (Gadea et al., 2004).

Materials and Methods

The study was carried out at the Artificial Insemination Unit of the National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria, Nigeria (Ovi maps 2015) Three (3) Friesian × Bunaji bulls between 2-3 years of age were used for the experiment. The bulls were kept under intensive management system. Semen was collected by means of an artificial vagina weekly from three bulls on each collection day. A dilution rate of 1:4 v/v (semen: diluent) was used. The dilution was done in 5ml boujour bottles. Boujour bottles each containing the diluted semen using the different egg yolk extenders were stored in a refrigerator at -50C over a period of 3 days and monitored or evaluated at 0, 24, 48 and 72 hours. Thawed semen was observed with an Olympus CX23 microscope at 100X and abnormal

spermatozoa percentages were counted using a hand counter, and recorded as ratios as described by (Salisbury, 1978).

Results and Discussion

The non-significant effect of egg yolk type on MPD (Mid piece droplet), DH (Detached head), FT (Free tail), CT (Coiled tail) and BT (Bent tail) of the spermatozoa disagrees with the study of Al-Daraji, (2002) who showed that increase in orange juice as a source of Vitamin C in liquid storage of roosters semen had significantly lower abnormalities (Head, Neck, Tail) than the control group and also agrees with Hu et al. (2010) who reported that increase in supplementation level of Vitamin C up to 6mg/ml decrease the total spermatozoa abnormalities with more normal cells after chilling at about -50C of bull semen.

Conclusion

It was concluded that supplementation with vitamin C up to 6mg/ml of Friesian x Bunaji semen after chilling at -50C for 72 hours maintained sperm quality thereby decreasing abnormalities.

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Table 1: Effect of Vitamin C levels on Percentage Sperm Abnormalities of Chilled Bull semen in Chicken and Quail Egg yolk extender at different Storage Periods.

	ABN			MPD			DH			FT		
ST	E+V(mg/ml)		C0	C3	C6	Q0	Q3	Q6	LOS	C0	C3	C6
	Q0	Q3	Q6	LOS	C0	C3	C6	Q0	Q3	Q6	LOS	
0		0	0	0	0	0	0	NS	3.0b	5.0a	2.0ac	5.0a
	3.0b	3.0b	*	4.0b	5.0	2.0	2.0a	4.0b	4.0b	*		
24		0	0	0	0	0	0	NS	4.0ab	6.0a	5.0b	5.0b
	5.0b	5.0b	*	6.0	6.0	5.0	4.0b	5.0ab	5.0ab	NS		
48		0	0	0	0	0	0	NS	5.0c	7.0a	5.0c	6.0b
	5.0c	4.0cd	*	7.0	6.0	6.0	5.0	5.0	5.0	NS		
72		0	0	0	0	0	0	NS	5.0cd	9.0a	6.0	8.0bc
	6.0c	8.0b	*	7.0	9.0a	7.0b	6.0	6.0	7.0	*		
SEM		0.09	0.10	0.68								

abcdMeans within the same row with different superscripts are significantly different (P<0.05). SEM - Standard Error of Mean, LOS - Level of Significance, Free Tail - FT, Mid Piece Droplet - MPD, Detached Head - DH. V - Vitamin C, C - Chicken Egg Yolk Extender, Q - Quail Egg Yolk Extender, ST - Storage Times, ABN - Sperm Abnormalities, E – Extenders

Table 1 Continued:Effect of Vitamin C levels on Percentage Sperm Abnormalities of Chilled Bull semen in Chicken and Quail Egg yolk extender at different Storage Periods.

	ABN			CT			BT					
ST	E+V(mg/ml)		C0	C3	C6	Q0	Q3	Q6	LOS	C0	C3	C6
	Q0	Q3	Q6	LOS								
0		0.0	0.0	0.0	0.0	0.0	0.0	NS	2.0	2.0	3.0	3.0
	2.0	2.0	NS									
24		0.0	1.0	0.0	0.0	0.0	0.0	NS	3.0	3.0	4.0	3.0
	2.0	3.0	NS									
48		1.0	1.0	1.0	0.0	0.0	0.0	NS	3.0	4.0	4.0	5.0
	2.0	3.0	NS									
72		2.0	1.0	1.0	2.0	0.0	1.0	NS	4.0	4.0	6.0	7.0
	3.0	4.0	NS									
SEM		0.68	0.64									

SEM - Standard Error of Mean, NS – Not significant, LOS - Level of Significance, Coiled Tail - CT and Bent Tail - BT, ABN - Sperm Abnormalities, E - Extenders, V - Vitamin C, C - Chicken Egg Yolk Extender, Q - Quail Egg Yolk Extender

Effect of common salt (Nacl) on haemocyte count and haemolymp biochemical parameters of Giant African Land snail (*A. marginata*) during dry season

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Abstract

A study was conducted on effect of common salt (NaCl) on haemocyte count and haemolymph biochemical parameters of Giant African Land snail (*Archachatin amarginata)*. Forty (40) snails with weight range of 150g to 180g were used for this study. Four (4) treatment with each consisting of ten (10) replicate include: T1 (Control: concentrate + 0g of salt (NaCl)), T2 (concentrate+0.05g of salt (NaCl)), T3 (concentrate+0.15g of salt (NaCl) and T4 (concentrate + 0.25 of salt (NaCl)). The experiment lasted 13 weeks. Haemolymph were collected at the end of 13 weeks. The parameters measured include: haemocyte count, total protein, albumin, globulin, alanine transaminase (ALT) and aspartate transaminase (AST). The haemocyte count was determined using Nubeurheamocytomer, while haemolymph biochemical parameters were determined using spectrophotometric methods. Mortality record was taken as the experiment progressed. Results showed that serum biochemical parameters were not significantly ($P>0.05$) affected by various level of salt used. However, common salt (NaCl) significantly affected ($P<0.01$) haemocyte count and mortality record of GALS. Snails fed 0.25g NaCl had the highest haemocyte count, followed by those fed 0.15g while snails fed 0g and 0.05g recorded the least. It was also discovered that 0 g Nacl inclusion into the diet of snail (*A.* marginata) recorded the highest mortality (60%) followed by 0.05 g Nacl inclusion level which gave 30 % mortality. However, inclusion level of 0.15 g and 0.25g Nacl into snail feed recorded no mortality.

It is obvious from this study that NaCl had significant effect on haemocyte count and mortality record of A. marginata without negatively affecting the haemolyme biochemical parameter of GAL. It is therefore recommended thatboth 0.15 g and 0.25g/kg be included into diet of *A. marginata*.

Key word: Sodium chloride, Haemolymph biochemical parameters, Haemocyte,

Introduction

Dry season is known to be a period in which all reproductive activities partially or totally seized depending on the degree of dryness. Feed consumption during this period may be affected depending on the housing condition. It is therefore important to consider feed fortification during this period to avoid mortality. One of such approach is to include appropriate vitamins or salts into the diet of this animal to stabilize production during this season. The use of salt (Nacl) in snail feed has being a subject of debate for decades due to the belief that snails do not consume salt. Machiels and Henken (1987) asserted that salt promote weight gain, Wu *et al*.(2017) reported positive influence on oesteoclast differentiation. It has also been reported to modulate homeostatic accessory function of renal mononuclear phagocytes (Schatz *et al*., 2017). Cytokines chemokines and tumor necrosis factor release had also been reported to be influenced by Nacl (Long et al., 2002; Kostvk *et al*., 2006). In order to maintain the wellbeing of this animal during the dry season, this study therefore aimed at investigation the effect of common salt (Nacl) on

haemocyte count and haemolymph biochemical parameters of *A. marginata* during the dry season.

Material and Method

Experimental Site:

This experiment was carried out at the snail Unit of College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta, Ogun-State.The location lies within the rainforest belt of Western Nigeria (latitude 7° N, longitude 3° 2' E and altitude 76m.a.s.l.).The climate is humid with a mean annual rainfall of 1,037mm, mean temperature of 34.7° and mean relative humidity of 82% .

Materials

A total of forty snails (40) *Archachatinamarginata*weighing between 150g to 180g were used for this experiment. The snails were kept in plastic cages with dimension of 30 cm by 40 cm by 24 cm, with small plastic feeding and drinking troughs in each of the cages.

Snails and their management

The plastic cages were clean prior to the commencement of the experiment; two weeks was set aside as a period of acclimatization. The snails were fed *ad libitum* throughout the period of the experiment. Drinking water was also provided daily *ad-libitum* in drinking troughs. Feed and water troughs were washed daily while the cages were also clean daily. The experiment lasted for thirteen (13) weeks.

Experimental design

The snails were randomly assigned to four treatments with ten (10) replicates each. The experimental treatments consisted of inclusion of 0, 0.05, 0.15 and 0.25 g/kg of the concentrate diet. Summarized below is the experimental set up:

Treatment 1: 0gram salt inclusion
Treatment 2: 0.05gram salt inclusion
Treatment 3: 0.15gram salt inclusion
Treatment 4: 0.25gram salt inclusion

Concentrate was given to the animal on a daily basis. Table 1 shows the composition of concentrate supplement (g) for treatments.

Table 1: Composition of concentrate supplement (g) for treatments

Ingredient	Composition			
	T_1	T_2	T_3	T_4
Maize	50.00g	50.00g	50.00g	50.00g
Wheat Offal	27.75g	27.70g	27.65g	27.50g
Groundnut cake	12.25g	12.25g	12.25g	12.25g
Soya bean meal	4.00g	4.00g	4.00g	4.00g
Bone meal	3.00g	3.00g	3.00g	3.00g

Oyster shell	3.00g	3.00g	3.00g	3.00g
Salt	0.00g	0.05g	0.15g	0.25g
Total	100g	100g	100g	100g

Haemolymph collection and total haemocytecount

Haemolymph from ten (10) snails per treatment were collected via the anterior part of the head with the aid of needle at the end of thirteen (13) weeks. A dilution of 1:19 was made with the aid of 5% eosin solution which was loaded into improved haemocytometer. Haemocyte found in the four squares were counted. Thereafter, numbers of cells counted were multiplied by a conversion factor (50,000) to obtain the total haemocyte count.

Haemolymph biochemical parameters

Haemolymph total protein, albumin, AST and ALT were determined via the usage of spectrophotometric method with the use of appropriate kits. Globulin values were calculated by subtracting total protein values from albumin values.

Mortality Record

The total numbers of snail that die under each treatment were recorded as the weeks of experiment increases. Thereafter, percentage mortality was calculated.

RESULTS AND DISCUSSION

Table 2 shows the least square means showing effect of salt (NaCl) on heamocyte count. Result showed that inclusion of 0.25g of salt in concentrate feed had the highest mean followed by 0.15g 0.05g while 0g had least haemocyte count. From the result it can be deduced that salt inclusion into the diet of snail has an immunomodulatory effect which is in agreement with the findings of Machiels and Henken (1987), Wu *et al*. (2017) and Schatz *et al*. (2017) since haemocytes are known to be the specialized immune cells in mollusc. Effect of salt (NaCl) on haemolymph biochemical parameters of Giant African Land snail (*A. marginata*) is shown in Table 3. All the biochemical parameters determined were not significantly influenced by various levels of salt used in this study. This observation is an indication that various levels of the salt used do not negatively affect the system of the animal. This means that normal biochemical part-ways were not affected; it only mobilized the haemocytes to be ready to eliminate any opportunistic infection that may alter the system of the animal negatively during this period.

Table 4 shows that snails fed 0 g of Nacl recorded highest mortality (60%), followed by those fed 0.05g (30%) while those that were fed 0.15g and 0.25g of common salt were not affected by the salt inclusion i.e. had no mortality. The reason for this observation could be as a result simulative role played by Nacl in the release of immune cells (Machiels and Henken, 1987; Schatz *et al*., 2017; Wu *et al*., 2017)

Conclusion

It was made clear from this study that Nacl significantly influenced haemocyte count and mortality pattern of *A. marginata* fed different levels without necessarily obstructing the haemolymph biochemical parameters. It is therefore recommended that both 0.15 g and 0.25g/kg be included into diet of *A. marginata* .

Table 2: Least square means showing the effect of treatment on haemocyte count of Giant African Land snail (*A. marginata*)

Treatment	Least square mean (x 10^6) ±S.E.M
0g salt inclusion	10.723±1.215[c]
0.05g salt inclusion	11.623±0.918[b]
0.15g salt inclusion	12.187±0.768[b]
0.25g salt inclusion	15.502±0.768[a]

Means on the same column with different superscript differs significantly (P<0.01)

Table 3: Effect of salt (NaCl) on haemolymph biochemical parameters of Giant African Land snail (*A. marginata*)

TREATMENT	TP	ALB	GLOB	AST	ALT
T1(0g)	8.84±1.77	1.36±0.37	7.47±1.58	21.75±8.37	81.25±12.20
T2(0.05g)	6.43±1.77	0.72±0.37	5.71±1.58	28.25±8.37	76.50±12.20
T3 (0.15)	9.86±1.77	1.33±0.37	8.54±1.58	23.50±8.37	97.75±12.20
T4(0.25)	8.08±1.77	0.89±0.37	7.19±1.58	34.50±8.37	85.00±12.20

Table 4: effect of common salt (Nacl) on mortality record of GALs (*a.marginata).*

TREATMENT	% MORTALITY
0g NaCl + Concentrate	60
0.05g NaCl + Concentrate	30
0.15g NaCl + Concentrate	0
0.25g NaCl + Concentrate	0

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SEMEN INDICES AND SEMINAL ZINC CONCENTRATION OF MALE RABBITS FED DIETS SUPPLEMENTED WITH ZINC

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ABSTRACT

An experiment was carried out to assess the effect of dietary levels of zinc on semen indices and seminal zinc concentration of rabbit bucks. Twenty male rabbits aged 6 months old were randomly allocated to four groups and fed diets containing 0, 50, 100 and 150 mg of zinc gluconate per kg diet respectively for eight (8) weeks with five bucks per group. Semen was collected from the bucks weekly using an artificial vagina. Samples of fresh semen were assessed for semen volume (ml), spermatozoa motility (%) and sperm concentration ($x10^8$/ml). The number of spermatozoa per ejaculate ($x10^8$) was also calculated. Seminal plasma was separated from the semen by centrifugation and seminal zinc concentration was determined using atomic absorption spectrophotometry. Data obtained were subjected to statistical analysis. The result showed that all semen parameters assessed were not significantly influenced by zinc levels fed to the bucks. Seminal zinc concentration was higher in bucks administered dietary zinc levels ($Z_{50,}$ Z_{100} and Z_{150}) compared to those on the control (Z_0). Bucks fed 100mg/kg diet had the highest seminal zinc concentration while the least was recorded in bucks on the control. It was concluded that dietary level of zinc gluconate as observed in this study may not enhance semen quality of rabbit bucks. However, supplemental levels of zinc gluconate may result in increased seminal zinc concentration in rabbit bucks.

keywords: Zinc gluconate, Male reproduction, Seminal plasma

INTRODUCTION

Poor semen production is a factor that hinders efficient reproductive performance in males. In the tropics, male rabbits are used for breeding purposes from about 6 months of age and expected to produce semen consistently from this age. This is not so in many tropical breeds and their crosses; as their performance is influenced by several factors among which diet play a significant role. Diets low in micronutrients contributes to inefficient spermatogenesis as they are essential for growth and development. Microelements are often provided to animals in diets as a component of the premix added and supplemented in diet or water as necessary. Certain microelements may be present in sufficient quantities in feed but their deficiency symptoms may still be observed in the animals due to their varying bioavailability or forms that cannot be utilized in the body (Wang *et al*., 2010). Salts of minerals are often used in oxides, carbonates, chlorides, and sulphates forms and the use of chelate forms is on the increase (Wang *et al*., 2010, Chrastinova *et al*., 2015). Zinc gluconate is a chelated form of dietary zinc and it has been used extensively in human. Zn is vital for growth and development, sexual maturation and reproduction, dark vision adaptation, olfactory and gustatory activity, insulin storage and release and for a variety of host immune defenses (Biswajit *et al*., 2013). The presence of Zn in the proper concentration in the diet of the animals is of immense importance not only for the well-being of the animals but also for optimizing the overall performance of the animals and to enhance their production potential (Shinde *et al*., 2006). Improvement in the sperm production and fertility has been

achieved following the supplementary feeding of Zn (Biswajit *et al*., 2013). Zinc functions as a cofactor of numerous enzymes and is involved in cell division processes; higher levels are required for reproduction and fur production than for maintenance and meat production (Halls, 2010). The zinc requirements for rabbits vary from 25 to 60 mg/kg diet (Mateos *et al.,* 2010). Oliveira *et al.* (2004) affirmed that the inclusion of zinc in the diet of breeding animals can influence spermatozoa concentration. Zinc is essential for the development of sex organs and spermatogenesis in the males. In order to select bucks on the basis of high fertility for breeding purpose, there is need to assess their semen quality especially at the age they are termed matured and supplement for zinc where necessary. Hence, this study aimed at evaluating semen characteristics and seminal zinc concentration of rabbit bucks fed supplemental levels of zinc in chelated form (zinc gluconate).

MATERIALS AND METHODS

A total of twenty (20) bucks aged 6 months with an average weight of 1.88kg were used for this experiment. The study was conducted at the rabbitry unit of the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria. Rabbits were housed individually in cages and fed same diet for two weeks for acclimatization. They were randomly allotted into 4 groups of 5 bucks per group and fed the experimental diet containing 0, 50, 100 and 150 mg zinc gluconate per kg diet for 8 weeks. The groups were designated as Z_0, Z_{50}, Z_{100} and Z_{150} respectively. The experimental diet was presented in a pelletized form and clean water was supply daily. The experimental diet contained 16.13% crude protein, 2396.6kcal/kg digestible energy and 10.38% crude fibre. Semen was collected from the bucks weekly using an artificial vagina. Samples of semen were assessed for semen volume, spermatozoa motility and sperm concentration. The number of spermatozoa per ejaculate was calculated as the product of semen volume and spermatozoa concentration. Seminal plasma was separated from the semen by centrifugation at 4000 rpm for 15 minutes and assessed for seminal zinc concentration using atomic absorption spectrophotometry. Data obtained were subjected to statistical analysis of variance procedure using Statistical Analytical System (SAS, 2009). Treatment means were compared using Duncan Multiple Range Test of the same software.

RESULTS AND DISCUSSION

Improvement in the sperm production and fertility has been achieved following the supplementary feeding of Zn (Biswajit *et al*., 2013). Table 1 shows the result on semen indices of rabbit bucks fed dietary levels of zinc. All the semen parameters assessed were not significantly influenced by supplemental levels of zinc fed to the bucks. The values obtained for the semen indices assessed are semen volume (1.38 – 1.69 ml), spermatozoa motility (80.31 - 89.88 %) and sperm concentration (3.78 – 5.05 $x10^8$/ml). This study therefore showed that dietary supplementation of chelated form of zinc as zinc gluconate may not improve semen production in male rabbits. The result from this study corroborates the report of Chrastinova *et al*. (2015) who observed a weak influence of Glycinoplex-Zn in young rabbit's performance. Egwurugwu *et al*. (2013) reported a significant effect of oral zinc administration on sex hormones and sperm quality in wistar rats. However, findings from this study is at variance with that of Moce *et al*. (2003) who reported a significantly higher total sperm production in adult male rabbit administered 100mg/kg dietary levels of zinc sulphate. Ogbu and Herbert (2018) reported a significant decrease in follicle stimulating hormone and interstitial cell stimulating hormone when dietary levels of zinc gluconate was fed to two (2) months old rabbits. Based on the relationship between reproductive hormones and semen production, it implies that supplementing rabbit diet with

zinc gluconate within this age range (2 – 6 months old) may not result in improve semen production. The result on seminal zinc concentration (mg/l) is presented in figure 1. The values obtained was significantly higher in bucks fed Z_{100} (1.09) and Z_{150} (0.95) than those fed the control diet Z_o (0.33) however the values were not significantly different from that of bucks fed Z_{50} (0.61). The increase in seminal plasma concentration of zinc shows that dietary levels of zinc influenced the activity of the accessory sex gland (prostate gland). This may help to enhance prostate health as Bentley and Grubb (1991) reported that apart from red and white blood cells; zinc is also stored in the prostate gland.

Table 1: Semen Indices of Rabbit Bucks Fed Supplemental Levels of Zinc

SEMEN INDICES	Z_0	Z_{50}	Z_{100}	Z_{150}	±SEM
Semen Volume (ml)	1.67	1.69	1.38	1.50	0.09
Spermatozoa Motility (%)	89.88	84.70	80.31	87.20	2.00
Sperm Concentration ($x10^8$/ml)	4.07	3.78	5.05	4.08	0.31
Number of spermatozoa /ejaculate ($x10^8$)	6.80	6.39	6.97	6.12	0.54

Z – Zinc

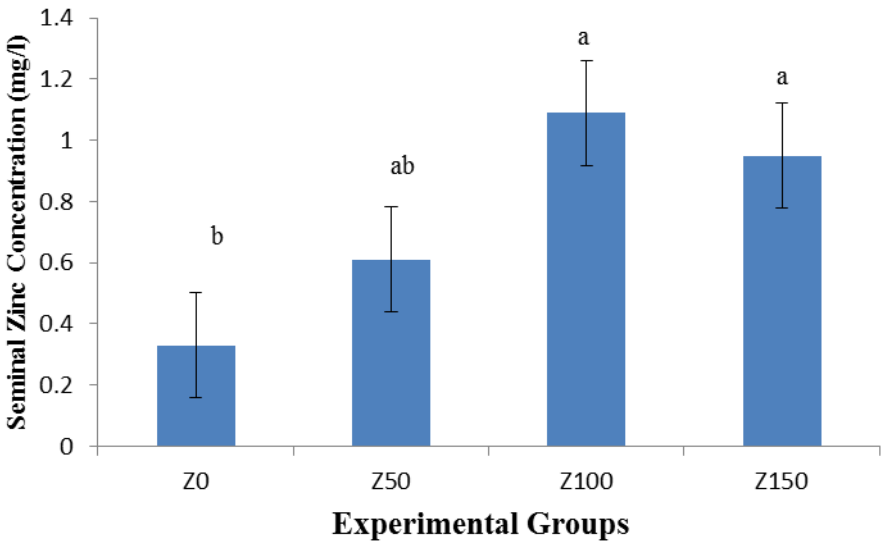

Figure 1: Seminal zinc concentration of male rabbits fed dietary zinc levels

CONCLUSION

It was concluded from the study that dietary levels of chelated form of zinc (zinc gluconate) may not improve semen quality of rabbit bucks. However, supplemental levels of zinc gluconate may result in increased seminal zinc concentration in rabbit bucks which is indication of improved prostate health.

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SERUM BIOCHEMISTRY OF GROWING JAPANESE QUAILS FED SUN-DRIED YAM PEEL MEAL BASED DIET WITH MAXIGRAIN(R) ENZYME SUPPLEMENTATION

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ABSTRACT

A 21-d study was carried out to evaluate the effect of dietary enzyme (Maxigrain®) supplementation on serum biochemistry of Japanese quails fed sun dried yam peel meal (YPM) based diets. Two hundred and forty (240) Japanese quail chicks of two weeks old were used and randomly distributed to the four dietary treatments with four (4) replicates of fifteen (15) birds each in a completely randomized design. Four experimental diets were formulated in which enzyme supplemented yam peel meal (YPM) replaced maize at 0, 25, 50, and 75% as T_1, T_2, T_3 and T_4 respectively. Blood samples were collected from three (3) birds in each replicate at the end of the feeding trial on day 21 for serum biochemical evaluation. Results revealed that variation in the mean values for hemoglobin, total protein and uric acid which were significantly (P>0.05) enhanced with increase in inclusion level of enzyme supplemented yam peel meal in the diets. Therefore, Japanese quail can tolerate enzyme supplemented yam peel meal at 75% replacement level for maize in their diets without any deleterious effect on their blood biochemical profile for healthy production.

Keywords: Maxigrain, Japanese quails, yam peel meal, serum biochemistry

INTRODUCTION

Maize (*Zea mays*) is a common feedstuff of choice as major supplier of energy in monogastic diets. The usual high inclusion of maize translates into high cost of feed, because of seasonality of production and competition for maize by man (Agbede *et al*; 2002). This necessitates the need to replace maize either partially or totally by other cheaper and available unconventional alternatives so as to reduce overall cost. Yam peel (*Dioscorea rotundata*) is a basic waste product when yam is peeled during processing for cooking and other purposes. Yam peel is cheaply available in Nigeria and may be used as a potential feed ingredient after proper sun-drying for 4-7days depending on the ambient temperature (Akinmutimi *et al.,* 2006, Enkenyem *et al*., 2006, Ezieshi and Olomu, 2011). It has been reported that enzyme supplementation permit the use of wide range of ingredient without compromising bird's performance and hence provide great flexibility in least cost formulation (Han, 1997; Obadina, *et al.,* 2006). Some beneficial effect of applying feed enzymes to poultry diets includes, enhancement of digestion and absorption of nutrient especially fat and protein, increase feed intake, weight gain and feed conversion ratio, improve apparent metabolically energy (AME) value of the diet, decreased size of gastrointestinal tract, reduced production of ammonia from excreta, reduced water content of excreta, reduction in digesta viscosity, altered population of micro-organisms in gastrointestinal tract, reduced output of excreta, including N and P (Samarasinghe *et al*., 2000; Odetallah *et al*., 2005; Wang *et al*; 2005; Zhu *et al*., 2014). The enzymatic profiles of Maxigrain enzyme contain both phytase and non-soluble poly-saccharides (NSPs) enzymes that brings about efficient utilization of wide range of agro-industrial by-products like yam peel meal (YPM) and it originates from the bacteria *Aspergillus oryzae* (Alu, 2012; Alu

et al., 2012). Therefore, this present was carried out to evaluate the serum biochemical indices of Japanese quail fed enzyme (Maxigrain(R)) supplemented yam peel meal based diets

MATERIALS AND METHODS

Experimental site: The experiment was carried out at the Teaching and Research Farm of the Federal College of Wildlife Management, New Bussa, Niger State.

Preparation of experimental test ingredient: Yam peels were collected within New Bussa town, Niger State. The yam peel was soaked in cool water for three (3) days and it was sun-dried for four days in order to remove the anti-nutritional factors present. The treated yam peel was milled into smaller particles before incorporation into the experimental diets.

Maxigrain® enzyme: Maxigrain® enzyme used in this study is a blend of a multi-enzyme consisting of β-glucanase, xylanase, phytase, arabinoxylanase, yeast and minerals. It is originates from the bacteria *Aspergillus oryzae* (Alu, 2012; Alu *et al*., 2012).

Management of experimental birds: The birds were fed *ad-libitum* and had access to drinking water at all times. Lighting source was provided using electricity bulbs during the night. The birds were administered anti-stress vitamin/mineral premix orally at the recommended dosage after the randomization before the commencement of the experiment. The birds were housed in a deep litter pens constructed using wire mesh to allow for adequate ventilation. Other routine management practices were adopted as outlined by Musa *et al*. (2008).

Experimental birds and treatments: Two hundred and forty (240), 2 weeks old quails were used; the birds were randomly distributed to four (4) treatment groups and each treatment was subdivided into four (4) replicates with fifteen (15) birds each using complete randomized design (CRD). Four (4) experimental diets ration were formulated, diet one (1) which served as control contain 0% of yam peel meal, while the other three (3) treatments diets (i.e. treatments 2, 3 and 4) contained 25, 50 and 75% graded level of treated yam peel meal to replace maize. Diets T_2, T_3 and T_4 contained 0.1% Maxigrain(R) enzyme. The composition of the experimental diets are presented in Table 1.

Table 1: Gross composition of experimental diets

Ingredients	T_1 (0% YPM)	T_2 (25% YPM)	T_3 (50% YPM)	T_4 (75% YPM)
Maize	46.00	34.50	23.00	11.50
Yam Peel Meal	-	11.50	23.00	34.50
Soy bean meal	36.00	36.00	36.00	36.00
Fish meal	3.00	3.00	3.00	3.00
Rice offal	10.00	10.00	10.00	10.00
Bone meal	3.00	3.00	3.00	3.00
Lime stone	1.00	1.00	1.00	1.00
*Premix	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Maxigrain(R)	-	0.01	0.01	0.01
Total	100	100	100	100

Crude protein (%)	22.87	23.04	23.23	23.39
ME (Kcal/kg)	2923.4	2853.18	2861.93	2876.68

Determination of Biochemical Indices: For preparation of serum sample, 2mls of blood was collected without anticoagulant in the sterile test tube from 3 randomly selected quails per replicate. The tube containing blood was placed in slanting position at room temperature for clotting. Blood samples were centrifuged at 3000 rpm for 10 minutes, then collected and stored at -20. Serum total protein, albumin, uric acid, cholesterol, aspartate amino transferse (AST), glucose, and creatinine were determined color-metrically using available commercial kits.

RESULTS AND DISCUSSION

The results of the treatment effects on the quail blood chemistry showed that total protein and uric acid were significantly (P<0.05) affected by varying dietary levels of enzyme supplemented YPM as presented in Table 2. Serum total protein was highest (p<0.05) for quail birds fed 50% YPM diet compared with control and 75% YPM diet which had similar values respectively. Dietary supplementation of Maxigrain at 50 and 75% YPM inclusion level resulted in reduced (p<0.05) serum uric acid concentration of the birds than those on control and 25% YPM diet. Higher (p<0.05) serum glucose was recorded in birds fed 50% enzyme supplemented YPM diet and was comparable to the control diet group while those fed 25% was recorded lower (p<0.05) concentration. The increased serum total protein with corresponding decrease in serum uric acid is a clear indication of resultant effect of efficient protein utilization. According to Oduguwa *et al*. (1996), where there is efficient energy or protein utilization, the concentration of serum uric acid is normally decrease as a result of low deamination. Higher values indicate that there is enzyme hydrolysis of dietary proteins and explained that the blood pool serves as a major source of amino acids needed for the synthesis of proteins (Njidda *et al*., 2006). This observation showed that the protein level in the diet was sufficient to sustain or support the normal protein levels in the blood. Non-significant differences (P>0.05) in the mean values of creatinine obtained in this study imply that enzyme supplemented YPM has a similar effect on the kidney of the birds across the dietary treatments (Ladokun *et al*., 2008). This result showed the normal physiological process in the quail birds fed the test diets and it confirmed the nutritional adequacy of the experimental diets (Maikano, 2014). The lower (p>0.05) cholesterol levels observed in this study are an indicator of health benefit of incorporating enzyme supplemented YPM in quail diets. The diets contained similar crude fat levels which may invariably lead to comparable dietary fat intake. The serum biochemical values were within normal ranges for quails as reported by Edache *et al*, (2003); Minka *et al*., (2012) and Jatoi *et al*., (2013). These observations could be an indication that the birds were in good health throughout the experimental period while the non-significant variation in most of the blood parameters due to enzyme supplementation supports the earlier reports (Ojebiyi *et al*., 2009; Shehab *et al*., 2012). This implies that the birds fed enzyme supplemented YPM were not anemic.

Table 2: Blood metabolites of Japanese quails fed graded levels of yam peel meal with supplemental Maxigrain(R) enzyme.

Parameters	T1 (0%YPM)	T2 (25%YPM)	T3 (50%YPM)	T4 (75%YPM)	SEM

Total protein (g/dl)	5.32[b]	5.12[b]	5.83[a]	5.66[a]	0.15
Albumin (g/dl)	3.15	2.78	3.62	2.86	0.75
AST (U/L)	221.83	241.08	228.33	236.68	14.49
Uric acid (mg/dl)	3.19[a]	3.04[a]	2.17[b]	2.63[b]	0.25
Creatinine (ɯmol/l)	5.66	5.20	4.56	4.50	1.41
Glucose (mg/dl)	234.13	221.67	240.04	228.86	10.43
Cholesterol (mg/dl)	228.0	202.6	210.16	212.21	13.09

[abc] Means with the same superscript in the same row are not significantly (p>0.05) different.

CONCLUSION

The result revealed that adding YPM at inclusion rate of 75% with enzyme supplementation can successfully replace maize in the diet of growing Japanese quails without any adverse effect on serum biochemical indices and is therefore recommended for a healthy quail production.

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EFFECTS OF LOCATION ON REPRODUCTIVE AND GROWTH PERFORMANCE OF TIV CHICKEN ECOTYPE

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Abstract
This study was conducted to assess the effect of location on the reproductive and growth performance of Tiv chicken ecotype. 55 birds (10 hens and 1 cock) were purchased from 5 localities and used as based population. The birds were housed base on their location and allowed to freely mate at a ratio of one cock to 10 hens. Fertile eggs were collected 4 weeks after onset of laying to achieve optimum fertility. The eggs collected were labelled with a marker according to their location and set for hatching in an automatic incubator. The result obtained from this study showed that location had significant ($P<0.05$) effect on hatch weight, weekly body weight, growth rate (at week 0-1, 5-6 and 6-7) and mortality rate. However, locations had no significant ($P>0.05$) on reproductive parameters except fertility and infertility which were significant. From the finding of this research it was recommended that selection of Tiv local chicken should be location based especially for those parameters where location had significant effect.

Keyword: Growth rate, hatchability, incubation, mortality rate, reproductive capacity.

Introduction

Chicken is one of the cheapest sources of animal protein available for human consumption but its performance is dependent on environmental and climatic conditions. The level of performance of local chicken especially Tiv ecotype chicken does not depend only on inherited capacity but, also to a great extent upon the environment they were raised (Gwaza *et al.,* 2015). Birds of different breeds/strains and of different age, sex, stage of production, and reproduction respond differently to locations. Classification of genetic resources of the Nigerian local chickens' ecotypes base on geographical location appears to be biased estimates of the genetic diversity (Pimm and Lawton, 1988) of local chicken genetic resources of Nigeria. The objective of the study was to investigate variations in the reproductive and growth performance of Tiv chicken ecotypes base on location.

Materials and Methods

The experiment was carried out at the Livestock Teaching and Research Farm of the Faculty of Agriculture, Shabu-Lafia Campus, Nasarawa State University, Keffi. 11 birds (10 hens and 1 cocks) were purchased from five randomly selected localities namely: Uikpan, Daudu, Kadarko, Yelwata and Cohor all in Benue State respectively. The birds were housed according to location for four weeks for quarantining and acclimatization. Fertile eggs for hatching were collected after four weeks from onset of laying. This was aimed at obtaining higher fertility and hatchability. The birds were fed formulated diet. Feed and water was provided ad-libitum. Hatching eggs were collected twice (morning and evening) every day and were identified using marker according to localities. The eggs were accumulated for 5 days and set for pedigree hatching in an automatic electric incubator. On hatching, chicks were brooded according to their localities in separate pen. The brooding house and experimental pens were thoroughly cleaned, scrubbed and disinfected using Vinkokil and allowed to fallow for two weeks before the arrival of the chicks. Brooding was carried out for a period of 21 days (3 weeks) using stoves and electric bulbs as sources of heat and illumination. Wood shavings were used at a sufficient depth (5cm) as litter materials.

Parameters that were measured

Reproductive Traits:

Fertility: fertility was determined based on total egg set. Percentage fertility was expressed as: $\frac{\text{Number of fertile egges}}{\text{total egg set}} \chi \frac{100}{1}$

Hatchability: This was expressed on the basis of fertile eggs and total eggs set. Percent hatchability on fertile egg = $\frac{\text{number of hatced chicks}}{\text{total fertile egg}} \text{X} \frac{100}{1}$

Percent hatchability base on total egg set (reproductive capacity) $= \frac{\text{number of hatced chicks}}{\text{total egg set}} X \frac{100}{1}$

Embryonic Mortality: This is the fertilized embryo that died before hatching. Embryonic mortality was measured at two levels, early and late mortality. Early embryo mortality was determined by candling at 14th day from the onset of incubation to ascertain fertilized eggs that died at that stage. After hatching, eggs that does not develop into full chick or developed into full chick but the chick died before hatching will be term late embryo mortality.

Percent early embryonic mortality = $\frac{\text{Number of dead embryo at day 14}}{\text{Total no.of Fertile eggs}} \chi \frac{100}{1}$

Percent late embryonic mortality = $\frac{\text{Number of dead embryo from day 14 till hatched}}{\text{Total no of fertile eggs}} \chi \frac{100}{1}$

Growth Traits

Body weight: Live body weights were measured at hatch using sensitive electronic scale and then at week 1 to 8 respectively.

Body Weight Gain: Average daily gains (ADG) were estimated using the formula: $\frac{W2-W1}{N}$ Where W2 is the present weight, W1 is the initial weight and N is the number of days taken from initial weight to the present weight.

Growth Rate: Absolute growth rate were determined from the weekly body weight changes using the formula: Growth Rate = $\frac{W2-W1}{W2}$ X100. Where W2 is the present weight, W1 is the initial weight.

Mortality Rate: The percentage mortality was estimated on weekly basis till eight week of age. This was estimated using the formula: Mortality rate = $\frac{\text{No.of dead chicks over the week}}{\text{No.of chicken at the begining of the week}} \chi \frac{100}{1}$

Experimental Design and Data Analysis

The design of the experiment was Completely Randomized Design (CRD). Data collected on all the parameters of reproductive traits and growth Performance were analyzed using the one way Analysis of Variance (ANOVA) procedure of SPSS statistical software 2011 version.

Results and Discussion

The effect of location on reproductive performance of Tiv local chicken is presented in table 1. The study revealed that location had no significant (P>0.05) effect on reproductive parameters except fertility and infertility as similarly reported by (Gwaza *et al.*, 2015). The mean value of fertility (88.00-100.00) obtained in this study is slightly higher than 77.75±6.28% reported by Gwaza *et al.* (2015) as the fertility for Tiv chicken ecotype. The value is also higher than 83.0-92.7% and range of 79.65±0.45% for normal feathered to 86.65±0.07% for Fulani ecotype reported by Islam and Nishibori, (2009) Amao (2017). The early embryonic mortality (5.17 – 14.24%) and late embryonic mortality (3.71-14.31%) are respectively lower than 14.90% reported by Gwaza *et al.* (2015). Hatchability ranges between 76.79-86.21% for the 5 locations is within the range of 52.4 -87.0%, 72- 93.1% and 85.07+8.90% reported by Islam and Nishibori, (2009), Ajayi *et al.* (2008) and Amao, (2017). The average body weight as presented in table 2 indicated that location had significant (P<0.05) effect on hatch weight and weekly body weight

of Tiv local chicken. The range of 22.54±0.56g to 24.33±0.45 at week 0 strongly agree with the value of 23±1.6g reported by Adedokun and Sonaiya (2001) but lesser than 30.23±0.06g reported Momoh (2005) as body weight at hatch. However at week 4, the mean body weight value of 58.77±1.74g to 69.00±2.74g is far lesser than 104±14.5g and 157.16±0.45 reported by Adedokun and Sonaiya (2001) and Momoh (2005). Also at week 8, the value of 141.59±4.94 to 185.58+6.56g obtained in this study is slightly lesser than 262±4.8g and 349.88±3.01g for week 8 as reported by Adedokun and Sonaiya (2001) and Momoh (2005). These observed differences could be due to environment, season, management practice, breed and selection among others.

le 1: Effects of location on the reproductive performance of Tiv Local Chicken Ecotype

Location	Fertility	Infertility	EEM	LEM	Hatchability	Reproductive Capacity
1	100.00±0.00[a]	0.00±0.00[a]	9.30±3.74	11.48±5.92	79.23±9.66	79.23±9.66
2	93.93±3.71[ab]	6.07±2.63[ab]	8.33±1.19	7.75±2.96	76.79±8.93	71.89±6.37
3	100.00±0.00[a]	0.00±0.00[a]	5.88±5.88	14.31±8.43	79.81±2.54	79.81±2.54
4	88.00±1.27[b]	12.00±0.09[b]	14.24±7.99	3.71±3.71	85.19±14.82	75.09±13.80
5	92.09±6.48[ab]	7.91±4.59[ab]	5.17±5.17	8.62±8.62	86.21±13.80	78.75±8.75
LOS	*	*	NS	NS	NS	NS

EEM = Early embryonic mortality, LEM = Late embryonic mortality, LOS = Level of significant, NS = Not significant, * = Significant at 5% level of probability [ab] = mean along the same column with different superscripts are significantly (P<0.05) different

Table 2: Effects of location on average weekly body weight of tiv local chicken ecotype

Location	1	2	3	4	5	LOS
Week 0	23.50±0.54[ab]	24.33±0.45[a]	22.95±0.65[ab]	22.69±0.62[ab]	22.54±0.56[b]	*
Week 1	36.32±0.85	34.72±0.72	35.92±1.09	35.74±0.98	37.28±0.92	NS
Week 2	44.00±0.96	42.5±0.98	43.41±1.38	42.73±1.26	46.00±1.61	NS
Week 3	52.45±1.29	50.28±1.44	53.18±1.76	53.49±1.76	55.26±1.92	NS
Week 4	63.10±1.90[ab]	58.77±1.74[b]	64.65±2.40[ab]	63.69±2.19[ab]	69.00±2.74[a]	*
Week 5	88.71±3.03[ab]	81.75±3.61[b]	95.74±3.80[b]	94.72±3.77[b]	107.51±5.34[a]	*
Week 6	104.32±4.50[b]	107.66±5.39[b]	115.94±4.26[ab]	111.24±5.03[b]	126.26±5.61[a]	*
Week 7	122.14±6.63[b]	120.50±5.50[b]	138.50±6.01[ab]	136.66±6.57[ab]	153.38±6.61[a]	*
Week 8	144.21±5.97[c]	141.59±4.94[c]	166.48±8.30[ab]	158.04±7.67[bc]	185.58±6.56[a]	*

WK = week, NS= Not significant at 5% level of probability, * =significant at 5% level of probability, LOS = Level of significant
[abc] = mean along the same column with different superscripts are significantly (P<0.05) different

The non significant mean value of body weight gain except at hatched obtained in this study (table 3) could not be compared to any previous work as there is no information regarding the parameter. However this study indicated that location had no significant (P>0.05) effect on weekly body weight gain except between body weight gain at hatch and week 1 were location 1 and 5 demonstrated the best result. Location 5 demonstrated higher value in most weeks that were not significant. The value obtained for growth rate across all the weeks ranges between (10. 57±0.38 to 39.60±0.01). Again this result could not be compared to any previous work as there is no information regarding the parameter.

Table 3: Effects of Location on Average Daily Body Weight Gain of Tiv Local Chicken Ecotype

Location	1	2	3	4	5	LOS
Week 0-1	2.12±0.07[a]	1.48±0.02[b]	1.88±0.18[ab]	1.87±0.12[ab]	2.11±0.09[a]	*
Week 1-2	0.81±0.25	1.12±0.01	1.07±0.08	0.10±0.23	1.25±0.51	NS
Week 2-3	1.19±0.45	1.13±0.34	1.39±0.10	1.52±0.39	1.33±0.36	NS
Week 3-4	1.51±0.45	1.22±0.23	1.57±0.50	1.46±0.11	1.97±0.63	NS
Week 4-5	3.68±0.45	3.35±0.88	4.40±0.86	4.50±0.99	5.56±1.97	NS
Week 5-6	2.23±1.29	3.30±2.18	2.88±0.12	2.35±0.70	2.61±0.01	NS
Week 6-7	2.55±1.12	2.38±0.35	3.20±1.12	3.37±0.44	3.88±0.84	NS
Week 7-8	3.16±1.07	2.90±1.78	4.05±0.91	3.31±0.97	4.54±0.99	NS

WK = week, NS = Not significant at 5% level of probability, * = significant at 5% level of probability, LOS = Level of significant. [ab] mean along the same column with different superscripts are significantly (P<0.05) different

Table 4: Effects of location on the percent growth rate of Tiv local chicken ecotype

Location	1	2	3	4	5	LOS
Week 0-1	35.15±0.89[b]	29.98±0.67[c]	36.39±1.44[b]	36.40±0.01[b]	39.60±0.01[a]	*
Week 1-2	17.49±0.90	18.47±0.21	17.08±0.82	16.11±1.31	18.33±3.26	NS
Week 2-3	15.83±3.36	15.60±2.51	18.23±0.66	19.97±3.17	16.89±2.95	NS
Week 3-4	16.51±2.27	14.36±1.12	16.88±2.58	16.06±0.69	19.95±3.52	NS
Week 4-5	28.92±0.70	28.01±2.55	32.10±1.77	32.72±2.88	34.94±4.47	NS
Week 5-6	13.97±3.76[b]	23.26±3.62[a]	17.58±0.51[b]	14..45±1.66[b]	14.72±1.02[b]	*
Week 6-7	13.87±2.13[ab]	10.57±0.38[b]	15.81±2.07[a]	17.39±0.23[a]	17.49±0.79[a]	*
Week 7-8	16.10±4.03	15.08±5.76	16.89±0.75	14.74±2.81	17.55±2.95	NS

WK = week, NS = Not significant at 5% level of probability, * = significant at 5% level of probability, LOS = Level of significant. [ab] mean along the same column with different superscripts are significantly (P<0.05) different

The effects of location on mortality rate of Tiv local chick is presented in table 5. From the result obtained, location had significant (P< 0.05) effect on mortality rate across all the weeks except weeks 1-2

and 3-4 respectively. The mean value obtained in this study for mortality rate (0.00±0.00% to 21.82±10.09% is fairly similar to the value of 11 - 14% reported by Momoh (2005).

Table 5: Effects of Location on the Mortality Rate of Tiv Local Chicken Ecotype

Location	1	2	3	4	5	LOS
Week 0-1	6.07±0.11^{ab}	12.70±0.92^{ab}	21.82±10.09^{b}	5.01±0.14^{a}	7.15±4.13^{ab}	*
Week 1-2	0.00±0.00	2.38±1.37	0.00±0.00	2.50±1.44	0.00±0.00	NS
Week 2-3	6.46±0.12^{b}	0.00±0.00^{a}	2.28±1.31^{ab}	5.27±3.04^{ab}	2.94±1.70^{ab}	*
Week 3-4	0.00±0.00	2.50±1.44	2.94±1.70	0.00±0.00	0.00±0.00	NS
Week 4-5	7.04±0.21	5.76±0.29^{b}	4.55±2.62^{b}	8.66±1.79^{c}	0.00±0.00^{a}	*
Week 5-6	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00$^{a\,b}$	8.50±1.51^{b}	2.78±1.61^{a}	*
Week 6-7	0.00±0.00^{a}	0.00±0.00^{a}	2.50±1.44^{ab}	11.77±6.79^{b}	0.00±0.00^{a}	*
Week 7-8	0.00±0.00^{a}	0.00±0.00^{a}	2.63±1.52^{ab}	6.67±3.85^{b}	2.94±170^{ab}	*

WK = week, NS = Not significant at 5% level of probability, * = significant at 5% level of probability, LOS = Level of significant. ^{ab} mean along the same column with different superscripts are significantly (P<0.05) different

Conclusion and Recommendation

The study was conducted to determine the effects of location on reproductive and growth performance of Tiv local chicken. From the result obtained, location had significant (P < 0.05) effect on hatch weight, weekly body weight, growth rate (at week 0-1, 5-6 and 6-7) and mortality. However, locations had no significant (P>0.05) on reproductive parameters except fertility and infertility which were significant. From the finding of this research, it is recommended that selection of Tiv local chicken should be location based especially for those parameters where location had significant effect.

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HAEMATOLOGICAL AND BIOCHEMICAL PARAMETERS OF RABBITS FED GRADED LEVELS OF *Garcinia kola* SEED MEAL

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Abstract
A 56-day study was carried out to evaluate the haematological and biochemical characteristics of weaner rabbits fed graded levels of garcinia kola seed meal (GKSM). A total of 32 mixed mongrel rabbits of about 8 weeks old were used for the study. The rabbits were randomly selected and assigned to four treatments. Each treatment had 8 rabbits and was replicated 2 times with four (4) rabbits per replicate in a completely randomized design (CRD). Four grower rabbit diets were compounded, incorporating (GKSM) at 0%, 1.5%, 3.0% and 4.5% respectively. The diets were designated T_1, T_2, T_3 and T_4, respectively, with T_1 served as the control (with no GKSM). The rabbits were given feed and water ad-libtum and were subjected to similar sanitary and husbandry conditions throughout the experimental period. Data were collected for haematological and biochemical analysis. Haematological parameters include RBC, WBC, PCV, Hb, neutrophils, lymphocytes, monocytes, basophils and eosinophils, while biochemical parameters include total protein**,** bilirubin, creatinine, cholesterol, albumin, sodium, potassium, calcium and phosphorus. Result of haematological parameters showed that only RBC showed significant ($P<0.05$) differences, while the rest showed non-significant ($P>0.05$). Result of biochemical parameters showed that total protein, cholesterol, sodium and potassium showed significant ($P<0.05$), while others showed non-significant ($P>0.05$) differences. Cholesterol values reduced as the level of the meal increased. Generally, the meal has no deleterious effect on the health of the animal.

Keywords*:* Haematological, Biochemical, GKSM and Rabbits

Introduction

The cost of providing feed and drugs in livestock and poultry industry in Nigeria are steadily increasing. These production cost which accounts for more than 70-80% has adverse effect on the producers and consumers in return. Cost is a major determinant of profitability on the side of producers, while the market price will determine the quantity consumers will purchase. Traditional animal healthcare practices involving use of some materials and herbal preparations called ethno-veterinary medicine is fast gaining grounds in the livestock industry especially in African and Asian countries (Ebenebe *et al.*, 2010) as they provide readily available and low cost alternative to orthodox medicine. It has therefore become necessary to investigate such plants for possibilities of incorporating their leaves or seeds in livestock and poultry feeds to serve as feed ingredients and/or prophylactic agents. Plant derived medicines have many benefits such as; low toxicity status/ relative safety, accessibility and affordability. Plants parts have been a source of herbal medicine which has been shown to be effective to about 80% of population as primary health care (Akinyemi, *et al*., 2000). Some plants, example garlic (*Allium sativum*), ginger (*Zingiber officinale*), neem tree leaves (*Azadiractha indica*), bitter kola (*Garcinia kola)* etc have been reported in livestock health care management (Owen and Amakiri 2013 and Obun *et al.*, 2013). *Garcinia kola* is a dicotyledonous belonging to the family Guttiferae or Clusiaceae and is widely cultivated throughout West Africa (Adedeji *et al*., 2006). In Nigeria, it is common in the South Western States and Edo State (Otor, *et al.*, 2001). According to Chilaka (2009), *G. kola* is used for social, therapeutic and nutritional purposes. Blood analyses have been used to predict the health status of animals. The importance of hematological and biochemical parameters as diagnostic tools and physiological indicators in birds has been documented (Harr, 2002; Hauptmanova *et al*., 2006). However, these parameters are greatly affected by sex, age and season (Fudge, 2000; Kececi and Col, 2011).The current study

therefore investigated the haematological and biochemical characteristics of rabbits fed graded levels of *Garcinia kola* seed meal (GKSM).

Materials and Methods

This experiment was carried out at the Rabbitry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria Nsukka. The G*arcinia kola* seeds were purchased from Ogige market Nsukka. They were processed and milled in a hammer mill with 2mm sieve to produce *Garcinia kola* seed meal (GKSM) that was used to compound the diet. A total of 32 weaner mixed mongrel rabbits of about 8 weeks old were used for the study. The rabbits were randomly selected and assigned to four treatment diets. Each treatment had 8 rabbits and was replicated 2 times with four (4) rabbits per replicate in a completely randomized design (CRD). Four grower rabbit diets were compounded, incorporating (GKSM) at 0%, 1.5%, 3.0% and 4.5% respectively. The diets were designated T_1, T_2, T_3 and T_4, respectively, with T_1 served as the control (with no GKSM). The trial lasted for 8 weeks (56 days) during which time the rabbits were given feed and water *ad-libtum* and were subjected to similar sanitary and husbandry conditions.

Blood Collection for Haematological and Biochemical Analysis

At the end of the feeding trial, about 5mls of blood sample was collected for the analysis. The blood samples were taken from the wing vein of the bird using disposable needle and syringe. For haematological analysis, about 2mls of blood used for analysis was stored in a bottle containing anticoagulant, ethylene diamine tetra acetic acid (EDTA) to prevent clotting. The following parameters were analysed WBC, PCV, RBC, Hb, neutrophils, lymphocytes, monocytes, basophils and eosinophils. While for serum biochemistry analysis, about 3mls was used. It was store without anticoagulant, after coagulation it was separated and the harvested sera were used to determine the following parameters total protein**,** bilirubin, creatinine, cholesterol, albumin, sodium, potassium, calcium and phosphorus

Data Collection and Analysis

Data collected for haematological and biochemical parameters were analyzed using analysis of variance (ANOVA) appropriate for (CRD) and treatment means were separated using Duncan multiple range test

Table 1: Composition of Experimental Diet

Ingredients	T_1 (0%)	T_2 (1.5%)	T_3 (3.0%)	T_4 (4.5%)
Maize	45.00	44.00	43.00	42.50
Wheat offal	40.00	39.50	39.00	38.00
Bitter kola	0.00	1.50	3.00	4.50
Fish meal	2.00	2.00	2.00	2.00
Blood meal	7.00	7.00	7.00	7.00
Soya bean meal	4.00	4.00	4.00	4.00
Bone meal	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25

Salt	0.25	0.25	0.25	0.25
Vit/min premix	1.00	1.00	1.00	1.00
Total	100	100	100	100

Results and Discussion

Table 2: Biochemical Characteristics of Rabbits fed *Garcinia Kola* Seed Meal

Parameters	**T_1 (0%)**	**T_2 (1.5%)**	**T_3 (3.0%**	**T_4 (4.5%)**
Total protein (g/dl)	5.80±0.00[b]	6.00±0.00[a]	6.50±0.50[a]	7.00±0.00[a]
Cholesterol (mg/dl)	74.00± 6.00[a]	67.00±1.00[ab]	62.00±2.00[ab]	60.00±1.00[b]
Creatinine (mg/dl)	2.00±0.00	2.00±0.00	2.50±0.50	3.00±1.00
Albumin (g/dl)	4.50±0.50	4.00±0.00	4.00±0.00	4.00±0.00
Sodium (mg/dl)	10.00±0.00[b]	11.50±0.50[a]	12.00±0.00[a]	12.00±0.00[a]
Potassium (mg/dl)	5.00±0.00[b]	7.00±1.00[ab]	7.50±0.50[a]	9.00±0.00[a]
Calcium (mg/dl)	10.00±0.00	10.00±0.00	11.00±0.00	10.00±1.00
Phosphorus (mg/dl)	6.00±0.00	6.00±0.00	5.50±0.50	6.00±0.00

a,b,ab Means within a row with different superscripts differ significantly ($p<0.05$).

The biochemical parameters of rabbits for this study are presented in Table 2. Total protein, cholesterol, sodium and potassium showed significant ($P<0.05$) differences. While creatinine, albumin, calcium and phosphorus showed non-significant ($P>0.05$) differences. The result of biochemical analysis of rabbits fed GKSM reveals that total protein concentration increases as the level of *Garcinia kola* increases. T_2, T_3 and T_4 is similar and it differs ($P<0.05$) significantly from T_1.The result differs from the range as reported by Ahemen *et al* (2013) in their studies. Meanwhile, the result is within the normal range (5.4-7.3 g/dl) as reported by Medirabbit (2007). Cholesterol concentration in T_1differs ($P<0.05$) significantly from treatments T_2, T_3, and T_4. It follows a decreasing trend as the GKSM inclusion level increases. The result is in agreement with the report of Fuhrman *et al.* (2000) who reported that plant foods possess cholesterol-suppressive capacity. The meal contains some hypocholestrolemic compounds. More so, the reduction suggests a decline in lipid mobilization and that the meal is capable of reducing serum cholesterol, hence assisting in the reduction and deposition of cholesterol in the muscle. It falls within the range10-80mg/dl as reported by University of Pennsylvania School of Veterinary Medicine (2002) and Medirabbit (2007).

Table 3: Haematological Characteristics of Rabbits fed *Garcinia Kola* Seed Meal

Parameters	T_1 (0%)	T_2 (1.5%)	T_3 (3.0%)	T_4 (4.5%)
PCV (%)	26.50±1.50	26.50±2.50	26.00±0.00	27.00±1.00
Hb(g/dl)	10.50±0.50	10.50±0.50	12.00±0.00	11.50±0.50
RBC ($x10^{12}$/1)	9.00 ±0.00^{b}	10.50 ±0.50^{a}	10.00±0.00^{ab}	10.50±0.50^{a}
WBC (x $10^3/mm^3$)	11.15±0.65	11.05±0.85	10.50±0.10	10.40±0.10
Neutrophils (%)	25.00±5.00	20.00±2.00	24.50±4.50	18.50±0.50
Lymphocyte (%)	74.00±6.00	78.00±2.00	73.50±3.50	81.00±1.00
Monocyte (%)	0.50±0.50	1.00±0.00	1.50±0.50	0.50±0.50
Basophils (%)	0.50±0.50	0.50±0.50	0.50±0.50	0.00±0.00
Eosinophils (%)	0.00±0.00	0.50±0.50	0.00±0.00	0.00±0.00

a,ab, Means within a row with different superscripts differ significantly (p<0.05). RBC=Red blood cell; WBC=White blood cell; PCV=Packed cell volume; Hb= Hemoglobin;

Table 3 showed the haematological characteristics of rabbits fed GKSM. All the parameters showed non-significant (P> 0.05) differences except RBC that showed significant (P< 0.05) differences. The PCV values (26.00-27.00 %) were within the normal physiological range (25.00-45.00 %) for growing rabbits as reported by Mitruka and Rawnsley (1977). Rabbits on T_4 recorded the highest PCV value of 27.00 % followed by T_1 and T_2 that had similar value 26.50 %, while the least value of 26.00 % was on T_3. Also the result was lower than the range 33.62-39.67 % reported by Ilo and Egu (2018). The disparity in the result may be connected to the differences in sex, age, physiological and nutritional status of the rabbits (Chineke *et al*., 2006: Isaac *et al*., 2013). Haemoglobin values were not significantly (P> 0.05) affected by the treatment. The value ranges from (10.50-12.00 $x10^{12}$/1) and it agreed with the normal haemoglobin levels of healthy rabbit as reported by (RAR 2009).

Conclusion

Values of both haematological and biochemical parameters obtained in this study were within the normal ranges. *Garcinia kola* seed meal does not seem to have deleterious effect on the health of the rabbits fed. The addition of GKSM can be tolerated by the animals at this stage. Further studies using 5.0% level of inclusion is recommended

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SUB-THEME: ANIMAL PHYSIOLOGY, REPRODUCTION AND BIOTECHNOLOGY
MODE OF PRESENTATION: ORAL

VIRGIN BIRTH IN FOUR STRAINS OF TURKEYS REARED IN NIGERIA

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Abstract
The study undertook to study the occurrence of parthenogenesis in four (4) strains of turkeys reared in Nigeria. The four strains comprised 1 exotic strain (White Nicholas) and 3 local strains (White, black and silver plumage colours). A total of forty (40) pre-pubertal hens consisting of 10 White Nicholas hens, 10 White Local hens, 10 Silver Local hens and 10 Black Local hens were used in the study. The study commenced with egg laying in those hens. Eggs from uninseminated virgin hens were collected and checked for the occurrence of parthenogenesis. Twenty-five eggs from each treatment were incubated. Embryonic mortalities at candling were determined by the presence of blood ring following egg breakout or as detected at candling. The positive developing eggs were allowed to hatch. The results of the study showed that only the White and Black Local hens showed signs of parthenogenesis with only the White Local strain having 12% fertility and hatchability values and the Black Local strain having 4% fertility and 0% hatchability values. It was concluded that strain differences with respect to parthenogenesis exist and that selection for parthenogenesis should be carried out in White and Black Local strains to help minimize losses arising due to embryonic mortalities in those strains. Therefore, an intending turkey farmer should wait for parthenogenesis to phase out in these two strains before natural mating or artificial insemination should set in to minimize the rates of embryonic mortalities in their fertile eggs.

Keywords: Parthenogenesis, plumage colour, strain, blood ring, turkeys

Introduction

Turkeys commonly reared in developing countries can be classified by their genotype or plumage colours (Thears, 2007). Several plumage colours of turkey genotype exists which include black, bronze, brown, red and white (Schoger, 1964) with black, bronze and white predominantly existing in the tropical environment (Okoro, *et al.*, 2012). Commercial turkey production in Nigeria is still rudimentary. The reason for this apparent low production seems to be lack of appreciation of its potential role in animal protein generation (Abeke and Ubani, 2008). For instance, one average sized turkey (8 kg body weight) is equivalent to 4 average sized broilers (2 kg each). Nevertheless, the full potentials in turkey cannot be harnessed until we come to terms with their reproductive capacity. For instance, turkeys have a myriad of reproductive problems ranging from infertility to management problems which include dearth of reliable data on management/reproductive potentials of indigenous local strains. The reproductive problems include unsuccessful natural mating due to size differences between toms and hens, parthenogenesis (a major cause of infertility in flocks), decreased libido due to difficulty in improving reproductive characteristics alongside growth parameters, decrease in fertility within a breeding season partly due to genetic incompatibility, nutrition, disease, stress (King *et al.*, 2000; Rosales, 2013) and other unknown factors.

Parthenogenesis from the Greek word parthenos, meaning "virgin", and genesis, meaning "creation" is a natural form of asexual reproduction in which growth and development of embryos occur without fertilization. Parthenogenesis occurs very rarely in birds (Scott, 1996).

Parthenogenesis, development from an unfertilized oocyte, has been documented in turkeys (Olsen and Marsden, 1954). Olsen (1960) reviewed much of his older work and concluded that 32.4% of infertile

turkey eggs normally underwent parthenogenesis, but the embryos died very early in most of these eggs. The incidence of parthenogenesis can be increased by inoculation of the hens with live Fowl Pox Virus and Newcastle Disease Virus (Olsen and Buss, 1967). Olsen (1972) in his later works recorded the incidence of parthenogenesis in different strains of turkeys, which reached the highest level at 49%. Parthenogenesis is responsible for some infertility in turkeys (Rosales, 2013).

Karl (2015) noted that Olsen's continued selection for increased incidence of parthenogenesis resulted in almost half of unfertilized eggs showing some development and some 8% percent of the embryos (200) hatched in the final year of selection, all were males. All of the parthenogenetic males were indistinguishable from males produced by natural or artificial mating and were capable of natural mating or producing semen for artificial inseminations. Research has shown that turkey parthenotes start as haploids, they then become diploid due to inhibition of cell division or cell fusion. In birds, females are the heterogametic sex (ZW) and males are the homogametic sex (ZZ), this is the opposite of mammals. WW parthenotes would not develop as this condition is not viable.

Parthenogenesis in turkeys is an accidental form of parthenogenesis which is erroneously believed to be a form of facultative parthenogenesis and it appears to result from a conversion of haploid cells to diploid (Revazova *et al.,* 2007); most embryos produced in this way die early in development. Rarely, viable birds result from this process, and the rate at which this occurs in turkeys can be increased by selective breeding (Revazova *et al.,* 2008), however male turkeys produced from parthenogenesis exhibit smaller testes and reduced fertility (Williams, 2007).

In turkey production, toms, which are product of parthenogenesis, are preferred to hens as they are more efficient converters of feed to meat. Nevertheless, since parthenogenesis is not an adaptive feature and poses a threat to fertility, the study therefore sought to investigate the occurrence of parthenogenesis in White Nicholas, Black, White and Bronze local hens, its management problems and ways of mitigating such problems.

Materials and Methods

The study was conducted at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. The four strains of turkeys used for the study were composed of 1 Exotic strain (White Nicholas) and 3 Local strains (the Black, White and Silver plumage colour types). A total of sixty female poults comprising 15 each of the above named strains were used for the study. The poults were procured at day old from Bachelor Farms at Ibadan for the White Nicholas and Obasanjo Farms at Ogun State for the Black, White and Silver local poults. The poults were housed together in well-ventilated netted pens. All the animals were fed 5% of their body weights throughout the experimental period and water was given *ad libitum*. The poults were fed commercial diets of chick starter mash from day old to ten (10) weeks old, chick finisher mash from ten weeks old to twenty-four weeks of age and chick layers mash for the remaining parts of the study. Prior to lay, 40 birds (10 from each strain) were separated according to varieties by placing them two (2) per pen to minimize fighting. Eggs from uninseminated virgin hens in each of the treatments were collected and checked for the occurrence of parthenogenesis. Twenty-five (25) eggs from each treatment were incubated. Candling was done at 7 days after setting and embryonic mortalities at this stage was detected by the presence of blood ring following egg breakout or detected at candling as described by Thomas (2008). The positive developing eggs were allowed to hatch. Data collected were reported using percentage occurrences.

Results and Discussion

The result on parthenogenesis in four strains of turkeys is presented in Table 1 and the values are graphically represented in Fig. 1.

Table 1: Parthenogenesis in four strains of turkey hens

Parameters/Strains	WN	Black	White	Silver

Fertility (%)	0	4	12	0
Hatchability (%)	0	0	12	0
Embryonic Mortality (%)	0	4	0	0

WN=White Nicholas

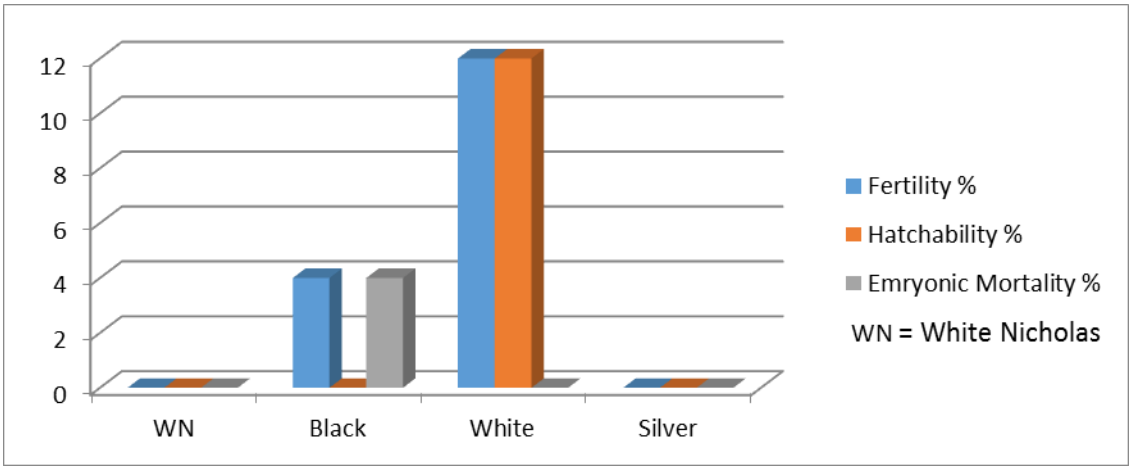

Fig. 1: Parthenogenesis in four strains of turkey hens

The fertility values ranged from 0-12% in all the strains studied with the highest value of 12% recorded in White Local hens and the lowest value of 0% recorded in WN and Silver hens. The hatchability values ranged from 0-12% with the highest value of 12% recorded in White Local hens while 0% was recorded in WN, Black and Silver hens. The embryonic mortality values ranged from 0-4% with the highest value of 4% recorded in Black local hens whereas 0% was recorded in WN, Whit Locale and Silver Local hens.

The high fertility and hatchability values noticed in only the White local hens may suggest the fact that they are descendants of the Bestville Small Whites in which Olsen and Marsden (1954) detected the first incidence of parthenogenesis in turkeys. However, the result on fertility in this strain without selection for this trait shows that they are better in terms of parthenogenesis than their presumed ancestors for which the above researchers recorded 8% with selection for parthenogenesis. Their reports on embryonic mortality in which out of 32.4% cases of parthenogenesis, most of the embryos died very early in most of the eggs shows that the White local strains are better in terms of parthenogenesis as 0% embryonic mortality was recorded in them. It shows that with selection, the White local turkeys may do better than the Bestville Small Whites, and parthenogenesis, if well managed, can become an asset. Rosales (2013) identified parthenogenesis to be the major cause of infertility in turkey hens. The later findings of this research on duration of fertility (not included here) revealed that parthenogenetic hens (White and Black local hens) had higher incidences of embryonic mortalities following insemination with single dose of semen and not higher infertility rates. Therefore, a farmer using White and Black local hens for breeding purpose should embrace parthenogenesis at the onset of the breeding season to generate only male turkeys which are of more economic value to the farmer and then switch to normal breeding when parthenogenesis phases out. The rate of occurrence of parthenogenesis in White and Black local strains should be improved using selection and other methods locally available to the farmer to help minimize losses arising due to embryonic mortalities in them.

Conclusion

The 4% fertility and 4% embryonic mortality in Black local hens show that they have potentials for parthenogenesis and may be improved upon by selection.

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HAEMATOLOGY AND SERUM BIOCHEMICAL CHARACTERISTICS OF BROILER FINISHERS FED DIETS CONTAINING CASSAVA PEEL MEAL

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Abstract
A 56-day study was carried out to evaluate the haematological and biochemical characteristics of broiler finisher fed cassava peel meal (CPM).Ninety six (96) day old chicks were used for the experiment. The birds were randomly divided into four (4) treatment groups with three replicates containing 8 birds each in a completely Randomized Design (CRD). The experimental diets were formulated to contain 0% cassava peel meal (T_1) control, 5% (T_2), 10% (T_3) and 15% (T_4) respectively. Feed and water were served *ad-libitum* throughout the experimental period. Data were collected for haematological and biochemical parameters. Haematological parameters include RBC, WBC, PCV, Hb, MCHC, MCH and MCV, while serum biochemical parameters include urea, total protein, albumin, globulin, creatinine, cholesterol, and glucose. Result of the biochemical parameters showed that urea values on the control (18.94mg/dl) was significantly higher ($P<0.05$) than on the diet with 10% CPM (7.73mg/dl) only. Cholesterol values on the 5%CPM was significantly lower ($P<0.05$) than values on diet with 10%CPM (161.92) and that with 15%CPM (180.13 mg/dl). However, birds on the 15%CPM had significantly higher cholesterol values than on the other diets and on the control. Birds on 10%CPM had significantly lower albumin values (10.40g/l) than those on the control (13.38), 5% CPM (13.50) and 15%CPM (17.37g/l). Values for creatinine, glucose, globulin and total protein did not vary significantly ($P>0.05$) across the diets. None of the haematological parameters measured differed significantly across the diets indicating that the birds were healthy. However, the inclusion of processed CPM at 10% of the diet is recommended to minimize cholesterol intake by man.

Keywords*:* Haematology, Blood Chemistry, CPM and Broiler Finisher

Introduction
Profitability in the rearing of poultry birds like any other livestock in Nigeria as in other developing countries is influenced by a combination of various inputs which are required to maintain faster growth rate as well as reduce feeding cost which constitutes the highest operational cost. High production cost resulting from feed is a major factor affecting the development of livestock industries in developing countries (Kawe *et al.*, 2007). There is also a pressing need to explore the use of unconventional and local feedstuff, which is underexploited by poultry farmers in order to reduce feed costs. There is increased interest by Nigerian livestock farmers and researchers to harness unconventional feed ingredients. Cassava peels like most agricultural wastes is made up of mainly polysaccharides which are widespread in nature. They account for an estimated 66% of all global bound carbon (Gardnea, 1974). Cassava peel contains 27.9% dry matter, 5.3% crude protein and 1.2% ether extract. It is relatively high in crude fibre 20.97% and ash 5.93%. It contains 66.6% Nitrogen free extract (Omole and Sonaiya, 2000). The utilization will at the same time reduce the environmental pollution caused by this waste product. The great limitation in the utilization of cassava peel as substitute for maize is its high hydrocyanic acid (HCN) content which is toxic to monogastrics. The use of blood examination as a way of assessing the health status of animals has been documented (Muhammad *et al.*, 2000). The importance of hematological and biochemical parameters as diagnostic tools and physiological indicators in birds has been documented (Harr, 2002; Hauptmanova *et al.*, 2006). However, these parameters are greatly affected by sex, age and season (Fudge, 2000; Kececi and Col, 2011).The objective of this study is to evaluate the haematological and biochemical characteristics of broiler finisher fed diets containing cassava peel meal (CPM).

Materials and Methods

Study location: The research was carried out at the poultry project site of the Federal College of Agriculture, Ishiagu, Ebonyi State.

Source and processing of cassava peel: Cassava peel that was used as feed ingredient was procured from the College cassava milling unit. They were processed (sundried) and milled in a hammer mill with 2mm sieve to produce cassava peel meal (CPM) that was used to compound the diet.

Diet: The experimental diets were formulated to contain 0% cassava peel meal treatment 1 (T_1) that is the control, 5% (T_2), 10% (T_3) and 15% (T_4) respectively.

Experimental procedure: Ninety six (96) day old chicks were used for the experiment. The birds were randomly divided into four (4) treatment groups in a completely randomized design (CRD) with three replicates containing 8 birds each.

Blood Collection for Hematological and Biochemical Analysis

At the end of the feeding trial, about 5mls of blood sample was collected for the analysis. The blood samples were taken from the wing vein of the bird using disposable needle and syringe. For haematological analysis, about 2mls used for analysis was stored in a bottle containing anticoagulant, ethylene diamine tetra acetic acid (EDTA) to prevent clotting and subsequently analyzed to determine RBC, WBC, PCV, Hb MCHC, MCH and MCV. While for serum biochemistry analysis, about 3mls was used. It was store without anticoagulant, after coagulation, the serum separated was used to determine the following parameters urea, total protein, albumin, globulin, creatinine, cholesterol, and glucose.

Data Collection and Analysis

Data collected for haematological and biochemical parameters were analyzed using analysis of variance (ANOVA) appropriate for (CRD) and treatment means were separated using Duncan's multiple range test (Duncan, 1955)

Table 1: Composition of Experimental Diets

Ingredients	Treatments			
	T_1 (0%)	T_2 (5%)	T_3 (10%)	T_4 (15%)
Maize	50.00	45.00	40.00	35.00
Cassava Peel Meal	-	5.00	10.00	15.00
Soya bean	25.00	25.00	25.00	25.00
Fish meal	3.00	3.00	3.00	3.00
Palm kernel cake	18.00	18.00	18.00	18.00
Blood meal	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**

Results and Discussion

Table 2: Serum Biochemical Indices of Broiler Finisher Fed Diets Containing Cassava Peel Meal

Parameters	Treatments T_1 (0%)	T_2 (5%)	T_3 (10%)	T_4 (15%)	SEM
Urea (mg/dl)	18.94[a]	12.15[ab]	7.73[c]	11.07[ab]	1.46
Creatinine (mg/dl)	0.68	0.83	0.67	0.68	0.09
Cholesterol (mg/dl)	151.92[b]	149.48[c]	161.92[b]	180.13[a]	0.27
Glucose (mg/dl)	180.72	194.46	157.08	171.17	18.04
Albumin (g/l)	13.35[b]	13.50[b]	10.40[c]	17.37[a]	0.94
Globulin (g/l)	14.95	14.53	17.53	16.73	1.62
Total Protein (g/l)	28.30	28.00	33.95	33.83	2.06

a,b,ab,c Means within a row with different superscripts differ significantly ($p<0.05$).

Table 2 above showed the biochemical parameters of broiler finisher fed cassava peel meal (CPM). Urea values on the control were significantly higher than values on 10% CPM only. The urea values, (7.73-18.94 mg/dl) differed from that (19.82-54.80 mg/dl) of Adeyemo and Sani (2013) for broilers fed hydrolysed cassava peels as replacement for maize. Cholesterol value on 15% level differs significantly higher ($P<0.05$) than 5% levels, while 10% and 0% (control) levels are similar. The range (149.48-154.49 mg/dl) observed in the present study differed from that (81.46-154.49 mg/dl) for cholesterol. More so, albumin value on 15% level differs significantly higher ($P<0.05$) than 10% level, while that of 0% and 5% are similar. Range obtained for albumin (10.40-17.37 g/l) is at variance with that of Egbunike *et al* (2009) that reported (1.42-3.40 mg/dl). The differences observed could be due to the quality of feed materials and also the level of anti-nutritional factors present in the CPM as has been observed by Akinmutimi (2004). Almeida (2006) reported that at age 21, broilers had low cholesterol levels due to demand for energy caused by higher body development. Biochemical parameters generally can be used to monitor protein quality of feeds. They are important in the proper maintenance of the osmotic pressure between the circulating fluid and the fluid in the tissue spaces so that exchange of materials between the blood and cells could be facilitated. They also contribute to the viscosity and maintenance of normal blood pressure and pH (Ladokun *et al.,* 2008).

Table 3: Haematological characteristics of broiler finisher fed diets containing cassava peel meal

Parameters	T_1 (0%)	T_2 (5%)	T_3 (10%)	T_4 (15%)	SEM
RBC ($x10^{12}/1$)	3.73	3.94	3.82	4.02	0.18
WBC ($x10^{9}/1$)	8.77	6.93	7.60	8.80	0.16
PCV (%)	28.67	30.33	29.67	30.33	0.81
Hb (g/dl)	9.70	10.37	10.10	10.27	0.26
MCV (fI)	76.80	77.31	77.79	76.98	2.19
MCH (g/dl)	25.99	26.42	26.46	26.03	0.72
MCHC (%)	33.84	34.18	34.03	33.97	0.16

RBC=Red blood cell; WBC=White blood cell; PCV=Packed cell volume, Hb= Hemoglobin; MCHC=Mean corpuscular hemoglobin concentration; MCH=Mean corpuscular haemoglobin; MCV=Mean corpuscular volume.

Table 3 above showed the haematological characteristics of broiler finisher fed cassava peel meal (CPM). The result revealed that all the parameters showed that there were no significant differences across the diets. Hb values obtained ranged from 9.70-10.37 g/dl. T_2 had the highest value of 10.37 g/dl, followed by

T_4 10.27 g/dl while T_1 had the least value of 9.70 g/dl. The Hb values obtained in this study were within the normal range of (7.0-13.0g/dl) reported for birds (Jain, 1993). Haemaglobin concentration of blood has been associated with availability of nutrients to the animal body (Esonu *et al.,* 2001). PCV values obtained were all within the normal range of 22-35 % reported by (Jain 1993). They were however lower than the values of 25 to 45% reported by Mirtuka and Rawnsley (1997). Broilers in T_3 recorded the highest values in MCV (77.79 fl), followed by birds in T_2 (77.31 fl), while T_1 had the least (76.80 fl). The MCV values obtained was below the normal range of (90 to 140 fl) reported by Mirtuka and Rawnsley (1997). Mean corpuscular volume is an indication of the average volume of blood cells (Lazzaro, 2003).WBC result ranged from 6.93-8.80 $x10^9/1$. T_3 gave the highest value, followed by T_1 and the least was in T_2. The result disagreed with the findings of Adeyemo and Sani (2013) that showed significant ($p<0.05$) differences in the WBC of broilers fed CPM.

Conclusion

The study indicated that processed cassava peel meal could effectively be added to diets of finisher broilers at 10% of the diets to improve the performance of the animals. Moreover, there was no threat to the health of the birds as all haematological and some of the biochemical values were within the normal range for healthy birds.

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THE EFFECTS OF AQUEOUS GINGER *(ZINGIBER OFFICINALE*) EXTRACT ON SPERM QUALITY AND HAEMATOLOGY IN LEAD ACETATE TREATED MALE ALBINO RATS

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Abstract
This study was carried out to determine the ameliorative effects of aqueous ginger extract on sperm quality and haematology in lead acetate treated male albino rats. Twenty four male albino rats used for this study were randomly assigned into four groups (n = 6). Rats in group 1 served as normal control. Rats in group 2 were treated for 6 weeks with only lead (4 mg/kg). Rats in group 3 were treated with lead (4 mg/kg) and ginger (300 mg/kg) simultaneously for 6 weeks. Rats in group 4 were treated with lead (4 mg/kg) for 6 weeks and then with ginger (300 mg/kg) for another 6 weeks. Results obtained showed significant decreases ($P < 0.05$) in sperm motility and sperm viability in group 2 when compared to groups 1 and 3. There was no significant difference ($P > 0.05$) in sperm motility and viability of animals in group 3 when compared to group 1. There was no significant difference ($P > 0.05$) in sperm motility and sperm viability of animals in group 4 when compared to group 2. For haematological parameters, there was a significant decrease in RBC level of animals in group 2 when compared to those in groups 1 and 3. There was a significant increase in WBC of group 2 when compared to groups 1, 3 and 4. From the results, aqueous ginger extract showed protective potentials on sperm quality and haematology in lead acetate treated male rats.
Keywords: Ginger, Lead acetate, sperm quality, haematology

Introduction

Lead (Pb) is one of the most abundant heavy metal pollutants in the environment, and is well documented as a dangerous and insidious poison (White *et al*., 2007) Research has shown that lead toxicity causes severe damage to the reproductive system and haematology, interfering with spermatogenesis and reduces sperm production and quality (Biswas and Ghosh, 2006; Hamadouche *et al*., 2009). Oxidative stress induced by lead toxicity is the main cause of changes in sperm characteristics and haematology (Ashry *et al*., 2010). Ginger (*Zingiber officinale)* has been reported to have antioxidants properties (Prakash *et al*., 2010). Hence, the objective of this study was to determine the ameliorative effects of aqueous ginger extract on sperm quality and haematology in lead acetate treated male albino rats.

Materials and methods

The lead (Pb) acetate used was from Joe Chem Ventures Ltd, University of Nigeria, Nsukka, Enugu State.
Ginger: The ginger rhizome was purchased from Ogige market in Nsukka, Enugu State.

Extraction of Ginger *(Zingiber Officinale)* extract

The ginger rhizome was crushed using mortar and pestle. It was then filtered using Wattman no. 1 filter paper. The filtrate was concentrated in a hot air oven at 37^0C and stored at 4^0C during its use.

Experimental Design

Twenty four mature male albino rats were randomly assigned into four (4) groups of six rats each and treated once daily as follows:
Group 1: Rats in this group served as the normal control and were given distilled water as placebo.
Group 2: Rats in this group were treated, daily with lead alone at 4 mg/kg *per OS* [6] for six weeks
Group 3: Rats in this group were treated daily with lead at 4 mg/kg and ginger extract at 300 mg/kg *per OS* [11] from day one for six weeks
Group 4: Rats in this group were treated daily with lead at 4 mg/kg *per OS* for 6 weeks and then with ginger extract at 300 mg/kg *per OS* for the another 6 weeks.

Determination of testicular weight

After 30 days of treatment (end of study period), rats from each group were euthanized using chloroform. The testis from each rat was carefully dissected out, extraneous tissues removed and then weighed.

Determination of sperm motility

A drop of sperm from the cauda epididymis was placed on a warmed slide and observed using a light microscope. Sperm cells moving in a straightforward unidirectional motion were counted while sperm cells moving in circles, in backward direction or showing pendulous movement were excluded (Zemjanis, 1977)

Determination of sperm viability

One drop of semen was mixed with one drop of eosin-nigrosin stain on a warm slide. A thin smear was then made from the mixture of semen and stain. The smear was then air-dried and viewed under the microscope. The live and the dead sperm cells were separately counted and the ratio of the live to dead sperm cells was calculated in percentage. The sperm cells that appeared clear (white) were counted as live while those that picked up the stain (appeared pink/red) were counted as the dead cells (Zemjanis, 1977).

Determination of packed cell volume (PCV)

This was determined by the hematocrit method (Coles 1986). Values were expressed in percentage.

Determination of white blood cell (WBC) and red blood cell (RBC) counts

These were estimated using the improved Neubauer counting chamber (Coles 1986). Values were expressed as number of counts x 10^6/µl of blood.

Determination of hemoglobin (Hb) concentration

This was done using cyanomethaemoglobin method (Coles 1986) and values recorded in g/dl

Differential Leukocyte count

Lieshamann Technique (Coles 1986) was used. Each type of white blood cell was expressed as a percentage of the total count and converted to the absolute value per microlitre of blood.

Statistics

Data obtained from the study was statistically analysed using one way analysis of variance (ANOVA). The variant means were separated using Duncan Multiple Range Test. Level of significant was accepted at $p < 0.05$.

Results and Discussion

Table 1: Mean values of the testicular weight, sperm motility and viability.

PARAMETER	GROUPS			
	1 (normal control)	2 (lead only)	3 (lead + ginger)	4 (lead 6 weeks, then ginger 6 weeks)
Testicular Weight (grams)	1.10 ± 0.00	0.90 ± 0.16	0.90 ± 0.10	1.07 ± 0.03
Sperm Motility (%)	76.68 ± 8.82^a	30.00 ± 5.77^b	73.33 ± 3.33^a	40.00 ± 5.77^b
Sperm Viability (%)	76.67 ± 8.82^a	40.00 ± 5.77^b	66.67 ± 3.33^a	46.67 ± 3.33^b

Key: a, b = different superscripts indicating differences between the mean ($p<0.05$)

Table 2: Mean values of Packed Cell Volume, Haemoglobin concentration and Red Blood Cell count.

PARAMETER	GROUPS			
	1 (normal control)	2 (lead only)	3 (lead + ginger)	4 (lead 6 wks, then ginger 6 weeks)
Packed Cell Volume (%)	49.67 ± 2.03^{a}	41.67 ± 0.67^{b}	47.33 ± 1.45^{a}	46.33 ± 0.88^{a}
Haemoglobin conc. (g/dl)	10.70 ± 0.31^{a}	7.27 ± 0.88^{b}	9.10 ± 0.23^{c}	8.43 ± 0.26^{c}
Red Blood Cell count (10^6/µl)	28.17 ± 1.09^{a}	24.00 ± 0.58^{b}	26.00 ± 0.58^{ac}	24.33 ± 0.33^{bc}

Key: a, b, c = different superscripts indicating differences between the mean ($p<0.05$)

Table 3: Mean values of different cells of the leukocytic series

PARAMETERS	GROUPS			
	1 (normal control)	2 (lead only)	3 (lead + ginger)	4 (lead 6 weeks, then ginger 6 weeks)
Total WBC	70.00 ± 1.15^{a}	82.00 ± 2.00^{b}	68.66 ± 0.67^{a}	72.00 ± 1.15^{a}
Neutrophil	40.67 ± 0.67^{a}	30.67 ± 0.67^{b}	46.00 ± 1.15^{c}	30.00 ± 0.00^{b}
Lymphocyte	58.00 ± 1.54^{a}	68.00 ± 1.15^{b}	52.00 ± 1.15^{c}	68.00 ± 1.15^{b}
Monocyte	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00
Eosinophil	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00

Key: a, b, c = different superscripts indicating differences between the mean ($p<0.05$)

There were no significant differences ($P > 0.05$) in the mean testicular weight of animals among the groups. This was however not in line with the study that reported atrophy of the testes of rats treated with lead acetate (Chowdhury,2009). The significant decrease ($P < 0.05$) in sperm motility and viability observed in group 2 (lead only) animals when compared to animals in groups 1 (normal control) and 3 (lead + ginger) may be as a result of lead-induced oxidative stress (Auger *et al*., 2001). Lipid peroxidation destroys the structure of lipid matrix in the membranes of spermatozoa, and it is associated with loss of sperm motility and viability (Sharma and Agarwal, 1996). There was no significant difference ($p > 0.05$) in sperm motility and viability of animals in group 3 (lead + ginger) when compared to group 1 (normal control). This may be due to antioxidant properties of ginger (Ahmed *et al.*, 2000). There was no significant difference ($p > 0.05$) in sperm motility and viability of animals in group 4 (lead 6 weeks, then

ginger 6 weeks) when compared to group 2 (lead only). This may be because the toxic effect of lead had occurred before commencement of treatment with ginger. This suggests that it is better to prevent lead toxicity with consumption of ginger than allowing the toxicity to occur before treatment with ginger. For haematological parameters, there was a significant decrease ($p < 0.05$) in packed cell volume (PCV) and haemoglobin (Hb) concentration of group 2 (lead only) animals when compared to groups 1 (control), 3 (lead + ginger) and 4 (lead 6 weeks and then ginger 6 weeks). There was also a significant decrease in red blood cell (RBC) count of group 2 animals when compared to those in groups 1 and 3. These decreases in PCV, Hb and RBC of group 2 were in line with previous studies (Alsaleh, 1994). Red blood cells have a high affinity for lead. Lead has a destabilising effect on cellular membrane and RBCs, decreasing cell membrane fluidity and increasing the rate of RBC haemolysis. Haemolysis appears to be the end result of ROS-generation and lipid peroxidation in the RBC membrane (. Lawton and Donaldson, 1991). In the total white blood cell (WBC) count, a significant increase ($p < 0.05$) in group 2 animals when compared to groups 1, 3 and 4 was observed. This may be as a result of the body's immune response to lead toxicity, hence the increased production of WBCs. There was a significant decrease ($p < 0.05$) in the number of neutrophils of animals in groups 2 and 4 when compared to groups 1 and 3 but all the values fell within the normal range reported for this specie. There was a significant increase ($p < 0.05$) in the number of lymphocytes of animals in groups 2 and 4 when compared to groups 1 and 3 but all the values fell within the normal range reported for this specie.

Conclusion and recommendation

In conclusion, ginger extract demonstrated a significant protective potential on sperm quality (motility and viability) and haematology in lead acetate treated male rats. The study also showed that ginger may be more effective when supplemented in animals diet rather than used as a therapeutic agent after the occurrence of lead toxicity. Hence, supplementation of ginger (*Z. officinale*) in animal's feed is recommended. This may be effective in reducing the toxic effect of lead on sperm quality and hematology, hence improving fertility in male animals.

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HAEMATOLOGICAL AND SERUM BIOCHEMICAL INDICES OF BROILERS FED INORGANIC AND CHELATED TRACE MINERALS

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Abstract

This study was carried out to evaluate the effect of supplemental inorganic and chelated Cu, Zn and Mn on haematology and serum biochemistry of broiler chickens. A 42-day feeding trial was conducted using a total of three hundred Arbor Acre broiler chickens. The birds were allocated to five dietary groups. Each group had six replicates with ten birds each. The treatments were control (basal diet), 100% inorganic trace minerals (ITMs) supplemental level (15, 100, 100 mg/kg for Cu, Zn, Mn respectively), 50% ITMs supplemental level (7.5, 50, 50 mg/kg of Cu, Zn, Mn), 50% Chelated trace minerals (CTMs) supplemental level (7.5, 50, 50 mg/kg of Cu, Zn, Mn) and 25% CTM supplemental level (3.75, 25, 25 mg/kg of Cu, Zn, Mn, in that order). Data collected were subjected to one–way Analysis of Variance using a Completely Randomised Design. A lower ($p<0.05$) white blood cell count ($11.07x10^6/mm^3$) and an improved ($p<0.05$) red blood cell count ($13x10^6/mm^3$) was observed for the group fed 50% CTM supplemental level. The group fed 50% supplemental level of CTM had the highest ($p<0.05$) total protein (73.2 g/L), albumin (41.20 g/L) and globulin (32 g/L) in serum as compared to the other groups. The serum Cu, Zn and Mn were significantly higher ($p<0.05$) for the group fed 25% supplemental diet of CTM. The study concluded that trace minerals supplementation increased serum trace minerals of broiler chicken.

Key words: chelates, inorganic salts, haematology, serum biochemistry, broilers

Introduction

Evaluating haematological and serum biochemical parameters is a means of assessing the health status of animals and effect of treatments can be deduced from these analyses. Trace minerals are essential nutrients in broiler chicken's diets and they play very important roles in birds and these include cell proliferation and growth, tissue and bone development and integrity, immune development and response, reproduction, enzymes formation, gene regulation, and protection against oxidative stress and damage (Richards *et al*., 2010). Inorganic trace minerals (ITM) of Cu, Zn and Mn are often used in broiler chicken diets at the higher inclusion level than the recommended quantity by NRC (1994), but the absorption is limited because of the antagonistic effect in diet and gastrointestinal tract (Manangi *et al*., 2012). This results to increasing concerns over the excretion of minerals as pollutant in the environment (Manangi *et al*., 2012). A chelated mineral means the bonding or combination of metal ions with organic ligand or ligand complex such as amino acids, proteinate, polysaccharides or organic yeast (Bao, *et al*., 2006). Therefore, this study was carried out to investigate the effect of supplemental inorganic and chelated Cu, Zn and Mn on haematology and serum biochemistry of broiler chickens.

Materials and Methods

This study was carried out according to the research ethics and guidelines of the College of Animal Science and Livestock Production of the Federal University of Agriculture, Abeokuta, Nigeria. It was carried out at the broiler section (unit) of the Directorate of University Farm (DUFARM), Federal University of Agriculture, Abeokuta, Ogun State. A total of 300 unsexed day old Arbor Acre (AA) broiler chicks used for the study. The broilers were allocated to five (5) treatments; each treatment was divided into six (6) replicates with ten (10) birds each, making a total of sixty (60) birds in a treatment. The treatments were control (basal diet), 100% inorganic trace minerals (ITMs) supplemental level (15, 100, 100 mg/kg for Cu, Zn, Mn respectively), 50% ITMs supplemental level (7.5, 50, 50 mg/kg of Cu, Zn, Mn), 50% Chelated trace minerals (CTMs) supplemental level (7.5, 50, 50 mg/kg of

Cu, Zn, Mn) and 25% CTM supplemental level (3.75, 25, 25 mg/kg of Cu, Zn, Mn, respectively). Feed and water were given *ad libitum* throughout the experimental period. Chelated trace minerals of Cu, Zn and Mn (Mintrex®) containing 15% Cu from Cu (2-hydroxyl- 4-methylthiobutanoic acid as $HMTBa)_2$, 16% Zn from $Zn(HMTBa)_2$ and 13% Mn from $Mn(HMTBa)_2$ were obtained from Novus Inc., USA. The inorganic sources of Cu, Zn and Mn were purchased from an inorganic manufacturer in Lagos. The composition of the inorganic sources used are described as follow; copper sulphate pentahydrate ($CuSO_4.7H_2O$: containing 25% Cu), zinc oxide (ZnO: containing 72% Zn) and manganese dioxide (MnO_2: containing 64% Mn) were used as inorganic supplemental Cu, Zn and Mn respectively. The five (5) treatments diets with varying supplemental level of inorganic trace minerals (ITM) and chelated trace minerals (CTM) is shown in Table 1.

Table 1: Gross Composition of Experimental Basal diets

Ingredients (Kg)	(0 – 3 weeks)	(4 – 6 weeks)
Maize	54.00	65.00
Soya meal	40.00	30.70
Wheat Bran	2.00	1.00
Lime stone	1.50	1.00
Bone meal	1.20	1.00
Fish meal (72% CP)	0.50	0.50
Methionine Hydroxyl Analog	0.25	0.20
Lysine	0.20	0.20
Salt	0.15	0.15
Vitamin-Mineral Premix (Cu, Zn & Mn free)[1]	0.25	0.00
Vitamin-Mineral Premix (Cu, Zn & Mn free)[2]	0.00	0.25
Determined analysis		
Dry matter (%)	88.90	94.00
Crude protein (%)	23.70	19.20
ME (KCal/kg)	2946.23	3054.90
Nitrogen free extract (%)	47.02	55.6
Crude Fibres (%)	4.11	4.48
Ether extract (%)	5.23	4.92
Ash content (%)	8.84	9.80

Blood Sample Collection

At day 42, 30 birds (a bird from each replicate) were bled via wing vein puncture. 2 mL of blood was collected from each bird using sterile syringe and needle and deposited into tubes containing ethylenediamine-tetra-acetate (EDTA) and another 2 mL was collected into plain sterile bottles. The blood in the EDTA bottles were used to determine haematological parameters while that in the plain bottles were used to determine serum parameters The PCV was determined by microhaematocrit method and Hb and RBC were determined using colorimetry cyanomethaemoglobin and improved Neubauer haemocytometer methods respectively. The serum total protein, albumin and globulin were analysed colorimetricaly using a diagnostic reagent kit.

Statistical Analysis

Data collected were subjected to a Completely Randomized Design using SAS (2007). Comparisons among means were done using Tukey's test of the software.

Results and Discussion

The effect of supplemental trace minerals on haematology are presented in Table 2. Groups fed 50% and 25% supplemental level of CTM had higher ($p<0.05$) packed cell volumes (34.67% and 33.67%) and haemoglobin (11.33 g/dL and 11.20 g/dL respectively) relative to other dietary groups. Higher haemoglobin and PCV concentration in blood of broiler birds fed diets supplemented with chelated trace minerals compared to BD reflects the importance of Cu in haemoglobin synthesis. This indicates

that Cu was more bioavailable in the CTM groups since Cu and Fe are known to play vital roles in the synthesis of haemoglobin and for the synthesis of enzyme needed for normal metabolism (Close, 1999). The white blood cell of the group fed 50% CTM level was significantly lower ($p<0.05$) compared to the other groups and it also had a significantly higher ($p<0.05$) red blood cell while the groups fed 100% ITM, 50% ITM level and BD had lower RBC. The increased WBC of birds given BD relative to those receiving CTM suggests a stimulation of the immune system by the control diet. This showed that the birds fed CTM supplemented diets with the lower WBC had immune stability and the birds were not challenged. This is in line with the report of Jegede *et al*., (2011) who reported higher haemoglobin and PCV with lower WBC in broilers fed Cu-proteinates.

Table 2: Effect of inorganic and chelated trace mineral on the haematological parameters of the experimental broiler chickens (42 days)

PARAMETERS	Control	ITM		CTM			
	(BD)	100%	50%	50%	25%	SEM	P-Value
PCV (%)	28.50^{b}	31.00^{ab}	32.33^{ab}	34.67^{a}	33.67^{a}	0.66	0.00
Hb (g/dL)	9.57^{b}	10.33^{ab}	10.67^{ab}	11.33^{a}	11.20^{a}	0.21	0.02
WBC (10^6/mm^3)	17.97^{a}	17.43^{a}	18.67^{a}	11.07^{b}	13.90^{ab}	0.92	0.01
RBC (10^6/mm^3)	2.42^{c}	2.80^{b}	2.89^{ab}	3.12^{a}	2.98^{ab}	0.07	0.00
Neutrophil (%)	51.00^{a}	26.00^{b}	27.33^{b}	15.67^{b}	14.00^{b}	3.73	0.00
Lymphocyte(%)	46.00^{b}	70.67^{a}	69.00^{a}	80.00^{a}	81.33^{a}	3.71	0.00
Basophil (%)	0.00	0.33	0.00	0.33	0.67	0.15	0.68

^{abc} Means in the same row having different superscripts are significantly different at ($P<0.05$)

The effect of supplemental trace minerals on serum biochemistry of the experimental birds is shown in Table 3. Birds fed 50% CTM recorded the highest ($p<0.05$) total protein value (73.2g/L), albumin (41.20 g/L) and globulin (32 g/L) in serum as compared to other groups with the group fed 100% ITM level having the lowest ($p<0.05$) serum protein of 62.53g/L. Also, the group fed BD had a significantly lower ($p<0.05$) albumin (35.77g/L) compared with 41.2g/L of the group fed 50% supplemental diet of CTM. The serum Cu (16.5ug/dL), Zn (14.13ug/dL) and Mn (1.88ug/dL) were significantly higher ($p<0.05$) for the group fed 25% CTM compared to the group fed 100% supplemental ITM level with 15.08, 11.03, and 1.61ug/dL of serum Cu, Zn and Mn respectively while the group fed BD had the lowest ($p<0.05$) Cu, Zn and Mn in the serum. The improvement in total protein, serum albumin and globulin in groups fed diet supplemented with CTM as a result of the supplemented methionine hydroxyl analog (MHA) chelated with trace minerals compared to the groups fed diet supplemented with ITM. The higher serum protein, albumin and globulin show that the MHA or 2- hydroxyl -4- methyl thiobutanoic acid (HMTBa) which is regarded as precursor of DL- methionine (first limiting amino acid) (Richards *et al*., 2007) were released from the ligand. Copper is also involved in blood proteins and has capacity to influence serum protein (Uany., *et al*, 1998) This study is supported by Corzo *et al*., (2009) who reported that supplemental amino acid (valine and isoleucine) in broiler chicken diet increased the serum protein, albumin and globulin. The increased serum Cu, Zn and Mn of the groups fed supplemental diet of CTM compared with the groups fed ITM level and BD with lower serum minerals indicates that the CTM were more bioavailable to the broiler chickens and this also shows that there is less antagonism with other dietary minerals and among themselves. This study agrees with the report of Salami *et al.*, (2016) who reported higher bioavailability of trace mineral from mineral chelates and less antagonistic interaction of chelates with other dietary constituents in the digestive tract compared with inorganic salts.

Table 3: Effect of inorganic and chelated trace minerals of serum biochemistry of the experimental broiler chickens (42 days)

PARAMETERS	Control	ITM		CTM			
	(BD)	100%	50%	50%	25%	SEM	P-Value
TP (g/L)	65.90^{c}	62.53^{d}	67.00^{bc}	73.20^{a}	69.87^{b}	0.99	0.00
Albumin (g/L)	35.77^{c}	36.67^{bc}	38.30^{bc}	41.20^{a}	39.73^{ab}	0.60	0.00
Globulin (g/L)	30.27^{ab}	25.87^{c}	28.70^{b}	32.00^{a}	30.13^{ab}	0.58	0.00
Creatinine (mg/dL)	0.77	1.40	1.27	0.87	1.43	0.11	0.17
Uric (mg/dL)	5.80	8.57	8.33	7.93	7.60	0.41	0.21
Serum Cu (ug/dL)	6.77^{c}	15.08^{b}	15.53^{b}	16.17^{a}	16.50^{a}	0.97	0.00
Serum Zn (ug/dL)	4.05^{e}	11.03^{d}	12.80^{c}	13.53^{b}	14.13^{a}	0.98	0.00

^{abc} Means in the same row having different superscripts are significantly different at ($P<0.05$)

Conclusion

Trace mineral supplementation increased serum trace mineral concentration. Supplementation of CTM (Cu, Zn and Mn) at 50 % improved haemoglobin and packed cell volume of broiler chickens.

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BLOOD PROFILE OF YOUNG DOE RABBITS FED DIETS CONTAINING TWO VARIETIES OF COMPOSITE SWEET POTATO (*Ipomoea batatas* LAM*)* MEAL IN A PALM KERNEL BASED DIET

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Abstracts
Eighty-four does of mixed breeds aged 6-8 weeks, weighing 550–600 g were used to determine the effect of feeding two varieties of composite sweet potato (*Ipomoea batatas*) meal (CSPM) on the hematological and serum biochemical indices of rabbits. The rabbits were randomly allocated into seven treatments; T1 as control, T2, T3, T4, containing CIP440293 CSPM replacing 25, 50 and 75 % of maize, and T5, T6 and T7 containing TIS87/0087 CSPM replacing 25, 50 and 75 % of maize, with four replications per treatment in a Completely Randomized Design (CRD) experiment. The diets contained 10.6-12.6 % crude fibre, 16.4-17.6 % crude protein and 2610-2788 Kcal/Kg metabolizable energy. At the end of nine weeks of feeding trial, blood samples were collected from three rabbits per treatment. The results indicate that the dietary treatments had Significant ($P<0.05$) influence on the white blood cells and eosinophils. However, there were no significant influence of the diets on other haematological parameters. For the serum biochemical parameters, total protein, urea, globulin and creatine were not affected ($P>0.05$) by the treatment diets but albumin, cholesterol, glucose, aspartate transaminase (AST), alanine transaminase (ALT) and alkaline phosphatase (ALP) were influenced by the different dietary treatments. These results show that CSPM of two varieties can be included up 50 % in growing rabbit diets without adverse effect on haematology and serum indices of rabbits.
Keywords: Rabbits, Sweet potato composite meal, haematology, serum biochemistry

INTRODUCTION
The soaring price of animal protein source in developing countries and in Nigeria particularly has led to increasing search by animal nutritionists for alternative feedstuffs that could replace the major feed ingredients such as cereals. However, there is need to explore every possibility of incorporating unconventional feedstuffs into livestock feeds in order to reduce the cost of feed and maximize returns, and ensuring that the protein requirements of humans are met. Rabbits have a short generation interval and more importantly prolific, and its practice of caecotrophy enhances its performance. The cost of rabbit production is low and equally they have a fast growing rate (Oyawoye and Ogunkunle, 1989). Rabbit is a monogastric herbivore and can utilize a wide variety of feed sources (Bamikole *et al.,* 2000). Sweet potato (*Ipomoea batatas*) also referred to as the 'global plant', cultivated in more than 100 countries including Nigeria, is an important food security promoting root crop in the world, especially in sub- Saharan Africa (*Low et al*., 2009). Sweet potato is well adapted to the tropical and subtropical regions. Sweet potato is an excellent source of energy (438 kJ/100 g edible portion) and can produce more edible energy per hectare per day than cereals, such as wheat and rice (Abu *et al.,* 2000) and has other advantages, such as versatility, high yield, hardiness, and wide ecological adaptability (Laurie *et al.,* 2012). The root is reported to have higher protein content than cassava and yams (Oloo *et al.,* 2014). In addition, some varieties of sweet potatoes contain coloured pigments, such as β-carotene, anthocyanin, and phenolic compounds. Sweet potato leaves are recognized to be rich in essential amino acids, such as lysine and tryptophan which are always limited in cereals. Hence, sweet potato can easily replace cereal based diets in livestock nutrition (Mwanri *et al.,* 2011; Oloo *et al.,* 2014). However, the potential benefits

of sweet potato are marginalized and underutilized despite their useful potential which is well recognized and exploited elsewhere.

Dietary components have measurable effects on blood components; hence, blood constituents are widely used in nutritional evaluation in animals (Gbore and Akele, 2012). The objectives of the study was to evaluate the effect of graded levels of composite sweet potato meal (CSPM) as a replacement for maize on haematology and serum biochemistry of rabbits so as to assess the physiological response of the animals to CSPM based diets.

MATERIAL AND METHODS

Test ingredient-Two varieties of sweet potato plants CIP 440293 (Orange flesh) and TIS 87/0087 (White flesh) were collected from the National Roots Crops Research Institute, Umudike, Abia State, Nigeria. The composite sweet potato meal was prepared and contained 65 % whole root tubers and 35 % of the leaves and vines. The whole root tubers were chipped and sun dried for 3-5 days while the leaves and vines were dried in a similar manner. The composite meal was included in young doe rabbit diets at graded levels. The diets were labeled as T1-control, 25, 50, and 75 % of orange flesh sweet potato composite meal were T2, T3 and T4 respectively and 25, 50, and 75 % of white flesh sweet potato composite meal were T5, T6 and T7 respectively. Other ingredients used included soybeans, maize offal, maize, rice offal, premix, bone meal and salt. The diets were formulated to meet 16 % CP requirement for growing rabbits (Table 1).

Animals and management-The research was carried out at the Rabbitry Unit, Teaching and Research Farm University of Ibadan, Nigeria. A total of 84 mixed breeds female rabbits weighing 550-600 g were allotted to seven dietary treatments of twelve animals per treatment. All rabbits were certified clinically healthy. Pelletized feed and water were provided *ad libitum* for 9 weeks. At the end of the feeding trial, blood samples were collected from the animals.

Table 1: Composition of the experimental diets

Ingredient		Levels of orange flesh CSPM			Levels of white flesh CSPM		
	T1(0%)	T2(25%)	T3(50%)	T4(75%)	T5(25%)	T6(50%)	T7(75%)
Maize	50.00	37.50	25.00	12.50	37.50	25.00	12.50
*CSPM	-	12.50	25.00	37.50	12.50	25.00	37.50
Soya bean meal	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Palm kernel cake	19.00	19.00	19.00	19.00	19.00	19.00	19.00
Fish meal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Wheat offal	8. 50	8. 50	8. 50	8. 50	8. 50	8. 50	8. 50
**Others	5. 50	5. 50	5. 50	5. 50	5. 50	5. 50	5. 50
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
CalculatedNutrients							
CP(%)	16.90	17.29	17.01	17.60	16.72	16.60	16.40
CF (%)	10.56	11.14	11.09	12.58	11.01	12.01	12.56
ME(Kcal/Kg)	2788.00	2760.00	2690.00	2742.00	2780.00	2680.00	2610.00

*CSPM: Composite sweet potato meal **Others: Cassava root meal; 2.00., Table Salt ;0.25., Vitamin Premix; 0.25., Bone Meal; 1.00., Limestone; 2.00. CP: Crude Protein, CF: Crude Fibre, ME: Metabolizable Energy.

Blood collection: Three rabbits per treatment were bled through the ear vein and their blood collected into two vaccutainer tubes for each animal, one containing a calculated amount of ethylene diamine tetraacetic acid (EDTA) for haematological studies and the other sterile vaccutainer tubes without EDTA.

The second set of tubes were covered and centrifuged, with serum separated out, decantedand deep-frozen for serum biochemical analyses. Packed cell volume (PCV) and erythrocyte counts were determined as described by Ewuola and Egbunike (2008).Total leukocyte counts were determined using Neubauer haemocytometer after appropriate dilution. Blood constants (Mean cell Volume, MCH, Mean cell haemoglobin, MCH and Mean cell haemoglobin concentration, MCHC) were calculated using formulae by Jain (1986). Serum total protein was determined using Biuret method (Kohn and Allen, 1995). Albumin was determined using Bromoscresol green (BCG) method (Peter *et al.*,1982). The globulin concentration was obtained by subtracting albumin from total protein.

Data Analysis-Data obtained were subjected to analyses of variance using SAS 9.2 statistical package. Significant differences between treatment means were separated using Duncan's Multiple Range Test.

Table 2: Hematology of rabbits fed dietary levels of two varieties of composite sweet potato meal based diets

		Levels of orange flesh CSPM			Levels of white flesh CSPM				
Parameters	T1(0%)	T2(25%)	T3(50%)	T4(75%)	T5(25%)	T6(50%)	T7(75%)	SEM	P-Value
PCV(%)	30.50	30.50	29.50	28.50	29.00	29.00	30.00	0.30	0.86
RBC($\times10^6$/mm^3)	4.65	5.35	4.72	4.95	4.75	5.08	4.85	0.09	0.75
Hemoglobin value(mg/100 mL)	10.17	10.17	9.84	9.50	9.64	9.67	10.00	0.10	0.85
WBC($\times10^7$/mm^3)	1.30^{ab}	1.13^{abc}	1.06^{bc}	1.34^{a}	1.06^{bc}	1.04^{bc}	1.02^{c}	0.05	0.08
Blood Platelets (x10^3/l)	188.50	162.50	185.50	200.00	195.00	173.00	163.00	5.69	0.38
Lymphocytes (%)	54.00	52.50	55.50	51.00	60.00	52.50	58.50	1.26	0.51
Neutrophils (%)	37.5	40.00	37.50	42.00	34.00	39.50	35.00	1.26	0.66
Monocytes (%)	4.0	4.00	2.50	3.50	3.50	3.00	4.50	0.25	0.82
Eosinophils (%)	4.50^{a}	3.5^{ab}	4.5^{a}	3.5^{ab}	2.5b^{c}	5.00^{a}	2.00^{c}	0.42	0.01
MCV (*fl*)	65.59	57.01	62.5	57.58	61.05	57.09	61.86	1.24	0.21
MCHC (g/dL)	33.34	33.34	33.36	32.87	33.24	33.43	33.33	0.07	0.46
MCH(pg)	21.38	19.39	20.29	22.11	20.14	18.99	20.3	0.41	0.51

[abc] Means with the same superscript in the same row are not significantly (P> 0.05) different, SEM- standard error of means

Table 3: Serum Biochemistry of rabbits fed varying dietary levels of two varieties of composite sweet potato meal based diets

		Levels of orange flesh CSPM			Levels of white flesh CSPM				
Parameters	T1(0%)	T2(25%)	T3(50%)	T4(75%)	T5(25%)	T6(50%)	T7(75%)	SEM	P-Value
Total Protein(g/dL)	6.21	7.71	6.37	6.10	6.44	8.92	5.29	0.46	0.6163
Albumin (g/dL)	3.16^{bdc}	3.46^{abc}	2.79^{d}	3.09^{cd}	3.26^{abc}	3.54^{ab}	3.62^{a}	0.11	0.0092
Globulin (g/dL)	3.05	4.24	3.57	3.010	3.19	5.39	1.68	0.44	0.6430
Cholesterol(mmol/L)	95.00^{cd}	95.67^{cd}	130.34^{b}	175.33^{a}	112.67^{cb}	93.34^{cd}	70.34^{d}	12.88	0.0016
AST (iu/L)	28.335^{a}	18.190^{b}	15.360^{b}	18.370^{b}	13.050^{b}	18.90^{b}	15.270^{b}	1.87	0.0249
ALT (iu/L)	25.460^{a}	18.30^{ab}	8.320^{c}	14.940^{bc}	14.005^{bc}	13.240^{bc}	9.520^{c}	2.18	0.0127
ALP (iu/L)	37.73^{ab}	41.82^{ab}	39.09^{ab}	36.82^{ab}	49.775^{a}	28.18^{b}	36.59^{ab}	2.45	0.2437
Blood Urea(mmol/L)	21.61	21.18	21.54	19.38	21.83	20.48	21.47	0.33	0.8003
Creatine(μg/dl)	1.100	1.550	1.10	1.350	1.10	1.150	1.250	0.06	0.2200
Glucose(mg/dl)	24.99^{cd}	25.76^{cd}	31.42^{b}	34.92^{a}	29.98^{bc}	26.51^{cd}	21.25^{dc}	1.73	0.0016

[abc] Means with the same superscript in the same row are not significantly (P> 0.05) different, SEM- standard error of means

CSPM: Composite sweet potato meal , AST: Aspartate Transaminase, ALT: Alanine Transaminase, ALP: Alkaline phosphatase

RESULTS AND DISCUSSION

The haematological response of does to the dietary treatments containing varied levels of composite sweet potato meal is as shown in Table 3. All the haematological parameters differential counts of rabbits examined were not significantly (P>0.05) influenced by dietary treatments except the white blood cell and Eosinophils which were higher in T6 (50%) and T1(0%) than the other five treatments. The similarities in the value of Hb, PVC, RBC, MCV, MCH, MCHC could be related to the nutritional adequacy and suitability of the test ingredients. All the haematological parameters measured in the experiment were within the normal physiological ranges reported for rabbits (Jenkins, 1993; Hillyer, 1994).

There were significant differences (P < 0.05) in the mean values of the various biochemical components of doe studied (Table 4). The Albumin, Cholesterol, AST, ALT, ALP and Glucose values were all significantly different. The values obtained reveals that cholesterol in the diet containing 75 % replacement of maize with orange flesh composite meal was significantly (P < 0.05) higher (175.33) than all other treatments. This may be due to the high level of total soluble sugar present in the orange fleshed sweet potato variety, that becomes dissolved into the blood stream of the rabbits. The serum biochemical variables of doe presented in the study were similar to the results of Van Praag (2004). This observation agrees with the results of Elamin *et al*.,2011 who reported that sweet potato has the potential to improve feed conversion ratio of local rabbit and have no negative effects on the blood constituents.

Conclusion

The findings showed that sweet potato composite meal can be fed to rabbits replacing up to 50 % of maize without any detrimental effect on the haematology and serum biochemistry of rabbits.

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COMPARATIVE STUDY ON THE SEMEN QUALITY CHARACTERISTICS OF PARTHENOTES AND PARENT TOMS REARED IN NSUKKA

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Abstract
The study was conducted to evaluate the semen quality characteristics of turkey parthenotes and their parent toms. A total of twenty four turkeys were used for the study. These comprised of twelve parthenotes toms and twelve parent toms. Parthenotes are male turkeys produced through parthenogenesis. The toms were subjected to abdominal massage techniques for semen collection. Semen collection was done twice per week and analyzed for volume, motility, sperm concentration, like sperm, abnormal sperm, normal sperm, dead sperm, total sperm/ejaculates and total motile sperm cells. The results showed that there were significant differences ($p<0.05$) in semen volume, sperm concentration, normal sperm cell, abnormal sperm and total motile sperm with mean values being 0.35ml, $1.74x10^9$/ml, 97.80%, 2.20%, $1.68x10^{12}$ and 0.41ml, $1.50x10^9$/ml, 94.00%, 6.00% and $1.42x10^{12}$, respectively, for both parthenotes and parent toms. However, semen parameters such as motility, live sperm cell, dead sperm cell and total sperm/ejaculate showed no significant difference ($p>0.05$) with values of 96.7%, 97.7%, 2.30% and $6.07x10^9$ for parthenotes toms and 93.20%, 98.50%, 1.50% and $6.23x10^9$. It was observed from the results that turkey parthenotes posse good quality semen characteristic and therefore, recommended for use in poultry industry for turkey production.

Keywords: Turkeys, semen quality, parthenotes and parent toms

Introduction
Parthenotes are male turkeys produced through parthenogenesis (without mating and fertilization) whereas parent toms are male turkeys produced through mating and fertilization. The incidences of parthenogenesis in turkey have contributed to the evident improvement in the growth of turkey industry. Walker (2010) defined parthenogenesis as the natural form of asexual reproduction in which growth and development of embryos occur without fertilization. McDaniel (2007) reported that some female organisms are capable of producing an ovum which develops into a new individual without being fertilized by a male gamete. In this case, the mother only contributes her genetic material to the offspring. Natural parthenogenesis is frequently observed in rotifers, insects, mollusk, crustaceans and flat worms, though; this method of reproduction is much less common among vertebrates (McDaniel, 2007). However a few species of fish, amphibians and reptiles are known to reproduce via parthenogenesis. Turkey is very unusual being a bird which can reproduce through this means (McDaniel, 2007). Parthenogenesis occurs in turkeys through the doubling of haploid cells. Biologists have discovered that the rate at which this occurs can be increased by selective breeding (McDaniel, 2007). Poults produced through parthenogenesis are capable of growing into healthy viable toms indistinguishable from toms with more traditional parentage. Parthenogenesis was first discovered by Olsen and Marsden (1953). They found that 14% of the unfertilized eggs laid by Belts-Ville small white (BSW) turkeys developed parthenogenically.

Parthenogenesis occurs naturally in many plants, some invertebrate animal species (including nematodes, some scorpions, aphids, some bees and parasitic wasps) and a few vertebrates (such as some fish, amphibians, reptiles and birds) (Savage, 2005; Walker, 2010). Among the vertebrates, strict parthenogenesis is only known to occur in lizards, snakes, birds and sharks, with fish, amphibians and reptiles exhibiting various forms of gynogenesis (a phenomena in which a sperm triggers the development of the egg cell into an embryo but make no genetic contribution to the embryo (Walker, 2010; Savage, 2005).

Materials and methods

Study location

This experiment was carried out in the Poultry Unit of the Department of Animal Science Teaching and research farm, University of Nigeria, Nsukka. Nsukka

Experimental birds and management

A total of 24 mature local turkeys were used for the experiment, these comprised of twelve parthenotes and twelve parent toms. The two groups were housed separately. The toms were trained for semen ejaculation over a period of four weeks. The toms were subjected to abdominal massage techniques for semen collection. Semen collection was done twice per week and evaluated for semen quality characteristics. Parameters considered were semen volume, percentage sperm motility, sperm concentration, percentage abnormal and normal sperm, percentage live sperm and dead sperm, total sperm/ejaculates and total motile sperm cells. The birds were given feed and water *adlibitum*. They were treated against external parasites such as fowl lice using Rambo (Insect powder) with permethin 0.60% as active ingredient. The birds were also dewormed and administered with multi-vitamin injections and antibiotic to boost their immunity.

Experimental Design and Statistical Analysis

This experiment was carried out using T. test and the model is a shown below.

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\Sigma x_1^2 - {}^{(\Sigma x_1)^2}/_{n_1} + \Sigma x_2^2 - {}^{(\Sigma x_2)^2}/_{n_2} \times \left({}^{1}/_{n_1} + {}^{1}/_{n_2}\right)\right)}{n_1 + n_2 - 2}}$$

Where;

Σ = summation

$\bar{X}_1$ = mean of the X_1

$\bar{X}_2$ = mean of the X_2

Σx_1^2 = the sum of scores in group one then squared

$\Sigma(x)$ = sum of scores in group I

n_1 = the number of scores in group one only

Σx_2^2 = sum of all the scores in group II then squared

$\Sigma(X_2)$ = sum of scores in group II

n_2 = the number of scores in group II

Results and Discussion

Table 2: The mean and probability level of semen quality characteristics of ejaculate from parthenotes toms and their parent toms

Parameters	Semen Volume (ml)	Semen Motility (%)	Sperm Conc. ($x10^9$/ml)	Live sperm cells (%)	Dead sperm cells (%)	Normal sperm cells (%)	Abnormal sperm cells (%)	Tot. sperm/ eja. ($x10^9$)	Tot. motile sperm cells ($x10^{12}$)
Parthenotes Toms (PN)	0.35*	96.70^{NS}	1.74**	97.70^{NS}	2.30^{NS}	97.80**	2.20**	6.07^{NS}	1.68**
Probability level	0.049	0.20	0.004	0.40	0.40	0.014	0.014	0.769	0.003
Parent toms (PA)	0.41*	93.20^{NS}	1.50**	98.50^{NS}	1.50^{NS}	94.00**	6.00**	6.23^{NS}	1.42^{**}
Probability level	0.049	0.202	0.004	0.402	0.42	0.016	0.016	0.769	0.003

Tot. = total, Eja = ejaculate, NS = Not significant (P>0.05), * = significant, ** = highly significant, PA = Parent toms, PN = Parthenotes

The mean and probability level of semen quality characteristics of ejaculate from parthenotes and parent toms were presented in table 2. The result indicated that there were significant ($p<0.05$) differences in semen volume, semen concentration, normal sperm cells, abnormal sperm cells and total motile sperm cells. However, parameters such as the percentage motility, live sperm cells, dead sperm cells and total sperm in ejaculates showed no significant difference ($p>0.05$).

The semen volumes obtained in this study indicated significant ($p<0.05$) difference 0.35ml and 0.41ml for both parthenotes and parent toms, respectively, were significantly ($p<0.05$) higher than the result of Zaharaddeen *et al*. (2005) who reported an average volume of 0.17 to 0.2ml in Bauchi State. The higher mean value obtained could be attributed to differences in genetics and system of management. However, the result is within the normal range of volume 0.35 – 0.40ml as documented by Christensen (2005). The semen motility had no significant difference ($p>0.05$), values being 96.70% and 93.20% for both parthenotes and parent toms, respectively. These values were higher than 84.25 $\pm$ 2.23 and 83.47$\pm$ 2.30% which were the highest value recorded by Zaharadeen *et al*., (2005) in local and exotic turkey, respectively. Holsberger *et al*. (1998) reported a mean motility value of 90.8 $\pm$ 1.3% for high mobility phenotype exotic turkey. The motility value obtained also agrees with those of Onyimonyi *et al*. (2013) who ejaculated local toms under twice, thrice per week and reported no significant effect in motility of semen ejaculates. The sperm concentration was highly significant ($p<0.05$), values being 1.74 and 1.50 $x10^9$ cell/ml for parthenotes and parent toms. These values were also lower than the finding of Zaharaddeen *et al* (2005) that had an average of 2.81 $\pm$ 74.93 x 10^9 cell/ml. The percentage live sperm cells, obtained in this study (97.90% and 98.50%) for parthenotes and parents toms, respectively, were not significantly ($P>0.05$) different. The result agrees with results of Ngu *et al*, (2013) who reported non-significant different in live sperm cells in semen of two breeds of turkey in Bauchi State.

In the normal sperm cells, the percent morphologically intact sperm cells recorded in this study were consistent with the acceptable range (80 – 100%) reported by Bearden *et al* (2004). The values of percentage abnormal sperm cells recorded in this study were below 20% reported by Bearden *et al* (2004) as base line value beyond which fertility may be impaired. This result, however show that high fertility could be achieved with semen from both parthenotes and parent toms. Total sperm ejaculates were not significant ($p>0.05$). It was observed that parent toms had the highest total sperm/ejaculates when compared to that of parthenotes toms ($6.23x10^9$ and $6.07x10^9$). Korlowska *et al*. (2005) reported 4.16 $\pm$ $0.38x10^9$, 3.10 $\pm$ $0.58x10^9$ and 3.02 $\pm$ 0.49 x 10^9 for BIG-6, Hybrid large white and white Nicholas toms, respectively. The values obtained in this study were however higher than those reported by these authors. The reason for this could be attributed to the individual variability in sperm production rate (Thatohatsi, 2009). The total motile sperm cell was found to be significantly ($p<0.05$) higher 1.68 x 10^{12} for parthenotes toms than 1.42 x 10^{12} for parent toms. This is an index of fertility. It suggests further that there is genotype variation within the local breeds that can be improved. The reason for high values of total motile sperm cells in this study could be attributed to individual genotypic difference and variability in sperm production rate (Thatohatsi, 2009).

Conclusion

High fertility could be achieved with both parthenotes and parent toms when used in artificial insemination since high percentage motility and sperm concentration were obtained. Thatohatsi (2009) had earlier reported that there is a positive correlation between total sperm cells inseminated and fertility. It was observed from the results that turkey parthenotes posse good quality semen characteristic and therefore, recommended for use in poultry industry for turkey production.

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AMELIORATIVE EFFECTS OF FISETIN AND PROBIOTIC (*Saccharomyces cerevisiae*) ON TONIC IMMOBILITY IN BROILER CHICKENS EXPOSED TO HEAT STRESS

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Abstract
The study evaluated changes in tonic immobility (TI) of broiler chickens, administered with probiotic and fisetin and exposed to heat stress. Sixty Arbo Acre breed of broiler chickens at day-old, allotted into 4 groups of 15 birds each, were used. Group I (Control) was given only sterile water; Group II, fisetin (5 mg/kg); Group III, probiotic (4.125×10^6 cfu/100 mL); and Group IV, fisetin + probiotic (5 mg/kg and 4.125×10^6 cfu/100 mL, respectively). At weeks 3, 4 and 5, thermal environment parameters and TI were recorded each day at 07:00 h, 13:00 h and 18:00 h. Temperature-humidity index (25.60 - 35.30) was outside the thermoneutral zone for broiler chickens above 3 weeks of age. Week 3 had the longest duration of TI in the controls ($P < 0.05$), but the shortest ($P < 0.05$) duration was recorded in the fisetin + probiotic group. At week 4, the shortest ($P < 0.05$) TI duration was recorded in the probiotic-supplemented group, while the longes ($P > 0.05$) TI was obtained in the control group. The shortest ($P < 0.05$) TI duration was recorded at week 5 in the probiotic, and fisetin + probiotic groups. In conclusion, probiotic and/or fisetin administration ameliorated the detrimental effects of heat stress by reducing the duration of TI and may be beneficial in enhancing broiler chicken productivity under heat-stressed conditions.

Keywords: Tonic immobility, Broiler chickens, Heat stress, Probiotic, Fisetin

Introduction

Tonic immobility (TI) is used to evaluate fear or stress level (Campo et al., 2014) and the adaptability of broiler chickens to stressful environmental factors (Egbuniwe et al., 2016). Fear reactions are produced in stress, especially during predator defence (Sinkalu et al., 2016). Antioxidants, including probiotic and fisetin (Aluwong et al., 2017; Sandeep et al., 2018), are widely used as ingredients in dietary supplements, and they are beneficial against stress-induced tissue damages. Probiotics are living microorganisms which possess antioxidant activity, and their administration is beneficial to broiler chickens (Gatrell et al., 2018). Probiotics may serve as promising alternative to antibiotics in broiler chicken production, especially under stressful environmental conditions (Sugiharto et al., 2017). Fisetin (3,3′,4′,7-tetrahydroxyflavone) is a flavonoid contained in fruits and vegetables. It exhibits antioxidant, anti-inflammatory, antibacterial, antiviral, immuno-stimulating, anti-ageing, antiproliferative, anticarcinogenic and neuroprotective activities. It exerts antioxidant effects by scavenging reactive oxygen species (ROS) and prevents or retards the lipoperoxidation of cell membranes by ROS (Sandeep et al., 2018). The aim of the study was to evaluate changes in TI responses in heat-stressed broiler chickens, treated with fisetin and probiotic and exposed to heat stress.

Materials and methods

The experiment was conducted on broiler chickens at the Department of Veterinary Physiology, Ahmadu Bello University, Zaria (11° 10′ N, 07° 38′ E), located in the Northern Guinea Savannah zone of Nigeria. The study was carried out during the early rainy season, characterised by high ambient temperature and high relative humidity (RH). Apparently, healthy day-old broiler chicks (Arbor Acres, n = 60), comprising both sexes and purchased from Zartech Farms, Ibadan (07° 22′ N, 03° 58′ E), Nigeria, served as subjects. They were kept in a poultry pen under an intensive management system. The pen dimension

was 8.4 m × 5.6 m × 1.91 m and the stocking density of the broiler chicks was 15 birds/m^2 (Aluwong et al., 2017). The broiler chicks were given access to broiler starter (day 0-28) and broiler finisher (day 29-42) and water *ad libitum*. The feed composition and proximate analysis of the feeds are shown in Table 1. The broiler chicks were divided into 4 groups of 15 chicks each. Group I was administered with distilled water *ad libitum*; Group II, fisetin at a dose of 5 mg/kg; Group III, probiotic (*Saccharomyces cerevisiae*) at a dose of 4.125×10^6 cfu/100 mL and Group IV, administered with fisetin and probiotic. All administrations were performed orally by 1-mL tuberculin syringe for the first seven days of life (Aluwong et al., 2017). The dry-bulb temperature (DBT) and wet-bulb temperature (WBT) were measured inside the poultry pen by a wet- and dry-bulb thermometer. THI was calculated (Tao and Xin, 2003): THI = 0.85(Tdb) + 0.15Twb, where THI = temperature-humidity index for broiler chickens, Tdb = dry-bulb temperature and Twb = wet-bulb temperature. The values were recorded inside the poultry pen on each experimental day. The TI was induced at weeks 3, 4 and 5 (Sinkalu et al., 2016) in 60 broiler chickens (15 per group) at 07:00 h, 13:00 h, and 18:00 h. Briefly, at each hour of measurement, each bird was placed on its back on an improvised cradle, and its breast was pressed gently for 15 s. The cradle, measuring 50 × 40 × 25 cm, was made using Dunlop foam and covered with cloth (Wang et al., 2014). Any broiler chicken that righted itself within 2 s was caught gently again, and the procedure was repeated. If TI induction failed after 5 attempts, then TI duration was recorded as 0 s. If the broiler chicken did not acquire standing position after 600 s, which was the permissible maximum duration of TI, then the induction process was interrupted and TI duration was recorded as 600 s (Egbuniwe et al., 2016). Thermal environment and TI data were analysed using one-way analysis of variance and Kruskal-Wallis analysis of variance, respectively. The analyses were performed using GraphPad Prism 5.03 for windows. Values of $P < 0.05$ were considered significant.

Results

The overall DBT for the study period ranged from 26.00 - 36.00 °C, with a mean of 30.57 ± 0.36 °C. The RH during the study period ranged from 49.00 - 93.00 %, with a mean of 79.22 ± 1.26 %. The mean THI for the study period was 30.10 ± 0.34 and it ranged from 25.60 - 35.30. There was no significant ($P > 0.05$) difference in THI between the weeks of the study period. The TI duration in control group respectively increased as the age of the broiler chickens increased at weeks 3, 4 and 5 (135.7 ± 13.65 s, 162.2 ± 20.33 s and 171.10 ± 30.41 s, respectively). Week 3 had the longest duration of TI in the controls (135.7 ± 13.65 s), while the shortest duration was recorded in the fisetin + probiotic group (94.27 ± 10.97 s). At week 4, the shortest TI duration was recorded in the probiotic-supplemented group (68.62 ± 12.34 s), while the longest TI (162.2 ± 20.33 s) was obtained in the control group. At week 5, the probiotic, and fisetin + probiotic groups (67.27 ± 13.97 s and 81.86 ± 7.12 s, respectively) had the shortest duration of TI. At 7:00 h, the longest ($P < 0.05$) diurnal TI duration (166.00 ± 15.50 s) was recorded in the controls, while the shortest ($P < 0.05$) diurnal TI duration (43.89 ± 9.20 s) was obtained in the probiotic-administered group. At 13:00 h, the controls had the longest diurnal duration of TI (226.10 ± 20.12 s), while the shortest ($P < 0.05$) and the least TI (58.34 ± 11.78 s) was recorded in the probiotic-administered broiler chickens. At 18:00 h, the longest diurnal TI duration was recorded in the control group of broiler chickens (200.11 ± 5.50 s), but the shortest diurnal TI duration (54.33 ± 8.42 s) was obtained in the broiler chickens administered with probiotic (Table 2).

Discussion

The THI, which revealed the impact of DBT and WBT on animals, indicates that the broiler chickens were exposed to heat stress (Tao and Xin, 2003). Tao and Xin (2003) showed that THI values greater than 20.8 induce heat stress in broiler chickens. The result shows that administration of the antioxidants probiotic and fisetin may be beneficial during the thermally stressful season. The results show that the broiler chickens reared under heat-stressed conditions and administered with fisetin and/or probiotic recorded the shortest TI duration, when compared with the control group that recorded the longest TI duration. The result agreed with the finding of Sinkalu et al. (2016), who demonstrated that exposure of

broiler chickens to heat stress reduces welfare and increases behavioural stress as evidenced by longer duration of TI. Thus, heat stress by prolonging TI duration increases fear responses in broiler chickens. The decreased fear responses in broiler chickens supplemented with fisetin and/or probiotic demonstrated that antioxidants depressed adverse behavioural stress responses induced by heat stress, apparently by ROS scavenging mechanism. The TI indicates fearfulness and its duration is an index of stress level in birds. The longer ($P < 0.05$) TI duration at week 3 than week 4 or 5 in the broiler chickens administered with probiotic, apparently, shows that the fear response increase in age in the group and that probiotic alone best decreased impact of behavioural stress on broiler chicken exposed to heat-stressed conditions and may improve their welfare and health. Heat generation increases as broiler chickens grew as a result of increase in metabolic rate, which further increases the heat load on the birds (Sugiharto et al., 2017). The result shows, for the first time, that probiotic and/or fisetin administration to broiler chickens subjected to heat-stressed conditions reduced TI duration by alleviating the metabolic and environmental heat loads.

Table 1: Composition and proximate analysis of broiler chicken diets

Feed Composition	Starter	Finisher
Ingredients (%)		
Crude protein	22.00	19.5
Fat	5.10	3.80
Crude fibre	4.30	3.00
Calcium	1.20	1.20
Available phosphorus	0.45	0.44
Methionine	0.56	0.50
Lysine	1.30	1.20
Metabolisable energy (Kcal/kg)	3000.00	3100.00
Proximate analysis		
Crude protein (%)	22.00	21.00
Fat (%)	7.90	6.80
Crude fibre (%)	4.30	3.00
Calcium (%)	2.00	2.00
Available phosphorus (%)	0.80	0.70
Methionine (%)	0.56	0.50
Lysine (%)	1.20	1.20
Metabolisable energy (Kcal/kg)	2900.00	2980.00

Table 2: Effects of age, probiotic and fisetin administration on diurnal variations in tonic immobility duration in Arbo Acre broiler chickens

Age,Week	Hour of the day, h	Group (s, Mean ± SEM; n = 15)			
		Control	Fisetin	Probiotic	Fisetin + Probiotic
3	7:00	123.80 ± 11.77	118.00 ± 7. 13	88.00 ± 8.90[1]	98.20 ± 13.21
	13:00	162. 94 ± 24.70 [a]	111.00 ± 13.40[a]	95.10 ± 9.53[b]	73.60 ± 14.99[b]
	18:00	120. 37 ± 11.42	101. 87 ± 11.33	108 .00± 9.42[2]	111.00 ± 21.06
	Sub-total mean ± SEM	135.70 ± 13.65[a]	110.30 ± 4.67[a,i]	97.03 ± 5.85[b,i]	94.27 ± 10.97[b]
4	7:00	130. 50 ± 12. 38[1]	134. 60 ± 11.98	93.20 ± 13.78[1]	115.00 ± 27.09
	13:00	156.00 ± 25.00	130.70 ± 10.89	58.34 ± 11.78[2]	78.27 ± 10.20
	18:00	200.11 ± 5.50[a,2]	118.00 ± 27.00[a]	54.33 ± 8.42[b,2]	83. 43 ± 7.22[b]

	Sub-total mean ± SEM	162.20 ± 20.33[a]	127.80 ± 5.01[b,ii]	68.62 ± 12.34[b,ii]	92.21 ± 11.49[b]
5	7:00	166.00 ± 15.50[1]	134.70 ± 09.50[1]	43.89 ± 9.20[1]	79. 50 ± 11.37
	13:00	226.10 ± 20.12[2]	126.11 ± 11.70	92.21 ± 9.50[2]	95.20 ± 8.25[1]
	18:00	121.11 ± 10.24[3]	109.00 ± 14.21[2]	65.70 ± 9.31[3]	70.89 ± 0.90[2]
	Sub-total mean ± SEM	171.10 ± 30.41[a]	123.30 ± 7.55[b,ii]	67.27 ± 13.97[c,ii]	81.86 ± 7.12[c]

[a,b,c,1,2,3]= Means with different superscript letters, numbers and sub-total mean with superscript [i,ii] are significantly different ($P < 0.05$).

Conclusion

Administration of probiotic alone or in combination with fisetin ameliorated heat stress, evidenced by a short duration of tonic immobility in broiler chickens, and may enhance broiler chicken productivity exposed to heat-stress during the early rainy season in the zone.

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POINTED-END AND BLUNTED-END EGG SHAPE BIASED SEX OF JAPANESE QUAILS AT NATIONAL VETERINARY RESEARCH INSTITUTE, VOM

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Abstract
Following sex determination at about 3 to 6 weeks old in Japanese quail, several undesired growers are often culled from the convoy. Thus, it becomes pertinent to predetermine only the desired sex during egg incubation. Many techniques and ideas have been developed to identify Japanese quail sex at day old but to no avail. Therefore, this study was aimed at investigating the claims and speculations by many Nigerian traditions and beliefs that "pointed-end" and "blunted-end" eggs produce male and female hatchlings respectively in poultry species. To achieve this, a total of 1,100 Japanese quail eggs were carefully sorted and distributed based on the shape into 550 "pointed-end" eggs and 550 "blunted-end" eggs. Data were collected on incubation period, hatchability and sex ratio. In the "pointed-end" eggs, incubation period was between 17 and 18 days, hatchability was 50.7% and more cocks (207) representing 74.2% compared to only 72 hens (representing 25.8%) were recorded with a sex ratio of 1 hen: 2.9 cocks. Whereas, among the "blunted-end" eggs, chicks emerged on the 18th day of incubation, 59.5% hatchability was observed and more hens (238 representing 72.8%) relative to 89 cocks representing 27.2% were recorded with a sex ratio of 2.7 hens: 1 cock. Consequently, the claims and speculations by many Nigerian traditions and beliefs that egg shape could determine the sex of poultry species appeared to be correct. At the moment, in-depth research findings are required, to elucidate this preliminary finding before its adoption.

Keywords: Egg shape, Japanese quails, NVRI, sex determination, sex ratio.

Introduction
Japanese quail like fowls, pheasants and partridges belong to the family *Phasianoidea* of Order *Galliformes* of the Class *Aves* of the Animal Kingdom. Species or subspecies of the Genus *Coturnix* are native to all continents except the Americas. The domesticated subspecies *Coturnix coturnix japonica* was called Japanese quail also known as Common quail, Eastern quail, Asiatic quail, Stubble quail or Pharaoh's quail. Meanwhile, the correct popular nomenclature for *Coturnix coturnix japonica* was given as Japanese quail or *Coturnix* and not *Coturnix* quail because the Latin word "*Coturnix"* may be translated as quail (Fah, 2009; Howes, 1964). According to Haruna *et al*. (1997), Japanese quail (*Coturnix coturnix japonica*) was introduced into Nigeria in 1992, where it has gradually gained popularity over other poultry species. Japanese quail is believed to be a veritable source of nutrients that can satisfy human requirements for healthy living (Boni *et al*., 2010; Raji *et al*., 2015). In particular, the eggs have been reported to be rich in minerals and vitamins that could meet the recommended daily requirements of human beings irrespective of the age. Essentially, quail products have been reported to be low in fats and cholesterol contents and as such very medicinal as they help against digestive tract disorder, anaemic, diabetic and hypertensive conditions (Jean, 2009; Musa *et al*., 2007; Sati *et al*., 2012).

Since quails mature at 30 – 60 days old, weighing between 100 – 220g with potency of laying 250 – 320 eggs per year (Jean, 2009), its products would be readily available to meet human demands. It is believed that if fertile eggs are needed in quail convoy, 1 male: 1 or 2 to female(s) ratio should be maintained and quail egg fertility continues for up to 14 days even when the male is withdrawn from the convoy

(Woodward *et al*., 1973). The quest for fertile egg production has resulted in undue pressure on quail chicks demand and supply but sexing at day old is impossible. Although, Fah (2009) reported that quail sex identification is possible at 3 weeks of age using plumage pattern, it requires reaffirmation at 6 weeks old. Unfortunately, there is little or no reliable information on quail chick sexing at day old, even with the Japanese vent examination hi-tech facilities and the sex-linked colour auto-sexing recently developed. Many Nigerian traditions and beliefs have it that ""pointed-end"" and "blunted-end" eggs produce male and female hatchlings respectively in poultry species. Thus, this study was targeted at investigating the influence of egg shape on Japanese quails sex.

Materials and methods

The study was conducted at the National Veterinary Research Institute (NVRI), Vom, Jos. Jos is a city in Plateau State in the Middle Belt of Nigeria located on latitude 9° 55' 42.56"N and longitude 8° 53' 31.63"E. The altitude is about 1,264.5m (4,148.62 Feet) above sea level with about 1,400 millimetres (55 inches) of rainfall annually. Average monthly temperatures of 21 – 25°C (70 – 77°F) and hail sometimes falls during the rainy season because of the cooler temperatures at high altitudes (Wikipedia, 2018). A total of 1,100 Japanese quail eggs were collected from a convoy at the peak of lay in the Breeding Unit, Poultry Division NVRI. The eggs were carefully sorted and distributed based on the shape into 550 "pointed-end" eggs and 550 "blunted-end" eggs (See plates 1 and 2).

Plate 1: "Pointed-end eggs"

Plate 2: "Blunted-end eggs"

All the eggs were incubated in 8 clutches in automated incubator, regulated at 38^{o}C with relative humidity set appropriately at 60 – 60% depending on the incubation day. Incubation period represented the time between egg incubation and chick emergence, hatchability was determined by dividing the number of hatched chicks with the number of incubated eggs and death of the birds was recorded as mortality. At 3 weeks old, sex of the birds was identified using breast plumage and at 6 weeks old, the identified sex was reaffirmed using breast plumage. Cocks population relative to the hens represented the sex ratio. The data collected were analysed using simple descriptive statistics as prescribed by Adesoye (2006).

Results and discussion

Table 1 shows the effect of "pointed-end" egg shape on hatchability and sex ratio in Japanese quails. The incubation period of 17 – 18 days was in consonant with the reports of Romao *et al*. (2009). The hatchability value was relatively lower than 69.6 – 72.7% reported by Farghly *et al*. (2015) in Japanese quails except in the 5th and 7th egg clutch where 66% and 76% were recorded. This could be largely due to infertility level of the eggs incubated and partly due to bias selection of the eggs used in the study. More cocks (207) representing 74.2% were recorded in all the egg clutches incubated. This probably indicated that "pointed-end" egg shape may influence Japanese quail sex. More importantly, the sex ratio was biased to more cocks in the convoy, suggesting that the excess cocks could be slaughtered for meat production. Though mortality was apparently higher (41) in cocks compared to 36 in hens, it was

recorded in both sexes. Therefore, "pointed-end" or blunted egg shape may not determine survivability rate in Japanese quails.

Table 1: Influence of "pointed-end" egg shape on hatchability and sex ratio in Japanese quails

Parameters		Egg clutches incubated								
		1	2	3	4	5	6	7	8	Grand total
No. of eggs incubated		100	100	100	50	50	50	50	50	550
Incubation period		18	17	18	18	18	17	17	18	-
No. of hatched eggs		43	51	50	22	33	20	38	22	279
Hatchability (%)		43	51	50	44	66	40	76	44	50.7
No. of hens		14	13	14	6	7	5	10	3	72 (25.8%*)
No. of cocks		29	38	36	16	26	15	28	19	207 (74.2%*)
Hen : cock ratio		1:2.1	1:2.9	1:2.6	1:2.7	1:3.7	1:3	1:2.8	1:6.3	1:2.9
Mortality	Hen	3	8	4	2	8	1	7	3	36
	Cock	6	7	6	4	3	3	9	3	41

*: Percentage values grand total number of hatched eggs; embryo physiological status of the unhatched eggs was not evaluated; mortality cut across both sexes.

Table 2 presents the effect of "blunted-end" egg shape on hatchability and sex ratio in Japanese quails. The incubation period was uniformly 18 days in all the egg clutches incubated throughout the study period. This agreed with the observation of Romao *et al*. (2009) that Japanese quail eggs hatch normally between 16 and 18 days of incubation. In a total of 550 eggs incubated in 8 egg clutches, 327 eggs (representing 59.5%) hatched. This value was similar to the observations of Mani *et al*. (2008) and Romao *et al*. (2009) in Japanese quails. Out of this, 72.8% (238) were hens and 27.2% (89) were cocks, corroborating Nigerian traditions and beliefs that "pointed-end" eggs produce male hatchlings in poultry species. Even when more mortality (41) was observed among the cocks, it occurred in both sexes thus, the observation may not be due to the "pointedness" or "bluntness" of the egg shape.

Table 2: Influence of "blunted-end" egg shape on hatchability and sex ratio in Japanese quails

Parameters		Egg clutches incubated								
		1	2	3	4	5	6	7	8	Grand total
No. of eggs incubated		100	100	100	50	50	50	50	50	550
Incubation period		18	18	18	18	18	18	18	18	-
No. of hatched eggs		69	53	57	29	43	23	25	28	327
Hatchability (%)		69	53	57	52	86	46	50	56	59.5
No. of hens		44	42	48	16	32	17	17	22	238 (72.8%*)
No. of cocks		25	11	9	13	11	6	8	6	89 (27.2%*)
Hen : cock ratio		1.8:1	3.8:1	5.3:1	1.2:1	2.9:1	2.8:1	2.1:1	3.7:1	2.7:1
Mortality (%)	Hen	9	5	5	4	7	3	2	4	39
	Cock	12	8	9	2	3	5	1	1	41

*: Percentage values grand total number of hatched eggs; embryo physiological status of the unhatched eggs was not evaluated; mortality cut across both sexes.

More essentially, the sex ratio was observed to skew towards more hens indicating that "blunted-end" egg shape apparently influenced sex determination in Japanese quails. This observation lent more credence to the observations of Göth and Booth (2005) and Eiby *et al*. (2008) that more hens hatched in avian species in Japanese quail but contradicted the observations of Idahor *et al*. (2015a; b; c; d) in some poultry species.

Conclusion

Since "pointed-end" egg shape apparently hatched more cocks and "blunted-end" egg shape yielded more hens, this study seemingly elucidated the claims and speculations of many Nigerian traditions and beliefs on the influence of poultry egg shape on sex determination in poultry species. However, repeated in-depth research should be conducted in this regard, before the adoption of this preliminary finding.

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MONOGASTRIC ANIMAL PRODUCTION, NUTRITION AND FEED

EFFECT OF FRESH LEAVES AND SUCCULENT STEMS (FLSS) OF *FICUS THONNINGII* AS FEED INGREDIENT ON NUTRIENT DIGESTIBILITY AND CARCASS CHARACTERISTICS OF RABBITS

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Abstract
A 12 week feeding trial involving four groups of weaned rabbits was conducted to evaluate the feed effect on nutrient digestibility and carcass characteristics of rabbits fed experimental diets in a completely randomised design. There were no differences between treatments with regards to Ether Extract (EE%) and Nitrogen Free Extract (NFE%) digestibility. More of the Dry matter and crude fibre respectively, were digested by rabbits fed the ficus diets than the control diet. Crude protein digestibility was not enhanced by the consumption of both forage and concentrate by the rabbits, rather, concentrate or forage alone gave better CP digestibility results. The dressed weight was negatively affected by the test diets but dressing percent of the rabbits fed T3 diet was similar to those fed the control. The organ weights of rabbits fed experimental diets are presented in Table 4. The results showed that the weights of the Pancreas, Stomach, Kidney fat and the Visceral fat varied significantly ($P<0.05$) among treatments. The feeding of ficus had no significant ($P>0.05$) effect on the weight of oesophagus, liver, kidney, heart, spleen, bile, small intestine, large intestine and the caecum. It is concluded that, whereas FLSS of ficus was not a suitable sole feed for young rabbits, it can be fed in combination with concentrate feed especially when both the concentrate diet and the FLSS are fed separately and both *ad libitum*.
Keywords: Concentrate, fresh leaves, *Ficus thonningii*, rabbits, sole feed

Introduction

Animal scientists and livestock farmers always have the problem of seasonal fluctuation in both quality and quantity of animals feeds combined with high cost of conventional feed ingredients in Nigeria. Efforts to resolve these challenges has led to led to several investigations to unveil the replacement value of conventional feed ingredients with unconventional materials mostly agricultural and industrial by-products (Anugwa *et al.*, 1987) that are cheap and readily available. Alternative and cheaper energy sources are sought by scientist and animal industries. Cresswell and Zainudin (2000) reported that maize offal can replace maize on a weight for weight basis in broiler diet without any compensation being made for lower energy content of the offal. Fadugba (2009) showed that industrial maize offal is as good as maize in growers' ration. The rabbit can easily be reared on diets low in grain and high in roughage. They are better converters of roughages and by-products which cannot be used by man than cattle, sheep and goats. It has a high reproductive capacity, rapid growth rate, short gestation interval and ability to rebreed immediately after kindling. . Increased production of rabbit represents one of the fastest means of correcting the shortage of animal protein in tropical Africa. The study was designed to evaluate the feed effect on nutrient digestibility and carcass characteristics of rabbits fed.

Materials and Methods

Concentrate feed using toasted full soyabeans was formulated to contain eighteen percent crude protein and 2700 kcal/kg energy (Table 1). Fresh leaves and succulent stems of ficus were harvested from *Ficus thonningii* trees around Makurdi town, in the mornings, washed and left to wilt overnight before being fed to the rabbits. Twenty crossbred weaned rabbits weighing between 646 – 675 g, were obtained and allocated to four groups, balancing for live weight and sex and randomly assigned to four treatments. Each rabbit was individually housed in a cage equipped with metal feeders and concrete drinkers. The rabbits were allowed an acclimatization period of seven days before

Table 1: Ingredient and nutrient composition of concentrate diet

Ingredient composition (g/100g)		Nutrient composition (g/100g DM)	
Maize	31.98	Dry matter	88.12
Full fat soyabean	35.22	Crude protein	18.00
Parm oil	1.00	Crude fibre	13.42
Rice offal	29.00	Ether extract	4.09
Bone meal	2.00	Calcium	0.82
Salt	0.30	Phosphorus	0.98
Min/vit premix	0.25	Lysine	0.48
Methionine	0.25	ME (kcal/kg)	2712.10
Total	100kg		

ME= Metabolizable energy

commencement of the experiment. The diets fed, which represented the experimental treatments, were as follows. Treatment 1 (T1) concentrate only, *ad libitum*. Treatment 2 (T2) FLSS only, *ad libitum*, Treatment 3 (T3) both the concentrate diet and the FLSS, fed separately and both *ad libitum*. Treatment 4 (T4) FLSS *ad libitum* in addition to 50% of the daily concentrate feed intake of rabbits in T1. Each rabbit was given 0.02ml of ivermectin (each ml contains 10mg of *ivermectin*© and 1ml solvent), subcutaneously, at the start of the experiment and as a prophylactic treatment, coccidiostat (*Embazin-forte*©) was administered in drinking water. At the end of the study, four (4) rabbits from each treatment group were slaughtered and the carcass and organ weights evaluated according to Shaahu *et al.* (2005). The weights were expressed as percentages of the live weight. Data collected was subjected to Analysis of Variance (ANOVA) for Completely Randomized Design (CRD) and where significant differences were indicated among treatment means, they were separated by Duncan's multiple range test using the Statistical Package for Scientific Solutions, 21st version (SPSS 21, 2016) software.

Results and Discussion

The dry matter digestibility values obtained in this study ranged from 57.11 – 74.59% with an increase in digestibility as *Ficus* forage was introduced into the diet (Table 2). The results correlates the reports of Gidinne *et al.* (1998) who observed higher DM digestibility when the fibre content of a diet is high. This is contrary to the report of Idowu *et al.* (2013) who fed rabbit with diets containing bamboo leaf meal and found that digestibility decreased from 75.57 to 69.03% as the level of the leaf meal increased in diet. This indicates that the type of forages used in diet may have different effect on DM digestibility. *Tridax procumbens* utilization in cassava based diets increased DM digestibility in rabbits from 79.68 – 82.79% as *tridax* inclusion was increased from 0%-20% (Igba, 2002).

The results obtained revealed that crude protein digestibility was not enhanced by the consumption of both forage and concentrate by the rabbits, rather, concentrate or forage alone gave better CP digestibility results. This indicates that supplying concentrates and forages to rabbits does not exert any stimulating effect that could enhance crude protein digestibility. The significant differences ($P0<0.5$) and the higher crude fibre digestibility by rabbits fed T2, T3 and T4 diets in this study is in contrast to Adegbola and Okwonkwo (2002) and Igba (2002) who reported a reduced crude fibre digestibility at high levels of dietary fibre inclusion in rabbit diet. Adegbola and Okwonkwo (2002), observed that, fibres from

different sources vary in digestibility depending on the proportion of cellulose, hemicellulose and lignin. *Ficus thonningii* may not be too lignified for it to be highly digested by rabbits in this study. The values obtained in the present study were slightly lower than those of Ortserga (2002) who reported values of 85.40 – 87.81%, and Igba (2002) who reported values of 71.47 – 87.11% for ether extract digestibility. Babatunde (2002) reported similar ether extract values of 74.87 – 79.69% with those in the study. The higher ether extract digestibility obtained in T1, where animals received only concentrate feed may be attributable to high metabolizable energy in the concentrate diet, which decreases with introduction of ficus leaves in the diet. The ether extract and nitrogen free extract digestibility was not significant among treatment.

The range for dressing percentage of 62.91-69.92% obtained in this study (Table 3) is higher than 50.90-52.90% reported by Abu and Ekpeyong (1993) and 45.83-51.58% reported by Onifade and Towe (1982). This could be a reflection of the nutritive value of *Ficus* forage, when supplemented with concentrate feed.

Table 2:Digestibility of Experimental Diets by Growing Rabbits

%	T1	T2	T3	T4	SEM
Dry Matter	57.11[b]	74.59[a]	67.57[ab]	67.89[ab]	2.70
Crude Protein	79.49[a]	79.42[a]	65.17[b]	62.71[b]	2.64
Crude Fibre	47.25[b]	76.07[a]	66.63[a]	64.15[a]	3.58
Ether Extracted	74.78	68.55	68.71	69.05	1.43
Nitrogen Free Extract	63.99	75.70	69.96	72.18	2.42

[abc] Means in the same row with different superscripts are significantly different (P<0.05).
SEM standard Errow of means.

Table 3:Effect of Feeding ExperimentalDiets on Meat Yield of Rabbits

Parameters	T1	T3	T4	SEM
Slaughter weight (g)	2180[a]	1800[b]	1650[b]	84.38
Dressed Weight (g)	1520[a]	1163.75[b]	1038.75[b]	69.90
Dressing percentage (%)	69.92[a]	64.76[ab]	62.91[b]	1.37

[abc] Means within the same row with different superscripts are significantly different (P<0.05).
SEM means Standard Error of Means.

Table 4: Effect of Feeding Experimental Diets on Visceral Organ Weights of Rabbits

Parameters(%)	T1	T3	T4	SEM
Oesophagus	0.10	0.11	0.09	0.013
Liver	1.93	2.06	2.14	0.058
Paired Kidney	0.46	0.48	0.43	0.017
Lungs/Trachea	0.63	0.67	0.54	0.445
Heart	0.26	0.26	0.19	0.017
Pancreas	1.47[a]	1.89[a]	0.54[b]	0.203
Spleen	0.06	0.04	0.14	0.010
Bile	0.03	0.05	0.05	0.009
Stomach	0.79[b]	0.83[b]	1.23[a]	0.063
Small Intestine	1.50	1.52	1.37	0.070
Large Intestine	1.36	1.39	1.40	0.044
Caecum	1.10	1.36	1.41	0.057
Kidney fat	2.38[b]	5.92[a]	1.60[b]	0.706
Visceral fat	1.26[a]	1.70[a]	0.43[b]	0.269

[abc] Means within the same row with different superscripts are significantly different (P<0.05).
SEM Standard Error of Means

The advantages of combining concentrate feed with forages, as opposed to feeding concentrate alone are also advocated by Pote *et al.* (1980) and Harris *et al.* (1984). The differences observed could, however, be due to differences in slaughter weight. Garcia *et al.* (1993) observed that rabbits slaughtered at 2kg-2.5kg live weight gave a dressing percentage of 58% to 60%, while Igwebuike (2001) reported a dressing percentage of 48.22-52% from rabbits weighing between 1200g to 1532g. Variations in observations of dressing percentage among researchers may also arise from differences in their definition of dressed carcass. In Europe, the head and feet are left on the carcass, so the rabbit dressing percentage obtained (60 – 62%) is higher than that in the United State (mean of 50%) where the head and feet are removed. In Nigeria, the head, skin and feet, which contribute about 10%, 11% and 3% respectively to dressed weight, are left on the carcass, since they are considered edible (Aduku *et al.,* 1986).

The lack of differences between treatments 1, 3 and 4 in the weights of the oesophagus, liver, paired kidney, lung/trachea, heart, spleen, bile, small intestine, large intestine, and caecum (Table 4) is in agreement with the observation of Rao *et al.* (1978), that the growth and development of these organs are not affected by inclusion of forage in the diet of rabbits. The heavier stomach weights observed for treatment 4 can be explained on the basis of the high content of forage in the diet. A larger stomach to contain the higher feed volume is logical. The same argument could have been used to explain the same trend in caecum weights, because of the large amounts of fibre expected from feed high in forage, but caecum and small intestine weights showed no treatment effects. There are significant differences between treatments in the weights of pancreas, kidney and visceral fats. These are readily explained on the basis to dietary energy. Treatments 1 and 3 had higher proportions of concentrate in their diets, and correspondingly heavier fat deposits, compared to treatment 4. According to Anugwa *et al.* (1989), when the nature of the diet is such that high amounts of energy are required to process it, it results in repartitioning of nutrients from edible parts to the visceral organs, resulting in higher visceral organ proportions. Heavier relative weights of the organs of the rabbits fed *Ficus thonningii* diets in the present study may be a reflection of the energies required for fibre digestion and detoxification of anti-nutritional factors.

Conclusion

It is concluded that, whereas FLSS of ficus was not a suitable sole feed for young rabbits, it can be fed in combination with concentrate feed especially when both the concentrate diet and the FLSS are fed separately and both *ad libitum*.

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GROWTH PERFORMANCE OF SIX TROPICALLY-ADAPTED CHICKEN BREEDS IN BACKYARD FLOCKS ACROSS KEBBI STATE, NIGERIA

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Abstract
On-farm growth assessment of six tropically-adapted breeds of chicken was conducted in six locations in Kebbi state, Nigeria. The birds were distributed by the African Chicken Genetic Gains (ACGG) project. The study was designed to generate baseline data that could be used in the chicken selection and improvement program in the study area. A semi-structured questionnaire and field observation were used for data collection. Data were collected from 208 households, each with one of the six chicken breeds randomly distributed in batches at six weeks of age covered growth of birds from week 7-18. General Linear Model (GLM) of the SPSS was used for analyzing the data. Mean body weight at 18 weeks was similar and higher for Noiler, Sasso, Kuroiler and Funaab alpha (1383g, 1374g, 1339g and 1303g) than that of Fulani (1116g) which is higher than that of ShikaBrown (817g) respectively across the locations ($P<0.05$). Expectedly, Cocks recorded higher mean live weight than the pullets (1338 versus 1104g) in all the breeds and across the locations ($P<0.05$). The significance of interaction between location and breed on the overall growth performance of the birds was underlined.

Keywords: Growth, On-farm, Chicken breed, Location, Sex

Introduction

Chickens are regarded as the most important and widely spread avian species among poultry birds (Dutta *et al.,* 2013). They are said to be one of the important animal genetic resources used as weapons for fighting poverty and malnutrition, especially in rural areas of most developing countries, which results in the growing interest on the use of chicken as a tool for poverty alleviation in villages throughout the world (Dunya *et al.,* 2015). However, chicken growth and development is a complicated life process and is subject to a significant amount of control by genetic and non-genetic factors (Pourtorabi *et al.,* 2017; Zhenqiang *et al.,* 2013).

Chicken consumption in the rural areas of Nigeria is reserved for special occasions due to the low level productivity of free range birds (Adene, 2006). There is also no comprehensive list of the breeds and varieties of chickens kept by rural smallholders and their characterization becomes difficult due to cross-breeding with the exotic breeds and random mating within the flock (Sonaiya and Swan, 2004). Most performance evaluations of chicken stains were usually conducted under intensive system of management (Sonaiya and Swan, 2004), hence true reflection of their performance under extensive or backyard extensive systems is lacking.

If production from family poultry is to remain sustainable, it must emphasize the use of adapted breeds, family labour, and better management of stock and local feed resources among other factors (Sonaiya and Swan, 2004). This therefore suggests the need to study different chicken breeds with the aim of determining their appropriateness under the local environment and the prevailing production system.

Materials and methods

Study area

The study was conducted in six villages: Alwasa and Lailaba in Argungu Local Government Area (LGA); Senchi and Kwendo in Zuru LGA and Jiga and Sabiyal in Aliero LGA. The three LGAs represent Kebbi North, Kebbi South and Kebbi Central Senatorial Districts of Kebbi State, Nigeria. Kebbi state experiences two alternating seasons: the short wet (rainy) season; which starts from May/June and ends in September/October, and the long dry season; which completes the remaining part of the year. The mean annual rainfall is about 841mm, mean temperature varies from 16.4°C to 39.5°C recorded in December and April respectively (Climate-Data.Org, 2017). The open Savanna vegetation pattern in the state

provides opportunity for extensive livestock rearing and cultivation of short duration arable crops. Thus, most of the people in the state are agro-pastoralists: rearing livestock alongside arable crop production.

Sampling technique and birds' allocation

Multi-stage sampling procedure was employed for selecting respondents. At first stage, one LGA was selected from each senatorial district. In the second stage, purposive sampling was used to select two villages from each of the selected LGAs and the third stage involved random selection of 35 households in each village. Each household was randomly allocated one of the six chicken breeds (Kuroiler, Sasso, Fulani, Funaab alpha, Noiler and ShikaBrown) which makes 208 flocks.

Collection and analysis of data

Monthly body weight data on all the ACGG birds in each household were recorded according to breed and location. The data were collected using a semi-structured questionnaire designed to collect information on birds' performance and management practices in each household. The collected data were subjected to the GLM of SPSS (2013) for analysis. Means were compared using Duncan's Multiple Range Test (DMRT). The following general linear model was used:

$Y_{ijk} = \mu + B_i + G_j + T_k + e_{ijk}$

Where, Y_{ijk}= Dependent variable BW@WK 6… MBW@WK 18)

μ = Overall population mean for a given variable;

B_i = Fixed effect of i^{th} sex (1, 2);

G_j = Fixed effect of j^{th} location (1, 6)

T_k = Fixed effect of k^{th} breed (1, 6)

e_{ijk} = Random residual error associated with Y_{ijk} observation.

Results and discussion

Growth performance of the birds

The mean final body weights of all the birds according to breed, location and sex are presented in Table 1. Significant differences were observed for mean body weight at 18 weeks across the study villages ($P<0.05$). The respective mean final body weight (1383g, 1374g, 1339g and 1303g) of Noiler, Sasso, Kuroiler and Funaab-alpha were statistically similar, but higher than that of Fulani (1116g) which was higher than 817g of ShikaBrown.

Similarly, location had significant effect on the overall growth performance of the breeds ($P<0.05$). Aggregate mean final body weight of the birds was highest in Lailaba (1674g), followed by Alwasa with 1309g, which was higher than 1192g and1166g recorded in Jiga and Kwendo, respectively. The aggregate mean final body weights recorded in Jiga and Kwendo were similar ($P>0.05$), Kwendo and Senchi in Zuru LGA recorded no significant difference in the aggregate mean final body weight (1166g versus 1099g; $P>0.05$). The least performance was recorded in Sabiyal with 857g.

Table 1: Mean values for final body weight of birds according to breed, location and sex

Breed		Sex/Breed		Location		Sex	
Noiler	1383.10[a]	M	1500.58[a]	Lailaba	1673.72[a]	M	1904.57[a]
		F	1290.53[b]			F	1456.44[b]
Sasso	1374.30[a]	M	1491.34[a]	Alwasa	1308.56[b]	M	1491.23[a]
		F	1254.10[b]			F	1151.08[b]
Kuroiler	1339.27[a]	M	1509.98[a]	Jiga	1192.46[bc]	M	1251.19[a]

		F	1172.82[b]			F	1141.82[b]
F-alpha	1302.98[a]	M	1511.83[a]	Kwendo	1166.11[c]	M	1246.90[a]
		F	1122.60[b]			F	1087.84[b]
Fulani	1115.88[b]	M	1172.55[a]	Senchi	1098.64[c]	M	1214.11[a]
		F	1062.35[b]			F	989.76[b]
		M	862.69[a]	Sabiyal	857.43[d]	M	900.05[a]
S-Brown	816.59[c]	F	774.12[b]			F	816.27[b]

The Growth Curve

The average monthly body weight performance of all the breeds is shown in figure 1. The growth pattern from the age of introduction (6weeks) was steady during the first month of the study. The growth continues at an increasing rate with Noiler having recorded the highest mean body weight all through which sharply declined from 14 to 18 weeks. This change in normal growth pattern could be due to the interaction of genetic (breed) and non-genetic factors (farm, season, feeding systems, flock management, housing, vaccination etc) affecting growth (Hossen, 2010; Desha et al., 2016). Sasso breed appeared to have outweighed Kuroiler and F-alpha at 18 weeks of age and almost attained the same weight with Noiler. The growth of Funaab alpha and Kuroiler followed a similar pattern, one (Kuroiler) slightly higher than the other (F-alpha). The growth of Fulani and Shikabrown is less than the rest of the breeds due to the disparity in their genotype. The Fulani being natives of the research locations with no selection records, exhibited a more stable growth pattern and grew faster than ShikaBrown.

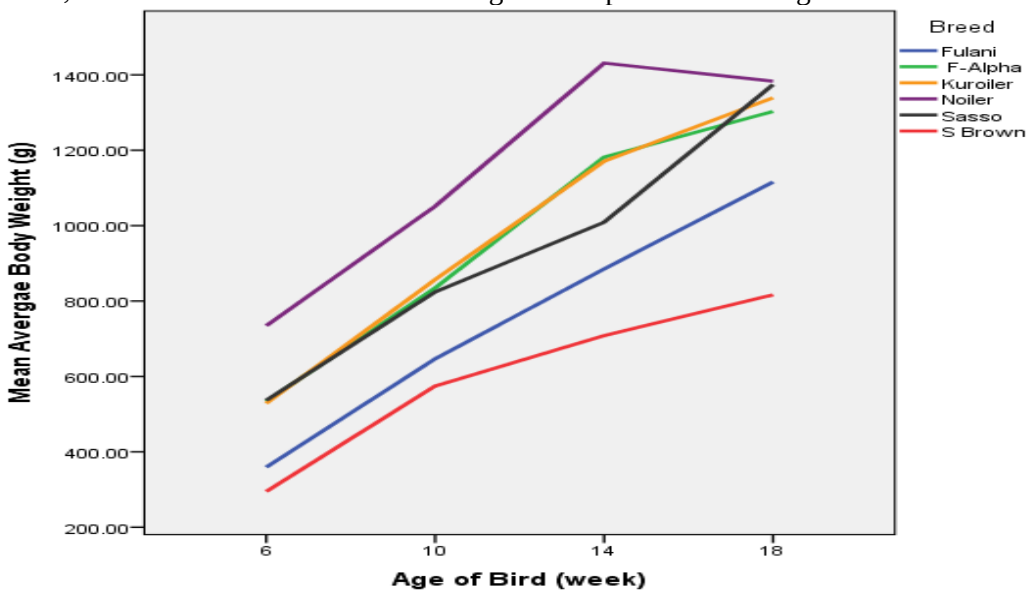


Figure 1: Growth curve of six tropically-adapted chicken breeds

Genotype × Environment Interaction on Growth of Chickens

Lailaba village proved to be the most favourable environment for almost all the breeds. The farmers in Lailaba had wider range of choice of chicken breeds, since all the breeds performed relatively better when compared with the other villages. Similarly, Alwasa supported a relatively good growth performance, similar to Jiga. There was no significant difference ($P<0.05$) between the overall growth performance of the breeds in Jiga and Kwendo and Senchi. The lowest overall growth performance was recorded in Sabiyal.

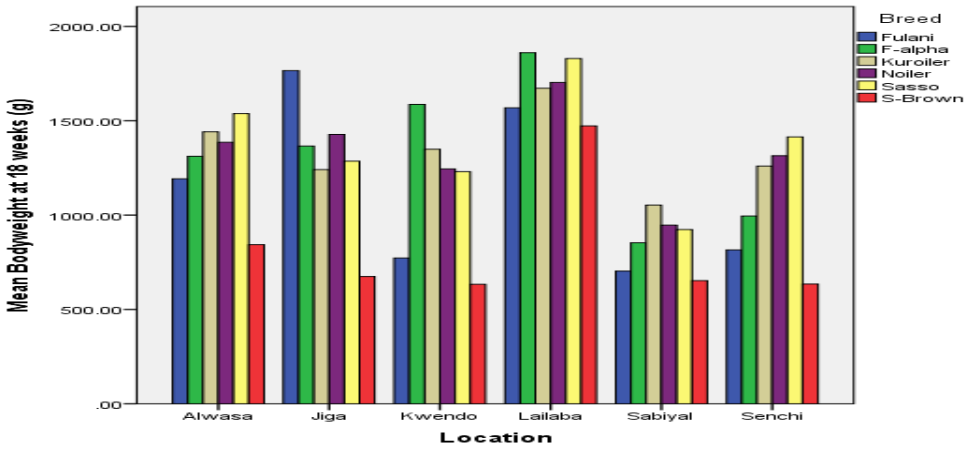
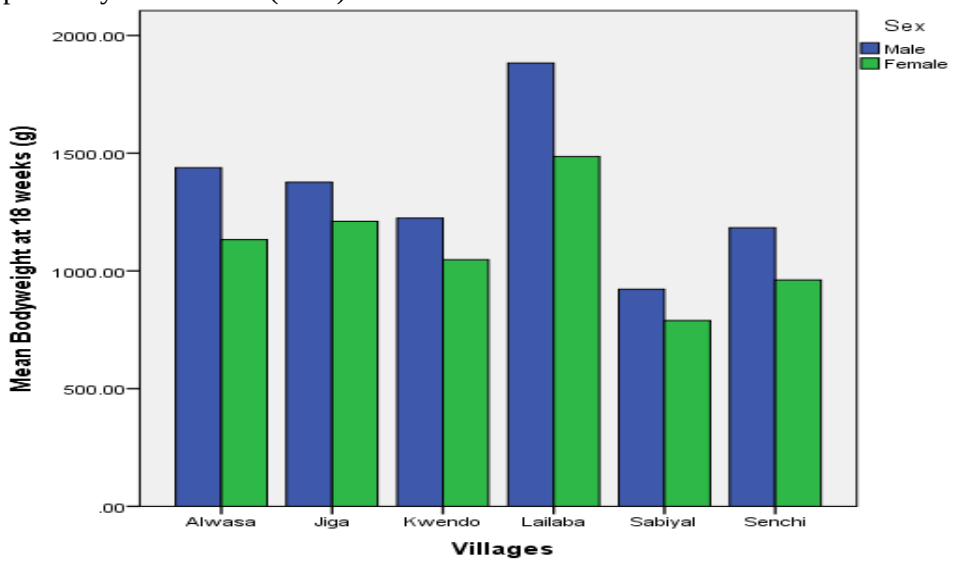


Figure 2: Genotype × Environment Interaction on Growth of Chickens

Sex ×location effect on growth of chickens

Figure 3 shows mean body weight of cocks been higher than that of the pullets (P<0.05) which proves that, regardless of breed and location cocks attain heavier body weight than pullets. A similar finding was reported by Desha *et al*. (2016).



Conclusion and recommendation

From the results of this study, it can be deduced that on-farm growth performance of chicken is affected by genetic factors peculiar to breed(s). Non-genetic factors which include sex, age, location and varying flock management practices in different locations exert great influence on growth. Farmers in the study locations ought to choose breed(s) suitable to their location and give preference to cocks for better growth performance.

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MANAGEMENT OF GUINEA FOWL UNDER CAPTIVITY IN BAUCHI STATE – A CASE STUDY OF MISAU LOCAL GOVERNMENT AREA

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Abstract

An attempt was made to study the management of guinea fowl under captivity by local farmers in Misau Local Government Area of Bauchi State. Data were collected using a questionnaire from five districts of the Local Government Area. Ten local farmers were randomly selected each of the five districts. The study focused on the management, feeding, housing, and disease control for guinea in the study area. The result showed that 76% of the farmers practiced extensive system of management. 46% of them use mud and thatched roofs for housing. Most of the farmers (56%) keep guinea fowl commercial, support and hobby (CS &H). The result also revealed that 72% of the respondents provide supplementary feeding for the birds, 62% of them do not provide accommodation for the birds. 86% each were recorded by the farmer for disease outbreak and mortality. Guinea fowl rearing in the rural area should be encouraged by the Government through veterinary services and developed feeds using local feed materials to increase the productivity of guinea fowl under captivity

Introduction

It is obvious that the animal protein intake of most Nigerians is far below the minimum requirement of as recommended by FAO (2012).

The meat production from cattle, sheep, goat and swine is unlikely to meet the demand for protein in developing countries like Nigeria due to their long generation intervals (Aduku and Olukosi, 1990). Poultry species have relatively shorter generation intervals and therefore a faster rate of multiplication. Poultry has been reported to be second to none in their ability to produce more edible meat per unit of live weight (Elkan et al, 1995). Guinea fowl is a poultry specie on which systemic studies have been limited. It is indigenous to Africa. The guinea fowl (Numida maleagris galeata) is a local avian specie commonly found in the Northern Savana areas of Nigeria. It is usually brought from the wild by the local farmers who tame and keep them as a back yard poultry for meat and egg (Ayeni et. Al., 1985). This study was intended to look at how guinea fowl under captivity are managed particularly with regard to nutrition and feeding, housing and disease control in Misau Local Government Area of Bauchi State.

Materials and Methods

A structural questionnaire was drawn and administered to owners of guinea fowls in the five districts of Misau Local Government of Bauchi State. The districts were Misau, Hardawa, Dagauda, Dambam and Jalam. Data were collected from one hundred (100) randomly selected farmers with twenty (20) from each district of the Local Government Area. Parameters investigated were mean age of the respondents, educational qualification, size of the family, types of animal kept, method of management, commonly used feed, cost of feeds, common diseases and mortality. Data were collected from two main sources; Primary and secondary. The primary sources involved the personal administration of the questionnaires. The secondary sources involved the information from visit to market and consultation of text and publications. The major variables selected for measurement were age and farming experience, family sizehousing for the birds, methods of management, disease management and mortality.

Results and Discussion

The distribution of the respondents according to age, educational level and experience is presented in Table 1. Majority of the people that keep guinea fowl aged between 31 – 60 years indicating that it is an adult business. The educational level was observed to be generally low among the respondents. While 48% of them were illiterate, those who had primary and adult non-formal education consist of 8% and 20% respectively. Those with post primary and higher education made up 10 and 14 % respectively. This implies that educational level is not a barrier to guinea fowl rearing. The experience of the respondents indicated 2% has 16-20 years while 90% has 1-15 years of experience. The distribution of respondents according to reasons for keeping Guinea Fowl, management practice and shelter provision for guinea fowl is shown in Table 2. Three main reasons were discovered as to why the despondence keep Guinea Fowl. These are Wealth (Commercial), Support and Hobby . The survey revealed that 56% of the respondents kept Guinea Fowl for both Commercial, Support and Hobby (C, S & H) and 32 % of them kept Guinea Fowl for Commercial and Support (C & S) only. The system of management employed by the respondents showed that 76% used extensive system of management by allowing the birds on a free range, 20% used semi-intensive system only while 4 % of the respondents, however, maintained guinea fowl on an intensive system where the birds are provided with shelter (confined) and feed and water are provided. The high percentage (76%) of respondents that use the extensive system of management as observed in this study agrees with

the report of Ayeni, (1983) that guinea fowl under captivity performed better when kept on free range (Extensive system of management). From the total respondents who provided shelter for their guinea fowl, 46% used mud and grasses, while those who used mud & zinc and corn stalk & grasses constituted 10 % each. The high percentage (46%) of respondence who used mud and grasses for house construction could be attributed to the fact that these materials are cheaper and readily available in the area under study. The distribution of respondents according number of birds, provision of feeds, shelter, disease outbreak and mortality are as indicated in Table 3. 76% and 18% kept 1-20 and 21-40 number of birds respectively. 72% provided supplementary feeds to their birds. 38% of the respondents provide shelter for the birds while 62% did not. This is seen in the disease outbreak where the respondents who do not provide shelter (62%) recorded high disease prevalence (86%) as against the respondents who provide shelter (38%) recording low disease (14%) outbreak. High mortality of 86% was observed in respondents that did not provide feeding and shelter for their birds.

Conclusion and Recommendation

The findings from this study revealed that it easy and cheaper to manage guinea fowl on a free range particularly in terms of shelter and feeding. The major problem observed is that of disease outbreak which causes high mortality rate.

It is hereby recommended that the rural dwellers should be encouraged, through the extension services, to keep guinea fowl as it does require intensive capital. Veterinary assistance should be provided to the existing farmers to reduce disease prevalence and increase productivity of the birds.

Table 1.Distribution of the Responde nts According to Age, Educational Level and Experience.

Age (Yrs.)			Educational Level			Experience		
Age	**Freq.**	**%**	**EDL**	**Freq.**	**%**	**EXP (Yrs)**	**Frequency**	**%**
20-30	**6**	**12**	**Illiterate**	**24**	**48**	**1-5**	**21**	**42**
31-40	**27**	**54**	**Primary**	**4**	**8**	**6-10**	**14**	**28**
41-50	**11**	**22**	**Adult & non formal**	**10**	**20**	**11-15**	**10**	**20**
51-60	**6**	**12**	**Post primary**	**5**	**10**	**16-20**	**4**	**8**
--	**--**	**--**	**High level**	**7**	**14**	**21-25**	**1**	**2**
Total	**50**	**100**		**50**	**100**		**50**	**100**

Table 2. Distribution of the Respondents According to Reason for Keeping Guinea Fowl, Management and materials used for shelter Provision for Guinea Fowl

Reasons	Freq.	%	Management.	Freq.	%	Materials Used For Shelter	Freq.	%
CS&H	**28**	**56**	**Extensive**	**38**	**76**	**Mud & grass**	**23**	**46**
C&S	**16**	**32**	**Intensive**	**2**	**4**	**Mud & zinc**	**10**	**20**
C&H	**1**	**2**	**Semi-intesive**	**10**	**20**	**Cornstalks & grasses**	**10**	**20**
S&H	**3**	**6**	**--**	**--**	**--**	**Wood, Zinc &Wire mesh**	**7**	**14**
S	**1**	**2**	**--**	**--**	**--**	**--**	**--**	**--**
H	**1**	**2**	**--**	**--**	**--**	**--**	**--**	**--**
Total	**50**	**100**	**--**	**50**	**100**	**--**	**50**	**100**

Table 3. Distribution of Respondents According to Number of Birds, Provision of Feeds, Shelter, Disease Outbreak and Mortality.

	No. of Birds			Feed Provision			Shelter Provision			Disease Outbreak			Mortality	
Birds	Freq.	%	Feed	Freq.	%	Shelter	Freq.	%	Disease	Freq.	%	Mortality	Freq.	%
1-20	38	76	Feeding	36	72	Yes	19	38	Yes	7	14	Yes	7	14
21-40	9	18	No feeding	14	28	No	31	62	No	43	86	No	43	86
41-60	2	4	--	--	--	--	--	--	--	--	--	--	--	--
60 & above	1	2	--	--	--	--	--	--	--	--	--	--	--	--
Total	50	100		50	100		50	100		50	100		50	100

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EFFECT OF HIGH FIBRE DIETS WITH OR WITHOUT ENZYME ON SENSORY EVALUATION AND MEAT CHARACTERISTICS OF BROILERS CHICKEN

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Abstract

This experiment was conducted to evaluate the effect of feeding high fibre diet to broilers chicken on sensory evaluation, primal cuts and meat characteristics. A total of two hundred and forty, one-day old Arbor Acres broiler chicks of mixed sex was obtained from a commercial hatchery were used for the trial. An average (33±0.12g body weight) were weighted individually and randomly divided into three (3) Treatments with ten replicate per treatment and eight birds\er replicate using a completely randomized design. The diet contained T1= 8.70% fibre; T2= 13.10% with enzyme and T3= 13.10% fibre without enzyme. The experiment lasted for eight week. Parameters measured were primal cuts, sensory evaluation, cooking loss and yield using a standard procedure. Data were analysed using descriptive statistic and ANOVA at $\alpha_{0.05.}$

There were no significant differences (P>0.05) observed in the primal cuts and sensory evaluation. The cooking loss was significantly higher in Treatment 1(control with 8.7% fibre) 33.36% with least cooking loss in Treatment 3 containing 13.10% (21.54%). Treatment 3 had the highest cooking yield (78.46%) compared to other treatment. The study showed that feeding high fibre diet to broilers chicken at 13.10% enhances better cooking yield and lower cooking loss.

Keywords: High fibre diet, primal cuts, cooking loss, cooking yield, sensory evaluation

Introduction

Meat quality is greatly affected by the diet fed to the farm animal (Oshibanjo, 2010). Diet is an important aspect of animal production, and different bird species or lines have different nutrient requirements depending on age, genetic background and environment as well as the health status of the birds. Thus, nutritionists are faced with a challenge of formulating diets with the available feed ingredients, but also having to mitigate the resulting diet effects to achieve optimum bird production (Walugembe, 2013).

Use of feed ingredients high in dietary fiber in poultry nutrition has generally been discouraged due to the negative effects exerted on nutrient utilization and performance such as decrease in body weight gain and feed conversion (Walugembe, 2013). It is important to note that fibre in monogastric diets is mainly utilized in the hind gut (i.e. ceca, rectum and the colon). Feeding animals diets high in dietary fiber, particularly soluble fiber alters the rate of fecal passage, microbiota, metabolites, and efficacy of digestion (Bach Knudsen, 2001). This experiment was carried out to evaluate the effect of feeding high fibre diet to broilers chicken on sensory evaluation, primal cuts and meat characteristics.

MATERIALS AND METHODS

Experimental site:
The experiment was conducted at Poultry unit Division of National Veterinary Research Institute, Vom Plateau State, Nigeria.

Experimental animal and management:

A total of two hundred and forty, one-day old Arbor Acres roiler chicks obtained from a commercial hatchery were used for the trial. An average (33±0.12g body weight) were weighted individually and randomly divided into three (3) Treatment with ten replicate per treatment and eight birds per replicate. The brooding temperature was kept at an average of 26.5^0C from the first to second week of age. Thereafter, the temperature was lowered to 22^0C for the rest of experimental period. Wood shaving was used as litter material. From day-old, anti-stress and antibiotic were given to the birds for three days. From week two to three, first and second Infectious Bursal Disease Vaccine (IBDV) was administered. Then, at week four and five Anticocidial drug and Newcastle Disease Vaccine Lasota were given to the birds respectively. The experiment was conducted for the period of eight weeks. The primal cuts of the broiler fed high fibre diet was measured and recorded.

Cooking loss was determined according to the procedure described by Mahendraker *et. al.* (1988).

$$\text{Cooking yield} = \frac{\text{Weight of meat after cooking}}{\text{Weight of meat before cooking}} \times 100$$

Sensory evaluation
Sensory parameters were evaluated using nine-point hedonic scale. A total of twenty trained panelists between the ages of 20 and 40 years were used to evaluate two replicate of the prepared sausage for colour (1-4 dark, 5- intermediate, 6-9 light), tenderness (1-4 tough, 5- intermediate, 6-9 tender), juiciness (1-4 dry, 5- intermediate, 6-9 juicy), and overall acceptability, OA (1-4 low, 5- intermediate, 6-9 high) Mahendrakar (1988).

Experiment diet:

Three experiment diet was formulated with high fibre content as shown in Table 1.

Table 1: Feed composition

Ingredients	T1	T2	T3
Lysine	0.35	0.35	0.35
Methionine	0.20	0.20	0.20
Premix	0.45	0.45	0.48
Salt	0.37	0.37	0.37
Enzyme	0.03	0.03	-
Toxin Blinder	0.02	0.02	0.02
GNC	27.90	27.90	27.90
Maize Bran	25.00	60.00	60.00
Rice Bran	7.50	7.50	7.50
Bone Meal	2.40	2.40	2.40

Lime Stone	0.60	0.60	0.60
Oyatozyme	0.20	0.20	0.20
Maize	35.00	-	-
	100.016	100.016	100.016
Total Percentage	***100***	***100***	***100***

T1= Control (8.7% Fibre); T2= 13.10% Fibre with enzyme T3= 13.10% Fibre without enzyme

Experimental design: Completely randomized design was used.

Statistical Analysis: Data obtained were subjected to analysis of variance using SAS (2010). The means were separated using Duncan's Multiple Range Test of the same procedure.

Results and discussion

Table 2 shows the primal cuts of broilers chicken fed high fibre diet. Comparing the thigh, drumsticks, back, breast meat and wings across the treatment shows no significant difference. Besides, the colour, aroma, flavor, juiciness, tenderness, texture and overall acceptability examined under sensory evaluation shows no difference among the treatment as shown in Table 3. Similar result was obtained by Al-Hajo *et al.* (2013) who compared chicken groups fed high fibre did not differ in terms of juiciness, flavour, overall acceptance, and general acceptance. The cooking loss and yield of meat from broilers chicken fed high fibre diet is represented in Table 4. The cooking loss of breast meat from broilers chicken fed control (8.70% fibre) had the highest cooking loss with least cooking loss in Treatment 3. While Treatment 3 had the highest cooking yield with lowest cooking yield in Treatment 1. Meanwhile both the cooking loss and yield for drumstick and thigh shows no significant differences. The result obtained could be due to ability of the high fibre to hold water within the muscle of the broilers chicken.

Table 2: Primal cuts of broilers chicken fed high fibre diet.

Parameters (g)	T1	T2	T3	SEM
Thigh	266.67	286.67	263.67	14.19
Drumstick	209.33	222.67	231.33	8.26
Back	277.00	312.33	335.67	14.69
Breast	511.33	569.00	554.00	22.63
Wings	161.67	173.67	173.33	5.49

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05

T1= Control (8.7% Fibre); T2= 13.10% Fibre with enzyme T3= 13.10% Fibre without enzyme.

Table 3: Sensory evaluation of meat from broilers chicken fed high fibre diet

Parameters	T1	T2	T3	SEM
Colour	5.10	4.80	4.80	0.29
Aroma	3.60	2.10	3.50	0.38
Flavour	3.60	3.30	3.50	0.29
Juiciness	5.30	4.00	4.00	0.36
Tenderness	5.00	5.10	5.00	0.29
Texture	4.30	4.40	4.50	0.29
Overall acceptability	4.30	3.50	3.10	0.34

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05

T1= Control (8.7% Fibre); T2= 13.10% Fibre with enzyme T3= 13.10% Fibre without enzyme.

Table 4: Cooking loss and yield of meat from broilers chicken fed high fibre diet

Parameters	Primal cuts	T1	T2	T3	SEM
Cooking loss	Breast	33.36[a]	24.74[b]	21.54[b]	2.16
	Drumstick	28.17	21.15	19.62	2.93
	Thigh	29.29	24.48	22.42	2.11
Cooking yield	Breast	66.64[b]	75.26[a]	78.46[a]	2.16
	Drumstick	71.83	78.85	80.38	2.93
	Thigh	70.71	75.52	77.58	2.11

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05

T1= Control (8.7% Fibre); T2= 13.10% Fibre with enzyme T3= 13.10% Fibre without enzyme.

Conclusion

The study showed that feeding high fibre diet to broilers chicken at 13.10% without the use of enzyme enhances better cooking yield and lower cooking loss.

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EFFECT OF HIGH FIBRE DIET WITH OR WITHOUT ENZYME ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS

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Abstract

An eight weeks feeding trials was conducted to evaluate the Influence of high fibre diet fed to broilers chicken on growth and carcass performance. A total of two hundred and forty, one-day old Arbor Acres broiler chicks obtained from a commercial hatchery were used for the trial. An average (33±0.12g body weight) were weighted individually and randomly divided into three (3) Treatment with ten replicate per treatment and eight birds per replicate using a completely randomized design. The diet contained T1= 8.70% fibre; T2= 13.10% with enzyme and T3= 13.10% fibre without enzyme. Parameters measured were the daily feed consumption, weekly body weights, weight gain and feed conversion ratio were properly recorded. Carcass performance parameters were measured and recorded for both the external and internal organs. Data were analysed using descriptive statistic and ANOVA at $\alpha_{0.05.}$ There were no significant differences ($P<0.05$) for weight gain and feed conversion ratio while Treatment 3 had the highest daily feed consumption and weekly body weights with least daily feed consumption, and weekly body weights in Treatment 1. The result shows that there were not differs in carcass performance, external organs weight as well as internal organs weight. In conclusion, broiler chicken can be fed with 13.10% fibre diet without enzyme without any adverse effect on the growth and carcass performance.

Keywords: Growth performance, carcass performance, high fibre diet, feed conversion ratio, broiler chicken

Introduction

The aim of farmers is to ensure high productivity and profitability. Due to the high competition for conventional feeding stuff such as maize between human and animal to meet their energy requirement which has lead to high cost of production and in turns reduce the profits (Samuel Etop *et al.,* 2018). Farmers has adopted the use of alternative feeding materials that are less or not consumed by humans and yet meets the energy requirement of animal such as broiler chicken. Such feeding material is fiber from cereals such as rice, corn, wheat and oat.

Fiber content of diets is mainly more important in ruminants; however there are good results with fiber content in non-ruminants as pigs and poultry (Abo Omar, 2005). Fiber provides health benefits, with several physiological functions (Bersamin *et al.,* 2008). Also, fiber in feed ingredients may affect cecal microbial population, nutrient digestibility, and volatile fatty acid production. Interactions of these effects can affect bird performance (Walugembe, 2013).

Thus, this study is designed to investigate the Influence of high fibre diet fed to broilers chicken on growth and carcass performance.

MATERIALS AND METHODS

Experimental site:
The experiment was conducted at Poultry unit Division of National Veterinary Research Institute, Vom Plateau State, Nigeria.

Experimental animal and management:

A total of two hundred and forty, one-day old Arbor Acres broiler chicks obtained from a commercial hatchery were used for the trial. An average (33±0.12g body weight) were weighted individually and randomly divided into three (3) treatment with ten replicate per treatment and eight birds per replicate. The brooding temperature was kept at an average of 26.5^0C from the first to second week of age. Thereafter, the temperature was lowered to 22^0C for the rest of experimental period. Wood shaving was used as litter material. At DOC, antibiotic and anti-stress were given to the birds for three days. From week two to three, first and second Infectious Bursal Disease Vaccine (IBDV) was administered. Then, at week four and five Anticocidial drug and Newcastle Disease Vaccine Lasota were given to the birds respectively. The experiment was conducted for the period of eight weeks. The daily feed consumption, weekly body weights, weight gain and feed conversion ratio were properly recorded. Carcass performance parameters were measured for both the external and internal organs.

Experiment diet: Three experiment diet was formulated with high fibre content as shown in Table 1.

Table 1: Feed composition

Ingredients	T1	T2	T3
Lysine	0.35	0.35	0.35
Methionine	0.20	0.20	0.20
Premix	0.45	0.45	0.48
Salt	0.37	0.37	0.37
Enzyme	0.03	0.03	-
Toxin Blinder	0.02	0.02	0.02
GNC	27.90	27.90	27.90
Maize Bran	25.00	60.00	60.00
Rice Bran	7.50	7.50	7.50
Bone Meal	2.40	2.40	2.40
Lime Stone	0.60	0.60	0.60
Oyatozyme	0.20	0.20	0.20
Maize	35.00	-	-
	100.016	100.016	100.016
Total Percentage	***100***	***100***	***100***

Nutrients Composition of Diets			
Metabolizeable energy (Kcal/Kg)	3197.00	2984.00	2716.00
Crude Protein %	18.16	18.50	17.83
Crude Fat %	7.40	9.15	9.15
Crude Fibre %	8.70	13.10	13.10
Ash %	5.20	6.24	6.24
Calcium %	1.50	1.50	1.22
Available Phosphorus %	0.67	0.72	0.42
Methionine %	0.49	0.46	0.46
Lysine %	0.95	1.00	0.96
Methionine + Cystine %	0.77	0.76	0.74

T1= Control (8.7% Fibre); T2= 13.10% Fibre with enzyme T3= 13.10% Fibre without enzyme

Experimental design: Completely randomized design was used.

Statistical Analysis: Data obtained were subjected to analysis of variance using SAS (2010). The means were separated using Duncan's Multiple Range Test of the same procedure.

Results and discussion

The growth performance was shown in Table 2. The fiber had no effect on both the weight gained and FCR among the treatments. The feed intake /week/ replicate was higher ($p<0.05$) in Treatment 3 with least values in Treatment 1. Furthermore the feed intake/bird/week was also higher in both Treatment 2 and 3. In agreement with previous reports (Donkoh *et al*., 1999; Loar *et al*., 2010; Lumpkins *et al*., 2004;), broiler chicks' body weight gain was reduced at higher concentrations of high fiber dietary ingredients which was in line with the findings of the study, although there was no significant difference in the weight gained. A possible explanation for the reduced performance could be that inclusion of high fibre source in broiler diets.

Table 2: Growth performance of broiler chicken fed high fibre diet

Parameters	T1	T2	T3	SEM
Intial weight(g)	40.50	40.75	39.90	0.50
wgt gain/wk(g)	239.84	271.2	265.6	12.15
FI/WK/REP(g)	8077.39[b]	9999.97[a]	10111.31[a]	374.27
FI/Bird/wk(g)	479.18[b]	566.23[a]	561.74[a]	16.68
FCR	2.64	2.11	2.21	0.22

[a,b,c] Means across rows with different superscripts differ significantly at $P<0.05$; wgt: Weight; wk: Week; FI; Feed Intake; F.C.R: Feed Conversion Ratio;. S.E.M: Standard Error of the Mean

T1= Control (8.7% Fibre); T2= 13.10% Fibre with enzyme T3= 13.10% Fibre without enzyme.

Table 3: Carcass performance as affected by high fibre diet

Parameters(Kg)	T1	T2	T3	SEM
Live Weight	2.12	2.30	2.30	0.07
Bled Weight	2.02	2.21	2.22	0.07
Defeathered weight	1.95	2.11	2.12	0.07
Evicerated Weight	1.71	1.84	1.83	0.06
Dressed Weight	1.44	1.58	1.57	0.06

Dressed percentage(%)	68.29	68.78	68.31	0.18

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05
T1= Control (8.7% Fibre); T2= 13.10% Fibre with enzyme T3= 13.10% Fibre without enzyme.

Table 4: External organs of broilers as affected by high fibre diet

Parameters(g)	T1	T2	T3	SEM
Head	56.00	57.00	56.67	1.24
Neck	90.00	100.00	101.33	2.93
Shank	87.00	94.33	93.33	2.22
Abdominal fat	14.67	21.67	26.67	3.17

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05
T1= Control (8.7% Fibre); T2= 13.10% Fibre with enzyme T3= 13.10% Fibre without enzyme.

Table 5: Internal organs of broilers as affected by high fibre diet

Parameters(%)	T1	T2	T3	SEM
Liver Weight	2.01	1.90	2.13	0.08
Heart Weight	0.53	0.51	0.49	0.03
spleen weight	0.20	0.17	0.13	0.02
bile weight	0.05	0.13	0.10	0.02
Gizzard Weight	2.57	1.91	2.40	0.14
Empty gizzard	1.65	1.41	1.68	0.09
Intestine weight	5.23	4.79	4.53	0.21
Intestine length(cm)	11.18	10.10	8.28	0.61
Proventriculus	0.29	0.31	0.35	0.03

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05
T1= Control (8.7% Fibre); T2= 13.10% Fibre with enzyme T3= 13.10% Fibre without enzyme.

Table 3, 4 and 5 showed that treatments had no significant (P>0.05) effect on both the external and internal organs such as weights of necks, heads, shanks, abdominal fat, livers, hearts, spleens, bile, gizzards, empty gizzards, intestinal weight, intestinal length and proventriculus, as these parameters did not show differences (P>0.05)across the diets. The result obtained could be due to include higher total intake of high fiber feed ingredients in the broiler chicks resulting in reduced both the internal and external organs.

Conclusion

In conclusion, broiler chicken can be fed with 13.10% fibre diet without enzyme without any adverse effect on the growth and carcass performance.

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EFFECT OF FEEDING YEAST (*Saccharomyces cerevisiae*) AS A PROBIOTIC IN CASSAVA BASED DIETS ON THE NUTRIENT UTILIZATION OF BROILERS

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Abstract
One hundred and twenty (120) Anak broilers were used to evaluate the effect of feeding yeast (S*accharomyces cerevisiae*) as a probiotic in a-cassava based diets on the nutrient utilization of broilers. Birds of one (1) week of age were weighed and randomly assigned to four (4) dietary treatment formulated to contain the test ingredient probiotic (*Saccharomyces cerevisiae*) at 0 %, 0.5 %, 1.0 % and 1.5 % diatary inclusion levels. Thirty (30) birds allotted to each of the treatment and the treatments were replicated three times. Feed and water were provided *ad libitum* for the seven (7) weeks duration of the experiment. It was a completely randomized design (CRD) experiment.. Result show that there were no significant differences (P>0.05) in final live weight, average daily weight gain, average daily feed intake and feed conversion ratio among the treatments. The implication of these results is that those parameters measured were not significantly (P>0.05) influenced by the dietary levels of the probiotic (*Saccharomyces cerevisiae*). Also decreasing feed production cost (₦75.57/kg, ₦75.06/kg, ₦74.74/kg and ₦74.55/kg for diets I, II, III and IV respectively) was observed as inclusion level of the Probiotic (*Saccharomyces cerevisiae*) increased from 0 to 1.5 %. Breast, leg, gizzard, neck, liver and heart weight were increased across the treatments. Wings and abdominal fat weight were decreased with increase in the inclusion level of probiotic (*Saccharomyces cerevisiae*) from 0-1.5 %. Hence, it can be concluded that yeast (*Saccharomyces cerevisiae*) can included up to 1.5 % in the diet of broilers without any negative effect on their growth performance, and carcass characteristics. There was decrease in ₦/kg production cost with increase inclusion level of Yeast (*Saccharomyces cerevisiae*) in the diets.

Keywords: Yeast, Cassava Diets, Broilers, Nutrient Utilization

Introduction

Probiotic is defined as microorganisms that are believed to provide health benefits when consumed. In many parts of the world, feed additives, such as probiotics and prebiotics, are being experimented upon to alleviate the problems associated with the withdrawal of antibiotics from feed. Probiotics are biological products, which stimulate the immune system and increase its defensive activity against pathogenic bacteria. Probiotics competitively exclude *Salmonella* bacteria from the intestinal tract of the treated chickens. *Saccharomyces cerevisiae* is one of the most widely commercialized types of yeast, and has long been fed to animals. Results of earlier studies with yeast fed to chickens, however, have not been consistent. It has been reported (Ignacio, 1995; Onifade *et al*., 1999; and Spring *et al*., 2000) that feeding yeast to chicks improves body weight gain and feed/gain ratio. The bacterial populations in the gut of birds were altered when micro-organism were added to their diets. The intestinal bacterial flora of domestic animals has an important role in digestion and absorption of feed ingested by the host. It takes part in the metabolism of dietary nutrients such as carbohydrates, protein, lipids and minerals and also in the synthesis of vitamins. This study is aimed at investigating the effect of different levels of inclusion of

yeast (*Saccharomyces cerevisiae*) on the growth performance, carcass characteristics and economics of production of broilers.

Materials and Methods

Cassava Root Processing

Fresh cassava roots (12 months old, variety Umucas 1368) were washed to dislodge all adhering soil, immediately after harvest and chipped with chipping machine at the Garri Processing Unit of the National Root Crops Research Institute (NRCRI), Umudike. The chips were dewatered with hydraulic pressing machine for 24 hours. This method of processing of the cassava root meal had been described by Okereke *et al.*, 2012. Thereafter, it was sun dried on a clean nylon mat for five-six days, milled and stored in a bag for the feeding trial.

Experimental Diets

The study was conducted at the Poultry Farm of Collage of Animal Science and Animal Health, Michael Okpara University of Agriculture, Umudike. One hundred and twenty (120) Anak broiler birds of one (1) weeks of age were weighed and randomly assigned to four (4) dietary treatment formulated to contain the test ingredient probiotic (*Saccharomyces cerevisiae*) at 0 %, 0.5 %, 1.0 % and 1.5 % dietary inclusion levels. Thirty (30) birds were allotted to each of the treatments each treatment was replicated three times. All other ingredients remain constant except maize and soybean meal. The birds were placed on a commercial broiler starter mash for one week before the experiment on a deep litter system. Feed and water were provided *ad libitum* for the seven (7) weeks duration of the experiment. Body weights were taken at the onset of the experiment and thereafter on weekly basis. Feed intake was taken daily by subtracting the weight of left over feed from the weight of the feed given. Weight gain was calculated from body weights, while feed conversion ratio was calculated from feed intake and weight gain.

Table 1: Composition of the Experimental Diets

Ingredients	I (0%)	II (0.5%)	III (1%)	IV (1.5%)
Maize	41.74	38.81	37.00	35.39
Cassava root meal	10.00	10.00	10.00	10.00
Saccharomyces cerevisiae	0.00	0.50	1.00	1.50
Soybean meal	20.06	22.49	23.69	24.91
Groundnut Cake(GNC)	12.00	12.00	12.00	12.00
Wheat offal	5.00	5.00	5.00	5.00
Palm Kernel cake (PKC)	5.00	5.00	5.00	5.00
Fish meal	2.50	2.50	2.50	2.50
Bone meal	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25
Vitamin premix*	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Calculated value				
Crude Protein (CP) %	22	22	22	22
Crude Fibre (CF) %	4.52	4.39	4.25	3.99
Metabolisable Energy kcal/kg	2868.60	2821.80	2798.48	2775.00

*Provide the following per kg of feed: Vit A 10 000 000 iu; Vit D3 2 000 000 iu; Vit B1 0.75 g; Vit B2 5 g; Nicotinic acid 25 g; Calcium pantothenate 12.5 g; Vit B12 0.015 g; Vit K3 2.5 g; Vit E 25 g; Biotin 0.05 g; Folic acid 1 mg; Choline chloride 250 g; Co 0.4 g; Cu 8 g; Mn 64 g; Fe 32 g; Zn 40 g; I 0.8 g; Flavomycin 100 g; Spranycin 5 g; 3-Nitro 50 g; DL-Methionine 50 g; Se 0.16 g; L-Lysine 120 g; BHT 5 g.

Chemical and Data Analysis

Proximate analysis of pro-vitamin A rich cassava root meal was carried out using a standard method (AOAC, 1990). The crude protein content was calculated by multiplying the nitrogen content by 6.25. All results were subjected to one-way analysis of variance for completely randomized design experiment (CRD) according to the procedure of Steel and Terrie (1980), while differences between treatment means were separated using LSD.

Cut Parts and Organ Weights

At the end of the experiment, two birds per replicate were randomly selected, starved for 24 hours, weighed and slaughtered by serving the jugular vein. They were bled thoroughly, scalded in hot water and defeathered. The defeathered birds were then weighed. The head, neck, shank and visceral were separated from the carcass and the dressed weight taken. Each dressed carcass was cut into parts as reported by Ojewola and Longe (1999) for the purpose of carcass evaluation. All parts such as breast, drumstick, thigh, wings and backcut were weighed and expressed as percentage dressed weight. Organs like liver, heart and gizzard were also weighed and expressed as percentage of live weight.

Results and Discussion

Composition of the Experimental Diets

Table 1 shows the compositions of the experimental diets: it has similar crude protein level of 22 % but the energy content differed. As the level of maize decreased across the diet, the caloric values of the diet decreasesed. The chemical composition of pro-vitamin A rich cassava root meal is presented in Table 2. The crude protein (2.10 %), crude fibre (3.43 %), ether extract (1.02 %), ash (3.15 %) and NFE (81.80 %) are comparable to those of Oyenuga (1978) who worked on cassava root meal.

Table 2: Chemical composition of pro-vitamin A rich cassava root meal

Parameter	Composition
Crude protein	2.10%
Crude fibre	3.43%
Lipids/fat	1.02%
Ash	3.15%
Nitrogen Free Extract (NFE)	81.80%
Metabolisable Energy (ME)	3200Kcal/g
Hydrogen Cyanide (HCN)	14.49mg/g

Growth Performance

The growth performance of broilers fed diets containing diffent levels of probiotic (*Saccharomyces cerevisiae*) at 0, 0.5, 1.0, and 1.5 % dietary inclusion levels showed that there were no significant differences ($P<0.05$) in final live weight, average daily weight gain, average daily feed intake and feed conversion ratio among the treatments (Table 3). The implication of these result is that those parameters measured were not significantly ($P>0.05$) influenced by the dietary levels of the probiotic (*Saccharomyces cerevisiae*).

Table 3: Performance of broilers fed probiotic (*Saccharomyces cerevisiae*).

Parameters	I (0%)	II (0.5%)	III(1.0)	IV(1.5)	LSD
Initial Live weight (g)	35.70	35.70	35.70	35.70	0.04
Final Live weight (g)	750.13	760.10	770.63	770.47	3.97
Average daily weight gain (g)	15.30	15.50	15.80	15.90	0.08
Average daily feed intake (g)	104.01	106.10	107.06	105.14	0.04
Feed conversion ratio	6.80	6.85	6.78	6.61	0.04
Feed cost (₦/kg)	75.57	75.06	74.74	74.55	-
Mortality	0	0	0	0	-

Decreasing feed production cost (₦/kg) (75.57, 75.06, 74.74 and 74.55 naira) was observed as inclusion level of Probiotic (*Saccharomyces cerevisiae*) increased from 0 to 1.5 % (Table 3).

Carcass characteristics

Table 4 represents breast, leg, gizzard, neck, liver and heart weight was increased across the treatments. Wings and abdominal fat weight was decreased with increase in the inclusion level of probiotic (*Saccharomyces cerevisiae*) from 0-1.5% of *Saccharomyces cerevisiae.* The result agreed with, Kalavathy *et al*., (2003) who made similar observation that supplementation of *Saccharomyces cerevisiae* reduces abdominal fat.

Table 4: Effect of different levels of yeast (Saccharomyces cerevisiae) on carcass weight of broiler chicks

Organ	I (0%)	II (0.5%)	III (1%)	IV (1.5%)
Breast weight	570	653	628	678
Leg weight	471	414	423	437
wings weight	153	147	132	89
Gizzard	32	30	32	37
Neck weight	51	57	58	59
Liver weight	35	40	40	42
Heart weight	7	8	9	11
Fat weight	39	33	26	20

Conclusion and Recommendations

Yeast (*Saccharomyces cerevisiae*) can be included up to 1.5 % in the diet of broilers without any negative effect on their growth performance and carcass characteristics. There was decrease in ₦/kg production cost with increase in quantity of Yeast (*Saccharomyces cerevisiae*) in the diets.

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Growth Performance and Cost Implication of Broiler Chickens fed Fortified Composite Cassava Stump Meal-based Diets

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Abstract

This study investigated the effect of fortifying composite cassava stump meal with cassava leaf meal on growth performance and cost-implication of producing broiler-chickens. Composite cassava stumps were collected, crushed, pressed, subjected to heat treatment and then milled (CCSM). Cassava leaves were obtained, air-dried and milled (CLM). Thereafter, the CLM and CCSM were mixed together in ratio 1:9 to produce fortified composite cassava stump meal (FCCSM). The FCCSM was used as feed ingredient. 5 broiler-starter diets were formulated using FCCSM at the graded levels of 0, 5, 10, 15 and 20% and designated diets I, II, III, IV and V, respectively. The same procedure was followed for the finisher phase. 150 broiler chicks of Abor-Acre breed were assigned to 5 dietary treatments of 3replicates at 10 chicks per replicate in a Completely Randomized Design. The respective formulated diets and water were fed to the chicks *ad libitum* from 1 – 49 days. All data collected were subjected to Analysis of variance using SPSS version 17 package. Results shows that highest total weight gain (2477±159.10g/bird) and best FCR (2.12±0.01) were obtained with birds fed diet I, while the lowest total weight gain (2040.28±159.59g/bird) and poorest FCR (2.68±0.05) were observed with birds fed diet IV. Bird fed diet V yielded highest profit (₦807.35±12.88). Based on this study, it is recommended that 20% FCCSM can be included in broiler diet without adverse effect on growth performance and also give the highest returns on the production process.

Keywords: Performance, fortified, cassava stump, cassava leaf and cost

Introduction

Chicken constitutes one of the most common sources of animal protein in developed countries but this is not the case in developing countries mostly due to the cost which is beyond the reach of the common man and this could be as a result of high cost of feed ingredients especially grains which results in high cost of feed, which makes up to 60-70% of the total cost of production of monogastric animals under intensive system (Adegbenro *et al.,* 2012). The ever-rising cost of maize is brought about by its declining production conditions and stiff competition for its use by man and other livestock species (Agbede *et al.,* 2002). Therefore, there is a need to explore the use of alternative feed sources that have the capacity to yield the same output as conventional feedstuffs and at a cheaper cost. This will help to reduce the cost of feeds and also minimize the direct competition between man and livestock for the available conventional feedstuffs. One such economical substitute ingredient for maize is cassava meal (Anthony, 2009). Thus, this study was designed to evaluate the potential of fortified cassava stumps as energy source in broiler chicken diets.

Materials and Methods

The experiment was carried out at the Poultry Unit of Teaching and Research Farm (T&RF), Federal University of Technology, Akure Nigeria. Cassava stumps were collected, crushed and subjected to heat treatment by frying. The cassava leaves were obtained in large quantities and air-dried. The cassava

stumps and cassava leaves were milled separately. The cassava leaf meal and cassava stump meal were mixed together in ratio 1: 9 (1kg cassava leaf meal meal+ 9kg cassava stump meal) to produce the fortified cassava stump meal. Five experimental diets were produced in such a way that the fortified cassava stump meal was used as one of the feed ingredients at 0, 5, 10, 15 and 20% and each diet was designated Diets I, II, III, IV and V, respectively. The diets were thoroughly mixed. The same procedure was followed for the finisher phase. The gross composition of the starter and finisher diets are as presented in Tables 1 and 2, respectively.

Table 1: Gross Composition of broiler chicken Experimental Diet (g/100g) (Starter)

INGREDIENTS	DIET I	DIET II	DIET III	DIET IV	DIET V
Maize	54.00	49.00	44.00	39.00	34.00
Wheat offal	3.30	3.30	3.30	3.30	3.30
Soybean meal	21.00	21.00	21.00	21.00	21.00
Groundnut cake	12.00	12.00	12.00	12.00	12.00
Fish meal	5.00	5.00	5.00	5.00	5.00
FCCSM	0.00	5.00	10.00	15.00	20.00
Lysine	0.10	0.10	0.10	0.10	0.10
Methione	0.10	0.10	0.10	0.10	0.10
DCP	1.00	1.00	1.00	1.00	1.00
Limestone	1.50	1.50	1.50	1.50	1.50
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Vegetable oil	1.50	1.50	1.50	1.50	1.50
TOTAL	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 2: Gross Composition of broiler chicken Experimental Diet (g/100g) (Finisher)

INGREDIENTS	DIET I	DIET II	DIET III	DIET IV	DIET V
Maize	54.00	49.00	44.00	39.00	34.00
Wheat offal	5.80	5.80	5.80	5.80	5.80
Soybean meal	21.00	21.00	21.00	21.00	21.00
Groundnut cake	12.00	12.00	12.00	12.00	12.00
FCCSM	0.00	5.00	10.00	15.00	20.00
Lysine	0.10	0.10	0.10	0.10	0.10
Methione	0.10	0.10	0.10	0.10	0.10

DCP	1.50	1.50	1.50	1.50	1.50
Limestone	2.00	2.00	2.00	2.00	2.00
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Vegetable oil	3.00	3.00	3.00	3.00	3.00
TOTAL	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

FCCSM = *Fortified composite cassava stump meal*, DCP = *Dicalcium phosphate*

One hundred and fifty Abor-Acre strain of broiler were assigned to five dietary treatments of three replicates and ten chicks per replicate in a Completely Randomized Design. Their respectively starter diets were fed *ad libitum* for 1 – 28 days. Thereafter, the finisher diets were fed *ad libitum* between 29 – 49 days during which weekly feed consumption and weight changes were measured and feed conversion ratio was calculated. The economics and cost of producing experimental diets were estimated in comparative fashion. The cost of feed consumed per bird and total cost of production were calculated. The average price gained per bird was calculated by subtracting average price realized per bird from total cost of production. All data collected were subjected to Analysis of Variance (ANOVA) using SPSS version 17 package. Where significant differences existed, Duncan Multiple Range Test (DMRT) of the same package was used to separate the means.

Results and Discussion

From Table 3, Birds fed diet I were not significantly different ($P<0.05$) from those fed diets II, III and V with respect to the final body weight (FBW) and total weight gain (TWG). Numerically, highest FBW (2517.00g/bird) and highest TWG (2477.18g/bird) were recorded with birds fed diet I while lowest FBW (2080.00g/bird) and lowest TWG (2040.28g/bird) were observed with birds fed diet IV. Also, feed conversion ratio (2.12) of birds fed diet I was significantly ($P<0.05$) lower than those fed diets III, IV and V but similar to birds fed diet II (2.16). Variation in growth performance characteristics obtained were in accord with Adeyoyin *et al.*(2010) who reported significant differences in final weight, weight gain and feed conversion ratio when unpeel cassava grit was fed to layers. Higher feed conversion ratio recorded for birds fed diet IV could be responsible for increasing feed intake in order to meet up with nutritional requirement especially energy of the birds that significantly exhibit higher live bodyweight as the dietary energy increased (Greenwood *et al.,* 2004). There were significant ($P<0.05$) differences observed in cost of feed per bird, cost of production per bird and profit made from sales of birds as presented in Table 4. Costs of feed (₦ 925.32±23.63) and production (₦ 1175.32±23.63) were highest in diet I. Cost of production and cost of feed decrease progressively as the inclusion of fortified composite cassava stump increases. Diet V which contained highest level of fortified composite cassava stump yielded better (₦ 807.35±12.88) profit. Cost of day-old chicks, cost of drug and vaccinations per bird, and sales price per bird was the same for all the treatments. The variation in the cost of feed and production indicated that diet V had the least cost of feed consumed and cost of production. This is in agreement with the report of Omoikhoje *et al.* (2008) that least-cost of feed consumed recorded in birds fed 100% cassava grit meal (CGM) could be as a result of cheap cost of cassava grit used in the diet. In the same vein, the total cost of production was least in birds fed diet V and this could be due to the cheap nature of the basal diet that reduced the cost of formulating the diet per kilogram.

Conclusion and Recommendations

In this study, it was demonstrated that having up to 20% level of FCCSM did not adversely affect growth and feed efficiency in broiler chickens. It indeed brought about an increased profit margin in the production process. From the outcome of this study, it is therefore recommended that; farmers and feed millers could use FCCSM up to 20% as replacement for maize in broiler chicken diets.

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Table 3: Growth Performance of broiler chickens fed fortified composite cassava stump meal-based diets

Parameter	Diet I	Diet II	Diet III	Diet IV	I
Initial weight (g)	39.82±0.79	39.71±0.59	39.67±0.49	39.72±0.49	39
Final weight (g)	2517.00±159.29[a]	2346.67±180.95[a]	2340.00±104.08[a]	2080.00±160.00[b]	2286
Weight gain (g)	2477.18±159.10[a]	2306.95±181.52[a]	2300.33±104.31[a]	2040.28±159.59[b]	2246
Feed intake(g)	5263.50±58.95[b]	4987.91±23.03[c]	5160.26±103.75[bc]	5465.55±29.47[a]	4657
Feed conversion ratio	2.12±0.01[a]	2.16±0.03[a]	2.24±0.03[b]	2.68±0.05[c]	2.2

Means without identical superscripts in the same horizontal row are significantly different ($p<0.05$)

Table 4: Cost analysis of broiler chickens fed fortified composite cassava stump meal-based diets

Parameters	Diet I	Diet II	Diet III	Diet IV

Cost of day-old chick	180	180	180	180	
Cost of feed consumed (₦/Bird)	925.32±23.63[a]	853.18±19.07[a]	858.16±85.59[a]	865.16±9.12[a]	74
Cost of drug + vaccine (₦/Bird)	250.00±0.00	250.00±0.00	250.00±0.00	250.00±0.00	2
Total cost of production (₦/Bird)	1175.32±23.63[a]	1103.18±11.01[a]	1108.15±49.41[a]	1115.16±5.27[a]	99
Sales price of bird (₦/Bird)	1800±0.00	1800±0.00	1800±0.00	1800±0.00	
Net profit/bird produced (₦)	624.68±23.63[b]	696.82±11.01[b]	691.85±49.41[b]	684.84±5.27[b]	80

Means without identical superscripts in the same horizontal row are significantly different ($p<0.05$

COMPARATIVE EFFECTS OF HERBAL FEED ADDITIVES ON HEAMATO LOGICAL AND SERUM BIOCHEMICAL PARAMETERS OF BROILER CHICKENS

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Abstract

The experiment was conducted to evaluate the effect of some herbal plant extracts used as alternative growth promoters on hematology and serum biochemical parameters of broiler chickens. Four different phytogenic plants were collected i.e. *Moringa oleifera, Senna occidentalis, Cassia tora and Vynonia amagdylina* leaf aqueous extract as feed additives. A measured (50mls/litre of water) quantity of the filtrate according to the experimental treatment was added to water and served to the birds while keprocyl pawder was given as positive control. One hundred and twenty armor broiler chicks were randomly allotted to five treatments. Each of the treatment was replicated four times (six birds per replicate) in a completely randomized design (CRD). At the end of the eight weeks experiment, hematological and serum biochemical evaluation were carried out. Results of hematology showed that there were significant differences in packed cell volume (PCV) (19.00-29.50), white blood cells (208.20-267.05), and red blood cell (1.76-2.51). Serum creatine (36.59-47.21), glucose (10.34-12.46) and total protein (26.93-32.68)were affected by the treatments. It was concluded that phytogenic leaf extracts can be fed to broilers as a feed additive without deleterious effects on hematology and serum biochemical parameters.

Keywords: Additives, hematology, serum biochemical, phytogenic plants, broiler chickens

Introduction

Herbs and plant extracts utilized in animal feed are referred to as phytogenic or herbal feed additives, which are derivative compounds of plant origin. The inclusion of these phytogenic additives in animal feed can enhance productivity through the enhancement of digestibility, nutrient assimilation and elimination of pathogens resident within the animal gut (Dantas *et al*., 2008: Maidala *et al*., 2017). Plants with medicinal properties have been used against various ailments affecting man and animals since time immemorial, these promoters are now recognized in broiler industry as additives to shorten the period for attaining the market weight by stimulating growth, improving feed efficiency and survivability of broilers (Hossain, Khairunnesa, and Das, 2015). Millions of naira is spent annually in Nigeria on feed additives which may have negative effect on the animals and human beings (Stolker and Brinkman, 2005). This study was therefore designed to investigate the effect of *Moringa oleifera, Senna occidentalis, Cassia tora and Vynonia amagdylina* leaf aqueous extract as feed additives on hematology and serum biochemical parameters of broiler chickens.

Materials and Methods

Experimental location and climate

The experiment was carried out in Katagum local government area of Bauchi State Nigeria. It is located between latitudes 11^0 42' and 11^0 40^0 and longitude 10^0 31' and 10^0 11' east (Anon, 2009).

Processing of phytogenic leaf extract

The fresh leaves of *Moringa oleifera, Senna occidentalis, Cassia tora* and *Vynonia amagdylina* were collected after which they were thoroughly rinsed and dried. They were then sparsely spread on jute bags at room temperatures between 28ºC and 30ºC for 6 – 7 days until they became crispy. The leaves were regularly turned to avoid uneven drying and decay to ensure that the greenish color of the leaves was maintained. The dried crispy leaves were crushed using a hammer milled and then sieved through a 2mm sieve before storage in airtight containers to avoid the absorption of moisture. They were later used in preparation of the aqueous extract. A measured quantity (50g) each of the phytogenic plants of the ground leaves was infused in 1litre of hot water and allowed to stay overnight (12hours). The solution was filtered in the morning using a clean white piece of cloth and a measured (50mls/litre of water) quantity of the filtrate according to the experimental treatment was added to water and served to the birds keprocyl powder was given as positive control. One hundred and twenty (120) day old chicks were used for this experiment. The chicks were divided into five treatments replicated four times (six birds per replicate) in a completely randomized design (CRD).

Experimental diets

Broiler starter and finisher diets were formulated. The percentage composition of the experimental diets is shown in Table 1 and 2 for starter and finisher respectively

Blood collection

Four birds were selected from each treatment, one from each replicate for blood analysis. The blood was collected at the end of the experiment using wing vein with a syringe and needle. The blood was put in tubes containing EDTA to prevent coagulation and another tube without EDTA for serum biochemical parameters.

Data analysis

The data collected from all parameters were subjected to analysis of variance. ANOVA. Least significance difference was used to separate the means.

Results and Discussion

The hematological parameter of broiler chickens fed diets containing different types of medicinal plants is presented in Table 3. Results showed that packed cell volume (19.00-29.50) were affected (P<0.05) by different phytogenic plants. Depressed packed cell volume was identified among birds fed *Cassia tora* this may be attributed to high content of heamogluttinnins in the plant. Packed cell volume is involved in the transport of oxygen. Increased packed cell volume shows a better transportation in the body of animals. The white blood cells were affected by different medicinal plants, the control diets and other plants had better values than those fed *Cassia tora* (P<0.05), The major functions of the white blood cell and its differentials are to fight infections, defend the body by phagocytosis against invasion by foreign organisms and to produce antibodies in immune response. Therefore, animals with low white blood cells are exposed to high risk of disease infection, while those with high white blood cell counts are capable of generating antibodies in the process of phagocytosis and have high degree of resistance to diseases (Soetan *et al*., 2013). According to Isaac *et al.* (2013) red blood cell is involved in the transport of oxygen and carbon dioxide in the body. Thus a reduced red blood cell count implies a reduction in the level of oxygen that would be carried to the tissues as well as the level of carbon dioxide returned to the lungs. Mean corpuscular volume was higher among birds fed *Senna occidentalis* (P<0.05). Mean corpuscular hemoglobin (pg) was better among birds fed *Senna occidentalis* and *cassia tora* (P<0.05) while Mean corpuscular hemoglobin concentration (%) was better among birds fed bitter leaf and *cassia tora* (P<0.05). Serum biochemical parameter of broilers fed different type of medicinal plants are presented in Table 4. Results showed that urea (0.52-1.01) was not affected by different phytogenic plants (P>0.05). Broiler chickens utilized medicinal plants as they utilize the synthetic additives. It was observed that total protein and albumin among the control group and other groups were significantly higher than those fed *Senna occidentalis* (P<0.05). The level of carbohydrate metabolism was determined by the blood glucose content. Blood glucose of chickens fed different phytogenic plants was significantly (P<0.05) lower than those fed control. This suggests that the plants can be used in the control of blood glucose. Depressed creatine and cholesterol were identified (P<0.05) in birds fed different phytogenic plants with birds fed bitter leaf having the least values. The conjugate bilirubin, was affected by different medicinal plants with the control diets and other plants having better values feed *Senna occidentalis* (P<0.05).

Conclusion and Recommendations

Considering the results of this study, it was concluded that phytogenic leaf extracts can be fed to broilers as feed additives without deleterious effects on hematology and serum biochemical parameters. Therefore the four medicinal plants can be used as additives in broiler production without compromising the health of the birds in the tropics.

Percentage composition of experimental diets fed to broiler starter

Ingredients	**Control**	***Moringa oleifera***	***Senna occidentalis***	***Cassia tora***	***Bitter leaf***
	1	**2**	**3**	**4**	**5**
Maize	42.35	42.35	42.35	42.35	42.35
Soybean	41.75	41.75	41.75	41.75	41.75
Wheat offal	10.00	10.00	10.00	10.00	10.00
Fishmeal	2.00	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Sodium chloride	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20

Methionine	0.20	0.20	0.20	0.20	0.20
Vitamin mineral premix*	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis					
Crude protein	23.00	23.00	23.00	23.00	23.00
Metabolizable energy	2810	2810	2810	2810	2810
Crude fibre	6.25	6.25	6.25	6.25	6.25

Table 2: Percentage composition of experimental diets fed to broiler starter

Ingredients	**Control**	***Moringa oleifera***	***Senna occidentalis***	***Cassia tora***	***Bitter leaf***
	1	**2**	**3**	**4**	**5**
Maize	53.81	53.81	53.81	53.81	53.81
Soybean	22.29	22.29	22.29	22.29	22.29
Wheat offal	15.00	15.00	15.00	15.00	15.00
Fishmeal	5.00	5.00	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Sodium chloride	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20
Vitamin mineral premix*	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis					
Crude protein	20.00	20.00	20.00	20.00	20.00
Metabolizable energy	2860	2860	2860	2860	2860

Table 3: Hematology of broilers fed different medicinal plants

Parameters	**Control**	***Moringa oleifera***	***Senna occidentalis***	***Cassia tora***	***Bitter leaf***	***SEM***
	1	**2**	**3**	**4**	**5**	
Hemoglobin (g/dl)	9.00	9.80	8.45	8.35	9.10	1.45NS
Packed cell volume (%)	27.00 [a]	29.50 [a]	25.50 [a]	19.00 [b]	27.50 [a]	4.25 *
White blood cell (% x 10^6ul)	242.75 [a]	267.05 [a]	259.65 [a]	208.20 [b]	245.25 [a]	43.24*
Red blood cells (x 10^6 ul)	2.43 [a]	2.72 [a]	1.76 [b]	1.85 [b]	2.51 [a]	1.20*

Mean corpuscula volume (um^3)	111.11 [b]	108.46 [b]	144.87 [a]	102.70 [b]	109.56 [b]	8.24*
Mean corpuscula hemoglobin (pg)	37.04 [a]	36.03 [b]	48.01 [a]	45.14 [a]	36.25 [b]	6.21*
Mean corpuscula hemoglobin concentration (%)	33.33 [b]	33.22 [b]	33.14 [b]	43.95 [a]	47.89 [a]	9.26*

Means bearing different superscripts in the same rows are significantly different (P<0.05).

Table 4: Serum biochemical parameters of broilers fed different medicinal plants

Parameters	**Control**	***Moringa leaves***	***Senna occidentalis***	***Cassia tora***	***Bitter leaf***	***SEM***
	1	**2**	**3**	**4**	**5**	
Urea (MMOL/L)		1.01	0.52	0.67	0.60	0.62	0.45NS
Creatine (UMOL/L)		47.21 [a]	36.24 [b]	40.08 [a]	38.96 [a]	36.59 [b]	8.63*
Glucose (MMOL/L)		12.46 [a]	11.51 [b]	10.35 [b]	10.35 [b]	10.34 [b]	2.43*
Cholesterol (MMOL/L)		4.56 [a]	3.16 [b]	3.24 [b]	3.37 [b]	3.10 [b]	1.63*
Total bilirubin (MMOL/L)		6.12 [a]	5.79 [a]	6.86 [a]	6.23 [a]	5.46 [b]	1.23*
Conjugate bilirubin (MMOL/L)		2.79 [b]	2.68 [b]	4.11 [a]	2.49 [b]	2.44 [b]	0.52*
Total protein (G/L)		31.51 [a]	32.68 [a]	26.93 [b]	34.11 [a]	30.75 [a]	5.21*
Albumin (G/L)		15.25 [a]	15.82 [a]	12.95 [b]	17.06 [a]	15.99 [a]	2.01*

SEM=Standard error of means, NS= Not significant, *= (P<0.05), Means bearing different superscripts in the same rows are significantly different (P<0.05).

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ERFORMANCE AND ECONOMIC EVALUATION OF AFRICAN GIANT LAND SNAIL (*Achatina achatinta*) FED DIFFERENT LEVELS OF WHOLE JACKFRUIT MEAL

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A study was undertaken to investigate the performance and economic evaluation of the African Giant Land Snail *Achatina achatina* fed different levels of Whole Jack Fruit Meal (WJFM). A total of 120 growing snails of similar weight were used for the study which lasted for 8 weeks. The Snails were randomly allotted to four treatment groups, (T_1, T_2, T_3 and T_4) with the inclusion levels of Whole jackfruit meal and each of the treatments replicated three times in a CRD experimental design. The jackfruit was sourced from Igbo-Ukwu in Aguata local government area of Anambra state. At the end of the experiment the following growth parameters were evaluated and observation noted; Weight Gain, Average Daily and Total Feed Intake, Shell Length, Shell Aperture, Shell Girth, Shell Thickness, Feed Cost and Feed Conversion Ratio. The finding revealed that the snails fed with WJFM showed a progressive increase in body weight with no significant difference ($P>0.05$) among the mean body weight at the end of the experiment and also with the Shell Aperture ($P>0.05$). Increase in Shell Length, Shell Girth and Shell Thickness were all recorded, with significant difference ($P<0.05$) among treatments. There was also no significant difference ($P>0.05$) between treatments in Average Daily and Total Feed Intake, Feed Cost/ Weight Gain and the Feed Conversion Ratio (FCR). Thus it can be deduced from the study that farmers may incorporate whole Jackfruit meal based diet on the production of snails since it proved acceptable to snails and at the same time influenced the overall performance of the snails.

Keywords: *Achatina achatina*, Whole Jackfruit Meal, Growth Performance.

Introduction

Animal protein is sourced from both macro-livestock such as cattle, sheep, and goats and micro livestock including grass cutter and snails as well as fisheries. Livestock and livestock products are estimated to make up over half of the total volume of agricultural output in the industrialized countries and about a third of the total developing countries (Ejidike, 2002). Livestock provides about 58% of the meat consumption in Nigeria. The major source of animal protein for the Nigerian populace come mainly from livestock in the form of chicken, beef, mutton and pork (Ejidike, 2002). These major sources are being decreased by persistent drought, disease, high cost of feed, primitive animal husbandry techniques and low productivity of local animal breed. The increasing human population increased the demand for protein especially from animal source. This is because the protein consumption in most developing countries is inadequate compared with the developed countries of the world (Omole *et al*., 2000).

One of the major problems facing the rearing of snails is the formulation of an improved and acceptable diet that will meet the nutrient requirement of snails at low or no cost. Studies suggested the animal protein intake of Nigerians to be low, and this has led to an acute malnutrition amongst the greater percentage of the rural populace. Also Agbogidi and Okonta (2011) reported that the protein consumption in Nigeria is below 67g recommended by the World Health Organization. Since the growth, development and reproduction of an

animal are highly dependent on the quality of its feed, there is need undertaking the study on "the growth performance and economic evaluation of Giant African Land Snails (*Achactina achatina)* fed whole jackfruit meal (*Arthocapus heterophyllus*) based diet.

Materials and methods

The study was carried out at the Snail and Edible Insect unit of the Teaching and Research farm of the Department of Animal Science and Technology, Nnamdi Azikiwe University, Awka, Anambra State. The location lies between Latitude 6.24^{o}N & 6.28^{o}N and longitude 7.00^{0}E and 7.08^{o}E on the South Eastern part of Nigeria. (Ezenwaji *et al*, 2013).

One hundred and twenty (120) grower snails (*Achatina achatina*) of similar weight were procured from a reputable source at Onitsha, Anambra State. The experimental design was a Completely Randomized Design (CRD), with four treatments of 30 snails per treatment and three replicates of 10 snails.

The snails were fed once a day, in the evenings due to the snail's nocturnal feeding habit. The snails in treatment one (T1) were fed with diet without any inclusion of whole jackfruit meal, those in T2 had 5% level of inclusion of WJM, T3 had 10% level of inclusion of WJM and T4 had 15% level inclusion of WJM as shown in table 1. The feed saucer was cleaned daily before introduction of fresh feed. The soil was pulverized and watered to make it moist. The study lasted for a period of 56 days

The feed intake was measured by subtracting the feed refused from feed offered on daily basis. The shell length and shell girth were measured using Vernier caliper on weekly basis. The shell thickness was measured using a micrometer Screw guage at the beginning and end of the experiment. The shell aperture circumference was measured using a thread and meter rule on weekly basis. The weight gain was measured using a sensitive scale on weekly basis. The proximate analysis to chemically evaluate the nutritional potential of the whole jackfruit meal and experimental diets were determined by the methods of AOAC (2002).

Table 1: Percent Composition of Feed Ingredients of Snails Fed with Different Levels of Whole Jack Fruit Meal

Ingredients	**T1 (0%)**	**T2 (5%)**	**T3 (10%)**	**T4 (15%)**
Maize	49.25	44.25	39.25	34.25
Cassava Flour	11.00	11.00	11.00	11.00
WJPM	0.00	5.00	10.00	15.00
Soybean cake	15.00	15.00	15.00	15.00
Fish meal	3.00	3.00	3.00	3.00
Wheat offal	10.00	10.00	10 00	10.00
Palm kernel cake	3.00	3.00	3.00	3.00
Bone meal	5.00	5.00	5.00	5.00
Limestone	3.00	3.00	3.00	3.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
TM/Vit premix	0.25	0.25	0.25	0.25

Total	100	100	100	100

Results and Discussions

The growth performance evaluation of *Achatina achatina* is presented in Table 2. There was no significance difference among treatments in the Average Daily (ADI) and Total Feed Intake (P>0.5). Although, feed intake as observed in T_1 (0% WJFM inclusion) appears to be moderately high compared to the snails fed WJFM at T_2 5%, T_3 10%, and T_4 15% respectively. The greater feed intake not significant at (P>0.5) could be attributed to the greater palatability of the control diet T_1, to the snails compared to the Whole Jack Fruit Meal diet (WJFM).

The Total Weight Gain (TWG) of the Snails compared to the control diet (T_1) did not show any significant difference. Even though the snails consumed more of the control diet T_1. This findings agrees with Oji, (2000) where he stated that the growth performance of the snails is the measure of increase in body weight over time and largely dependent on the nutrient absorbed by the specific tissues of the body. Even though the snails on T_1 consumed more feed, it may be that the body could not utilize it efficiently. This result may have agreed with this finding that the Whole Jack Fruit Meal at 15% inclusion level (T_4) contains nutrient enough to effect changes in the total weight gained by the *A. achatina* snails although not significantly different (P>0.5).

This study showed that there was higher Feed Conversation Ratio (FCR) recorded by the snails on T_1 over the snails on T_2, T_3 and T_4, although without significant difference (P>0.05). This indicates that the African giant land snail *A. achatina* utilized nutrients in T_1 with 19.63% CP, more effectively. It was observed from the findings that the diet containing lower percentage of Crude Fiber (CF) was found to have higher Feed Conversion Ratio compared to the snails on Whole Jack Fruit Meal (WJFM). This may have attributed to the higher FCR as seen in control diet T_1. This could also have resulted due to some anti-nutrients found in Jackfruit seed as reported earlier by Ebenebe *et al*., 2014.

The findings from this study showed a clear difference between the costs of feed per weight gained by the *A. achatina* snails between the treatments with the WJFM diets having lower cost. It was observed that the feed cost per kg weight gain and the cost of feed intake of the snails decreased with increasing level of the Whole Jackfruit Meal (WJFM) in the diets, with snails placed on T_4, having the least value at ₦28.846/g and ₦14.032 respectively. While those on T_1 cost ₦30.785 per feed intake and ₦129.266/g. This low cost of WJFM based diets could have been as a result of the easy accessibility of the Jackfruit. The finding agrees with Ndyomugyeni *et al.,* 2014 that reported that Jackfruit is readily available in rural areas and will eventually be obtained at low or no cost. The result suggest that the cost of producing snail feed with Whole Jackfruit Meal (WJFM) would be lower to the corresponding body weight gain compared to the control diet (T_1), thereby making it more economical in snail farming, since the cost of feed is believed to constitute the greater percentage in livestock production.

Table 2: Growth performance and cost evaluation of *Achatina achatina* fed whole jackfruit meal based diet.

Parameters	**T1**	**T2**	**T3**	**T4**
Average daily feed intake.	0.89 ± 0.40^a	0.62 ± 0.36^a	0.85 ± 0.37^a	0.60 ± 0.35^a
Total feed intake	43.67 ± 19.52^a	30.13 ± 17.73^a	41.57 ± 18.34^a	29.23 ± 17.23^a
Total weight gain	10.40 ± 6.22^a	5.90 ± 0.00^a	9.95 ± 0.92^a	14.40 ± 0.00^a
Average daily weight gain	0.21 ± 0.13^a	0.12 ± 0.00^a	0.20 ± 0.02^a	0.30 ± 0.00^a
Initial weight gain	53.15	51.50	56.55	51.80

Final weight gain	63.55	57.40	66.50	66.20
Feed cost per weight gain	31.35	25.08	26.91	8.78
Feed cost	0.17	0.16	0.16	0.15
Cost of feed intake	7.46	4.91	6.44	4.32
Feed conversion ratio	4.20	5.11	4.18	2.03

Rows sharing similar subscript are not significantly [p (P>0.05) different from each other

The shell growth Characteristics of *Achatina achatina* fed whole jackfruit meal based diet is shown in Table 3. The Findings from this study revealed that there was significant difference (P<0.05) in the total Shell Length Gain (SLG) between the treatments, although, snails in T_1, T_2 and T_3 were not significantly different from each other. The significant difference (P<0.05) as observed in snails fed 15% inclusion of WJFM (T_4) with the other treatments could be as a result of the balanced mineral bound in the Ash (Phosphorus and Calcium) necessary for snail shell as well as the Calorie-Protein Ratio (CPR) of the Whole Jack Fruit Meal.

The Shell Thickness (ST) was significantly different (P<0.05) between the treatment with the snails on T_1 superior to the other treatments. Even though at 0% and 15% (T_1 and T_4). The Shell Girth Gain (SGG) was also found to be significantly different (P<0.05) between the treatment. On the contrary, the study revealed that there was no significant difference (P>0.05) in the Shell Aperture Gain of the snails between T_1, T_2, T_3 and the control diet (T_1). The study also revealed that the Average and the Total Weight Gain, the Shell Length (SL) and the Shell Girth (SG) Gain of snails which consumed the diet containing Whole Jackfruit Meal (WJFM) at 15% inclusion level (T_4) with 3184.82 kcal/kg ME, was superior to those on T_1, T_2 and T_3. This could be attributed to the report by (Odunaiya and Akunnusi, 2008) where they asserted that a positive correlation between the Growth Performance, Shell Length, and Shell Girth had been established, especially in growing snails. This was observed from the finding as the snails on T_4 increment in SL, WG and SG was superior to the other treatment in a positive relationship even though they significantly do not differ at (P>0.05).

Table 3: Shell Growth Characteristics of *Achatina achatina* fed whole jackfruit meal based diet.

Parameters	**T1**	**T2**	**T3**	**T4**
Shell length initial	7.96	7.89	8.17	7.79
Shell length final	8.13	8.07	8.26	8.37
Shell length increase	0.17 ± 0.19^{b}	0.19 ± 001^{b}	009 ± 0.05^{b}	0.54 ± 0.58^{b}
Shell girth initial	3.99	3.92	4.05	3.89
Shell girth final	4.10	4.10	4.18	4.18
Shell girth increase	0.12 ± 0.04^{c}	0.19 ± 0.03^{b}	0.14 ± 0.01^{bc}	0.30 ± 0.01^{a}
Shell aperture initial	10.77	10.84	11.15	10.68
Shell aperture final	11.17	11.15	11.36	11.18
Shell aperture increase	0.40 ± 0.18^{a}	0.33 ± 0.21^{a}	0.22 ± 0.23^{a}	0.52 ± 0.02^{a}
Shell thickness initial	0.91	0.86	0.85	0.79

Shell thickness final	1.26	1.31	1.15	1.15
Shell thickness increase	0.35 ± 0.00^{b}	0.46 ± 0.01^{a}	0.30 ± 0.01^{c}	0.37 ± 0.01^{b}

Rows sharing similar subscript are not significantly (P>0.05) different from each other while rows sharing different subscript ^{a,b,c} *shows significance difference (P<0.05).*

Conclusion

The study showed that whole Jackfruit is a very good feed resource for the snails since it was able to improve their performance and can be obtained at low or no cost according to earlier report making it possible for the low income earners to engage in the production and at the same time meeting up with the protein requirement of the teeming populace as recommended by FAO. Therefore 15% inclusion level of Whole Jack Fruit Meal can be recommended as it did not only gave relatively better result on the growth performance (SL, SG, WG) but also found to have the least Feed Cost and Feed Cost/Kg Weight Gain making it a cheap source of snail feed.

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Effect of Quantum blue® enzyme supplementation on the growth parameters of weaner rabbits fed toasted castor seed (*Ricinus communis*) meal (TCSM)-based diets

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ABSTRACT

Sixteen weaner rabbits weighing between 900 - 1000g liveweight were utilized in an experiment that lasted which lasted for 42days to investigate the effect of toasted castor seed (*Ricinus communis*) meal-based diets (TCSM) on growth performance supplemented with or without Quantum blue® enzyme. Four diets were compounded to be isonitrogenous (18% crude protein) and isocaloric (2800kcal/kg, ME). Treatments T1 and T2 contained 0% TCSM supplemented Quantum blue® at 0 and 100PPM while treatments T3 and T4 contained 30% TCSM and supplemented with the enzyme as in T1 and T2, respectively giving a 2x2 factorial. The rabbits were randomly allotted to the 4 treatments and each treatment was replicated 4 times. The results of the effect of enzyme supplementation or TCSM and that of their interactive effects on the growth performance of weaner rabbits shows that there was no significant variation (P>0.05) in all the parameters evaluated. Rabbit farmers can adopt toasting method of processing castor seeds and could include up to 30% TCSM especially when supplemented with Quantum blue® in the diets of grower rabbits without affecting their growth rate.

Key words: Castor seed meal, weaner rabbits, growth performance, enzyme supplementation, TCSM.

Introduction

Animal nutrition studies have shown that castor oil seed (*Ricinus communis,* L) meal can be used to a limited extent, as oil seed cake in feeds for ruminants (Rao *et al.,* 1988), rabbits (Adedeji *et al.,* 2006), pigs (Geary, 1950) and poultry birds (Okorie *et al.,* 1985). However, reports show that dietary inclusion at high levels in poultry rations suffered serious limitations due to the presence of residual ricin, ricinin and castor allergen (Puttaraj *et al.,* 1993; Ani and Okorie, 2002).

Deleterious factors present in feedstuffs have been reported to modify mucosal structure and function, affect nutrient mobility, digestion and absorption in poultry birds (Reid, 1987; Klopfenstein, 1988). Other anti-

nutritive factors like tannins have been implicated in changes relating to intestinal absorption of nutrient, reduction in villi width and length of duodenum and jejunum (Johnston, 2005; Kim and Miller, 2005) while, non-starch polysaccharides concentration has been implicated in changes relating to weights and length of the gastrointestinal tract (Johnson *et al.,* 1984).

During the production of castor oil, undehulled seeds are normally used leaving behind a fibrous meal. The fibrous nature of the castor seed also constitutes a major constraint to its utilization in poultry nutrition. Fibrous ingredients have been reported to, negatively affect nutrient utilization by diluting macronutrients (Longe and Ogedengbe, 1989), modifying gut characteristics and intestinal morphology (Wu *et al.,* 2004) and modifying the upper and lower part of the digestive tract of poultry (Gabriel *et al.,* 2003; Hetland *et al.,* 2003). Although several processing methods have been attempted in the past, studies on dietary inclusion of ethanol treated castor oil seed meal in feed for broilers are rare. The use of exogenous enzymes in alleviating these effects on animals has been documented (Alu *et al.,* 2011; Alu *et al.,* 2012) with positive results in poultry. The objective of this research is therefore, to investigate the effect of Quantum blue® enzyme supplementation on the growth parameters of weaner rabbits fed toasted castor seed (*Ricinus communis*) meal (TCSM)-based diets.

Materials and Methods

The experiment was carried out in the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University.

Source of test ingredients

Castor seeds were purchased from Masaka Market in Karu Local Government Area of Nasarawa State, Nigeria and were used alongside other ingredients to compound the experimental diets.

Experimental rabbits

Sixteen weaner rabbits were purchased from a commercial farm and reared in the open-side wire mesh rabbit hutches. Light was provided using electric bulb throughout the experimental period to enable the rabbits eat both day and night. The rabbits were fed and given water *ad-libitum*. All recommended routine medications were carried out and standard management practices were adopted as described by Aduku and Olukusi (1990).

Feed description and design of experiment

Four diets were compounded to be isonitrogenous (18% crude protein) and isocaloric (2800kcal/kg, ME) with two levels of TCSM, 0 and 30%. Treatments T1 and T2 contained 0% TCSM supplemented Quantum blue® at 0 and 100PPM, respectively while treatments T3 and T4 contained 30% TCSM and supplemented as in T1 and T2, respectively giving a 2x2 factorial; the experiment lasted for 42d. The chemical and energy compositions of the diets are shown in the Table 1.

Table 1**. Percent ingredient, chemical and energy composition of experimental diets for weaner rabbits**

Feedstuffs	**T1 (0%TCSM +0PPM)**	**T2 (0%CSM +100PPM)**	**T3 (30%CSM +0PPM)**	**T4 (30%CSM +100PPM)**
Maize	50.00	50.00	43.98	43.98
Soybeans(Fullfat)	25.00	25.00	18.10	18.10
Groundnut cake	7.68	7.68	14.20	14.20
TCSM	-	-	30.00	30.00
Bone meal	5.00	5.00	0.01	0.01
Fish meal	5.00	5.00	0.01	0.01
Palm oil	3.57	3.57	0.50	0.50
Lysine	0.25	0.25	0.01	0.01
Methionine	0.25	0.25	0.01	0.01
Salt	3.00	3.00	0.01	0.01
Premix	0.25	0.25	0.25	0.25
Enzyme (ppm)	-	100	-	100
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated chemical and energy compositions				
*Energy (kcal/kg, ME)	2860.30	2860.30	2860.10	2860.10
Crude protein (%)	18.98	18.98	18.98	18.98
Crude fibre (%)	13.42	13.42	13.42	13.42
Calcium (%)	0.90	0.90	0.90	0.90
Phosphorus (%)	0.34	0.34	0.34	0.34

The vitamin – mineral premix supplied the following per 100kg of diet: Vitamin A 15,000 I.U, Vitamin D_3 300,000 I.U., Vitamin E 3,000 I.U., Vitamin K 2.50mg, Thiamin, (B_1) 200mg, Riboflavin (B_2) 600mg, Pyridoxine (B_6) 600mg, Niacin 40.0mg, Vitamin B_{12} 2mg, Pantothenic acid 10.0mg, Folic acid, 100mg, Biotin 8mg, Choline chloride 50g, Anti-oxidant 12.5g, Manganese 96g, Zinc 6g, Iron 24g, Copper 0.6g, Iodine 0.14g, Selenium 24mg, Cobalt 214mg. **TCSM-**Toasted castor seed meal, * Calculated from (Pauzenga (1985).

Experimental design

The experiment were designed as a factorial one and lasted for 12 weeks. Individual rabbits were weighed at the commencement of the experiment and were subsequently weighed weekly. Feed consumption was measured by calculating the difference in the quantity of feed offered daily and the quantity left.

Proximate analysis

The proximate analysis of TCSM and the experimental diets were carried out at the Institute of Tropical Agricultural Research (ITAR) Ibadan, using the procedure outlined by AOAC (1990).

Data collection

The growth performance parameters evaluated included initial weight, final weight, weight gain, feed intake, FCR, PER, feed cost per weight gain.

Statistical analysis

Data obtained were subjected to Two Way Analysis of Variance and where significant differences ($P<0.05$) were observed, means were separated using Duncan's Multiple Range Test as described by Steel and Torrie (1980).

Results and Discussion

The results of the effect of enzyme supplementation or TCSM on the growth performance of weaner rabbits (Table 2) shows that there was no significant variation ($P>0.05$) in all the parameters evaluated. However, numerical differences existed which tended to improve most of the parameters.

Table 2. Effect of enzyme supplementation or TCSM on the growth parameters of weaner rabbits

Parameters	T1 (0PPM Enzyme)	T2 (100PPM Enzyme)	SEM	LOS	T1 (0%TCSM)	T2 (30%TCSM)	SEM	LOS
IW (g/rabbit)	1162.50	1062.5	126.53	NS	1175.00	1050.00	126.53	NS
FW (g/rabbit)	1543.75	1347.92	114.38	NS	1662.50	1229.17	114.38	NS
WG (g/rabbit)	381.25	385.42	86.82	NS	487.50	279.17	86.82	NS
FI (g/rabbit)	4411.21	4561.13	80.60	NS	4648.63	4323.72	80.60	NS
PER	2.09	2.31	0.57	NS	2.69	4.71	4.57	NS
FCR	2.99	1.80	0.94	NS	1.60	2.19	3.94	NS
Cost /WG (₦/kg)	120.38	120.62	12.63	NS	15.38	9.63	2.63	NS

NS = Not significant (P>0.05), **LOS**= Level of significant, **SEM** = Standard error of mean, **PER** =Protein efficiency ratio, **FCR**=Feed conversion ratio, **TCSM-**Toasted castor seed meal, **IW**=Initial weight, **FW**=Final weight. **WG**=Weight gain, **FI**=Feed intake

The results of the interactive effects of enzyme supplementation and TCSM on the growth performance of weaner rabbits is summarized in Table 3. The results show that there was no significant variation ($P>0.05$) in all the parameters evaluated but numerical differences existed which tended to improve most of the parameters.

Table 4.Interactive effect enzyme and TCSM on growth parameters of weaner rabbits.

Parameters	T1 (0%TCSM +0PPM)	T2 (0% TCSM +100PPM)	T3 (30% TCSM +0PPM)	T4 (30% TCSM +100PPM)	SEM	LOS
IW (g/rabbit)	1225.00	1125.00	1100.00	1000.00	171.59	NS
FW (g/rabbit)	1762.50	1562.50	1325.00	1133.30	109.15	NS
WG (g/rabbit)	537.50	437.50	225.00	333.33	97.26	NS
FI (g/rabbit)	4634.53	4662.73	4187.90	4459.53	77.62	NS
PER	28.32	23.05	11.86	17.56	5.13	NS
FCR	1.49	1.71	2.49	2.89	0.55	NS
Cost /WG (₦/kg)	128.25	128.93	145.94	146.10	10.97	NS

NS = Not significant (P>0.05), **LOS**= Level of significant, **SEM** = Standard error of mean, **PER** =Protein efficiency ratio,

FCR=Feed conversion ratio, **TCSM**-Toasted castor seed meal, **IW**=Initial weight, **FW**=Final weight. **WG**=Weight gain, **FI**=Feed intake

The observations recorded in the present studies show that the diets were adequate for this class of animals besides, enzyme effect are mostly noticed in diets that have crude fibre above the carrying capacity of the animal (Alu *et al.,* 2009; Alu *et al.,* 2011). The values recorded in the present studies tally with those previous reported by (Alu, 2015; Alu, 2018).

Conclusion and Recommendations

Rabbit farmers can adopt toasting method of processing castor seeds and could include up to 30% TCSM especially when supplemented with Quantum blue® in the diets of grower rabbits without affecting their growth rate.

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Effects of raw karaya gum tree (*Sterculia setigera*) seed meal on haematological and serum biochemistry indices of grower rabbits.

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Abstract

Effects of feeding raw Karaya gum tree seed meal on haematological and serum indices were studied in a ten (10) weeks experiment using grower rabbits. Four diets were compounded with the control diet having no Karaya gum tree seed meal while diets 2, 3, and 4 had 2%, 4% and 6% respectively. Thirty-six mixed breed grower rabbits with an average initial weight of 600±10g were allocated to the four diets in a completely randomized design with nine rabbits per treatment. At the end of the feeding trial, blood samples were collected for haematological and serum biochemical indices. All the parameters determined for both haematological and serum indices were significantly ($P<0.05$) influenced with increase in the test ingredient. It is thus concluded that raw Karaya gum tree seed meal had effect on the health status of grower rabbits.

Keywords: Karaya gum, grower rabbits, compounded, heamatological, serum.

Introduction

High cost of feed and feed ingredients has necessitated the need to look for alternative sources of feed ingredient which are nutritionally adequate, affordable and available locally to reduce competition between man and livestock. Utilization of locally available cheap and less competitive feedstuff in feeding rabbits will minimize the incorporation of the highly cost feed sources while maximizing output at least cost of production. Karaya gum tree (*Sterculia setigera* Del.) is a savanna tree, widespread in savanna areas of tropical Africa with natural distribution from Senegal to Cameroon in West Africa, eastwards to Eritrea, and southwards to Angola (Agishi, 2004). The tree produces seeds in hairy pods that split open when ripe to reveal black seeds that are less competed for by man and animals and could therefore be alternative source of feed ingredient for livestock.

Materials and Methods

This research work was carried out at the Teaching and Research Farm of Federal College of Wildlife Management, New Bussa, Niger State, Nigeria. Matured seeds were collected from ripened fruits of Karaya gum tree (*Sterculia setigera* Del.) collected within New Bussa. The seeds were cleaned to be free from unwanted particles; sun dried to constant weight, and milled for inclusion in the rabbit diets. Four experimental diets were compounded with raw karaya gum tree seed meal included in the diets at graded levels of 0%, 2%, 4% and 6% respectively (Table 1). Thirty-six mixed breed grower rabbits with average initial weight of 600±10g were used. The rabbits were divided into four treatment groups. Each treatment had triplicates with 3 animals per replicate housed in wooden/wire hutches in a well-ventilated pen. They were allotted to the four treatment diets in a completely randomized design. Prior to the experiment, the animals were given prophylactic treatment against parasites (with ivermectin) and coccidiosis (with coccidiostat). 2 weeks adjustment period was given for adaptation followed by 10 weeks experimental period. Feed and water were served ad-libitum.

At the end of the experimental trial, blood samples were collected into sterile universal bottles containing anti-coagulant, Ethylene Diamine Tetra Acetic acid (EDTA), for haematological parameters evaluation while blood samples were also collected into sterile bottles without anti-coagulant for serum biochemical indices. Packed cell volume (PCV), haemoglobin (Hb), red blood cells (RBC) and white blood cells (WBC) were determined while their differentials that include mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC) were calculated according to Jain (1986). Serum biochemical indices determined include total protein, albumin, urea, serum glutamate oxalotransaminate, serum glutamate pyruvate transaminate, total bilirubin and conjugate bilirubin. All data collected were subjected to analysis of variance (ANOVA) according to the procedure of Steel and Torrie (1980) while means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

Composition of the experimental diets is shown in Table 1. The result of proximate analysis (Table 2) of the test ingredient had shown that the seed is relatively high in protein (18.72%), fat (18.80%) and nitrogen free extract (45.23%). This is an indication that the seed could be a good source of nutrient for livestock to be used as replacement for costly ingredients. The crude protein used in this study is 18.12% - 18.50% which is sufficient for grower rabbit. Aduku and Olukosi (1990) had recommended 16-18% protein for growing rabbits. Haematological indices of the experimental rabbits are represented in Table 3. The haemoglobin (Hb), packed cell volume (PCV), red blood cells (RBC) and mean corpuscular haemoglobin concentration (MCHC) were higher (14.60g/dl, 37.50%, 7.06 x 10^9l and 38.93% respectively) in control (diet 1) than diets 2,3 and 4 with the lowest in diet 4. The values decreased with increase in test ingredient. The values for haemoglobin were all within the normal range (9.9-19.3g/dl) (Tuffery 1995) for healthy rabbits. PCV has highest (37.50%) in diet 1 and lowest (29.68%) in diet 4. The values for diets 1, 2 and 3 were within the normal range (31-50%) (Mitruka and Rawnsley,1977) while PCV for diet 4 was below the normal range. The similar trend for Hb and PCV could be ascribed to the relationship between Hb and PCV (Jain, 1986). White blood cells (WBC) decreased with increase in the test ingredient while red blood cells decreased with increase in the test ingredient. This might be due to presence of anti-nutritional factors. MCV values did not follow the same trend with Hb, PCV, WBC and RBC. MCV for diet 1, was below the normal range (57.8 – 65.4μ^3) while diet 4 (96.68 μ^3) was above the normal range. MCH values were not in definite order. However, MCH of diets 1, 2 and 3 were within the normal range of 17.1 – 23.5µµg (Mitruka and Rawnsley, 1977) but higher than normal range for diet 4. The normal MCH values indicate that the animals were free from anaemia. MCHC values were higher than normal range for diets 1,2 and 3 but favoured diet 4. The MCHC of diet 4 was within the normal range. Higher MCHC suggests presence of hyperchromasia. Serum biochemistry indices are presented in Table 4. The result had indicated total protein to be between 4.30g/dl and 6.75g/dl with the highest value in diet 4 while diet 1 had the lowest value. The values increased with increase in test ingredient. Low level of total protein is an indication of adequacy of protein in the diets. This is in line with Fasuyi and Ibiayo (2010) who stated that total protein is indirect indices for measuring the nutritional protein adequacy. Albumin values were between 3.00 g/dl and 3.75g/dl with the highest in diet 1 and lowest in diet 4. The values decreased with increase in test ingredient. This could be due to anti-nutritional factors in the seed. Ewuola *et al.* (2010) stated that high albumin is an indication that the rabbit did not suffer from any toxin or infection. Urea values increased with increase in the seed meal. This may be an indication of amino acid imbalance which resulted in increased blood urea as reported by Olafadehan *et al.* (2010). Serum glutamate oxalotransaminate (SGOT) and serum glutamate pyruvate transaminase (SGPT) followed the same trend with urea. The values increased with increase in seed meal in the diets. This could also be as a result of anti-nutritional components. This agreed with Olafadehan *et al.* (2010) who reported that an increase in serum SGOT and SGPT signify necrosis and myocardial infection or response to the presence of a number of toxic factors. Total bilirubin and conjugate bilirubin increased with increase in the seed meal in the diets. However, the total and conjugated bilirubin values were within the normal range of 0-6mg/dl and 0-3mg/dl respectively (Sirois, 1995 ;Olafaaaadehan *et al.*, 2010). All the values for heamatological and serum biochemical parameters were significantly ($P<0.05$) different between the treatments.

Conclusion

Conclusively, the results of this study had shown that feeding diet with raw karaya gum tree seed meal had effect on both haematological and serum biochemical indices of grower rabbits. There is therefore need to detoxify the test seed before inclusion in rabbit diet.

Table 1: Composition of the experimental diets

	Diet			
Ingredients (%)	1 (0%)	2 (2%)	3(4%)	4 (6%)
Maize bran	66.76	65.00	63.00	61.00
Groundnut cake	18.24	18.00	18.00	18.00

Rice husk	7.00	7.00	7.00	7.00
Blood meal	4.00	4.00	4.00	4.00
Sterculia setigera	-	2.00	4.00	6.00
Bone meal	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50
Premix	0.50.	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00

*SS = *Sterculia setigera* seed meal

Table 2: Proximate Composition of the experimental diets and *Sterculia setigera* seed meal

Nutrient (%)	Diet				
	1 (0%)	2 (2%)	3(4%)	4 (6%)	*Sterculia setigera* seed meal
Dry matter	91.67	91.95	92.11	92.11	95.17
Crude protein	18.12	18.20	18.35	18.50	18.72
Crude fibre	11.69	11.65	11.59	11.53	8.82
Fat	16.74	17.42	18.35	18.79	18.80
Ash	6.32	6.65	6.84	7.12	3.60
Nitrogen free extract	39.00	38.03	36.98	36.17	45.23

Table 3: Haematological indices of rabbits fed diets containing *Sterculia setigera seed meal*

Parameters	Diet				SEM
	1 (0%)	2 (2%)	3 (4%)	4 (6%)	
Haemoglobin (g/dl)	14.60 [a]	13.85 [a]	11.72 [b]	9.98 [c]	0.98
Packed cell volume (%)	32.50 [a]	35.87 [b]	32.43 [c]	29.68 [d]	1.46
White blood cells ($x10^4/mm^3$)	6.24 [c]	6.63 [c]	8.56 [b]	10.71 [a]	0.53
Red blood cells ($x10^{22}/mm^3$)	7.06 [a]	6.92 [a]	5.30 [b]	3.07 [c]	0.37
Mean Corpuscular Volume (μ^3)	53.12 [c]	57.84 [c]	61.19 [b]	96.68 [a]	2.68

Mean Corpuscular Haemoglobin (µg)	20.68 c	20.01 c	22.11 b	32.51 a	1.36
Mean Corpuscular Haemoglobin Conc.(%)	38.93 a	38.61 a	36.14 b	33.63 c	1.51

a.b.c.dMeans in the same row with different superscripts differ significantly (P<0.05)

SEM = Standard Error of Mean

Table 4: Serum biochemical indices of rabbits fed diets containing *Sterculia setigera seed*

	Diet				
Biochemical Parameters	1 (0%)	2 (2%)	3 (4%)	4 (6%)	SEM
Total Protein (g/dl)	4.30 c	4.80 c	5.70 b	6.75 a	0.34
Albumin (g/dl)	3.75 a	3.68 a	3.50 a	3.00 b	0.10
Urea (mg/dl)	4.10 d	4.63 c	5.82 b	6.90 a	0.26
Serum glutamate oxalotransaminase (µ/l)	10.15 c	10.75 c	12.43 b	15.23 a	1.58
Serum glutamate pyruvate transaminase (µ/l)	9.86c	10.07 c	11.68 b	13.37 a	1.43
Total Bilirubin(mg/dl)	3.45c	3.87 c	5.21 b	7.43 a	0.87
Conjugate Bilirubin (mg/dl)	1.80c	2.42bc	2.86 b	3.68 a	0.09

a.b.c.dMeans in the same row with different superscripts differ significantly (P<0.05)

SEM = Standard Error of Mean

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Effect of toasted castor seed (*Ricinus communis*) meal (TCSM)-based diets on growth performance of grower rabbits supplemented with or without Quantum blue® enzyme

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Abstract
A 42d experiment was conducted using 16 weaner rabbits of live weight of between 400 -900g to investigate the effect of toasted castor seed (*Ricinus communis*) meal-based diets (TCSM) on growth performance of grower rabbits supplemented with or without Quantum blue® enzyme. Four diets were compounded to be isonitrogenous (15% crude protein) and isocaloric (2800kcal/kg, ME). Treatments T1 and T2 contained 0% TCSM supplemented Quantum blue® at 0 and 100PPM while treatments T3 and T4 contained 30% TCSM and supplemented with the enzyme as in T1 and T2, respectively giving a 2x2 factorial. The animals were randomly allotted to the 4 treatments and each treatment was replicated 4 times. Enzyme supplementation significantly (P<0.05) reduced initial weight (1818.75 vs. 1368.75 g/rabbit) while initial (1862.50 vs. 1325.00 g/rabbit) and final (2112.50 vs. 1204.17 g/rabbit) weights of the rabbits were significantly (P<0.05) reduced with the inclusion of TCSM. The interactive effects of enzyme supplementation and TCSM did not affect (P>0.05) all the parameters evaluated. Rabbit farmers can adopt toasting method of processing castor seeds and could include up to 30% TCSM especially when supplemented with Quantum blue® in the diets of grower rabbits without affecting their growth rate.

Key words: Castor seed meal, grower rabbits, growth performance, enzyme supplementation, cost of feed.

Introduction

According to Nagalakshmi and Dhanalakshmi (2015), the chronic shortage of conventional oil cakes for livestock feeding in most of the developing countries has compelled for the search of alternatives for these costly protein supplements. The authors also maintained that groundnut cake is the conventionally used protein supplement in ration of most animals including ruminants in most parts of the country but at times its limited supply and seasonal availability escalates its cost.

India ranks first in castor seed (*Ricinus communis*) production with an annual availability of 1. 644 million t (FAO (2014). The residue obtained after extraction of oil from castor seeds i.e., Castor Seed Cake (CSC) is available to the tune of 1.12 million t and has potential to be used as protein supplement in animal diets because of its high crude protein and energy comparable to the conventional ones but limited because of potent anti-nutritional factors such as ricin, ricinine, allergen and chlorogenic acid (Albretsen *et al.*, 2000; Audi *et al.*, 2005) as cited by Nagalakshmi and Dhanalakshmi (2015).

Detoxification methods employed in processing which includes dehulling, soaking, heating, steaming, boiling, autoclaving and extrusion and use of chemicals and enzyme supplementation (Anandan *et al.*, 2005; Ani and Okorie, 2009; Oliveira *et al.*, 2011; Alu *et al.*, 2012) have been experimented with minimal limitations and the results were variable.

These unconventional oil seed meals could be used as such in limited amounts considering its nutrient profile and anti-nutritional factors present in them. Gowda *et al.* (2009) and Oliveira *et al.* (2015) reported no adverse effect on the nutritional performance of adult sheep and male goats due to feeding of raw or lime treated castor seed cake replacing soybean meal in the rations.

The use of synthetic enzymes in alleviating the effects of anti-nutritional factors on the performance of livestock has been documented (Alu *et al.*, 2011; Alu *et al.*, 2012). The aim of the research was therefore, to evaluate the effect of TCSM-based diets on growth performance of grower rabbits supplemented with or without Quantum blue® enzyme.

Materials and Methods

Study area

The experiment was carried out in the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University.

Source of test ingredients

Castor seeds were purchased from Masaka Market in Karu Local Government Area of Nasarawa State, Nigeria and were used alongside other ingredients to compound the experimental diets.

Experimental rabbits

Twenty grower rabbits were purchased from a commercial farm and reared in the open-side wire mesh rabbit hutches. Light was provided using electric bulb during the experiment which enables the rabbits to eat both day and night. The rabbits were fed and given water *ad-libitum*. All recommended routine medications were carried out. Other routine management practices were adopted as described by Aduku and Olukusi (1990).

Feed description and design of experiment

Four diets were compounded to be isonitrogenous (15% crude protein) and isocaloric (2800kcal/kg, ME) with two levels of TCSM, 0 and 30%. Treatments T1 and T2 contained 0% TCSM supplemented Quantum blue® at 0 and 100PPM, respectively while treatments T3 and T4 contained 30% TCSM and supplemented as in T1 and T2, respectively giving a 2x2 factorial; **t**he experiment lasted for 42d. The chemical and energy compositions of the diets are shown in the Table 1.

Table 1. Percent chemical and energy composition of experimental diets for grower rabbits

Feedstuffs	T1 (0%TCSM +0PPM)	T2 (0%CSM +100PPM)	T3 (30%CSM +0PPM)	T4 (30%CSM +100PPM)
Maize	51.95	51.95	40.00	40.00
Soybeans(Fullfat)	15.00	15.00	17.00	17.00
Groundnut cake	12.00	12.00	6.00	6.00
Castor seed toasted	-	-	30.00	30.00
Bone meal	0.70	0.70	0.70	0.70
Fishmeal	5.00	5.00	4.00	4.00
Palm oil	5.00	5.00	0.55	0.55
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	1.00	1.00	1.00	1.00
Premix	0.25	0.25	0.25	0.25
Enzyme (ppm)	-	100	-	100
Total	**100:00**	**100.00**	**100.00**	**100.00**
Calculated energy and chemical compositions				
*Energy (kcal/kg, ME)	2857.52	2857.52	2845.34	2845.34
Crude protein (%)	15.54	15.54	15.71	15.71
Crude fibre (%)	12.61	12.61	13.77	13.77
Calcium (%)	1.87	1.87	0.11	0.11
Phosphorus (%)	1.15	1.15	0.40	0.40

The vitamin – mineral premix supplied the following per 100kg of diet: Vitamin A 15,000 I.U, Vitamin D_3 300,000 I.U., Vitamin E 3,000 I.U., Vitamin K 2.50mg, Thiamin, (B_1) 200mg, Riboflavin (B_2) 600mg, Pyridoxine (B_6) 600mg, Niacin 40.0mg, Vitamin B_{12} 2mg, Pantothenic acid 10.0mg, Folic acid, 100mg, Biotin 8mg, Choline chloride 50g, Anti-oxidant 12.5g, Manganese 96g, Zinc 6g, Iron 24g, Copper 0.6g, Iodine 0.14g, Selenium 24mg, Cobalt 214mg.

TCSM-Toasted castor seed meal, *Calculated from (13 Pauzenga (1985).

Proximate analysis

The proximate analysis of TCSM and the experimental diets were carried out at the Institute of Tropical Agricultural Research (ITAR) Ibadan, using the procedure outlined by AOAC (1990).

Data collection

The growth performance parameters evaluated included initial weight, final weight, weight gain, feed intake, FCR, PER, feed cost per weight gain.

Statistical analysis

Data obtained were subjected to Two Way Analysis of Variance and where significant differences ($P<0.05$) were observed, means were separated using Duncan's Multiple Range Test as described Steel and Torrie (1980).

Results and Discussion

The result of the effect of Quantum blue® enzyme supplementation or TCSM on the growth parameters of grower rabbit is presented in Table 2. Enzyme supplementation significantly ($P<0.05$) reduced initial weight

(1818.75 vs. 1368.75 g/rabbit). Final weight (1737.50 and 1579.17 g/rabbit), feed intake (5571.00 and 3980.61g/rabbit), PER, FCR and feed cost per weight gain were not significantly (P>0.05) affected but numerical reductions (P>0.05) were recorded.

Initial (1862.50 vs. 1325.00 g/rabbit) and final (2112.50 vs. 1204.17 g/rabbit) weights of the rabbits were significantly (P<0.05) reduced with the inclusion of TCSM. However, weight gain, feed intake, PER, FCR and feed cost/ weight gain were not affected (P>0.05) by the inclusion of TCSM in the diets.

Table 2. Effect of enzyme supplementation or TCSM on growth parameters of grower rabbits

Parameters	T1 (0PPM Enzyme)	T2 (100PPM Enzyme)	SEM	LOS	T1 (0%TCSM)	T2 (30%TCSM)	SEM	LOS
IW (g/rabbit)	1818.75[a]	1368.75[b]	117.88	**	1862.50[a]	1325.00[b]	117.88	***
FW (g/rabbit)	1737.5	1579.17	141.52	NS	2112.50[a]	1204.17[b]	141.52	***
WG (g/rabbit)	293.75	210.42	42.68	NS	250.00	254.17	42.68	NS
FI (g/rabbit)	5571	3980.61	485.25	NS	4263.51	5288.10	485.25	NS
PER	1.69	1.38	0.72	NS	1.90	1.17	0.72	NS
FCR	2.71	2.11	0.39	NS	3.68	3.03	0.39	NS
Cost /WG (₦/kg)	121.07	121.13	13.09	NS	123.62	133.11	12.39	NS

NS = Not significant (P>0.05), **LOS**= Level of significant, **SEM** = Standard error of mean, **PER** =Protein efficiency ratio, **FCR**=Feed conversion ratio, **TCSM**-Toasted castor seed meal, **IW**=Initial weight, **FW**=Final weight. **WG**=Weight gain, **FI**=Feed intake

Table 3 summarizes the interactive effects of Quantum blue® enzyme supplementation and TCSM on growth parameters of rabbits. The results shows that there was no significant variation (P>0.05) in all the parameters evaluated. The values recorded in the present study are in consonance with those earlier reported by Kpanja *et al.* (2016) that fed soaked castor seed meal to rabbits and observed non-significant variation in the growth parameters. However, Akande *et al.* (2013) reported significant improvement in most of the growth parameters when fed to broilers.

Table 3. Interactive effects of TCSM and Quantum blue enzyme supplementation on growth parameters of grower rabbits

Parameters	T1 (0%TCSM +0PPM)	T2 (0% TCSM +100PPM)	T3 (30% TCSM +0PPM)	T4 (30% TCSM +100PPM)	SEM	LOS
IW (g/rabbit)	1987.50	1650.00	1737.50	1000.00	62.27	NS
FW (g/rabbit)	2200.00	1275.00	2025.00	1133.33	62.39	NS
WG (g/rabbit)	212.50	375.00	287.50	133.33	43.21	NS
FI (g/rabbit)	5308.60	5833.40	3218.43	4742.80	471.30	NS
PER	3.52	3.86	3.29	3.48	0.75	NS
FCR	1.28	2.14	2.07	3.92	0.15	NS
Cost /WG (₦/kg)	112.42	112.60	123.40	123.750	10.29	NS

NS = Not significant (P>0.05), **LOS**= Level of significant, **SEM** = Standard error of mean, **PER** =Protein efficiency ratio, **FCR**=Feed conversion ratio, **TCSM**-Toasted castor seed meal, **IW**=Initial weight, **FW**=Final weight. **WG**=Weight gain, **FI**=Feed intake

Conclusion and recommendation

The positive correlation established between total feed consumed and body weight gain among dietary treatments suggests that rabbit farmers can include up to 30% of TCSM as a protein source supplemented with Quantum blue® enzyme without affecting the growth rate of rabbits.

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DIETARY EFFECTS OF MIXED SAW DUST WITH ENZYMES AS A SUBSTITUTE FOR WHEAT OFFAL ON SERUM BIOCHEMISTRY OF BROILER STARTER (3-5WEEKS)

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ABSTRACT

The experiment was conducted using 99 broilers to determine the dietary effect of substituting mixed sawdust for wheat offal on serum biochemistry of broiler fed experimental diets. Birds were allocated to three (3) dietary treatments. Three dietary treatments were formulated with mixed sawdust substituting for wheat offal at 0%, 30%, and 60% respectively. The data obtained was arranged in a completely randomized design (CRD) and analyze by ANOVA. The experiment lasted for 21 days. It was observed that the value recorded for total serum protein, serum albumin and creatinine showed no significant ($p>0.05$) differences across the dietary treatments with the exception of AST and ALT which showed significant ($p<0.05$) difference across the dietary treatments. The highest value (3.30 g/dl) of total serum protein was obtained in treatment one (T1) while the lowest value (2.90 g/dl) was obtained in treatment two (T2). It was observed also that the value recorded for AST showed significant ($p<0.005$) difference across the dietary treatments. The highest value (191.50I.ul) of AST was obtained for broiler fed diet 1 (T1) while the lowest value (180.00I.ul) was noticed in broiler fed diet 3 (T3). It could be concluded that 60% substitution level mixed sawdust with enzymes could effectively be substituted for wheat offal without adverse effect on the health status of the birds fed experimental diet.

Key words: Broiler, Mixed sawdust, Enzymes, Wheat offal, Serum biochemistry.

INTRODUCTION

In an attempt to boost poultry production, nutritionists have tried to harness and utilize agro-industrial by-products that are not directly utilized by man (Kehinde *et al.,* 2013). A large number of alternative feedstuffs that have potential as poultry feed ingredients abound in Nigeria (Kehinde *et al* 2013; Ogundipe S. O (1996). It has been stated that research into the use of cheaper industrial by-products and wastes have been intensified in the last few years to determine the efficiency of their utilization in terms of growth and production (Kehinde *et al* 2013). The search for cheaper sources of feed ingredients for livestock feeding in Nigeria and many developing countries will continue, as long as the protein requirement in human diet has not been met (Ogundipe S. O 1996). One alternative novel feed ingredient that is receiving attention is mixed saw dust. However, feeding poultry present a great challenge to the farmers and nutritionist in Nigeria (Etuk *et al*., 2000) and several tropical countries. Unfortunately, this therefore call for rethink and expansion of resources based that can accommodate some unconventional feed ingredient that have comparative nutrient potentials like convention ingredient. There is therefore need to explore alternative source of feeding ingredient which are less competitive and available within the environment (Fanimo *et al*., 2003).

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm, Oyo State College of Agriculture Igb-oora, A total of 99 day old broiler chicks were obtained from a reputable farm in Ibadan. The birds were weighed individually and allocated into 9 brooding units, Each units housed 11 birds and were offered one of the three dietary treatments such that there were 3 replicate assigned to each dietary treatment Three experimental diets were formulated for the broiler starter phase. Experimental diets were introduced from 2-5 weeks and fed for the duration of the experiment. Three substitution level of mixed saw dust substituting wheat offal at 0, 30% and 60% levels respectively. Three (3) birds per treatment were randomly selected at the end of the feeding experiment. Blood samples of about (3ml each) were collected using sterilized needle and syringe through the wing vein of the birds into plain tube for serum biochemistry measurements. Total protein (Burrete method, coade.Rekt 391), albumin (BCG dye method, coad. 061) were analyzed in the automatic blood analyzer serum creatinine (SC) was determined using the principle of jaffe reaction as describe by Bonches and Taussky; 1945 while the serum Uric Acid (SUA) was determined using the kit (Quinica Clinica Spain) as described by wootton. 1964.

RESULTS AND DISCUSSION

Table 1: Proximate analysis of mixed saw dust

Parameters	Composition
Dry matter	86.60%
Crude protein	10.50%
Crude fibre	18.99%
Ether extract	18.90%
Ash	3.00%
Moisture content	13.40%
Nitrogen free extract	35.21%
Metabolizable energy	3184.48kcal/kg

Table 2: Gross composition of experimental diet

		Treatment	
Ingredient	**T1 (0%)**	**T2 (30%)**	**T3 (60%)**
Maize	56.00	56.00	56.00
SBM	34.00	34.00	34.00
MSD	0.00	1.50	3.00
Wheat offal	5.00	3.50	2.00
Limestone	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00
Lysine	0.25	0.25	0.25

Methionine	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Broiler premix	0.25	0.25	0.25
Total	100	100	100
M.E (kcal/kg)	2934.50	2954.26	2973.97
C.P (%)	21.75	21.65	21.56

Table 2: Dietary effect of substituting mixed saw dust for wheat offal on serum biochemistry of broilers fed experimental diets

	Treatment			
Parameters	**T1 (0%)**	**T2 (30%)**	**T3 (60%)**	**SEM ±**
Total serum protein (g/dl)	3.30	2.90	3.00	0.06
Serum Albumin (g/dl)	0.90	0.55	0.70	0.08
Creatinine (mg)	0.65	0.50	0.50	0.04
ALT (I.ul)	29.00[a]	22.00[b]	19.00[c]	2.42
AST (I.ul)	191.50[a]	181.50[b]	180.00[bc]	2.95

[a,b,c]Means on the same rows with different superscript differ significantly (p< 0.05).

It was observed that the value recorded for total serum protein showed no significantly (p>0.05) differences across the dietary treatment. The highest value (3.30 g/dl) of total serum protein was noticed in treatment one (T1) i.e 0% substituting level of mixed sawdust for wheat offal while the lowest value (2.90 g/dl) of total serum protein was obtained in treatment two (T2) i.e 30% substituting level of mixed from sawdust for wheat offal. Also, the value obtained for serum albumin fluntuate across the dietary treatment. The lowest value (0.55 g/dl) was recorded in broiler fed 30% substitute level of mixed saw dust for wheat offal while the highest value (0.90 g/dl) was obtained in broiler fed 0% substitution level of mixed saw dust for wheat offal. These results negate the report of Monica Cheesbrough who reported that low protein intake as in protein energy malnutrition decrease the level of serum albumin. There were no significant (p>0.05) difference in the value obtained for creatinine across the dietary treatments. The highest value (0.65 mg) was noticed in broiler fed 0% substitution level of mixed saw dust for wheat offal, while the lowest value (0.50 mg) was recorded for broiler fed 30% and 60% substitution level of mixed saw dust for wheat offal. The non-significant difference of creatinine (p>0.05) across the treatment was an indication of good health of the birds fed experimental diets. The result obtained was in agreement with Monica Cheesbrough who reported that any disease or condition that causes fall in the Glomerular Filtration Rate (GFR) will increase plasma creatinine level and any disease associated with muscle wasting reduce the level of creatinine in the blood. The results also agrees the findings of Sogunle *et al.*, (2006) who reported that the blood parameters measured were significantly (p>0.05) influenced by the dietary treatment except creatinine. It was observed also that the value recorded for AST and ALT showed significant (p<0.005) difference across the dietary

treatments. The highest value (191.50I.ul) of AST was obtained for broiler fed 0% substitution level of mixed saw dust for wheat offal while the lowest value (180.00I.ul) was noticed in broiler fed 60% substitution level of mixed saw dust for wheat offal. This negates the finding of Monica Cheesbrough who reported that AST level with acute hepatocellular injury or liver disease increase the level of AST. Monica *et al.,* (1987) also reported that severe bacterial infections usually resulted in an increased in the AST levels. Monica Cheesbrough also reported that the destruction of an area of heart muscle because of its blood supply being cut due to a blood clot in a coronary artery resulted in an elevated AST activity. The result of this study also negate the finding of Fanimo *et al.,* (2003) who reported no significant ($p>0.05$) difference in the AST and ALT across the dietary treatment. The result of this study agrees with the findings of Harper *et al.,* (1997) who reported that increase in aspartate aminotransferase are clinical indication of diagnosing state of damage done to the visceral organs by toxic substance or infection. In the same vein the result of this study also agreed with the finding of (Ewuola *et al.,* 2008) who observe that increase in aspartate aminotransferase are clinical indication of diagnosis state of damage done to the visceral organs by toxic substance or infection.

CONCLUSION AND RECOMMENDATION

It could be concluded that 60% substitution level of mixed saw dust with enzymes could effectively be substituted for wheat offal in the broiler starter ration without adverse effect on the health status of the birds thus, the need for adoption of mixed sawdust with enzyme and improvement is now glaring as it also has an effect on the economy of production of many farmers.

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HAEMATOLOGICAL RESPONSE OF BROILER CHICKENS FED GRADED LEVELS OF HOT WATER- SOAKED *LAGENARIA BREVIFLORA* SEED AS REPLACEMENT FOR FULL- FAT SOYABEAN

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ABSTRACT

An experiment was conducted to assess the effect of graded levels of inclusion of hot water-soaked *Lagenaria breviflora* seed as a replacement for full-fat soyabean on haematological parameters of broiler chickens. Two hundred 1-day-old Abor acre broiler chicks were used for the experiment that lasted 21 day. Birds were randomly allotted to 5 treatments of 4 replicates with 10 birds each. Hot water soaked *Lagenaria breviflora* seed was used to replace full-fat soyabean at 0, 5, 10, 15 and 20%, respectively. Results showed there were no significant differences in the PCV, Hb, RBC WBC, platelets, heterophils, monocytes, eosinophils, basophils, MCV, MCHC of birds on the experimental diets. However, Lymphocytes and MCH were significantly ($P < 0.05$) varied. Birds fed diet without *Lagenaria breviflora* (T1) had lowest lymphocytes value (60.50%). Birds on diets T2, T3, T4 and T5 showed increasing lymphocyte values ($P < 0.05$) as the level of LBS increases in the diets. However, the Red blood cell values obtained in this study did not vary significantly ($P > 0.05$) with dietary treatments. This showed that graded dietary hot water-soaked LBS had no influence on RBC of birds. It revealed that the birds were not anaemic. It was therefore concluded that hot water soaked *Lagenaria breviflora* seed can adequately replace full-fat soyabean in broiler diets up to 20% without adverse effects on the haematological indices.

Key words: *Lagenaria breviflora* seed, Full fat–soyabean, Chicks, haematological indices.

INTRODUCTION

Poultry farmers and feed millers seem to depend mainly on conventional feed resources for formulating /compounding of feeds, with a great reliance on soya bean as sources of protein though there are other sources such as fish meal and groundnut cake with the aim of supplying required nutrient to produce a balanced diet for animals. Unfortunately, a major gap exists between demand and supply of conventional feed resources for feeding livestock in the world (Amata, 2014), which is one of the main problems facing poultry production in developing countries like Nigeria; this may be due to its unavailability sometimes, and competition for the conventional feed ingredients between livestock and humans (Magoda and Gous, 2011). Hence, need to search for alternative feed ingredients that are underutilized, less competitive for human consumption and locally available, which could possibly serve as an alternative to the conventional feed ingredients. One of such alternative is the *Lagenaria breviflora* seed.

Lagenaria breviflora Roberty belongs to the family cucurbitaceae (Hanno *et al.*, 2009). In Nigeria, different tribal groups have their indigenous names as: "Ogbenwa" in Igbo, "Tagiri" in Yoruba (Burkill, 1995).The fruit of *Lagenaria breviflora* Roberty is widely used in folklore medicine in West Africa as herbal remedy for the treatment of measles, digestive disorders, and as wound antiseptics, farm animal farmers use the fruit for the treatment of Newcastle disease and coccidiosis in some farm animal species, especially poultry (Sonaiya, 1999). Laboratory investigations have shown evidence in support of its anti-bacterial activity (Tomori *et al.*, 2007). Due to anti- nutritional factor and phytochemicals present in the *Lagenaria breviflora* seed (Adepegba and Abu, 2016). There is need to evaluate its effect on the haematological status of broiler chickens. This study was therefore conducted to evaluate the effects of graded levels of *Lagenaria breviflora* seed on haematological parameters.

MATERIALS AND METHODS

The study was conducted at the Poultry Unit, Teaching and Research Farm, University of Ibadan, Nigeria. Five dietary treatments were prepared containing 0, 5, 10, 15 and 20 % hot water soaked *Lagenaria breviflora* seed (HWSLBS) in place of full- fat soyabean as shown in Tables 1. The fresh fruits were purchased from Olorunda Abba market, Ibadan, Nigeria. The fruits were washed, lacerated and allowed to rot for a period of three days for easy removal of the seeds. The seeds were, washed, drained and then soaked in hot water at 60^{o}C till cold, then drained and sun-dried for three days, then milled (Plates 1 and 2) and added to the diets appropriately. Two hundred 1-d old Abor acre broiler chicks were randomly distributed into 5 treatment groups on beddings of wood shavings in well illuminated pens. The dietary treatments consist of four replicates of 10 birds each in a completely randomized design and were brooded for seven days. The five dietary treatments prepared were; treatment 1 (control diet contained no HWSLBS), while treatments 2, 3 4 and 5 contained 5, 10, 15 and 20% levels of HWSLBS, respectively. Experimental diets were offered *ad libitum* and birds had free access to clean water throughout the experimental period.

Blood collection

On day 21, three birds per replicate were selected and bled through the jugular vein into vacutainer tubes, containing ethylene diamine tetra acetic acid (EDTA) for haematological study

Haematological indices and corpuscular

The Packed Cell Volume (PCV) was determined using Micro haematocrit method as described by Kelly (1979).Red Blood Cell (RBC) and White Blood Cell (WBC) were determined using Neubauer haemocytometer after the appropriate dilution. Haemoglobin (Hb) concentration was determined by a Cyanmethaemoglobin method using Drabkin's solution as diluents. Blood indices and corpuscular constants: Mean corpuscular volume (MCV), Mean corpuscular haemoglobin (MCH) and Mean corpuscular haemoglobin concentration (MCHC) were determined using appropriate formulae (Jain, 1986).

Statistical analysis Data obtained were analyzed using descriptive statistics and ANOVA (P=0.05) (SAS, 2012). Mean differences were separated using Duncan multiple range test (Duncan, 1955).

Plate 1: fruits of *Lagenaria breviflora*

Plate 2: *Lagenaria breviflora* seeds

RESULTS AND DISCUSSION

The results of haematological indices of birds fed graded levels of hot water soaked *Lagenaria breviflora* seed in replacing full-fat-soyabean at starter phase are shown in Table 2. The haematological variables in this study showed that there were no significant variations (P > 0.05) in the values obtained for the PCV, Hb, RBC WBC, platelets, heterophils, monocytes, eosinophils, basophils, MCV, MCHC among the dietary treatments while the Lymphocytes and MCH were significantly (P<0.05) varied. Lowest lymphocytes value (60.50%) was observed on birds on dietary treatment 1.while similar variations (P < 0.05) was observed in birds on diets T2, T3, T4 and T5, as the level of LBS increases so the values of lymphocytes. The lymphocyte is considered the main type of white blood corpuscles and a good indicator of the increase in immune efficiency, the higher levels of lymphocytes values in birds fed hot water- soaked LBS over the birds on control in this study implied a develop immune system with such an increase in number of immune cells is offering

good health. (Daramola *et al*., 2005).The highest mean corpuscular haemoglobin (MCH) 55.81*pg* was observed in birds on dietary treatment 3 while the lowest value was observed in birds on the dietary treatment

2. The birds on dietary treatments 2, 4, 5 and control were statistically similar and significantly lower than dietary treatment 3. In view of the fact that MCH is an indicator of the blood

carrying ability of the Red Blood Cell, this possibly will imply that the birds on dietary treatment 3 with the highest value of MCH may be more capable of performing respiratory function as reported by (Soetan *et al.*, 2013). Similar result was observed by Abdulazeez *et al*., 2016, where baobab seed was included in the diet of broiler chickens as a replacement for soyabean meal. The values obtained for MCH in this study is an indication that the birds were not anaemic. This suggested that the diets were well tolerated by the experimental animals. The PCV, HB, RBC MCHC, lymphocytes and heterophils of birds in experimental diets did not have a definite trend but were similar to those on the control diet at starter phase. This suggests that both the control and test diets have similar dietary quality that resulted into identical haematological variables. All the haematological indices measured were within the normal range reported for broiler chickens (Mitruka and Rawnsley, 1981).

Table 1: Gross composition of Experimental Diets for Broiler starter

	Hot water-soaked *Lagenaria breviflora* seed (%)				
Ingredients	0	5	10	15	20
Maize	48.95	48.95	48.95	48.95	48.95
Fish meal	2.50	2.50	2.50	2.50	2.50
Full fat soya	37.00	35.15	33.30	31.45	29.60
HWSLBS	0.00	1.85	3.70	5.55	7.40
Wheat offal	8.00	8.00	8.00	8.00	8.00
Dicalcium phosphate	1.00	1.00	1.00	1.00	1.00
Limestone	1.75	1.75	1.75	1.75	1.75
Common salt	0.25	0.25	0.25	0.25	0.25
Vit. premix*	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.05	0.05	0.05	0.05	0.05
D-L Methionine	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
CALCULATED NUTRIENT (%)					
Crude protein	21.75	21.71	21.68	21.65	21.62
Crude fibre	3.30	3.50	3.70	3.90	4.20
Calcium	1.00	1.10	1.10	1.10	1.09
phosphorous	0.50	0.40	0.40	0.40	0.40
Lysine	1.30	1.30	1.30	1.20	1.20
Methionine	0.64	0.63	0.63	0.63	0.62
ME (Kcal/Kg)	3123.00	3149.90	3176.80	3203.70	3230.70

* *Vit. A 10,000,000 IU; Vit.D3 2,000,000IU; Vit. E 8,000IU; Vit.K 2,000 mg; Vit.B1 2,000 mg; Vit.B2 5,500 mg; Vit.B6 1,200 mg; Vit. B12 12 mg; Biotin 30 mg; Folic acid 600 mg; Niacin 10,000 mg; Panthothenic acid 7,000 mg; Choline chloride 500,000 mg; Vit. C 10,000 mg; Fe 60,000 mg; Mn 80,000 mg; Cu 8,000 mg; Zn 50,000 mg; I 2,000 mg; Co 450 mg; Se 100 mg; Mg 100,000 mg; Antioxidant 6,000mg.HWSLBS = Hot water soaked Lagenaria breviflora seed*

Table 2: Haematology Indices of Broiler Chickens fed hot water soaked *Lagenaria breviflora* seed meal at starter phase

	Hot water soaked *Lagenaria breviflora* seed meal (%)					
parameters	0	5	10	15	20	SEM
PCV %	25.00	26.00	21.75	23.00	22.25	0.65
HB (g/dL)	8.05	8.45	7.08	7.48	7.28	0.22
RBC($x10^6$/µl)	2.12	2.39	1.27	1.61	1.52	0.17
WBC($x10^3$/µl)	13.63	12.50	12.18	12.29	12.29	0.48
Platelets (x^5/ µl)	1.59	1.89	1.50	1.83	1.83	0.06
Lymphocytes (%)	60.50^{b}	63.25^{ab}	63.75^{ab}	64.00^{ab}	67.75^{a}	0.85
Heterophils (%)	29.50	28.50	25.00	32.50	109.00	16.29
Monocytes (%)	3.75	3.00	3.50	3.00	2.50	0.22
Eosinophils (%)	3.25	4.25	3.25	3.50	3.50	0.29
Basophils (%)	0.25	0.25	0.00	0.50	0.25	0.09
MCV(*fl*)	126.50	124.15	171.58	149.28	153.06	7.17
MCH(*Pg*)	40.89^{ab}	40.17^{b}	55.81^{a}	48.20^{ab}	49.97^{ab}	2.29
MCHC (%)	32.24	32.48	32.53	32.47	32.69	0.16

a, b, c Means with different superscripts on the same row are significantly different ($p<0.05$). SEM: standard error of mean, PCV: packed cell volume, HB: Haemoglobin, RBC: Red blood cell, WBC: White blood cell, MCV: Mean corpuscular volume, MCHC: Mean corpuscular haemoglobin concentration, MCH: mean corpuscular haemoglobin.*Pg*: pictogram, *fl* : femtolitre

Conclusion

This study revealed that *Lagenaria breviflora* seeds are a valuable replacement for full- fat soyabean up to 20% in broiler diets without adverse effects on the haematological parameters. This suggests that the test diets did not precipitate any detrimental effects on the haematological status of the experimental birds.

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NUTRITIVE AND PHYTOCHEMICAL EVALUATION OF SOME SEEDS AS SUPPLEMENT IN LIVESTOCK DIET

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Abstracts

The study was carried out to evaluate the proximate composition and phytochemical values of black cumin seed (*Nigella sativa*), mustard seed (*Brassica juncea)* and pawpaw seed (*Carica papaya*) as potential ingredient and phytogenic feed additive for livestock. The phytochemical analysis and proximate composition of mustard seed, pawpaw seed and black cumin seed meal of the dried seed were determined using standard methods. Proximate composition shows that Mustard seed meal had the highest crude protein (18.68g/100g), while pawpaw seed meal had the least crude protein with a value of (15.78g/100g). Pawpaw seed meal had the highest fibre fraction (11.86g/100g) while mustard seed meal had the least value (5.69g/100g), phytochemical composition showed that alkaloid and tannin were high in mustard seed (526.33mg/100g and 43.33mg/100g respectively) and pawpaw seed had high phenol, saponin and flavonoid (206.0033mg/100g, 310.6733mg/100g and 8.3333mg/100g respectively), while black cumin seed had the lowest value for alkaloid, tannin, phenol, saponin, and flavonoid (17.7933mg/100g, 2.3433mg/100g, 31.5733mg/100g, and 0.4133mg/100g) respectively. Thymoquinone concentration in black cumin seed is (25.29mmol/kg), benzyl isothiocyanate in pawpaw (35.65mmol/kg), Allylisothiocyanate in mustard (14.57mmol/kg). This study showed that the seed meal of the investigated plants can nutritionally serve as fed ingredient and can also be used as phytogenic feed additives for ruminant and non-ruminant.

KEYWORDS: Mustard, pawpaw, black cumin, nutritive value, phytochemical values

Introduction

In 2006 there was a ban on the use of antibiotic growth promoters in animal feed and a full ban in the US in 2017 (Cherif *et al.,* 2018). This ban, raise the awareness of the consumers to health hazard of antibiotics, the rising case of illness leading to mortality of bird and reduction in performance due to pathogens in farm altogether causing economic losses has led to search for alternative growth promoter. Also the increasing human population and the need to meet the protein requirements of this populace led to decade of improvement in livestock industry (Hodges 2009). There has been introduction of antibiotic feed additives which became widely used in animal feed for many decade to increase feed efficiency (Abd El-Hack *et al.,* 2016). This improvement brought about increase in production (eggs, meat) by combating gut pathogens that could have competed with beneficial intestinal microbes for nutrient. The antibiotics (mostly medically important) were used as growth promoter by continual addition to diet at sub-therapeutic levels, thereby improving productivity and diseases prevention. However, this relentless utilization has led to the increasing resistance of pathogens to antibiotics and perhaps, the accumulation of antibiotic residues in animal products has led to resistance of transmissible microbes (food pathogens) to antibiotics in human (WHO 2017). Several studies have shown that herbs would not only be of health benefits but would also improve gut health of the birds, growth pattern, increase performance, increase appetite, improve feed conversion rate (F.C.R) and feed efficiency (Islam *et al.,*2017). This is due to the present of minerals (selenium, zinc, manganese, phosphorous, magnesium, and iron), and the presence of alkaloid, tannin, phenol, saponin and flavonoid) vitamin E, all of contribute to human health and can induce physiological changes in the body. Many non-therapeutic substitutes such as prebiotics, probiotics, symbiotics, organic acids, essential oils and plant extract have been studied (AllouI *et al.,* 2013). However, due to ease of access or local availability, plants and their extracts might be a promising panacea to this challenge (Faniyi *et al.,* 2016). They are known to have health benefits (such as appetite and digestion stimulants (Janz *et al.,* 2007) anti-microbial action,

anti-inflammatory action, anti-oxidative action, immune-stimulant function and appetite/digestion stimulants. (Bodas *et al.,* 2012) on animals when used as feed additives in animal nutrition (Faniyi *et al.,* 2016).Aside the nutritional contribution of plants to diet, they naturally, contain plant secondary metabolite (bioactive components), which are responsible for the other medicinal action of plants. Thus these plant can function as nutraceuticals; these refers to crops containing plant secondary metabolites, which are considered for their beneficial effect upon health and also their direct contribution to the nutrition of animals (Waller and Thamsborg, 2004). Black cumin seed (*Nigella sativa*), Mustard seed (*Brassica juncea)* and Pawpaw seed (*Carica papaya)* have been used by few authors and are reported to improve productivity. However, there are discrepancies in these reports.

Pawpaw fruit (*Carica papaya*); the seed of these fruit has no edible benefit that endear human to eat it as they are always expunged when the fruit is eaten. However, the seed is rich in antioxidant, it contains proteolytic enzymes which is good for breaking down undigested protein in the digestive tract and helps to expunge intestinal parasites such as intestinal worms. Allou*l et al.,* 2013

Black Cumin Seed (*Nigella sativa*): is used as a natural remedy due to the presence of antimicrobial, antioxidant and other pharmacological properties and improves nutrient utilization and potentially suitable for the use in poultry diet as a feed ingredient and contains studies reported that BCS may increase polyunsaturated fatty acid content and antioxidant properties in meat (Abd El-Hack *et al*., 2016).

Mustard Seed (*Brassica juncea*): This is available in white, brown and black varieties they are slightly bitter in taste and are astringent. The selenium content in mustard seeds provides good resistance against diseases. It contains magnesium and omega -3(Al-Jasass and Al-Jasser 2012). There are certain nutrients in mustard that prevents occurrence of disease.

This study is conducted to evaluate the nutritional qualities, phytochemical and mineral constituents of plants seed for their potential as feed additives for animals.

Material and methods

Sample collection: Three plants seed; pawpaw (*Carica papaya*) gathered from different south western Nigerian states (Ogun, Oyo, Ekiti, Ondo and Osun states), brown mustard (*Brassica juncea*) was obtained from a local market and packaged by TRS wholesale Co Ltd, United Kingdom and black cumin(*Nigella sativa*) originated from Sudan was obtained from Kaduna State, Northern Nigeria.

Preparation and production of seed meal: The pawpaw seeds were removed from the pawpaw fruit and sundried for 14 days. The dried pawpaw seed, brown mustard and black cumin seed were all milled prior to analysis. They were milled and kept in cellophane bags till required for analysis.

Chemical analysis

Proximate Analysis: Proximate analysis was conducted using A.O.A.C 2005 method

Phytochemicals

Tannin Determination: The spectrometric method of AOAC (2005) and Joslyn (1970) was used for tannin analysis.

Alkaloids Determination: Henry (1993) and Allen (1992) method was used to analyse for Alkaloids

Flavonoids Determination: The Spectrophotometric method of Allen (1979) was used for Flavonoid Analysis.

Saponin Determination: Spectrophotometric method of Brunner (1984) was used for Saponin Analysis.

Phenol Determination: 0.20g of sample was weighed into a 50ml beaker, 20ml of acetone was added and homogenize properly for 1hr to prevent lumping. The mixture was filtered through a Whatman No.1 filter paper into a 100ml Volumetric Flask using acetone to rinse and made up to mark with distilled water with

thorough mixing.1ml of sample extract was pipetted into 50ml Volumetric flask,20ml water added,3ml of phosphomolybdic acid added followed by the addition of 5ml of 23% Na_2CO_3 and mixed thoroughly, made up to mark with distilled water and allowed to stand for 10min to develop bluish-green colour.

Standard Phenol of concentration range 0-10mg/ml was prepared from 100mg/l stock Phenol solution from Sigma-Aldrich chemicals, U.S.A. The absorbance of sample, as well as, that of standard concentrations of Phenol was read on a Digital Spectrophotometer at a wavelength of 510nm.The percentage Phenol is calculated using the formula:

$$\frac{Absorbance of sample \times gradient factor \times dilution factor}{Wt. of sample \times 10{,}000}$$

Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) using SPSS 22.0 software package. Significant treatment means were compared using the Duncan multiple range test of the same package.

RESULTS AND DISCUSSION

Chemical composition of Mustard *Brassica juncea* seed, pawpaw *Carica papaya* seed and black cumin *Nigella sativa* seed are shown in Table 1 Mustard seed, pawpaw seed and black cumin seed were significantly different ($p < 0.001$) from one another for crude protein (CP), crude fibre (CF), ash, ether extract (EE), organic matter (OM), nitrogen free extract (NFE). The values obtained for OM was 92.11, 88.59, 91.97 (g/100g) for Mustard, pawpaw and black cumin seed respectively. The ether extract of mustard seed (13.88g/100) was higher than that reported by (Sarker *et al.,* 2015) for black mustard (8.70%) but slightly lower than the values reported for brown mustard in this study (15.67%). The NFE (49.61g/100g) was higher than reported by Adejumo and Agboola (2016) as 28.42 and 37.4 for yellow and brown mustard.

Table 2 shows the result of phytochemical compositions of Mustard seed (*Brassica juncea)*, Pawpaw seed (*Carica papaya)*, and Black cumin seed (*Nigella sativa*). The value for Mustard, Pawpaw, and Black cumin seeds for alkaloid, tannin, phenol, saponin and flavonoid were significantly different ($p<0.001$) from one another. The values (mg/100g) of alkaloid; (526.33, 407.67 and 495.33 mg/100g), tannin; (43.33, 28.00, and 37.00mg/100g), phenol; (187.00, 206.00 and 176.33 mg/100g), saponin; (116.33, 310.67 and 126.67 mg/100g), and flavonoid; (7.10, 8.33 and 5.50 mg/100g) for mustard, pawpaw and black cumin respectively. Phytochemicals in this study was similar to that of neem fruit as reported by (Ekanem, 2016). Furthermore, the neem fruit was able to reduce rumen protozoa which exist in a hydrogen exchange relationship with methanogens.

Table 1: Chemical composition (g/100g) of mustard, pawpaw seed and black cumin seed

Parameters	Mustard	Pawpaw	Cumin	SEM	P-Value
Crude Protein	18.68^{a}	15.78^{c}	16.68^{b}	0.42	0.000
Ether extract	13.88^{a}	3.68^{b}	2.87^{c}	1.77	0.000
Crude Fibre	5.69^{c}	11.86^{a}	6.36^{b}	0.98	0.000
Ash Content	4.25^{c}	5.29^{a}	5.09^{b}	0.16	0.000
Organic Matter	92.11^{a}	88.59^{c}	91.97^{b}	0.58	0.000
Moisture	7.89^{c}	11.41^{a}	8.03^{b}	0.53	0.000

NFE	49.61[c]	51.99[b]	60.96[a]	1.73	0.000

a,b,c: Means with different superscripts along the same row are significantly different ($p < 0.05$)

Table 2: Phytochemicals composition (mg/100g) of mustard, pawpaw seed and black cumin seed

Parameters	Mustard	Pawpaw	Cumin	SEM	P-Value
Alkaloid (mg/100g)	526.33[a]	407.67[c]	495.33[b]	17.79	0.000
Tannin (mg/100g)	43.33[a]	28.00[c]	37.00[b]	2.34	0.001
Phenol (mg/100g)	187.00[b]	206.00[a]	176.33[c]	4.40	0.000
Saponin (mg/100g)	116.33[c]	310.67[a]	126.67[b]	31.57	0.000
Flavonoid(mg/100g)	7.10[b]	8.33[a]	5.50[c]	0.41	0.000

a,b,c: Means with different superscripts along the same row are significantly different ($p < 0.05$).

Conclusion

The nutritional value of these plants seeds could be used as feed supplement and could also provide health benefit to animals due to its bioactive constituent. The phytochemical concentration shows that these seed can also be used in microbial modulation in regulation of pathogenic microbes in and for rumen manipulation in livestock.

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PROXIMATE COMPOSITION OF RAW-DRIED AND HEAT TREATED *CANARIUM SCHWEIFURTHII* (ATILI) FRUIT AS NON-CONVENTIONAL INGREDIENT IN BROILER DIET

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Abstract

The research work investigated the proximate, and some anti-nutritional content of *Canarium schewifurth* (atili) fruit as non-conventional ingredient in broiler diet. The moisture content of *canarium* fruit for both Raw-Dried (RD) and Warm-Dried (WD) were 4.68 and 6.95 %, respectively. The crude protein of *Canarium schweinfurthii* fruit for RD and WD were 6.62 and 3.64 % respectively. The value of the crude fibre content for Raw-Dried is 6.08% while for Warm-Dried is 3.64%. It was observed that the Crude Fat of RD *Canarium schweinfurthii* fruit was higher (37.93%) when compared with the value in the WD *Canarium schweinfurthii* fruit (21.88 %). The study revealed that heat reduced the anti-nutritional content of the fruit; phytic acid (mg/100g) value in the RD was 12.78 and WD was 7.30 while the oxalate and tannins content were also reduced by heat.

Keyword: *Canarium schweinfurthii* fruit, Raw-dried, Warm-dried, anti-nutrient, broiler diet

Introduction

Poultry industries in Nigeria are constantly experiencing shortage of feed resources and where these resources are available they are in higher demands by man which make them unavailable or too expensive to feed livestock. A possible way to reduce poultry feed costs is finding alternatives to conventional nutrient sources that are less expensive, efficient and locally available (Amandeep 2016). Non-conventional feedstuffs refer to all those feed resources that have not been traditionally used in animal feeding or are not used commercially in the production of rations for livestock (Adelowo, 2018). There is therefore need to research into the use of non-conventional feed resources. Example of such seed is *Canarium schweinfurthii,* it belongs to the family *Burseraceae* and the genus *Canarium* (Keay, 1989; Wikipedia, 2007). In Nigeria, (Nyam *et, al.* 2014), reported that it thrives well in the rocky and flatlands. It is common in Bauchi, Southern Kaduna, Niger, Oyo and Plateau States of Nigeria (Nyam, 2011). The fruit contains a hard fluted stone in which is a seed. Inside the seed are edible and oily nuts (Nyam and Wonang, 2004). The slightly greenish outer pulp of the fruit is oily and edible. It can be eaten raw or soften in warm water to improve palatability. The pulp oil contains about 71% palmatic acid and 18% oleic acid which is edible. The fruits are similar in structure and color to the well-known fruits of Olive plant (*Olea europaeae*) of Israel, though from different families (Nyam *et, al.* 2014). It is a plant which can be described as multipurpose economic plant whose broad utilization in the West Africa Region has been documented (Burkill, 1985 and Orwa *et, al.* 2009).

Several scientific researches have been carried out on *Canarium schweinfurthii*, in order to determine its chemical composition. The phytochemical screening of *Canarium schweinfurthii* revealed the presence of chemical active compounds in all its parts. From leave: Saponins, tannins, cardiac glycoside, steroids and flovonoid (Ngbebe *et, al.* 2008); From bark: triterpenes, steroids, saponins, lipids and glycosides (Kouambou *et, al.* 2007); from resin: Triterpenoic acids (Yousuf *et al*, 2011); from seed: Tannins, balsams, cardiac glycosides, phenols and flavonoids (Uzama *et, al.* 2012), canarene (Tamboue *et al*, 2000). Some pure molecules have been isolated from this plant extracts. Yousuf *et al* (2011) isolated three triterpenoic acids, namely 3a- Hydroxytirucalla-8, 24-dien-21-oic acid, 3α- hydroxytirucalla-7,24-dien-21-oic acid (or epielemadienolic acid) and 3β-fluorotirucalla-7,24- dien-21-oic acid, from the resin of *Canarium schweinfurthii* Engl.

Materials and methods

The sample of *Canarium schweinfurthii* fruit was obtained from Mangu Local Government area of Plateau state. The sample was divided into two. The first sample was the Raw-Dried (RD), it was processed by peeling the shaft and was oven dried at 37^0C or two days and crushed with mortal to powder in the laboratory. The second sample was Warm-Dried (WD); steamed and sun dried for ten day (10days) and crushed with mortal to powdery form.

The Laboratory analysis was conducted at the Biochemistry Division of the National Veterinary Research Institute Vom Plateau state. The Moisture content was determined using methods described by Karl-Fischer (AOAC, 1990). While the Kjeldahl revised by Johann Kjeldahl (1948-1900) (AOAC, 1990) was used to determine the Protein content. The mineral contents sodium, potassium, magnesium and iron of the fruit were determined based on the methods in AOAC (1990) using Unican 969 Atomic Absorption Spectrophotometer (AAS) with serial number 501361 V5:50. The phosphorus content of the fruit was analyzed using Hach DR240 machine. Twenty-five millilitres of the sample was taken and 1.0 mL molybdovanate reagent added then swirled to mix thoroughly for 3 min before measurement was taken. Carbohydrate content of the mesocarp fruit of *C. schweinfurthii* was determined using AOAC (1990) by subtracting the total ash content, crude fat plus crude protein and crude fibre from the total dry matter. Tannins and phytic acid of the fruits were determined by alkaline titration (AOAC, 1984). Total oxalate of the fruit was determined by the permanganate titration (Dye, 1956).

Results and Discussion

Table 1: Proximate Composition of *Canarium schweinfurthii* fruit

Parameter	RD(g/100g)	WD(g/100g)
Moisture	4.68	6.96
Crude protein	6.62	5.91
Crude fibre	6.08	3.64
Crude fat	37.93	21.88
Ash	3.49	2.24
NFE	41.20	59.38
Calcium	0.27	0.35
Phosphorous	0.01	0.04

NFE=Nitrogen Free Extracts

Table 2: Anti nutritional content in *Canarium schweinfurthii* fruit

Parameters	RD(mg/100g)	WD(mg/100g)
Phytic Acid	12.78	7.30
Oxalate	27.50	10.00
Tannins	1.02	0.07

Table 1 shows the result of proximate analysis of ***Canarium schweinfurthii* fruit**. The result shows that the RD fruit contains higher values of crude protein 6.62%, crude fibre 6.08%, ash 3.49% and crude fat 37.93% while the WD values crude protein 5.91%, crude fibre 3.64%, ash 2.24% and crude fat 21.88% were slightly lower when compared with the RD. But the values of Moisture content 6.96%, NFE 59.38, calcium 0.35, and phosphorus 0.01 for WD were higher when compared with those of the RD fruit. This result is similar to the findings of Nyam *et. al.,* (2014) who reported the moisture content of *Canarium schweinfurthii* fruits to be 5.77%. High moisture content of fruits may speed up the deterioration of the fruit since excess water aids microbial spore germination (Nyam *et al.,* 2014). Ayoade *et al.,* (2015) also reported the fibre contents of *Canarium schweinfurthii* as 6.09%.

According to Agbo *et, al.* (1992), the *Canarium schweinfurthii* fruit pulp from Ivory Coast was found to contained 5.6% protein, 30–50% fat, 8.2% starch, 11.8% cellulose, potassium, 1.2% and calcium 0.4% which were similar to the value observed in the *Canarium schweinfurthii* fruit obtained in Plateau State Nigeria.

Table 2 shows the anti-nutritional contents of the RD and WD *Canarium schweinfurthii* fruit. It was observed that heat reduces the phytic acid, oxalate and tannin contents of the *Canarium schweinfurthii* fruit. Phytic acid in RD is 12.78 and WD is 7.30 respectively, while the Oxylate value was high in the raw-dried (27.50) compared with the WD (10.00), we can therefore conclude that heat treatment help to reduce the phytochemicals in the raw-dried fruit. Nyam *et. al.,* (2014) in their studies revealed that phytate, decreases the absorption of zinc, calcium, magnesium and iron. Tannins are complex phenolic polymers and the condensed ones are widely distributed in plants but pass through the digestive system unchanged. They are generally non-toxic but large doses can give rise to gastroenteritis (Nyam *et. al.,* 2014).They also play active roles in the healing of wounds and burns, also reduction of iron absorption. The result obtained may elicit adverse physiological responses, but initial processing such as pre-warming the fruit and fermenting fruit before oil extraction from the fruit is known to significantly reduce oxalate contents of vegetables (Akwaowo *et al.*, 2000). Fermentation processes as noted by Odunfa (1985) improves nutrient value and removes anti-nutritional factors of food. The oxalate level obtained in this study 26 mg/100g is far lower than that reported for *Solanum nigrum* leaf and seeds, 78.65.0 and 58.81, 0.01 mg/100 g; 800 mg of oxalate have been reported in whole grains (Garrow and James, 1993).

Conclusion

Canarium schweinfurthii fruit warm-dried can be used as a non-conventional feed resources in diet for broiler chicken.

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EFFECT OF SEX AND STRAIN ON GROWTH PERFORMANCE OF NIGERIAN INDIGENOUS CHICKENS (FUNAAB ALPHA AND YORUBA ECOTYPE)

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Abstract

A thirteen-week experiment was conducted to determine the effect of sex and strain on the growth performance of Nigerian indigenous chickens (FUNAAB Alpha and Yoruba ecotype). One hundred and twenty chickens comprising thirty (30) each of FUNAAB Alpha males, FUNAAB Alpha females, Yoruba ecotype males and Yoruba ecotype females were assigned to four treatments arranged in a 2 x 2 factorial arrangement. Sex significantly ($p<0.05$) increased the final weight, the daily weight gain, the daily feed intake of male indigenous chicken with better feed conversion ratio than their female counterparts. Similarly, significantly ($p<0.05$) higher final weight, the daily weight gain and the daily feed intake were observed with the FUNAAB Alpha over the Yoruba ecotype chicken breed. However, the female FUNAAB alpha chicken recorded significantly ($p<0.05$) higher final weight, the daily weight gain and the daily feed than both the male and female Yoruba ecotype while the Yoruba ecotype females recoded the least performance. It could be concluded that sex and strain has significant effect on the growth performance of indigenous chicken.

Keywords: FUNAAB alpha, Yoruba ecotype, sex, strain, growth performance,

Introduction

Poultry meat and egg consumption is vital in meeting the human daily protein requirements. Demand for poultry meat is higher because of its perceived superiority in health aspects when compared to red meat. The meat has comparably low contents of fat and cholesterol (Jaturashita, 2004). There is therefore the need to encourage increased production and consumption of chicken in Nigeria. The poultry industry in Nigeria is majorly composed of indigenous village scavenger breeds and high performing exotic breeds. According to Sil *et al*. (2002), the exotic breeds are not resistant to most of the endemic poultry diseases as their counterpart indigenous breeds do. The indigenous chickens are however, well adapted to the environment. Ogundipe *et al*. (1999) reported that, the advantage of having a stock that was developed locally includes ability to exhibit a greater adaptation to the environment than the imported stock. These indigenous chickens are preferred by rural and urban dwellers for their more flavoured and tough textured meat, good quality eggs and other reasons. LeBehan–Dual (2004) reported that, many consumers prefer the local chicken to the exotic ones due to its leanness and relatively low price. However, the indigenous chickens are generally less productive in terms of eggs and meat. According to Sonaiya (1990), the indigenous chicken is sadly rarely accorded primary consideration in economic development activities in most African countries; hence less research activities had been focussed on them for decades. This has limited their potentials. Through crossbreeding and intensive selection over many generations some chicken populations have also been developed in Nigeria including the FUNAAB Alpha at the Federal University of Agriculture of Agriculture, Abeokuta, for improved meat and egg production without sacrificing adaptation to tropical environment characterized with heat stress and infectious diseases (Ilori *et al.,* 2016). According to Assan (2015), the knowledge of growth performance is essential in poultry production being fundamental attributes for assessing growth and feed efficiency as well as important yardstick in management and economic decision making. A number of factors such as nutrition, growth rate, sex and age have been reported to affect growth response (Omeje and Nwosu, 1983). Among all these factors, according to Sola-

Ojo *et al.* (2012), sex has greatest impact on the possibility of genetically improving growth response. Therefore, this study is aimed to determine the effect of sex and strain on growth performance of Nigerian indigenous chickens (FUNAAB alpha and Yoruba ecotype).

MATERIALS AND METHODS

Experimental birds and management

The study was carried out at the poultry Unit of the Institute of Food Security, Environmental Resources and Agricultural Research, Federal University of Agriculture, Abeokuta. The farm is located in the derived savanna region with an average temperature of 38^0C and a relative humidity of 38%. It is in the region 70m above sea level of latitude 7^0 53'N and longitude 3^0 20'E. It receives a mean precipitation of 1037mm per annum. One hundred and twenty day old chicks comprising thirty (30) chicks each of FUNAAB alpha males, FUNAAB alpha females, Yoruba ecotype males and Yoruba ecotype females. These indigenous chickens were all sourced from the University hatchery. The birds were raised under the intensive system of management using deep litter system. Sexing was done at the end of the chick phase (8 weeks), when the distinguishing characteristics were obvious. Commercial chick mash was fed up to the end of chick phase at the eight week. Grower mash was fed at growing phase (8-21weeks). All necessary vaccination and medication were provided as at when due.

Data collection on growth performance

The data on weekly feed consumption, weekly body weight gain and final body weight were collected during the trial. The data collected on feed intake and weight gain were used to calculate feed conversion ratio (FCR) as followed:

$$FCR = \frac{\text{Feed intake}}{\text{Weight gain}}$$

Statistical analysis

The experimental layout was a 2x2 factorial arrangement. The data collected were subjected to Analysis of Variance (ANOVA) using SAS 2012. Significant ($p<0.05$) means among variables were separated using Duncan Multiple Range Test of the software.

Results and Discussion

The effect of sex on growth performance of the Nigerian indigenous chickens is presented on Table 1. The final weight, the daily weight gain and the daily feed intake increased significantly ($P<0.05$) in male chicken of both strains than their female counterparts. Similarly, the feed conversion ratio (FCR) of the male birds was better ($P<0.05$). This finding was similar to the findings of Atteh (1990) and Adedokun and Sonaiya (2001), who reported higher performance for the male than female of the Nigerian indigenous chickens in terms of final weight. The difference in the performance the two sexes may be due to the usual difference between sex differential hormonal actions which invariably leads to differential growth rates as reported by Baeza *et al*. (2001). The Table 2 shows the effect of strain on growth performance of the Nigerian indigenous chickens. Significant ($P<0.05$) effect of the strain was observed on the final weight, the daily weight gain and the daily feed intake of the birds. FUNAAB alpha recorded higher values in all parameters of significant ($P<0.05$) difference. The poor performance of the Yoruba ecotype chickens has been attributed to the lack of genetic and management improvement. FUNAAB alpha, through crossbreeding and intensive selection over many generations, have been developed for improved meat and egg production without sacrificing adaptation to tropical environment characterized with heat stress and infectious diseases (Ilori *et al.,* 2016). Momoh (2005) in his work on the growth performance of Nigerian indigenous chickens, reported that the heavy ecotype (strain) showed significant higher body weights than the light ecotype (strain) at all ages. The interaction effect between sex and strain on growth performance of the Nigerian indigenous chickens is presented on Table 2. FUNAAB alpha males recorded the highest ($P<0.05$) final weight, the daily weight gain and the daily feed intake, followed by the FUNAAB alpha females; followed by the village scavenger males while the Yoruba ecotype females had the least performance. However, no significant interaction effect

(P>0.05) of the sex and strain was observed on the FCR of the birds. The result of this study in the interaction effect was similar to the finding of Momoh *et al*. (2010) who worked on sexed heavy and light Nigerian local chickens.

Conclusion

The sex and strain significantly affected the final live weight, the daily weight gain and the daily feed intake of the Nigerian indigenous chickens. However, only the sex had significant effect on the feed conversion ratio of the birds.

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Table 1: The main effects of strain and sex on growth performance of the Nigerian indigenous chickens

Parameters	Male	Female	SEM
Initial weight	545.59	490.28	11.76
Final weight	1653.99[a]	1293.95[b]	40.52
Daily weight gain	13.52[a]	9.24[b]	0.48
Daily feed intake	79.17[a]	70.41[b]	0.96
FCR	6.01[b]	7.83[a]	0.28

[a,b]Means in the same row with different superscripts differ significantly (P<0.05).

Table 2: The effect of strain on growth performance of the Nigerian indigenous chickens

Parameters	FUNAAB Alpha	Yoruba ecotype	SEM
Initial weight	699.90	335.97	11.76
Final weight	1962.30[a]	985.64[b]	173.28
Daily weight gain	17.18[a]	5.58[b]	2.06
Daily feed intake	86.70[a]	62.88[b]	4.11
FCR	4.81	9.03	1.17

[a,b] Means in the same row with different superscripts differ significantly (P<0.05).

Table 3: The interaction effect between sex and strain on growth performance of the Nigerian indigenous chickens.

	Male		Female		
Parameters	F/Alpha	Y/ecotype	F/alpha	Y/ecotype	SEM
Initial weight (g)	734.34	356.94	665.56	315.00	16.63
Final weight(g)	2204.31[a]	1103.67[c]	1720.29[b]	867.61[d]	176.19
Daily weight gain (g)	20.06[a]	6.99[c]	14.30[b]	4.18[d]	2.10
Daily feed intake (g)	94.60[a]	63.73[c]	78.80[b]	62.02[d]	4.18
FCR	4.09	7.93	5.53	10.13	1.19

[abcd] Means in the same row with different superscripts differ significantly (P<0.05). F/alpha= FUNAAB Alpha. Y/ecotype = Yoruba ecotype

CARCASS TRAITS AND RELATIVE ORGAN WEIGHTS OF GROWING RABBITS FED GRADED LEVELS OF PROCESSED KOLA NUT (*Cola nitida)* POD HUSKS

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Abstract

Carcass traits and relative organ weights of growing rabbits fed graded levels of processed (ash treated and rumen liquor fermented) kola nut (*Cola nitida*) pod husks (PKPH) were investigated. One hundred and twenty (120) rabbits were randomly allotted to four (4) dietary treatments at 0, 10, 20, and 30 % inclusion levels and designated as diets 1, 2, 3, and 4 respectively. Each treatment group was replicated ten (10) times with three (3) rabbits representing a replicate and was fed *ad-libitum* for 56 days. Highest slaughter weight (1813.80 g/r), dressing weight (1068.70 g/r) and dressing percentage (58.54 %) recorded in rabbits fed diet 3 (20% PKPH) were similar to those fed the control diet (0 % PKPH) and diet 2 (10% PKPH) but was significantly ($P<0.05$) higher than those fed diet 4 (30 % PKPH). The lungs, liver, kidney, heart, and spleen of the rabbits fed dietary treatments showed no significant effect.

Keywords: Kolanut pod husk, Carcass traits, rabbits, rumen liquor, ash

Introduction

The declining world's raw materials as the population grow rapidly, coupled with the real threat of global food shortages has contributed to a growing awareness of the need for conservation and the re-use of things which once would have been thrown away without a second thought (Abioye *et al.*, 2006). Thus, in order to meet maximize food production to meet human protein requirement in Nigeria, all available reasonable options, especially the production of livestock that is yet to play a major role in animal production must be considered for efficient utilization amongst which is the rabbit. The major limitation to the production of rabbit in Nigeria is high cost of finished feed (Adeyemi *et al*., 2008) as it has been reported that feed accounts for 60-70 % of the total intensive production cost (Nworgu *et al.*, 1999). Efforts have been directed towards finding alternative sources of feed ingredients for livestock using materials that cannot be directly consumed by man as this is envisaged may alleviate competition between human and animal and reduce feed costs particularly for livestock species that are quite adapted for utilization of fibrous crop residues and by-products (Atuahene *et al.*, 1985) and such crop residues or by-products are kola nut pod husk (Abioye *et al.*, 2006). However, the presence of anti-nutritional factors such as caffeine, theobromine, and tannins restricts the use of kola nut pod husk (KPH) as animal feeds. Several methods have been employed to improve the nutritive value of KPH for livestock production and this include fermentation which led to increase in crude protein of fermented KPH as reported by Lateef *et al.* (2008) and also enhanced micronutrient bio-availability and aids in degrading anti-nutritional factors (Oboh, 2006). Internal organs of animals exhibit abnormal growth in response to toxins in feeds (Ayodele *et al*., 2016). Therefore, this study

aimed at assessing the carcass traits and relative internal organ weights of growing rabbits fed graded levels of processed kola nut pod husks.

Materials and methods

The experiment was carried out at the Rabbitary; Teaching and Research Farms of the Federal College of Agriculture (FECA), Akure, Nigeria. The kola nut pod husks were processed as previously described by Adeyeye*et al*., (2016). Kolanut pod husks were chopped into pieces with sharp stainless steel knife, sun-dried for 7-14 days. Dried corn stalks collected were also gathered and burnt to ashes and used to prepare Corn Stalk Ash solution (CSAS) by suspension in deionized water for 48 hours at room temperature and filtered. One gram of KPH was steeped in 7mls of CSAS for seven days anaerobically and thereafter sundried and named Ash Treated Kolanut Pod Husk (ATKPH) (Adamafio *et al*., 2004). Droppings of commercial layers' wastes were collected from FECA poultry unit sundried and milled. The ATKPH was mixed with dried layers waste (100g/kg) and molasses (50ml/kg). Freshly collected rumen liquor from slaughtered White Fulani cattle was added into the ATKPH and mixed properly with layers' wastes and molasses, covered and fermented anaerobically for 7 days, sundried for one week and named processed kola nut pod husks (PKPH) and analysed for chemical composition. Thereafter, four (4) diets (Table 1) were formulated in which processed cocoa pod husks were included at 0, 10, 20 and 30% and designated as diets 1, 2, 3 and 4 respectively and the rabbits' diets were pelletized (4mm diameter and 8mm long). One hundred and twenty (120) healthy, five-week-old growing rabbits were randomly allotted to the four (4) dietary treatments after balancing for weight in a completely randomly design. Each treatment group was replicated ten (10) times with three (3) rabbits representing a replicate. The rabbits were fed their respective diets *ad-libitum* throughout the period of eight (8) weeks. Two (2) rabbits were randomly selected from each treatment group of thirty (30) rabbits at the end of the 8 weeks feeding trial, starved overnight, slaughtered according to the guidelines of the World Rabbit Science Association (Blasco *et al*., 1993) and skinned. Their internal organs were removed and weighed while the dressed weights were determined and used to calculate the dressing percentage for the rabbits.

Results and Discussion

The variation in the slaughter weight (SW) of 1624.20-1813.80 g/rabbit and dressed weight (DW) of 937.75-1058.70 g/rabbit in this study could be ascribed to variations in the live weight of the experimental rabbits which increased as the levels of processed kola nut pod meal (PKPH) increased to 20 % and thereafter decreased in 30 % inclusion and this is similar to the report of Olafadehan (2011) and Retore *et al.* (2008). The slaughter weight was however lower than 1640.00-1860.00g earlier reported by Olafadehan, (2011) and 1677.44-2218.01 g reported by Ogunsipe *et al.* (2014). The dressed percentage range of 56.40-58.54% in this study was however higher than 50.03-58.51%, 52.05-53.36%, 43.24-53.83%, 48.70-49.45%, 43.76-51.45% and 51.10-57.39g reported by Olafadehan, (2011), Sobayo *et al.* (2008), Akinmutimi and Alufo (2006), Oteku and Igene (2006), Olajide and Adeniyi (2015) and Abegunde *et al*. (2014) respectively but lower than 68.00-70.34% and 61.69-66.66% reported by Adeyemi *et al*. (2011) and Togun *et al*. (2006). These variations could be due to differences in breeds, age, nutrition, and animal environment. Examination of organ weights and histo-pathological findings are considered the very important aspect of any routine studies because they reveal many of the age-related, naturally occurring lesions of the animal used (Ogbuewu, 2011). The relative organ weights of the growing rabbits in this study were not affected by the dietary treatments. This is an indication that the test diets promoted similar organs' development and health as the control diet.

Table 1: Gross composition of the experimental diets (g/kg)

	Levels of PFKPM inclusion (%)			
	0	10	20	30
INGREDIENTS	**Diet 1**	**Diet 2**	**Diet 3**	**Diet 4**

Maize	16.00	15.80	15.50	14.50
PFKPM	0.00	10.00	20.00	30.00
Wheat offals	2.50	1.50	1.50	1.50
Soya bean meal	8.65	7.65	7.65	7.65
BDG	25.90	26.10	19.40	13.40
Rice Bran	26.90	18.90	15.90	12.90
*Other ingredients	20.05	20.05	20.	20.05
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis (g/kg)				
Crude Protein	17.19	17.20	17.18	17.17
Crude fibre	16.03	16.06	16.04	16.02
Metabolizable energy (kcal/kg)	2540.80	2540.69	2533.19	2541.03

FKPM:Potash-rumen liquor fermented Kolanut pod husk meal, BDG: Brewers' dried grain.

*Other ingredients: soybean meal (5%), maize husk (13%), bone meal (1%), premix (0.25%), methionine (0.15), lysine (0.1%), salt (0.25%) and vegetable oil (0.3%)

Table 2: Carcass evaluation of weaner rabbits fed graded levels of Potash-rumen liquor fermented Kolanut pod meal (PFKPM)

	Levels of PFKPM inclusion (%)					
	0	**10**	**20**	**30**		
Parameters	**Diet 1**	**Diet 2**	**Diet 3**	**Diet 4**	**SEM**	***P value***
Slaughter weight (g)	1747.30[a]	1710.90[ab]	1813.80[a]	1624.20[b]	24.63	0.03
Dressing weight (g)	984.92[b]	978.08[b]	1058.70[a]	937.75[c]	13.30	0.00
Dressing percentage	56.40	57.26	58.54	57.79	0.57	0.66
Lung (%)	0.53	0.54	0.55	0.53	0.004	0.45
Liver (%)	3.20	3.24	3.40	3.17	0.05	0.43
Kidney (%)	0.63	0.65	0.64	0.67	0.02	0.85
Heart (%)	0.26	0.26	0.28	0.28	0.01	0.56
Spleen (%)	0.09	0.08	0.10	0.09	0.09	0.33

Means with different superscripts in the same row are significantly different ($p<0.05$).

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CARCASS AND ORGAN QUALITIES OF BROILER FINISHERS FED MULTI-ENZYME (MAXIGRAIN®) SUPPLEMENTED SOAKED-SUNDRIED CASSAVA PEEL MEAL BASED DIETS

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ABSTRACT

A 28-d feeding trial was conducted to investigate the effect of multi-enzyme (Maxigrain) supplementation on carcass and organ characteristics of broiler finishers fed soaked and sun-dried cassava peel meal (SSCPM) based diets. 200, 4 weeks old broiler chicks were randomly allocated to four experimental diets which were formulated to replace maize at 0, 25, 50, and 75% inclusion level respectively with supplementary enzyme (Maxigrain). The birds were further subdivided into 5 replicates of 10 birds each in a completely randomized design arrangement. The birds were raised on a deep litter; feed and water were supplied ad-libitum. At the end of the feeding trial, 2 birds per replicate were randomly selected, slaughtered and their carcass and organ properties were evaluated. The results showed that multi-enzyme supplementation produced significant ($p>0.05$) differences for live weight, carcass weight and dressing percentage among the treatments. The prime cut-up part (breast, thigh and back weights) and organ weights (gizzard, liver, spleen and small intestine) of birds fed control, 25% and 50% enzyme supplemented SSCPM diets were higher ($p<0.05$) than those on 75% replacement level. Therefore, multi-enzyme supplementation improved carcass and organ characteristics of broiler finishers fed SSCPM based diets up to 50% inclusion level without any adverse effect.

Keywords: Broiler, carcass, organ, enzyme, cassava peel meal.

INTRODUCTION

The rapid growth of human population has intensified the competition between humans and livestock for grains such as maize, which is the major source of energy in poultry feeds (Durunna *et al*., 2000; Mohammed and Agwunobi, 2009). It has been observed that unconventional tropical resources and their by-products which have potential use as alternative sources of feed for poultry could be utilized to reduce cost and limit dependence on maize (Annongu *et al*., 2006; Tuleun and Igba, 2008). One of such alternatives for partial replacement of maize in animal diets is the cassava peel meal (Abu and Onifade, 1996; Salami, 2000, Midau *et al*., 2011). Cassava peel is a major by-product of cassava tuber roots processing industry and is always discarded as waste, hence resulting to waste disposal problem in Nigeria (Oboh, 2006, Udoyong *et al*., 2010). These peels are potential feed resources for animals if properly harnessed by processing techniques to reduce toxic level of cyanogenic glycoside which is the major limitation to the use of cassava product and its by-product (Tewe, 1992; Salami *et al*., 2003). Besides, the use of cassava peel as a plant energy source is also limited by high level of fiber content (Tewe and Bokanga, 2001). Therefore, there is need for the use of feed additives which are considered appropriate to improve the nutritive value of agro-by-products. The use of exogenous enzymes in monogastric diets is said to have numerous benefits including the removal of anti-nutritional factors, increased digestibility of existing nutrients, increased digestibility of non-starch polysaccharides (NSPs), and complementing host endogenous enzymes (Classen and Cooper, 1999; Olukosi *et al*., 2014, and Wu *et al*., 2014). Therefore, this present study was conducted to evaluate the carcass and

organ characteristics of broiler finisher chickens fed soaked and sun-dried cassava peel meal based diet with multi-enzyme (Maxigrain) supplementation in replacing dietary maize.

MATERIALS AND METHODS

Experimental site: The research was conducted at Teaching and Research Farm of Federal College of Wildlife Management, New Bussa, Niger State, Nigeria.

Preparation of test ingredient (processed cassava peel meal): Cassava peels were collected fresh from cassava processing centers located within New-Bussa metropolis .The peels were soaked in water for a period of 5 days and later sun-dried for 3 days. Thereafter, the sun-dried peel was milled using a hammer mill to produce soaked-sundried cassava peal meal (SSCPM).

Maxigrain® enzyme: Maxigrain® enzyme used in this study is a blend of a multi-enzyme consisting of *β-glucanase, xylanase, phytase, arabino xylanase*, yeast and minerals. It is originates from the bacteria *Aspergillus oryzae*.

Experimental birds, management and design: 250 day-old unsexed broiler chicks (Arbor acre) were bought from a local commercial hatchery (Chi Poultry Farms, Ibadan, Nigeria) and housed in a deep litter brooder house with electric heaters. All birds were fed a commercial broiler starter diet formulated to meet the NRC (1994) requirements. On day 21,200 chicks were weighed and randomly allotted into four groups of 50 birds each. Each group was further sub-divided into five replicates of 10 birds in a completely randomized design (CRD). Fresh drinking water and trial diets were offered to birds *ad libitum* until 49 days of age.

Experimental diets and treatments: Four experiment diets were formulated to contain Maxigrain enzyme supplemented SSCPM to replace maize at 0, 25, 50 and 75% as T_1, T_2, T_3 and T_4 respectively. T_1 contained no enzyme while T_2, T_3 and T_4 were supplemented with Maxigrain enzyme at the rate of 0.1g/kg. The experimental ingredient composition is presented in Table 1.

Carcass and organ quality evaluation: At the end of the feeding trial, 3 birds per replicate were selected and weighed prior to slaughtering to obtain their live weights. The birds were slaughtered by severing the jugular vein. The carcasses were allowed to bleed freely for 5 minutes, defeathered using warm water and then re-weighed to obtain plucked carcass weight. They were then decapitated, eviscerated and weighed to obtain the dressed weights. The carcass was subsequently dissected into various primal cuts (breast, back, drumstick, thigh, wing and neck) and organ (gizzard, liver, kidney and heart) weights were also taken.

Statistical analysis: Data collected were analyzed by the general linear model (GLM) procedure of SAS (2006). Means were compared using Tukey test. Differences among means with $p < 0.05$ were accepted as statistical differences.

Ingredients %	T_1	T_2	T_3	T_4
Maize	61.00	45.69	30.39	15.09
Cassava peel meal	_	15.30	30.60	45.90
Soya bean meal	28.00	28.00	28.00	28.00
Fish meal	3.00	3.00	3.00	3.00
Wheat offal	4.00	4.00	4.00	4.00
Bone meal	2.00	2.00	2.00	2.00

Limestone	1.00	1.00	1.00	1.00
Premix	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20
Methionine	0.30	0.30	0.30	0.30
Salt	0.20	0.20	0.20	0.20
Maxigrain	0.00	0.01	0.01	0.01
Total	100	100	100	100
CP %	20.84	20.53	20.09	19.88
ME kcal/kg	3168.10	3098.18	3033.41	3008.28

Table 1: Gross composition of experimental finisher broilers diets

RESULT AND DISCUSSION

The effect of inclusion levels of enzyme supplemented SSCPM on the carcass and organ characteristics of broiler finisher birds are presented in Table 2. There were significant differences ($p<0.05$) in the live weight, carcass weight and dressing percentages. Broilers fed control diet had similar ($p>0.05$) live weight with those fed 25 and 50% enzyme supplemented SSCPM diets and were significantly ($p<0.05$) heavier than birds on 75% SSCPM diet which recorded lower mean values. The carcass weights and dressing percentage also followed the same trend as observed in live weight of the birds. In case of the prime cut-up parts, significant differences ($p<0.05$) were obtained for breast, thigh, and back weights while other parameters measured were not significantly ($p>0.05$) affected by the dietary treatments. The organ weights of heart, lung and kidney of the birds fed the control and enzyme treated SSCPM diets were similar ($p>0.05$) while significant differences ($p<0.05$) were observed in the gizzard, liver, spleen and small intestine weights among the treatment groups. The similarity of the live weight, carcass weight and dressing percentage as well as prime cut-up parts such as breast, thigh and back weight of birds fed the control, 25 and 50% replacement levels is a true reflection of similar tissue development. The improvements in the carcass yield are consistent with those obtained by previous researchers (Hetland *et al*., 2003; Obadire *et al*., 2014; Isikwenu, 2014; Wu *et al*., 2014) who reported improved carcass yield in broilers when diets are supplemented with multi-enzymes. Enzyme treatment is capable of solubilizing high amounts of cell wall thereby producing a good quality high level soluble carbohydrates from NSPs and also initiates fiber breakdown, and reduced anti-nutritional activities, causing a release of lock-up nutrients that encouraged good performance of broilers (Bedford and Morgan, 1996; Isikwenu, 2014). These results from the present study is in agreement with the findings of Iyayi and Oklankuele (2002) and Midau *et al*. (2011) who reported that breakdown of fibrous materials in the cassava meal by enzymes enable birds acquire more nutrients from the feed thus depositing them as tissues in the body.

CONCLUSION

The result of the study revealed that soaked and sun-dried cassava peel meal can be made a better feed stuff by improving the digestibility of the high fiber component via multi-enzyme supplementation.Therefore, supplementing soaked and sundried cassava peel meal with maxigrain enzyme at 50% inclusion level gave the optimum carcass attributes and is hereby recommended for poultry farmers.

Table 2: Carcass and organyield of broiler finisher fed soaked-sundried cassava peel meal (SSCPM) based diet supplemented with Maxigrain enzyme

Parameter	**T_1 (0% SSCPM)**	**T_2 (25% SSCPM)**	**T_3 (50% SSCPM)**	**T_4 (75% SSCPM)**	**SEM**

Live weight(g)	1920.04[a]	1890.20[a]	1850.30[a]	1407.12[b]	29.90
Carcass weight(g)	1216.7	1183.3	1016.7	983.3	48.14
Dressing %	75.48[b]	86.54[a]	72.46[b]	84.11	1.12
Wing (g)	9.20	9.23	8.51	9.99	0.80
Breast (g)	18.03[a]	19.09[a]	17.92a	12.43[b]	0.47
Thigh (g)	20.19[a]	18.53[ab]	18.87[ab]	16.82[b]	0.83
Back (g)	15.73[a]	14.28[a]	13.68[ab]	12.63[b]	0.17
Heart (g)	0.40	0.44	0.48	0.35	0.14
Gizzard(g)	1.41[b]	1.40[b]	1.51[b]	1.85[a]	0.04
Liver (g)	1.68[b]	1.88[ab]	1.81[ab]	1.92[a]	0.08
Spleen(g)	0.58[a]	0.55[a]	0.52[a]	0.34[b]	0.04
Small intestine(g)	4.13[b]	3.20[c]	3.53[bc]	5.70[a]	0.09
Lung (g)	0.52	0.47	0.87	1.16	0.48
Kidney(g)	0.66	0.88	0.59	0.80	0.55

[abc] Means in the same column without superscript in common are different at P<0.05.

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EVALUATION OF WHITE AND YELLOW MAIZE (*Zea mays*) VARIETIES ON THE PERFORMANCE OF BROILER CHICKENS

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Abstract

A Total of 180 day old Ross broiler chicks were used in a feeding trial to evaluate the performance of broiler chicken fed diets compounded with white maize, yellow maize and a combination of white and yellow maize. Chicks were allotted randomly to three treatments each replicated four times, with 15 chicks per replicate. They were raised with diet T_1 having yellow maize, T_2 having yellow maize and white maize mixed together in ratio of 50:50% and T_3 having white maize. Data were collected on comparative characteristics of white and yellow maize and growth performance of birds. All data collected were subjected to analysis of variance and significant differences among treatment means were compared using Tukey's HSD test of significance. There was a significant ($P<0.05$) difference in feed intake, birds fed white maize based diet showed the highest feed consumption (4984.50g) those fed yellow maize based diet showed the least feed consumption (4631.00g), whereas those fed yellow and white maize based diet were statistically similar (4813.40g) as birds of treatment 1 and 3. There was no significant ($P>0.05$) difference in their body weight gain, feed conversion ratio and feed cost/weight gain. The comparative characteristics of the two maize varieties in different forms (whole grain and grinded forms) as well as the three experimental diets were also determined which shows a significant ($P<0.05$) difference in their mass and density. These findings indicate that different maize varieties (white or yellow) did not significantly affect growth performance of broiler chickens, but lesser feed quantity is required to obtain maximum performance when yellow maize is used to compound feed as a result of its density over the white maize. However, birds fed diet compounded with yellow maize and also combination of both varieties had their shank and beak with yellow appearance as a result of the naturally occurring pigment (β-carotene) in yellow maize.

Key words: Broiler chicken, maize varieties, growth performance, diet, β-carotene.

Introduction

Maize (*Zea mays*) has been the most commonly used conventional energy source of plant origin in feed formulation for poultry. It is sometimes highly expensive, limited or at times scarce. Also, maize and other cereal grains are highly competed for by animals and humans as food. Supply of essential nutrients in adequate quantities to poultry is necessary for optimum growth, production and/or reproduction. The optimum biological performance of farm animals, especially the monogastrics is partly determined by feed quality. Feed quality is measured in terms of adequate amounts and correct proportions of the essential nutrients such as protein, minerals and vitamins to one another in animal feed in relation to its optimum energy content. Unlike cockerel, broiler chicken has genetic potential to attain live weight of 2.0kg and dressed weights of 1.5 kg in 6 – 8 weeks of age provided feeding is adequate not only in quantity but also in quality (Longe, 2006).

Maize comes in varying colours viz: white, yellow and bi-colour varieties. Of the varieties of maize, the most prevalent are white and yellow maize. White maize is the most common colouration of maize, followed closely by yellow maize, while the remaining are referred to as bi-coloured (which can range from red to orange – hued varieties). The difference between them is that the naturally occurring pigment (Beta-carotene) exert a yellow colouration on the endosperm of the yellow maize, hence its colour; while for the

white maize there is the absence of this pigment. Beta-carotene gives the yellow maize a bit of a nutritional edge over white maize. Hence, the need to evaluate the nutritional effect on performance of broiler chickens when fed with diet compounded with white maize, yellow maize or a combination of white and yellow maize.

Materials and Methods

Experimental Site

The experiment was conducted at the Poultry Unit of Department of Animal Science Teaching and Research Farm, Ahmadu Bello University, Zaria, Kaduna State Nigeria. Zaria is located in the Northern Guinea Savannah ecological zone on longitude $11^0$09' 01.78'N and $7^0$39' 14.79'E, 671m above sea level. The climate is characterized by a well-defined dry and wet seasons and relatively dry with annual rainfall ranging from 700 – 1400mm (Ovimaps, 2015).

Experimental Design and Management of Birds

One hundred and eighty (180) day old Ross broiler chicks were allocated to three (3) dietary treatments, each replicated four times with 15 chicks per replicate each in a Completely Randomized Design (CRD). The birds were reared in a deep litter house with feed and water supplied *ad-libitum* with all necessary routine vaccinations for the experimental period.

Experimental Diets

Three experimental diets were formulated at both the starter and finisher phases of the feeding trial to meet standard requirements of broiler chickens as recommended by NRC (1994) and Olomu, J.M (2011). The diets were as follows:

Treatment 1: Yellow maize based diet (100%YM)

Treatment 2: Yellow maize + white maize based diet (50:50%YM/WM)

Treatment 3: White maize based diet (100%WM)

Proximate Analysis

The proximate analysis of test ingredients and the three different formulated diets were conducted at the biochemical laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria using Association of Agricultural Chemist method. The samples subjected to this analysis were dried samples of the feeds, yellow maize and white maize to determine the moisture content (MC), dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), ash content and nitrogen free extract (NFE), (AOAC, 2005).

Data Collection

Physical characteristics of maize varieties and diets

The density of the maize varieties (yellow and white) and that of the diets formulated for each treatment was determined. Density of the maize varieties was determined at different forms such as whole grain and grinded form.

Growth parameters

Initial and final weights of birds were taken at the beginning and at the end of both starter and finisher phases. Feed intake was measured weekly, the changes in live weight of the birds were recorded on a weekly basis throughout the experimental period of seven (7) weeks. Feed to gain ratio, feed cost/kg, feed cost/weight gain and mortality were also computed.

Statistical Analysis

All data collected were subjected to statistical analysis of variance ANOVA using the Statistical Analysis of System procedure in a one-way analysis of variance. The effect of treatment was tested and significant difference between treatment means were separated by Tukey's HSD Test (SAS, 2002).

Results and Discussion

Table 1 shows the comparative characteristics of the two varieties of maize in different forms. The mass and density of yellow maize whole grain (745.43g and 0.745gcm^{-3} respectively) were significantly (P<0.05) higher than the white maize whole grain (723.33g and 0.723gcm^{-3}). This also applies to the grinded form where the mass and density (474.67g and 0.475gcm^{-3} respectively) for the yellow maize were significantly (P<0.05) higher than the mass and density (451.67g and 0.452gcm^{-3}) of the white maize, given the same volume.

Table 1: Comparative Characteristics of the two varieties of maize in different forms

		Varieties		
Samples	Parameters	Yellow maize	White maize	SEM
Whole grain	mass (g)	745.43^{a}	723.33^{b}	1.67
	Volume (cm^3)	1000.00	1000.00	
	Density (g/cm^3)	0.745^{a}	0.723^{b}	0.01
Grinded	Mass (g)	474.67^{a}	451.67^{b}	1.67
	Volume (cm^3)	1000.00	1000.00	
	Density (g/cm^3)	0.475^{a}	0.452^{b}	0.01

^{a,b,} Means with different superscript differ significantly across the row (P<0.05), SEM = Standard error of mean.

Table 2 shows the growth performance of broilers fed two different varieties of maize and a combination of both varieties. There was no significant (P>0.05) difference in the final weight and weight gain of the birds. This may be due to the fact that the test ingredient (maize) though vary in physical appearance (yellow and white) are of similar chemical composition or nutrients. This contradicts the findings of Bai (2002) who conducted a study on broiler with quality protein maize replaced with normal maize and obtained significant difference in weight gain. Feed intake was significantly (P<0.05) different across the treatments. Treatment 3 shows a significant (P<0.05) difference with birds in treatment 1, treatment 2 was statistically similar to treatment 1 and treatment 3. The highest feed consumption (4984.50g) was observed in birds fed white maize (T_3). The treatment containing yellow maize (T_1) had the least feed intake (4631.00g) while the treatment containing a combination of yellow and white maize (4818.40g) proves to be statistically similar with treatment 1 and treatment 3. This may be as a result of the density difference between the test ingredients (yellow and white maize). Birds fed with the T_1 diet consumed less as a result of the feed being denser than T_3 diet. At the end of the experiment, there was mortality for treatment 2 and treatment 3 which showed significant (P<0.05) difference with treatment 1. This is in close agreement with Lokesh and Singhal (2011) stating that the nutrients which have immuno-modulating effect include protein and energy, methionine, Vitamin A, E and C. The presence of Vitamin A and lutein in the yellow maize help to boost immunity of the birds fed yellow maize based diet which had no mortality.

Table 2: Growth performance of broiler chickens fed two different varieties of maize and a combination of both varieties at starter - finisher phase

Parameters	T_1 100%YM	T_2 50:50%YM/WM	T_3 100%WM	SEM
Initial weight (g/bird)	44.83	45.23	44.88	0.36
Final weight (g/bird)	2268.10	2275.00	2317.7	97.80
Weight gain (g/bird)	2223.27	2229.77	2272.82	97.83
Feed intake (g/bird)	4631.00[b]	4813.40[ab]	4984.50[a]	125.41
Feed conversion ratio	2.08	2.16	2.19	0.08
Feed cost (₦/kg)	215.24[c]	212.42[b]	209.59[a]	0.00
Feed cost/weight gain (₦/kg)	447.70	458.83	459.00	17.51
Mortality (%)	0.00[a]	6.67[a]	10.00[b]	3.69

[a,b,c] Means with different superscript differ significantly across the row (P<0.05), YM = Yellow maize, WM = White maize, SEM = Standard error of mean.

Physical/Visual Quality of Broiler Chickens Fed White Maize, Yellow Maize and a Combination of both Varieties

Birds fed yellow maize based diet (T_1) and 50:50% yellow and white maize based diet (T_2) were observed to be imparted with yellow coloration on their shank and beak. This is as a result of the pigment (β-carotene/xanthophil) present in the yellow maize. The accumulation of this pigment in the tissues of the animal imparted the colour as they are fed with these diets from day old. However, birds fed 100%white maize based diet (T_3) had their shank and beak to be dull white/normal as a result of the absence of beta-carotene pigment in the white maize.

Conclusion and Recommendation

Conclusion

From the results obtained from the research work, it can be concluded that different maize varieties (white and yellow) did not significantly affect the growth performance of broiler chicken. However, less feed was consumed by birds fed with the yellow maize variety but gave equivalent weight with those fed white maize and a combination of white and yellow maize. In addition, the presence of the natural occurring pigment (β-carotene) which gives the maize its yellow appearance impacted the yellow colour on the shank and beak of the birds fed diet compounded with the yellow maize.

Recommendation

The two maize varieties (white and yellow) can both be used to compound broiler diet to obtain maximum performances.

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PERFORMANCE CHARACTERISTIC OF BROILER BIRDS FED VARYING LEVELS OF *ALOE-VERA* GEL IN WATER

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ABSTRACT

The study was carried out at the Poultry Unit of the Teaching and Research Farms of Oyo State College of Agriculture and Technology, Igboora, Nigeria. A total number of 96 day old unsexed broiler chicks were purchased from a reputable farm at Ibadan for the experiment. At 8 days of age, birds were weighed and randomly allotted into 4 feeding treatments of 3 replicates consisting of 8 birds in a completely randomized design (CRD). T1 control, T2 (30 ml of AVGE + 1 litre of water), T3 (60 ml of AVGE + 1 litre of water), T4 (90 ml of AVGE + 1 litre of water). The experiment lasted for 49 days. Results showed that, there were no significant ($p>0.05$) differences existing among treatments groups in final body weight gain, feed conversion ratio and total water intake as well as the mortality except for the overall feed intake. Birds in T1 had the highest final body weight of 1870.33g which is followed numerically by birds in T4 with 1860.00g, T2 with 1798.33g and T3 with a numerical value of 1775.67g respectively. FCR was non-significant ($p>0.05$) but differs numerically across the treatment groups with birds in T4 having the least value of 2.01. Mortality value was highest in T1 (control) with a non-significant ($p>0.05$) value of 0.67 while T2 had no mortality recorded. It can be concluded from the experiment that the groups treated with Aloe vera gel extract showed better performance in weight, FCR, and mortality compared to the control.

Key words: Broiler, Aaloe vera gel extract, Weight gain, FCR, Mortality

INTRODUCTION

Antibiotic growth promoters have been helpful in improvement of growth performance and feed conversion ratio in poultry (Miles *et al*., 2006; Dibner and Buttin, 2002; Izat *et al*., 1990). However, constant treatment of poultry by antibiotic may result in residues of these substances in poultry products and bacteria resistance against treatments in human body. Due to such threats to human health, use of antibiotics in poultry is banned (Owens *et al*., 2008; Alcicek *et al*., 2004; Botsoglou and Fletouris, 2001; Hinton, 1988). Many studies have been carried out on using additives, including herbs, as alternatives to antibiotics, with direct or indirect effects on intestinal microflora, in poultry products (Taylor, 2001). *Aloe vera is* used as a multi-purpose medicine with anthelminthic, antimicrobial, anti-inflammatory and anti-oxidative properties. They also contain carotenoids, vitamins, terpernoids and phenols among other compounds (O'Brien *et al*., 2011). They are used in treating newcastle disease, internal parasites, fowl typhoid, coccidiosis, gall sickness and inflammation (Dold and Cocks, 2001). Apart from the above, anti-mutagenic effects and anti-hypersensitivity effects of *Aloe vera* have also been reported by some researchers (Snezana *et al.,* 2007 and Strickland, 1993). With numerous properties, *Aloe vera* is among the most well-known herbs. Thus, the study aim to examine the use of oral supplementation of aloe vera gel without commercial antibiotics and multivitamin for broiler chicken

MATERIALS AND METHODS

Study location

The study was carried out at the Poultry Unit of the Teaching and Research Farms of Oyo State College of Agriculture and Technology, Igboora, Nigeria

Preparation of 50 % *Aloe vera* gel extract

Fresh Aloe leaves were harvested from Igbo-ora community and environs. Aloe gel infusion was prepared accordingly to the method of Durrani *et al*. (2008). The leaves were washed with clean water to remove dirt. Aloe Vera gel was extracted from 1kg leaves manually by making a cut on the leaves with a pocket knife. The gel was scooped out with a small spoon and drained into in a beaker. A 50% concentrated infusion was prepared by taking 500 ml of fresh gel in a glass bottle and 500 ml of boiled water at room temperature was poured on it. The bottle was then agitated for about 5-7 minutes to ensure thorough mixing, after which it was kept for 30 minutes to 40minutes at room temperature prior to use. The homogenized gel extract was prepared at the intervals of two (2) days and served to the animals fresh according to treatments.

Experimental Procedure

A total number of ninety-six (96) day old unsexed broiler chicks were purchased from a reputable farm at Ibadan for the experiment. At 8 days of age, birds were weighed and randomly allotted into 4 feeding treatments of 3 replicates consisting of 8 birds in a completely randomized design (CRD). T1 control, T2 (30 ml of AVGE + 1 litre of water), T3 (60 ml of AVGE + 1 litre of water), T4 (90 ml of AVGE + 1 litre of water). Treatment 1 served as the control which contained vitalyte and antibiotics, representing the common commercial drug supplement that is usually made available to birds.

RESULTS AND DISCUSSION

Table 3: Effects of aloe vera gel extract (AVGE) on the performance characteristics of broiler birds

	Treatments				
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM ±**
Initial body weight (g)	53.84	53.84	53.84	53.84	0.00
Final body weight (g)	1870.33	1798.33	1775.67	1860.00	24.00
Feed intake (g)	3890.03[a]	3745.72[b]	3729.38[b]	3742.09[b]	37.90
Average feed intake (g)	648.34[a]	624.29[b]	621.56[b]	623.67[b]	6.32
FCR	2.08	2.09	2.11	2.01	0.03
Water intake (L)	738.77	787.51	754.57	751.19	12.77
Mortality	0.67	0.00	0.33	0.33	0.14

[a,b,c]Means on the same rows with different superscript differs significantly ($p < 0.05$)

* FCR= Feed Conversion Ratio, AVGE=Aloe Vera Gel Extract, SEM= Standard Error of the Mean

Birds in treatment T1 (control) had the highest non-significant ($p>0.05$) final body weight of 1870.33g which is followed numerically by birds in Treatment T4 (90 ml of AVGE + 1 litre of water) with 1860.00g and T2 (30 ml of AVGE + 1 litre of water) with 1798.33g as well as T3 (60 ml of AVGE + 1 litre of water) with a numerical value of 1775.67g respectively. The overall feed intake as well as the average feed intake /week were significantly ($p<0.05$) highest in treatment T1 (control), while T2, T3 and T4 had a comparable significant ($p<0.05$) means. Feed conversion ratio was non-significant ($p>0.05$) but differs numerically across the treatment groups. Birds in T3 (60 ml of AVGE + 1 litre of water) had the highest value of 2.11 while birds in T4 (90 ml of AVGE + 1 litre of water) had the least value of 2.01. The higher body weight gain and improved feed conversion ratio (FCR) values observed in this findings with the birds in treatments 4 (90 ml of AVGE + 1 litre of water) could be due to better performance of the broilers and the diversified antimicrobial activities of the aloe vera gel extract that had also been demonstrated by Swaim *et al*. (1992), giving aloe vera extract to chicken. The increase in body weight may be attributed to the fact that AVGE possesses a tonic effect on

the intestinal tract, with a reduced transit time. The bacterial flora in the gastrointestinal tract could also survive and thrive better because of a reduction in the presence of yeasts and a reduction in the PH. Danhoff and McAnally (1988) reported that Aloe vera accelerates the growth of new cells, thereby resulting to increased body weight. This also supports the previous findings done by Barbak *et al* (2011) using 10 ml of aqueous extract of aloe gel per liter of drinking water.

Water intake was numerically highest in T2 (30 ml of AVGE + 1 litre of water) 787.51L followed by T3 (60 ml of AVGE + 1 litre of water) 754.57L and T4 (90 ml of AVGE + 1 litre of water) 751.19L while T1 (control) had the least non-significant ($p>0.05$) value of 738.77L. There were no significant ($P > 0.05$) differences in total water intake of the birds. This is in support with Durrani *et al* (2008) who reported no significant difference in mean water intake among groups. Ismail *et al*. (2004) and Chand *et al*. (2005) also reported similar findings whereas; Mehmet *et al*. (2005) and Barbak *et al* (2011) reported higher water intake in aloe vera groups than antibiotic group. The reasons why there was no differences in water intake may be ascribed to the fact that avians have no developed taste bud. Another reason may be that the birds got adapted to the bitter taste of the aloe vera gel extracts.

CONCLUSION AND RECOMMENDATION

it can be concluded from the experiment that the groups treated with Aloe vera gel extract showed better performance in weight, FCR, and mortality compared to the control groups. It is recommended that farmers adopt the use of 30 - 90 ml of aloe vera gel extract in oral supplementation as an alternative to commercial antibiotics and probiotics

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GROWTH PERFORMANCE OF GROWER RABBITS FED DIET CONTAINING BOILED SORREL (*Hibiscus sabdariffa L.*) SEED MEAL

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Abstract

The experiment was conducted to evaluate the performance of grower rabbits fed sorrel seed *(Hibiscus sabdariffa L.)* meal. Thirty grower rabbits were randomly allotted to five (5) dietary treatments containing the control diet, raw seed diet and boiled sorrel seeds in already boiled water for 15, 30 and 45 minutes. Completely randomized design (CRD) was used with six (6) rabbits per treatment and two (2) rabbits per replicate. The result of the experiment showed that there was significant difference (P<0.05) in average daily feed intake but no significant (P>0.05) differences in final body weight gain, daily weight gain, total feed intake, feed conversion ratio and feed cost/kg gain of rabbits fed diet containing sorrel seeds boiled at varying boiling duration. Feed conversion ratio was better in rabbits fed the 30 minutes boiled sorrel seed based diet (6.28) compared to rabbits fed 45 minutes boiled sorrel seed based diet (7.69). The final weight increased as boiling duration increased but later declined as boiling duration increased to 45 minutes (1360.00, 1286.67, 1293.33, 1386.67 and 1306.00g/rabbit) respectively. Feed cost/kg gain value was lower in rabbits fed diet containing boiled sorrel seeds at 30 minutes (₦600.20) compared to other treatments. Based on the result of the study, it was therefore concluded that grower rabbits could tolerate up to 15% sorrel seed meal boiled for 30 minutes in their diets. Further studies should be checked for boiling periods above 30 minutes.

Key words: Rabbits, sorrel seed meal, boiling and performance growth

Introduction

The huge animal protein deficit in the diet of Nigerians can be addressed by placing emphasis on the production of highly prolific and short cycle animal species such as rabbits (Oyawoye, 2002; Hasanat *et al.,* 2006). Rabbits however, require a good balance dietary protein for their maximum performance. Conventional feed are short in supply, expensive and highly consumed by human in Nigeria. This constitutes a major setback to increased rabbit production in the country and calls for research into less conventional sources of protein for rabbit feeding. The use of unconventional feed ingredients in compounding livestock feed in order to reduce cost of production is documented in literature (Abeke, 2008 and Duru, 2010). Non-conventional feedstuffs offer the best alternatives in our environment for reducing feed cost and therefore a reduction in the cost of meat productions (Dafwang *et al*., 2001). There is need to find alternative feed ingredients that can substitute for the more conventional feedstuffs which are expensive and highly needed for human and industrial needs. Sorrel (*Hibiscus sabdariffa*) seed is an alternative feed resources that has been found to thrive on a wide range of tropical soil conditions, and can perform well on relatively poorer soil (Adanlawo and Ajibade, 2006). The seed contain high amount of protein, dietary fibre, and mineral such as phosphorus (P), calcium (Ca) and magnesium (Mg) (Ismail *et al*., 2008). The seeds contain about 35.90% crude protein (CP), 10.14% ether extract (EE), 10.09% ash and 15-17% crude fibre (CF) (Dashak and Nwanegbo, 2002). Kwari *et al.* (2011) also reported raw sorrel seeds to contain 5.18% arginine, 16.5% CF, 13.5% EE and 38.57% CP while Abdu *et al*. (2008) reported 23.46% CP value. However, Nyameh *et al*. (2012) reported that boiled sorrel seeds contain 22. 84% CP, 8.50% CF, 6.50% EE, 6.50% ash, 45.66% NFE and 91.70% DM. while Maikano *et al.* (2014) reported a value of 21.84% CP, 3.60% CF, 5.85% EE, 5.39% ash, 90.40% DM, 53.72% NFE, 1.12% Ca and 0.56% P, respectively.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Rabbitary Unit of the Department of Animal Science Teaching and Research Farm, Ahmadu Bello University, Zaria. Zaria is within the Northern Guinea Savanna zone of Nigeria, with Latitude 11^0 09′ 01.78″ N and Longitude 7^0 39′ 14.79″ E at an altitude of 671m above sea level (Ovimaps, 2015).

Sources of Rabbits and Sorrel Seeds

The rabbits of mixed breeds and sexes aged 7 – 8 weeks were sourced from rabbit farms within Zaria metropolis, the sorrel seeds and other ingredients were purchased from an open market in Sabon Gari, Zaria.

Processing of Sorrel Seeds

The raw sorrel seeds were sorted to ensure cleared grains. The method adopted by Ari *et al.* (2012) was used for processing. The cleaned sorrel seeds were poured into 20litres of already boiled water per batch of 10kg at 100^0C i.e. in ratio of 2:1 at different boiling duration of 0, 15, 30 and 45 minutes, respectively. The products were then sun dried by spreading on trays until well dried (at least 75-80%DM), after which it was milled, bagged and stored for experimental diet formulation purpose.

Experimental Diet

Five experimental diets were formulated to meet the requirements of rabbits according to NRC (1994).These include T1 (Sorrel seed free diet as control); T2 (Raw sorrel seeds diet); T3 (Diet containing Sorrel seeds boiled at 15 minutes); T4 (Diet containing Sorrel seeds boiled at 30 minutes) and T5 (Diet containing Sorrel seeds boiled at 45 minutes)

Table 1: Composition of experimental diets

	Duration of boiling of sorrel seeds (minutes)				
Ingredients (Kg)	**Control**	**Raw (0)**	**15**	**30**	**45**
Maize	45.05	36.98	38.09	38.12	38.33
Soya bean cake	12.45	5.52	4.41	4.38	4.17
Boiled sorrel seed meal	0.00	15.00	15.00	15.00	15.00
Groundnut Haulms	40.00	40.00	40.00	40.00	40.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
Crude protein (%)	18.41	18.99	18.60	18.59	18.52

Crude fibre (%)	6.82	8.62	8.55	8.55	8.54
Ether Extract (%)	5.39	5.76	5.73	5.73	5.72
Metabolizable energy (Kcal/kg)	2852	2767	2779	2779	2781
Calcium (%)	0.67	0.68	0.68	0.68	0.68
Available Phosphorus (%)	0.42	0.47	0.47	0.47	0.47
Lysine (%)	0.83	0.81	0.78	0.78	0.78
Methionine + cysteine (%)	0.72	0.67	0.66	0.66	0.65
Ca:P	1.6	1.4	1.4	1.4	1.4
Cost/kg diet (₦)	100.21	95.41	95.55	95.56	95.58

**Bio-premix supplied per kg of diet: Vit A, 12500 I.U;Vit D_3, 2500 I.U; Vit E, 50mg;Vit K_3, 2.5mg;Vit B_3, 3.5mg;Vit B_6, 6mg; Niacin, 40mg; Pantothenic acid, 10mg; Biotin, 0.8mg;Vit B_{12}, 0.25mg; Folic acid, 1mg; Choline chloride, 300mg; Manganese, 100mg; Iron, 50mg; Zinc, 45mg; Iodine, 1.55mg; Selenium, 0.1mg; Copper, 2mg; Cobalt, 20mg.

Experimental Design and Management of Animals

Thirty (30) weaner rabbits of mixed breeds and sexes aged 7-8 weeks were randomly allotted into five (5) treatments with three (3) replicates per treatment; each replicate had two (2) rabbits in a Completely Randomized Design (CRD). Before the commencement of the experiment, they were dewormed using ivermectin® dewormer. The rabbits were housed in galvanized wire cages of 40 x 60 x 60cm dimension. Each cage was equipped with a small rubber bowl drinker and a clay/earthen pot feeder. Feed and clean water were supplied *ad-libitum* for a period of 56 days after an adjustment period of a week.

Data Collection

Feed offered and left over were weighed to determine feed intake of the animals. After the initial weight, weekly weights were taken. These records were used to monitor and determine the performance parameters in terms of average feed intake (AFI), average weight gain (AWG), feed conversion ratio (FCR), final body weight and feed cost/kg gain. Mortality was also recorded as they occur.

RESULTS

There were no significant differences (P>0.05) in all performance parameters measured except for total and average daily feed intake which were reduced significantly (P<0.05) as the duration of boiling increases. Rabbits fed control, raw and 15 minutes based diets were statistically the same as compared to rabbits on 30 and 45 minutes based diets in terms of daily feed intake. It was observed that rabbits fed the 30 minutes boiled sorrel seed based diet had the lowest average daily feed intake, highest weight gain, the least FCR and feed cost /kg weight gain.

Table 2: Effect of different duration of boiled sorrel seed meal on performance of grower rabbits

	Duration of boiled sorrel seed (minutes)						
Parameters	Control	Raw (0)	15	30	45	SEM	LOS
Initial body weight	853.33	800.00	813.33	876.67	855.00	48.83	NS

(g/rabbit)							
Final body weight (g/rabbit)	1360.00	1286.67	1293.33	1386.67	1306.00	85.91	NS
Average daily weight gain (g/rabbit)	9.05	8.69	8.57	9.11	8.07	0.90	NS
Total feed intake	3476.48[a]	3517.36[a]	3587.36[a]	3178.56[b]	3265.92[b]	129.92	*
Average daily feed intake (g/rabbit)	62.08[a]	62.81[a]	64.06[a]	56.76[b]	58.32[b]	2.32	*
Feed conversion ratio	6.87	7.28	7.61	6.28	7.69	0.73	NS
Feed cost per kg (₦)	100.21	95.41	95.55	95.56	95.58	____	NA
Feed cost/kg gain	688.17	694.84	727.28	600.20	735.82	69.61	NS
Mortality (%)	0.00	0.00	0.00	0.00	0.33	0.15	NS

abc: means with different superscript on the same row differ significantly at $p<0.05$

SEM: standard error of mean LOS : level of significance NS : Not significant NS : Not analysed

DISCUSSIONS

The various diets fed to the rabbits showed no significant differences. Rabbits that performed best were those fed 30 minutes duration of BSSM because it showed the highest weight gain, the best feed conversion ratio (FCR) despite having the lowest feed intake. This can be an indication that the rabbits were able to utilize and convert feed to gain. The above result was in line with the result reported by (Kaga 2013) when *Delonix regina* seeds cooked at different duration were fed to rabbits. Mortality of 0.33% was only recorded for 45 minutes boiled sorrel seed based diet.

The FCR of rabbits fed 30 minutes boiled sorrel seed based diet was the best although there were no significant difference ($p>0.05$) when compared with control, raw (0), 15 and 45 minutes boiling duration. This agreed with the reports of (Musa and Ogbadoyi, 2012) who stated that boiling reduces the level of anti-nutrients and toxic substances with retention of most micro-nutrients in amount sufficient to meet animal's dietary requirement but boiling beyond 30 minutes reduces B-carotene levels in seeds. Despite the anti-nutrients present in the raw seed based diet, they performed better than 45 minutes based diet. This result agreed with the findings of Halimatul *et al.* (2007) who reported that the quality of two differently processed (dried and boiled) roselle seed powder are similar and affect performance significantly when the seeds were boiled at 100^0C for 30 minutes. Therefore, the anti-nutrient of raw roselle seed might not affect feed digestibility and biological value.

CONCLUSION AND RECOMMENDATIONS

Based on this experiment, the highest value for final weight and best value for FCR were obtained from rabbits fed 30 minutes duration of boiled sorrel seed meal (BSSM) despite showing no significant difference. It was observed that rabbits could tolerate raw sorrel and boiled sorrel seed meals up to 30 minutes duration in their diet without negatively affecting performance parameters. Higher duration of boiling beyond 45 minutes resulted in a decline in performance of the rabbits. This was attributed to the fact that prolonged

boiling reduces B-carotene levels in seeds or leaching and denaturation of protein in the samples. Boiling of sorrel seeds for 30 minutes was recommended as the optimum duration if boiling method is adopted.

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NUTRIENT AND PHYTOCHEMICAL COMPONENTS OF DRIED AND FRESH FORMS OF *TALINUM TRIANGULARE* INVESTIGATED FOR POSSIBLE USE AS NUTRACEUTICAL IN POULTRY AND LIVESTOCK PRODUCTION

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Abstract
This study serves as a prerequisite to proposed use of *Talinum triangulare* as nutraceutical composition in poultry and livestock production. Nutrient and phytochemical components of freshly harvested and dried-pulverised *T. triangulare* were determined using standard methods. Proximate analysis of *T. triangulare* revealed very high moisture content of 94.5 ± 0.10 % in the freshly harvested sample; and 6.1± 0.20 % in the dried. High levels of ash, protein, and fibre; moderate carbohydrate; and low lipid contents were observed in both samples. Minerals and vitamins studied occurred in appreciable quantities in both samples. Drying concentrated the nutrients and phytochemical components in *T. Triangulare.* Vitamin E was however completely destroyed during the drying process. Quantitative phytochemical analyses of *T. triangulare* revealed the presence of alkaloids, cyanogenic glycosides, flavonoids, oxalates, phenols, saponins, and tannins, in aerial shoot of freshly harvested plant. However, cyanogenic glycoside was reduced from 0.31± 0.02µg/g in the freshly harvested to 0.00 µg/g in the dried samples. Tannin constituted 1.6 % of the *T. triangulare* for the freshly harvested sample and 0.1 % in the dried sample. High nutrient and bioactive components in *T. triangulare* as observed in the study supports possible use as an ethno-medicinal protein/mineral-vitamin supplement or nutraceutical. Fortification of *T. triangulare* - leaf meal from dried sample with Vitamin E is advocated. Anti-nutritional factors, as found in cyanogenic glycosides and tannins respectively, were either eliminated or drastically reduced with drying, making the dried sample safer for use in supplements.
Key words: Quantitative analysis, *Talinum triangulare*, vitamin E, cyanogenic glucoside, ethno-medicinal.

Introduction
In a previous study we had identified *T. triangulare* as having potential to promote healthy productive life in pullets and to possess anti-lipidemic property (Aronu et al., 2018). It becomes important to further investigate the phytochemical, nutrient and anti-nutritional properties of the plant for possible packaging as a nutraceutical product for poultry and livestock production.
Moreover, component ingredients in phytobiotics are known to differ distinctly due to climatic conditions, soil, species, time of harvest, degree of maturation, including the part of the plant under consideration (Grashorn, 2010). It was based on the discrepancies in nutrient components of different presentations of same plant that comparison between dried and freshly harvested forms of *T. triangulare* cultivated in Nsukka in Enugu State, South-East of Nigeria became necessary.

Materials and methods
Experimental design: The study involved quantitative nutrient and phytochemical analyses of aqueous extract from freshly harvested samples and from dried samples of *T. triangulare*. Each sample collected and parameter investigated was done in three replicates.
Plant collection, identification and preparation: Succulent parts of *Talinum triangulare* (waterleaf) plant were harvested weekly from a vegetable garden planted near the student's demonstration poultry house of the Department of Animal Health and Production University of Nigeria, Nsukka, Enugu State, Nigeria. The leaves and succulent shoots of *T. triangulare* were washed after harvesting and drained; for the dried sample this was further shade-dried at room temperature on the laboratory table with frequent turning. The dried leaves were pulverized using harmer grinding machine to obtain a powdered form of the sample which was stored in the refrigerator at 4^{o}C until needed.
Nutrient analyses: comprised of proximate, vitamins, and mineral analyses carried out in three replicates. Proximate analysis: moisture, crude fibre and ash contents were determined using the method described by AOAC (2010). The method of John and Bernard (1990) was employed for determination of protein content. Lipid content was carried out using the method of Jensen et al. (2003). And the percentage carbohydrate in the

sample was obtained by summing up the percentage of moisture, protein, fat, ash and crude fibre and subtracting from 100% (AOAC, 2010). The method of Plumber (1978) was used for vitamin A. Vitamins B1 and B2 (Riboflavin) determinations were done following the method of Nwankpa et al. (2015). Vitamin C was evaluated using the method described by Russel (2004); and Vitamin E using the method described by Harold (1981). Mineral analysis: Precisely iodine, selenium, lead, calcium, manganese, and iron were determined using Atomic Absorption Spectroscopy (AACC, 2000). Nitrate was determined by the method of Rump and Krist (1988).

Phytochemical analysis: The flavonoid content was determined by the use of a slightly modified colorimetry method as reported by Geetha (2014). Phenol was determined by the Folin Ciocateau method as reported by Pekal and Pyrzynska (2014). For tannin the method of FAO/IAEA (2000) was employed, while alkaloid employed the method described by Adeniyi et al. (2009) and Eleazu et al. (2012), saponin, the method described by Algfri et al. (2014) and cyanogenic glycoside, the method described by Indira and Sinha, (1969). The method described by Adeniyi et al. (2009) was employed in the determination of oxalate component.

Data analysis

Excel was used to calculate means of replicate samples of *T. triangulare* used for the proximate and mineral analyses.

Results and discussion

Talinum triangulare was air dried under shade to avoid photolysis and thermal degradation (Swarna and Ravindhran, 2013). Drying reduced the water content in freshly harvested *T. triangulare* from 94.5 % to 6.1 % in the dried sample. The alarm water content of dried vegetables is within the range of 14-20% moisture content at 72% relative humidity and 20^{o}C (Okaka, 2005). The nutrient composition of *T. triangulare* from this study shows that it has high content of total ash, protein, crude fibre, individual mineral and vitamin (Table 1). This result is in agreement with the reports of other researchers (Aja et al., 2010; Ogbonnaya and Chinedum, 2013). The protein value of 18.52% is low when compared to 29.4 % reported by Akachukwu and Fawusi (1995). The high dietary fibre (16.80 ± 0.10) presents waterleaf as a good option for the treatment of some degenerate diseases (WHO, 2003). The low total lipid and carbohydrate content of *T. triangulare* is in agreement with the report of several other researchers (Aja et al., 2010; Swarna and Ravindhran, 2013).

Vitamins and minerals studied occurred in appreciable quantities in both samples of *T. triangulare*. However, Vitamin E was destroyed during the drying process (Tale 2). Vitamin E is the only chain breaking lipid soluble antioxidant, which protects the cells from damage caused by free radicals and peroxides (Lobo et al., 2010); incidentally this important nutrient was lost completely during drying. The implication of this finding is that in producing leaf meal from dried *T. triangulare*, fortification with vitamin E is important and therefore is recommended.

Table 1 Proximate composition of *T. triangulare*

Nutrient components of	**Freshly harvested Sample (%)**	**Dried Sample (%)**
Moisture content	94.5 ± 0.10	6.1 ± 0.20
Protein	0.84 ± 0.04	18.52 ± 0.10
Fibre	0.95 ± 0.08	16.80 ± 0.10
Ash	2.75 ± 0.10	25.34 ± 0.05
Lipid	0.12 ± 0.02	1.5 ± 0.15
Carbohydrate	0.84	31.74

Table 2 Quantitative Analysis of Some Vitamins for the freshly harvested and dried samples of *T. triangulare*

Vitamin	Freshly harvested sample	Dried sample
Vit A	12.65±0.1µg/g (Re)	85.41±0.08µg/g
Vit B1	21±0.002mg/g	189±0.5mg/g
Vit B2	0.084±0.2mg/g	1.74±0.02mg/g
Vit C	0.34±0.5mg/g	2.46±0.08mg/g
Vit E	0.44±0.003mg/g	0.00mg/g

Table 3 Quantitative analysis of Some Phytochemicals for the freshly harvested and dried samples of *Talinum triangulare*

Phytochemicals	Freshly harvested sample	Dried sample
Saponin	3.85±0.1mg/g	17.68±0.41mg/g
Alkaloid	1.08±0.2mg/g	29.06±0.5mg/g
Tannin	0.12±0.02mg/g	0.96±0.01mg/g
Phenol	0.26±0.006mg/g	2.55±0.08mg/g
Flavanoid	0.73±0.03mg/g	8.91±0.38mg/g
Oxalate	1.29±0.1mg/g	21.24±0.24mg/g
Cyanogenic glycoside	0.0003±0.02mg/g	0.00mg/g

The presence of alkaloid, cyanogenic glycoside, flavonoid, phenol, saponin, and tannin in *T. triangulare* support possible medicinal and dietary relevance of the plant which view is upheld by other authors like Oloyed (2005), Aja et al., (2010), and Ogbonnaya and Chinedum (2013). Cyanogenic glycoside occurred in a very low (safe) level in the fresh sample and was absent in the dried sample (Table 4). Cynogenic glycosides are plant toxicants (Chandra et al., 2012). Processing like crushing of foods before soaking in water and shade drying of plant, as observed in this study, detoxifies cyanogenic glycoside making these plant foods healthier for animal and human consumption (Essers, 1995). Tannin constituted 1.6 % of the *T. triangulare* for the freshly harvested sample and 0.1 % in the dried sample. Aja et al. (2010) reported the level of tannin in *T. triangulare* to be 1.44 mg/100 g and 1.09 mg/100 g for dry and wet samples respectively. According to Adebayo et al., (2000) the lethal value of tannin in animal nutrition is above 5%.

The outcome of this study therefore supports proposed use of succulent parts (aerial parts) of *T. triangulare* plant as a phytobiotic based supplement for livestock and poultry production.

Conclusion: High nutrient and bioactive components in *T. triangulare* as observed in the study supports possible use as an ethno-medicinal protein/mineral-vitamin supplement. Drying concentrated the nutrients and phytochemical components in *T. triangulare*. Vitamin E and cyanogenic glycoside were destroyed in the process of drying.

Recommendation: Fortification of *T. Triangulare* - leaf meal from dried sample with Vitamin E is advocated. Drying, packaging and transportation of plant protein sources from rural to urban settlements and for export is a viable business venture for women and teeming unemployed youth population in a developing nation like Nigeria.

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EFFECT OF LITTER SIZE ON GROWTH PERFORMANCE OF RABBIT KITS

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Abstract

This study was conducted to determine the effect of litter size on growth performance of rabbit kits. A total of thirty rabbits comprising of twenty-four does and six bucks were used to generate the kits for this study. The rabbit does were assigned into three treatments with eight replicates and one animal per replicate in a completely randomized design. Feed and water were supplied *ad-libitum* throughout the duration of the experiment which lasted about sixteen weeks. The kits were allocated according to their litter size at birth; litter size 1(LS1) litters with less than four kits, litter size 2(LS2) litters with five to six kits and litter size 3(LS3) litters with seven to eight kits. Data collected (average birth weight, final weight, weight gain, feed intake, feed efficiency and mortality) were subjected to one-way Analysis of Variance (ANOVA) in a completely randomized design. The results indicated that litter size had a significant ($P<0.05$) influence on litter size at birth and weaning, litter weight at birth, average birth weight and litter weight at weaning. Litter size and litter weight at birth (7.50 and 337.60g, respectively) and weaning (7.25 and 3306.00g, respectively) were highest in LS3 while kits in LS1 had a higher average birth weight (64.38g) than kits of LS2 and LS3 whose weights were similar (48.73g and 45.01g). It was therefore concluded that average birth weight and litter weight at weaning is a function of litter size.

Key words: Rabbit kits, litter size, growth performance

Introduction

Nigerian populace has been largely dependent on livestock such as cattle, sheep, goat, pig and poultry that would require more capital, space and time (Yusuf *et al*., 2009) but cannot supply the projected animal protein requirement for a population of over 190 million in the country (Worldometers, 2018). Furthermore, Lameed and Ogundijo (2006) observed that animal protein production in Nigeria from domestic livestock has been falling steadily by about 1.4% annually, while human population has been increasing at an annual rate of 3.3%. Hence, there is need to look inward for animals that can convert little resources to flesh or whose nutritional requirement does not put too much pressure on sources of feed. One of the animals that meet these requirements is rabbit. Rabbits have a short gestation period, early sexual maturity, ability to rebreed shortly after kindling and short generation interval (Hassan *et al.,* 2012). These qualities confer on rabbits a potential to bridge the shortage of animal protein where grain can only be justified for human use. In rabbit farming, litter size and weight are the important economic traits which are to be genetically improved for obtaining maximum productivity ultimately, increased profit. Litter size at birth had been identified as one of the main traits affecting the profit functioning of rabbit farm (Prayaga and Eady, 2000). Rommers *et al*. (2001) stated that kits are solely dependent on mother's milk and the intake of milk by the individual is affected by litter size at birth. This research was, therefore, carried out to assess the effect of litter size on growth performance of rabbit kits.

Materials and Methods

Experimental Site

The experiment was carried out at the Rabbitry Unit, Teaching and Research Farm Development (TREFAD), College of Animal Science and Livestock Production Farm, Federal University of Agriculture Abeokuta. It lies within the rainforest vegetation zone of South West Nigeria with a mean annual rainfall of 1037mm and a temperature of 43°C and a relative humidity of 82%. It is in the region of 70m above sea level, 7°S 5°N longitude 3°W 11.2°E. (Google earth, 2016).

Experimental Animals and Management

Thirty rabbits comprising 24 does and 6 bucks New Zealand White breeds were used to generate the kits for this study. The rabbit does were assigned into three treatments with eight replicates and one animal per replicate in a completely randomized design. The rabbits were kept in hutches equipped with concrete pots of feeders and drinkers. The animals were allowed to acclimatize for 1 week before mating. They were supplied with clean water in concrete drinkers and fed on commercial diet (Table 1) in concrete feeders and were also given *Tridax procumbens* twice a week.

Table 1: Nutrient composition of the commercial feed (as declared)

Parameter	Value
Crude Protein (%)	16.00
Fats and Oil (%)	5.00
Crude Fibre (%)	7.00
Calcium (%)	1.60
Available Phosphorus (%)	0.45
Lysine (%)	0.75
Methionine (%)	0.36
Salt (%)	0.30
Metabolizable Energy (kcal/kg)	2450

Experimental Procedure

After the animals were allowed to acclimatize the does were mated two to three times to ensure conception and then palpated to determine if they had truly conceived or not. The ones that had not conceived were re-mated. The kits gotten from the does were used for this study. The kits were allocated into treatments according to their litter size at birth. All routine management operations (such as feeding, cleaning) and medications were duly observed.

Experimental treatments

LS1: litter sizes with less than 4 kits (≤ 4)

LS2: litter sizes with 5 to 6 kits (5-6)

LS3: litter sizes with 7 to 8 kits (7-8)

Data Collection

Animals in each replicate were weighed at the beginning of the experiment and subsequent weighing was done on weekly basis to determine their weekly body weight and weight gain. Weight gain was determined as the difference in the body weight of two consecutive weighing for each replicate. Feed intake was determined weekly through deduction of leftover feed from initial feed supplied. Feed efficiency of each animal was determined weekly as the ratio of weight gain to feed intake.

Statistical Analysis

All data collected were subjected to One-Way Analysis of Variance (ANOVA) using the General Linear Model procedure of (SAS, 2000). The significant differences among means were separated using Duncan's New Multiple Range Test of the statistical package at 5% level of probability.

Results and Discussion

The effect of litter sizes on the growth performance of rabbit kits is shown on Table 2, with significant ($P<0.05$) difference observed in litter weight at birth, average birth weight and litter size and weight at weaning. Litter weight at birth (337.60 g) and weaning (3306.00 g) were highest in LS3 while kits in LS1 had a higher average birth weight (64.38 g) than kits of LS2 and LS3 whose weights were similar (48.73 g and 45.01 g, respectively). This might be due to the litter size, as kits of smaller litter sizes have more space to grow and more nutrients to develop than that of larger litter sizes. This goes along with the report that indicated that in rabbit individual birth weight is about 60-70 grams, but can range from 35-40 to 80-90 grams and that individual birth weight decreases with increase in litter size (Poigner *et al.,* 2000). Litters body weight at weaning is influenced by the number of kits survived at weaning (Risam *et al.*, 2005), and Ahmed *et al*. (2005) observed that individual birth weight declined with increased in litter size. The average weaning weight, pre-weaning weight gain, pre-weaning Loss and Doe-Kit feed intake were not significantly ($P>0.05$) influenced by litter size. The average weaning weight obtained in this study was similar across the treatments and disagreed with the reports of Poigner *et al*. (2000) that rabbit kits of larger litter size always have a lower weight at weaning than the corresponding weight for kits of smaller litter size. This is due to the fact that their body weight gain depends on the quantity of milk consumed. Doe's milk production is also positively correlated to litter size (Ayyat *et al.,* 1995).

Table 2: Growth performance of rabbit kits from different litter sizes

	TREATMENT			
PARAMETERS	LS 1 (≤ 4)	LS 2 (5-6)	LS 3 (7-8)	SEM
Litter size at birth	3.00^{c}	5.50^{b}	7.50^{a}	0.59
Litter weight at birth(g)	191.00^{b}	268.25^{ab}	337.50^{a}	25.11
Average birth weight	64.38^{a}	48.73^{b}	45.10^{b}	
Litter size at weaning	3.00^{c}	5.50^{b}	7.25^{a}	0.56
Litter weight at weaning (g)	1458.00^{b}	2496.75^{ab}	3306.00^{a}	311.79
Average weaning weight	469.63	450.44	463.93	28.96

(g)				
Average pre-weaning weight gain (g)	405.25	401.72	418.83	29.59
Pre-weaning Loss	0.00	0.00	0.25	0.08
Doe-Kit feed intake (g)	2984.50	2735.75	2529.76	102.82

[a,b,c] Means with different letters in a row differ significantly (P < 0.05)

LS: Litter size

Conclusion

The study concluded that litter size had significant effect on the litter size at weaning, average birth weight and litter weight at birth and weaning but its effect was not significant on kit weaning weight. Hence, average birth weight and litter weight at weaning is a function of litter size.

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EFFECT OF BAKER'S YEAST (*Saccharomyces cerevisiae*) SUPLEMENTATION AS PROBIOTIC ON AMINO ACID PROFILE OF BROILER CHICKENS

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Abstract

An experiment was conducted to evaluate the effect of baker's yeast (*Saccharomyces cerevisiae*) suplementation as probiotic on amino acid profile of broiler chicken. Two hundred and fifty five day old chicks were used for the study. The birds were fed diets containing graded levels of *Saccharomyces cerevisiae* (SC). There were five treatment groups for both starter and finisher phases. Each treatment group had three replicates with 17 birds per replicate and fifty one birds per group in a completely randomized design (CRD). Treatments 1, 2, 3, 4 and 5 contained 0, 0.5, 1.0, 1.5 and 2.0% SC respectively. Significant ($P<0.05$) differences were observed among the treatment groups; though the amino acid profiles of the groups treated with SC were higher than the control. It was concluded that supplementation of Baker's yeast in the diet of broiler chicks (0-8weeks) improved the amino acid profile of the meat. It was therefore recommended that SC should be included at 1% level in broiler diet for better meat quality.

Key Words: Baker's yeast, Probiotic, amino acid, broilers, meat quality

Introduction

Poultry industry is one of the fastest growing Livestock enterprises in Nigeria. The industry provides the populace with high quality protein in form of eggs and meat. Feed constitute about 70% of the cost of production, the quality of the feed also affects the products (eggs or meat) quality [Karangiya, *et al*., 2016]. Good quality feed is important for poultry performance. Probiotics have been reported to have the potential for improving the nutritional value of feed [Ashayerizadeh, *et al*., 2009]. Probiotics are live fed microbial that have beneficial effect on the host [Patel, *et al*., 2015]. The main effects of probiotic are improvement of digestive processes, prevention of gastrointestinal tract disease and strengthening of the immune system [Park, *et al*., 2016]. Use of probiotics in poultry nutrition helps in growth of beneficial bacteria. Probiotic binds with the epithelial cells in the stomach or gastro intestinal tract where it helps to synthesize the vitamins and amino acid thereby result in improving the digestibility of feed and better weight gain of birds [Chermesh and Eliakim, 2006]. The purpose of this study was to determine the effect of baker's yeast (*Saccharomyces cerevisiae*) suplementation as probiotic on amino acid profile of broiler chickens

Materials and Methods

The study was conducted at the National Agricultural Extension and Research Liaison Services, Skill Acquisition Farm, Ahmadu Bello University, Zaria, located within the Northern Guinea Savannah Zone of Nigeria at latitude 11^{o} 09' 06'' N and longitude 7^{o} 38' 55'' E, at an altitude of 706m above sea level [GPS, 2018] . Two hundred and fifty five day old broiler chicks of Ross white strain purchased from a reputable hatchery were allotted to five treatments consisting of 17 chicks per replicate and three replicates per treatment. T_1 was the basal diet (0.0% SC) while T_2, T_3, T_4 and T_5 had *Saccharomyces cerevisiae* included at 0.5, 1.0, 1.5 and 2.0% of the total diet. The design of the experiment was a completely randomized design (CRD). The birds were reared in deep litter system with feed and water provided *ad libitum* during the experimental period. The diets as shown in table 1 and 2 were formulated to meet the nutrient requirements of the broiler chickens according to [NRC, 1994].

The amino acid profile (Phynylalanine, Histidine, Isoleusine, Lysine, Leusine, Methionine, Threonine, Valine, Alanine and Trypthophan) of the meat was determined using the method described by [Shadidi, 1999]. The sample was dried, defatted, hydrolysed, evaporated in a rotary evaporator and loaded into the Technicon Sequential Multi-sample Amino Acid Analyzer (TSM) using ion-exchange chromatography (Technicon Instruments Corporation, Dublin, Ireland).

Data obtained from all the experiments were subjected to the analysis of variance (ANOVA) using the general linear model procedure of [SAS, 2001]. Significant differences among treatment means were separated using Dunnetts.

Table 1: Composition of Broiler Starter Diets

	Levels of inclusion of SC (%)				
Ingredients	**0.0**	**0.5**	**1.0**	**1.5**	**2.0**
Maize	50.66	50.63	50.60	50.55	50.52
Groundnut cake	25.31	24.81	24.31	23.82	23.32
Soya cake	12.59	12.59	12.59	12.59	12.59
Fish meal	3.00	3.00	3.00	3.00	3.00
Palm oil	3.69	3.72	3.75	3.79	3.82
Limestone	0.90	0.90	0.90	0.90	0.90
Bone meal	2.75	2.75	2.75	2.75	2.75
Common Salt	0.30	0.30	0.30	0.30	0.30
Premix**	0.30	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.25
Baker's yeast (SC)	0.00	0.50	1.00	1.50	2.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 2: Composition of Broiler Finisher Diets

	Levels of inclusion of SC (%)				
Ingredients	**0.0**	**0.5**	**1.0**	**1.5**	**2.0**

Maize	57.52	57.52	57.52	57.52	57.52
Groundnut cake	11.67	11.17	10.67	10.17	9.67
Soya cake	20.00	20.00	20.00	20.00	20.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Palm oil	2.81	2.81	2.81	2.81	2.81
Limestone	1.10	1.10	1.10	1.10	1.10
Bone meal	2.80	2.80	2.80	2.80	2.80
Common Salt	0.30	0.30	0.30	0.30	0.30
Premix**	0.30	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20
Baker's yeast (SC)	0.00	0.50	1.00	1.50	2.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Results and Discussions

Table 3 shows the effect of baker's yeast (*Saccharomyces cerevisiae*) suplementation as probiotic on amino acid profile of broiler chickens. Significant (P<0.05) differences were recorded for all the amino acid in all treatment groups. Treatment group supplemented with 1% SC had higher values of all the amino acid followed by treatment group supplemented with 1.5% SC. The control group had the least values in terms of histidine, lysine, methionine, threonine and valine compared to other treatment groups. No significant (>0.05) difference in the levels of phenylalanine, leucine and alanine between the control group and treatment group supplemented with 0.5% SC.

The improved amino acid profile observed in the SC treatment groups especially the group supplemented with 1% SC could be due to the role of SC in the metabolic functions as a strong stimulating action on the activity of certain important bacteria, which are actively involved with the digestive processes, protein synthesis and nutrient absorption in the gastrointestinal tract [Stockland, 1993]. Protein plays a very important role in almost all biological processes and amino acids are the building blocks of proteins. The cells, muscles and tissue are made up of amino acids, and are involved in important bodily functions. Therefore the improved level of the amino acid in the treatment groups supplemented with SC will improve the quality of the meat. Bonomi, *et al.,* 1999 Reported that enrichment of diet with yeast could favourably improve the quality of edible meat from broilers. Alfiya *et al,* (2017) also reported that probiotic additive fed to broilers at 1.5g/kg was more nutritious being richer in protein.

Table 3: Effect of supplementation of *Saccharomyces cerevisiae* (SC) as probiotic in the diet of broilers (0-8 weeks) on amino acid profile of broilers meat

	Levels of SC inclusion (%)					
Amino acid (g/100g)	**0.00**	**0.5**	**1.0**	**1.5**	**2.0**	**SEM**
Phenylalanine	4.84^{d}	4.84^{d}	5.28^{a}	5.10^{b}	4.93^{c}	0.01

Histidine	2.60^{e}	2.79^{d}	3.49^{a}	3.14^{b}	2.98^{c}	0.01
Isoleucine	3.59^{c}	3.62^{c}	3.85^{a}	3.72^{b}	3.69^{b}	0.02
Lysine	7.09^{e}	7.37^{d}	8.00^{a}	7.75^{b}	7.53^{c}	0.02
Leucine	7.63^{d}	7.69^{d}	8.33^{a}	8.10^{b}	7.89^{c}	0.03
Methionine	0.99^{e}	1.26^{d}	1.40^{a}	1.34^{b}	1.29^{c}	0.01
Threonine	3.30^{e}	3.49^{d}	4.00^{a}	3.80^{b}	3.63^{c}	0.02
Valine	4.81^{e}	4.96^{d}	5.54^{a}	5.20^{b}	5.05^{c}	0.03
Alanine	4.10^{d}	4.14^{d}	5.10^{a}	4.64^{b}	4.35^{c}	0.02

^{abcde}: Means with different superscripts along same rows show significant differences (P<0.05)

SEM: Standard Error of Means

Conclusion

It was concluded that SC inclusion in diet of broilers improved the amino acid profile of the breast meat. Therefore, based on the obtained results it is recommended that 1% SC should be included in the diet of broilers because it had the highest levels of amino acid profile in the breast meat which will have a positive effect to the nutritional value of the broiler meat.

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RESPONSE OF GROWING TURKEYS TO DIETS CONTAINING VARYING LEVELS OF TOASTED BAMBARA NUT (*Voandzeia subterrenea L*) WASTE

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Abstract

The study was conducted to investigate the response of growing turkeys to diets containing varying levels of toasted bambara nut (*Voandzeia* subterrenea L) waste. A total of 40 ten-week- old turkeys (*Meleagris gallopavo*) were randomly *divided* into four groups of 10 birds each. The groups were randomly assigned to four treatments of diets involving four levels (0, 10, 20 and 30%) of toasted bambara nut waste for 56 days. Each treatment was replicated two times with 5 birds per replicate. The experimental model used was a completely randomized design (CRD). In the experiment, the daily feed intake increased as the level of inclusion of the toasted bambara nut waste in the diet increased. There were significant ($p<0.05$) differences among treatments in the final body weight gain, total weight gain, average daily weight gain , feed conversion ratio, protein efficiency ratio and in feed cost per kg weight. Also there were significant ($p<0.05$) differences in body length, shank length, neck length and thigh diameter of turkeys feed toasted bambara nut waste. It could be observed and concluded that the performance of turkeys on treatment 4 (30% TBNW diet) in terms of total body weight gain, daily weight gain, feed conversion ratio, protein efficiency ratio and feed cost per kg gain was superior to that of turkeys on the control diets.

Key words: Bambara nut waste, growing turkey, growth performance, cost, body characteristics

INTRODUCTION

The most pressing problem facing poultry industry in Nigeria is the high cost of feed ingredients. The cost of feed accounts for 70-75% of the total cost of production and this has invariably led to a high cost of production (Esonu *et al*., 2006).This had led the animal nutritionist to search for alternative ways of inclusion using some of the affordable and available non-conventional waste ingredient, in order to minimize the cost of production. Bambara nut waste has been useful in this regards. According to Enwere (1998) Bambara nut has the following composition. Moisture content 9.7%, crude protein 16.0%, crude fat 5.9%, and ash 2.9% total carbohydrate 64.9%. It is fairly rich in calcium and iron but poor in phosphorus. It has been reported by Enwere (1998) that bambara nut is mainly processed into flour which is prepared and consumed in form of “okpa” popularly known among the Ibos of Nigeria. In the production of the flour, the seed coats are partially removed by splitting the seeds in mill, winnowing to remove loosened test and converting the cotyledon into fine flour by milling several times in a hammer mill followed by sieving, using sieves with 1mm pores. Processing of bambara nut result in fairly large edible protein called bambara nut waste. This study therefore aimed at evaluating the potency of the bambara nut waste as feed stuff in feeding growing turkeys.

MATERIALS AND METHODS

Location and durtion of the study: The experiment was carried out at the Poultry Teaching and Research Unit of the Department of Animal Science Research Farm, University of Nigeria, Nsukka. The study lasted for a period of seven weeks.

Procurement and Processing of Bambara nut waste: The bambara nut wastes were purchased from food grinding and processing plants in ObolloAfor Market and Ogige Market, Nsukka. Other feed materials and ingredients were sourced from chidera feed mill at onuiyi, Nsukka. The bambara nut wastes were heated

while being stirred in a large frying pan over burning firewood for about 5 – 10 minutes until a toasting aroma was perceived consistently, in order to remove some anti-nutritional factors like tannin and cyanogenic glycosides.

Experimental Animals and Management: A total of forty 10 weeks old turkeys were randomly divided into four groups of 10 birds each. The groups were randomly assigned to isocaloric (11.30 MJ /Kg ME) and isonitrogenous (20% crude protein) diets in a completely randomized design (CRD). Each treatment was replicated 2 times with 5 birds per replicate placed in 2.6m x 3m deep litter pens of fresh wood shavings. Feed and water were supplied ad *libitum* to the birds. Vaccinations and other management practices were strictly followed.

Parameters Measured: The following parameters were measured and determined: Average daily feed intake (g/bird/day), Average daily weight gain (g/bird/day), Feed conversion ratio and body characteristics.

Statistical Analysis: Data collected were subjected to analysis of variance using (ANOVA) of SPSS (version 20 of 2011).

RESULTS AND DISCUSSIONS: The result of Performance of growing turkeys fed graded levels of toasted bambara nut waste is presented in Table 1 There were significant ($p<0.05$) differences among treatments in the daily feed intake of the birds. The daily feed intake for T_4 (3005g) was significantly ($p<0.05$) higher than T_1 (2609g), T2 (2394g) and T_3 (2774g). T_4(2394g) showed significant ($p<0.05$) increase in value of total weight gain than turkeys on T1 (1915g), T2 (1725g), and T3 (2128g). Turkeys on T4 also showed significant ($p<0.05$) increase in average daily weight gain compared to turkeys on T1, T2 andT3. There were also significant ($p<0.05$) differences in the average daily weight gain. The results also showed that T2 (2.45) had a significant ($p<0.05$) higher value in food conversion ratio than T1 (2.05), T3 (1.90) and T4 (1.95). The result revealed that turkeys on T1 (2.45), T3 (2.70), and T4 (2.55) were significantly ($p<0.05$) higher in values in protein efficiency ratio than turkeys on treatment 2. Turkeys on T4 (243.36) showed significant ($p>0.05$) decrease in feed cost per kg than turkeys on treatments 1(295.71), 2(355.52), and 3(246.81).

Table 1: Performance of growing turkeys fed graded levels of toasted bambara nut waste

Parameters	Control T_1	10% T_2	20% T_3	30% T_4	SEM
Initial body wt(g)	693	668	664	671	11.9
Daily feed intake (g)	70.60^{d}	76.40^{c}	82.20^{b}	88.00^{a}	1.72
Final body wt (g)	2609^{bc}	2394^{c}	2774^{ab}	3005^{a}	67.37
Total wt gain (g)	1915^{bc}	1725^{c}	2128^{b}	2394^{a}	73.33
Av daily wt gain (g)	34.20^{bc}	30.80^{c}	38.00^{b}	42.75^{a}	1.31
Feed conversion ratio	2.05^{b}	2.45^{a}	1.90^{b}	1.95^{b}	0.26
Protein efficiency ratio	2.45^{a}	2.05^{b}	2.70^{a}	2.55^{a}	0.08
Feed cost per kg weight gain(₦ per kg)	295.71^{b}	355.52^{a}	246.81^{c}	243.36^{d}	17.20

Results from this study showed that turkeys fed the diets containing 30% of toasted bambara nut waste had the highest final body weight, total weight gain, average daily weight gain and had the least feed conversion ratio. The enhanced performance of the growing turkeys on treatment 4 with reference to those on the

control diets might be as a result of the ability of the turkeys to efficiently digest, absorb and utilize their feed more than those on the control diets. It is also probable that the common processing techniques for bambara nut such as grinding and heat treatment employed in this study have the ability to modify the nutritive availability to the turkey. This view is in harmony with the report of Onyimonyi and Okeke, (2007) that common processing techniques such as grinding, heat treatment, pelleting etc could modify the nutritive value of diets. The better performance could also be attributed to high protein content of bambara nut. Enwere (1998) reported that dry bambara groundnut seeds contained 21.13% crude protein, while the raw bambara nut waste contained 16.19% crude protein (Okeke, 2000). This findings was in agreement with the finding of Ani, *et al.,* (2012), Ani and Nnamani (2013), who showed that the performance of cockerel growers on (30% raw bambara nut offal diets without enzyme) in terms of total body weight gain, daily weight gain, feed conversion ratio, protein intake, protein efficiency ratio and feed cost was superior to that of birds on the control diet and other treatments. The result contradicts that reported by Ngwu, (2010) which showed that the final body weight, feed conversion ratio and protein efficiency ratio of broiler finishers fed diets containing 10% toasted bambara nut waste were the best, although the differences among the results could be as a result of species differences, since different species of birds have different ability to digest, absorb and utilize their feed.

Table 2 showed the body characteristics of turkeys fed graded levels of toasted bambara nut waste. The table revealed that the mean body length of turkey placed on treatment3 (43.10cm) showed significant ($p<0.05$) increase in value than turkey placed on treatments 1(41.25cm) and 2(41.05cm).The table also showed that the mean value of shank length of turkeys on treatment 3(8.60cm) was significantly ($p<0.05$) higher than turkey on treatment 2(7.85cm). Treatments 3(15.60cm) and 4(15.70cm) were significantly ($p<0.05$) higher in value of mean neck length than treatment 2(15.05cm). Finally turkeys on treatment 3(8.85cm) was significantly ($p<0.05$) higher than turkeys on treatments 1(8.45cm), 2(8.10cm) and 4(8.35cm) in thigh diameter.

Table 2: Body characteristics of turkeys fed graded levels of toasted bambara nut waste

Parameters	Control	10%	20%	30%	
	T1	T2	T3	T4	SEM
Body length(cm)	41.25^{b}	41.05^{b}	43.10^{a}	42.25^{ab}	0.27
Shank length(cm)	8.25^{ab}	7.85^{c}	8.60^{a}	8.20^{bc}	0.09
Neck length(cm)	15.25^{ab}	15.05^{b}	15.60^{a}	15.70^{a}	0.09
Keel length(cm)	7.95	8.10	7.90	7.95	0.06^{NS}
Thigh length(cm)	13.15	12.85	13.20	12.85	0.07^{NS}
Thigh diameter(cm)	8.45^{b}	8.10^{c}	8.85^{a}	8.35^{b}	0.08

The results from this study showed that turkeys on treatments 3 and 4 had a progressive increase in body characteristics. The progressive increase in their body characteristics were an indicative that the test diet at 20% and 30% inclusion level resulted in good performance of the turkey. This supports (Fetuga *et al,* 1995) who proposed that Pig's performance in terms of rate and efficiency of gains is closely related to the nutrient intake levels, especially protein and energy. This ability to utilize dietary nutrients resulted to increase in superior body characteristics of the turkeys.

CONCLUSION: From the results obtained in this present study, up to 30% levels of toasted bambara nut waste can be included in turkey diets for optimum performance, normal growth and cost effective of the production of turkey.

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EFFECT OF DIFFERENT ANIMAL PROTEIN SOURCES ON PERFORMANCE OF BROILER CHICKENS

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ABSTRACT

The experiment was carried out to determine the effect of different protein sources (maggot, termite, grasshopper and lizard meal) on performance of broiler chickens. A total of one hundred and fifty (150) day old broiler chicks of Marshall Breed were used for the experiment. An eight week study was conducted to evaluate the performance of broiler chicken fed four different sources of animal protein. Diet I contained 5% fish meal while Diets 2, 3, 4 and 5 contained 5% maggots meal, termites meal, grasshopper meal and lizard meal respectively at the starter phase. The finisher phase contained 2.5kg each of the protein sources respectively. The chicks were allotted to five dietary treatments each replicated thrice with ten birds per replicate in a completely randomized design (CRD). Data collected were subjected to one-way analysis of variance and significant means were separated using Duncan Multiple Range Test (DMRT). The feed intake value observed in birds fed Diet 1 was significantly ($P<0.05$) higher than others statistically. Birds fed Diet 2 showed significant ($P< 0.05$) better performance than others as regards final weight gain. Birds fed Diet 2 (maggot meal) performed better than others in absolute weight gain (2287g) which is very close to those fed fish meal (Diet 1). In conclusion, maggot meal in this study enhanced performance and is thus recommended as a replacement for fish meal.

Keywords: broiler chickens; performance; animal protein sources

INTRODUCTION

Poultry has become the fastest means of bridging the gap in animal protein intake in Nigeria, due to its short production period and quick return on investment. However, this potential is currently being undermined by escalating costs of feedstuffs, and poor funding of the industry (Nworgu, 2007). The search for the least cost feed component has brought about the replacement of some conventional feedstuffs with cheap and locally available alternatives in the formulation of poultry feeds. The high cost of fish meal for example, has led to exploring alternatives such as termite, grasshopper and maggot meal sources of feed ingredients. Atteh and Ologbenla (1993) reported that any alternatives to be used should have comparative nutritive value, be cheaper than the conventional protein sources and be available in larger quantities. It is from the above that this study focused on the use of maggot, termite, grasshopper and lizard meals as alternative protein sources to fish meal in broiler diets.

MATERIALS AND METHODS

The experimental site

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Ibrahim Badamasi Babangida University, Lapai Niger State. The area is located in the Vegetative Zone of Guinea Savannah, Middle Belt of Nigeria. It lies on longitude 9.02^{o}N and latitude 6.3^{o}E of the equator with an average temperature range of 23^{o}C - 34^{o}C and a maximum rainfall of 107.3mm (Anonymous, 2010).

Source and preparation of test ingredients

The maggots used in the experiment were bred from layers droppings. They were obtained by culturing housefly larvae (*Musca domestica*) on the droppings. The droppings were spread on a wet platform to attract houseflies which introduced the larvae on the dropping. After seven days, they were ready for harvesting, as they migrate to the surface of the substrate. The harvested maggots were oven-dried at 75^{o}C for three hours in order to reduce its moisture content for proper storage. Termites were caught by simple light traps after night rainfall. Flying termites were attracted by the light and were caught inside a yellow basin containing water. They were hand-picked, de-winged, oven dried to a constant weight and then ground into powdery form. Mature male and female *Agama agama* lizards were caught by hunting with catapults, stones and traps. The lizards were slaughtered and visceral removed. Lizard carcass was sundried for 12 days to appreciable moisture content in the month of December. Dried grasshoppers were purchased from Lapai local market. The carcass of *Agama agama* lizard, termite and grasshopper were later ground into meal using hammer mill into separate bags.

Experimental diets

The experimental starter diets (Table 1) composed of 5% fish meal as source of animal protein in diet 1 (control), 5% of maggot meal (MGM), termite meal (TMM), grasshopper meal (GHM), and lizard meal (LDM) in diets 2, 3, 4 and 5 respectively. At the finisher phase, 2.5% of each test ingredient replaced fish meal in diets 2, 3, 4 and 5 respectively (Table 2).

Experimental birds and management

The pens were cleaned and then disinfected using Izal before the arrival of the chicks. A total of one hundred and fifty (150) day-old broiler chicks of Marshal Breed were used for the study. They were allotted into five treatments of 30 chicks in a completely randomized design (CRD). Each treatment was replicated thrice with 10 birds each. The birds on arrival were placed on the experimental diets. The chicks were brooded on deep litter using charcoal pot as source of heat. Anti-stress (Vitalyte®) was administered to the chicks on arrival and routine management practices were adopted as recommended by Oluyemi and Roberts (2000). Experimental broiler starter feed was fed in the first four (4) weeks while the broiler finisher was fed in the last four (4) weeks. Feeds and water were supplied *ad-libtum*. The birds were vaccinated against gumboro disease at the end of weeks one and three, using Infectious Bursal Disease vaccine (IBDV) and Newcastle disease Vaccine (Lasota) at the end of 2nd and 4th weeks. Amprollium was administered to the birds against coccidiosis.

Data collection and statistical analysis

Data on body weight gain and feed intake were collected on weekly basis and they were used to determine feed conversion ratio. Feed intake was monitored by calculating the difference between the feed served and left over. The mean value of these parameters were obtained and recorded. Mortality was recorded as it occurred throughout the period of the experiment. Data collected were subjected to analysis of variance (ANOVA) according to the procedure of Steel and Torrie (1980). The significant means were separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1955) at 5% probability level.

RESULTS AND DISCUSSION

The performance of broiler bird fed diets containing different animal protein sources is shown in Table 3. The mean final weight gain recorded were 2400, 2367, 2167, 2167 and 1930g for treatment 1, 2, 3, 4 and 5 respectively. Absolute weight gains in grams were 2324, 3387, 2091, 2097 and 1857 for treatment 1, 2, 3, 4 and 5 respectively. Feed intake ranged from 4289.89g in birds fed lizard meal to 4700.16g in birds fed control diet, while average daily feed intake ranged from 76.60g in birds fed lizard meal to 83.93g in birds fed control diet. Feed conversion ratio was at the best (2.02) in birds fed with control diet, followed by those fed maggot meal (2.04), and the worst (2.31) from those fed lizard meal. Mortality increased from the control group and across other treatments and was obtained as 6.67, 13.33, 20.00, 23.33 and 33.33 for treatments 1, 2, 3, 4, and 5 respectively.

There were significant (P<0.05) differences among the treatments mean of feed intake. Treatment 1 (control) had the highest value (4700.16) followed by treatment 2 (4661.31) which was not significantly (P>0.05) different statistically from birds fed fish meal. This was similar to the report of Egbewande *et al.* (2017), who obtained no significant (P>0.05) effect when maggot meal was used to replace fish meal in diets of broiler birds. The lowest final weight (1930g), feed intake (4289.89g), absolute weight gain (1857g), and the highest mortality rate (33.33%) obtained in birds fed lizard meal might be as a result of the anti-nutritional factors in raw lizard as reported by Abulude *et al*. (2007). They added that *Agama agama* lizard contained tannin, oxalate and phytate. The final weight gain obtained from birds fed lizard meal in this study is however, higher than 1526g reported by Olabode *et al.* (2017). Feed conversion ratio for birds on treatment 1 and 2 were superior (2.02) and (2.04) respectively, compared with the rest of other treatment groups.

CONCLUSION

This study revealed that maggot meal can completely replace fish meal at 100% inclusion rate in broiler chicken diet without any significant effects on weight gain, feed intake and feed conversion ratio. The performance data in this study point to the potential of maggot meal as an alternative animal protein source to fish meal. Since growth is of paramount concern to poultry farmers, the performance of birds fed Diet 2 (maggot meal) seemed to indicate better nutrient adequacy than diets 3, 4 and 5 and is therefore, recommended.

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Table 1: Composition of experimental starter diets

Ingredient (%)	Treatment				
	Control	MGM	TMM	GHM	LDM
Fish meal	5.00	-	-	-	-
Maggot meal	-	05.00	-	-	-
Termite meal			05.00	-	-

Grasshopper meal	05.00	-
Lizard meal		05.00

Other feedstuffs had same value (%) across treatment group: maize – 50.00; groundnut cake – 10.88; soyabean – 19.42; wheat offal – 10.00; bone meal – 3.00; limestone – 0.80; starter premix – 0.25; salt – 0.25; lysine – 0.20; methionine – 0.20. Calculated Crude protein (%) and Metabolizable energy (kcal/kg): control = 23.24 and 2896; MGM = 23.97 and 2898.89; TMM = 23.85 and 2876.14; GHM = 23.63 and 2862.64; LDM = 23.13 and 2859.72 Key: MGM = Maggots meal; TMM = Termites meal; GHM = Grasshopper meal; LDM = Lizard meal

Table 2: Composition of experimental finisher diets

Ingredient (%)	Treatment				
	Control	MGM	TMM	GHM	LDM
Fish meal	02.50	-	-	-	-
Maggot meal	-	02.50	-	-	-
Termite meal	-	-	02.50	-	-
Grasshopper meal	-	-	-	02.50	-
Lizard meal	-	-	-	-	02.50

Other feedstuffs had same value (%) across treatment group: maize – 50.00; groundnut cake – 9.45; soyabean – 18.30; wheat offal – 15.00; bone meal – 3.50; finisher premix – 0.25; salt – 0.25; lysine – 0.30; methionine – 0.20. Calculated Crude protein (%) and Metabolizable energy (kcal/kg): control = 20.61 and 2913.73; MGM = 20.72 and 2954.85; TMM = 20.33 and 2913.73; GHM = 20.21 and 2916.73; LDM = 20.12 and 2911.73 Key: MGM = Maggots meal; TMM = Termites meal; GHM = Grasshopper meal; LDM = Lizard meal

Table 3: Performance of broiler chickens fed diets containing different protein sources

Parameter (g)	Treatment						
	Control	MGM	TMM	GHM	LDM	SEM	LSD
Initial weight	76.00	80.00	76.00	70.00	73.00	0.13	NS
Final weight	2400.00[a]	2367.00[b]	2167.00[c]	2167.00[c]	1930.00[d]	0.40	*
AWG	2324.00	2287.00	2091.00	2097.00	1857.00	0.52	NS
ADWG	41.50	40.75	37.33	37.44	33.16	0.02	NS
Feed intake	4700.16[a]	4661.31[a]	4350.06[b]	4439.55[b]	4289.89[c]	0.08	*
ADFI	83.93	83.23	77.67	79.27	76.60	0.21	NS
FCR	02.02	02.04	02.08	02.12	02.31	0.09	NS
Mortality (%)	06.67	13.33	20.00	23.33	33.33	-	-

Key: SEM: Standard error of mean; LSD: Level of significant difference; FCR: Feed conversion ratio, AWG: Absolute weight gain, ADWG: Average daily weight gain, ADFI: Average daily feed intake NS = Not significant, * = Signicant

[abcd] Means within the same row with different superscripts differs significantly (P< 0.05)

EFFECT OF NEEM (*Azadirachta indica*) LEAF MEAL ON THE GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF MALE GROWING RABBITS

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Abstract

A total number of 36 male growing rabbits of mixed breeds with an average weight of 550g were used to determine the growth performance and carcass characteristics of male growing rabbits fed diet containing neem leaf meal (NLM). The experiment was a complete randomized design (CRD) with four treatment diets replicated thrice. Wheat offal was replaced with NLM in the diets 0, 5, 10 and 15%, respectively. The study lasted for 13 weeks. Feed and water were supplied ad libitum. Results on growth performance showed that all the measured indices were similar (p>0.05) across the treatments. Carcass weight, dressing percentage, hind limbs, loin, neck and liver were significantly (p<0.05) influenced by neem leaf meal. It was concluded that male growing rabbit could only effectively tolerated 5%NLM dietary inclusion as a replacement of wheat offal.

Key words: growth, carcass, rabbit, neem

Introduction

An increase in the standard of living inevitably calls for an increase in availability of animal protein sources. This situation calls for the production of fast maturing livestock like rabbits which can utilize cheap and locally available feedstuffs (Balogun *et al.,* 2003). Rabbit production is one of the ways to reduce deficiency of animal protein intake in Nigeria (Unigwe *et al.,* 2009). The short gestation period and prolific habit of rabbit makes the animal tohave more advantages over other livestock. Rabbit is one of the cheapest meats that can easily fit into the wider segment of the population but has not been fully exploited in Nigeria. The high cost of conventional feedstuff sources (Esonu *et al.,* 2006) and their non-availability due to competition between man and animal has been a serious challenge to rabbit farmer. Therefore, there is the need to investigate alternative feed sources such as, *Azadirachta indica,* which leaves have been used as animal feed in many places.The main purpose of this study is to determine the effect of replacing wheat offal with neem (*Azadirachta indica)* leaf meal on growth performance and carcass characteristics of male growing rabbits.

Materials and Methods

Experimental location: The research was carried out in rabbit section of the Teaching and Research farm of the College of Animal science and livestock production, Federal University of Agriculture Abeokuta, Ogun State. Abeokuta geographical coordinates: 7º 9' 0" North, 3° 21' 0" East (Goggle Earth 2017).

Source of test ingredient: Fresh neem leaves were harvested from neem trees around the experimental site. The leaves were air dried until it becomes crispy, then the air-dried leaves were milled using commercial milling machine into neem leaf meal (NLM).

Experimental animals, Design and Management: Thirty- six (36) male weaner rabbits, with an initial average weight of 550g, were used in this experiment. The rabbits were assigned to four treatments, each having three replicates in a completely randomized design. The dietary groups involved replacement of wheat offal with Neem leaf meal at 0, 5, 10 and 15% as shown in Table 1. The rabbits were housed in wooden hutches. Water and feed were given to the rabbit *ad libitum* and general sanitization was done, with proper biosecurity and daily routine management. The study lasted for thirteen weeks.

Table 1: Percentage composition of the experimental diets

	Inclusion levels of NLM (%)			
Ingredients	0	5	10	15
Maize (white)	40	40	40	40
Wheat Offal	15	10	5	0
Rice Husk	17	17	17	17
Neem Leaf Meal	0	5	10	15
Soyabean Meal	23	23	23	23
Oyster Shell	1.5	1.5	1.5	1.5
Bone Meal	3.0	3.0	3.0	3.0
Vitamin/Premix	0.25	0.25	0.25	0.25
Salt (NaCl)	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Calculated analysis				
Crude protein (%)	18.01	18.10	18.22	18.27
Crude fibre (%)	10.01	10.19	10.22	10.33
Energy (kcal/kg)	2638.24	2589.84	2541.44	2493.04

Data collection: Growth performance indices (feed intake, weight gain) were taken weekly while feed conversion ratio was calculated by dividing feed intake by weight gain.

Carcass characteristics: On the last day of the experiment, one rabbit in each replicate was selected and starved for twelve hours without feed, so as to reduce the gastro-intestinal tract content of the animal. The rabbits were weighed and slaughtered and the viscera organs were eviscerated. The live weight, carcass weight, dressing weight and the cut parts (Head, Fore limbs, hind limbs, chest, loin, neck, back, tail) and viscera organs (liver, kidney, heart, lung,) were expressed as the percentage of live weight of each animal.

Statistical Analysis: Data obtained were subjected to one-way Analysis of Variance in a Completely Randomized Design, using SAS (2000). Significant means were compared using Duncan's Multiple Range Test of the software package.

Results and Discussion

The effect of neem leaf meal on growth performance of male weaner rabbit is shown in Table 2. The results indicated that the effect of NLM as alternative to wheat offal did not significantly ($p>0.05$) affect the growth response of male growing rabbit. The similarity in growth indices measured across the treatments indicated that the level of antinutritional factors such as terpene and limonoids (Ogbuewu, *et al*. 2011) in neem leaf meal at the level of inclusion were not detrimental to the growth performance of rabbit. This result negates the report of Unigwe *et al.* (2016) who observed significant difference when unsexed rabbits were subjected to the diets containing NLM at the same level of inclusion reported in this present study. The variations in the reports could be attributed to the sex effect because this present study focused only on male growing rabbits.

Table 2: Effect of neem leaf meal on growth performance of male weaner rabbit

Inclusion level of neem leaf meal (%)				
Parameters	0	5	10	15
Initial weight (g)	583.33±9.62	577.78±11.11	577.78±11.11	566.67±0.00
Final weight (g)	1344.44±155.56	1600.00±115.47	1255.56±29.40	1133.33±69.39
Total weight gain (g)	761.11±163.96	1022.22±105.99	677.78±29.40	566.67±69.39
Daily weight gain (g)	8.36±1.80	11.23±1.16	7.45±0.32	6.23±0.76
Total feed intake (g)	5169.44±173.52	6022.22±473.79	4683.33±130.17	4791.11±522.53
Daily feed intake (g)	56.81±1.91	66.18±5.21	51.47±1.43	52.65±5.74
Feed conversion ratio	7.56±1.79	5.94±0.39	6.92±0.12	8.71±1.38

The effect of replacing wheat offal with neem leaf meal on the carcass characteristics of male weaner rabbit is presented in Table 3. The result showed that all carcass weight dressing percentage hind limbs, loin, neck and liver were significantly ($p<0.05$) influenced by neem leaf mealamong the measured parameters. The carcass weight, dressing percentage and hind limbs decreased as the level of NLM increased across the treatment groups. The highest value of loin and neck were recorded in rabbit fed 5% NLM diet while the least values were recorded from those fed 15% NLM diet. Rabbits on control and 10% NLM diets had similar values of loin and neck. The liver weights increased ($p<0.05$) with increased levels of NLM. The adverse effect of increased level of neem leaf meal on liver could be as a result of presence of tannin and saponins. Suchitra and Wanapat (2008) reported that neem leaves contain large amounts of tannins (11%) and saponins (2.5%). In ruminants, condensed tannins and saponins may be used to improve rumen ecology but they are detrimental in monogastric species

Table 3: Effect of neem leaf meal on carcass characteristics of male weaner rabbit

	Inclusion levels of neem leaf meal (%)			
Parameter	0	5	10	15
Live weight (g)	1666.67±101.38	1689.67±92.48	1478.67±33.93	1228.33±80.50
Carcass weight (g)	1245.33±70.04[a]	1244.67±47.81[a]	1044.33±44.95[b]	792.33±28.90[c]
Dressing (%)	74.77±1.03[a]	73.80±1.43[a]	70.81±4.45[ab]	64.74±1.78[b]
Head (%)	9.60±0.19	9.73±0.40	9.25±0.85	9.76±0.63
Fore limb (%)	5.55±0.54	8.06±0.76	6.72±1.43	7.44±0.17
Hind limb (%)	17.01±0.42[a]	15.59±0.71[ab]	15.99±0.83[ab]	14.61±0.56[b]
Chest (%)	15.51±0.29	12.11±1.97	12.36±2.21	10.76±1.34
Loin (%)	7.67±0.47[ab]	8.15±0.44[a]	7.77±0.41[ab]	6.12±0.70[b]
Neck (%)	1.68±0.03[ab]	2.33±0.23[a]	1.63±0.25[ab]	1.49±0.17[b]
Back (%)	15.14±0.44	15.35±1.45	14.24±2.07	12.06±0.89
Tail (%)	0.47±0.04	0.53±0.04	0.54±0.01	0.56±0.02
Liver (%)	1.97±0.12[b]	2.47±0.31[ab]	2.84±0.10[a]	2.99±0.11[a]
Kidney (%)	0.49±0.09	0.55±0.08	0.47±0.04	0.60±0.01
Heart (%)	0.26±0.04	0.28±0.01	0.23±0.03	0.29±0.08
Lungs (%)	0.55±0.06	0.55±0.10	0.51±0.03	0.60±0.05

[a,b] Means on the same row with different superscripts are significantly($P<0.05$) different

* Live weight was used as covariate

Conclusion

The study concluded that replacement of wheat offal with neem leaf meal in the diet of growing male rabbits above 5% had negative effect on dressed percentage and liver though the effect was not significantly seen on growth performance. It was therefore, recommended that the NLM inclusion should not exceed 5% in the diet of male rabbit for optimum performance.

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PROXIMATE COMPOSITION AND FEEDING VALUE OF ENSILED BLEND OF CASSAVA ROOT MEAL, WET BREWERS' GRAINS AND PALM KERNEL CAKE IN STARTER BROILER DIETS

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Abstract

The proximate composition and feeding value of ensiled blend of peeled cassava root meal, wet brewers' grain, and palm kernel cake (EB-CBP) were evaluated. Peeled cassava root meal, wet brewers' grain, and palm kernel cake were mixed in a ratio of 1.0:1.5: 0.5 and divided into three equal parts. The first part was sun dried after mixing while the second and third parts were ensiled in black polythene bags under room temperature for 7 and 14 days, respectively before sun drying. Samples of the 3 products were analyzed for their proximate compositions. Four experimental broiler starter diets were formulated such that diet 1(control) contained 100% maize. Diets 2, 3 and 4 contained 50% of the 0, 7 and 14days ensiled products as replacement for maize, respectively. One hundred and twenty (120) day old broiler chicks divided into 12 groups were randomly assigned to each of the four experimental diets in a complete randomized design, replicated three times. Except for crude protein and nitrogen free extract values, the 14 days ensiled product had the highest proximate and gross energy values. Weight gain, feed intake and feed conversion values of birds fed the product diets were comparable with that of the control. Cost of feed consumed and feed cost/kg weight gain were reduced in broilers fed EB-CBP product diets. It was concluded that ensiling enhanced the nutritive and feeding values of the products and that EB-CBP irrespective of ensilage period favorably replaced 50% maize in broiler ration at reduced cost of production.

Keywords: ensilage, proximate composition, performance, broilers, cassava root meal, wet brewer's grains, palm kernel cake

Introduction

The use of non-competitive, inexpensive, unconventional and locally available feedstuffs in poultry feeds as replacement for maize has been suggested by nutritionists as an effective way of reducing the current pressure on maize, and minimizing feed costs and maximizing profit in broiler productions (Neves *et al*., 2014). Cassava root meals are considered as energy feedstuff in poultry rations because of their high starch content and low fiber (NDF is less than 10% DM) contents which makes cassava root highly digestible in all livestock species (Regnier, 2011). The metabolisable energy value of good cassava meal (72% starch) is equivalent to that of maize (Savant *et al.,* 2004).

However, the protein content (typically less than 3%) is lower than that of cereal grains and could not replace them weight for weight in a balanced ration. Grating cassava results in high levels of fine particles which can reduce feed intake and possibly irritate respiratory organs (Garcia *et al.,* 1999). While there is no hard limit on the inclusion level of high-grade cassava in pelleted diets for grower - finisher broilers, the hydrogen cyanide (HCN) and low protein contents of cassava limits its inclusion to 30-40% to meet dietary requirements. There is need therefore, to look for ways of reducing the HCN and dustiness in cassava root and at the same time enhance its protein content.

This experiment was therefore designed to determine the effect of ensiling a blend of cassava root meal, wet

brewers' grain and palm kernel cake (EB-CBP) on its proximate composition and gross energy values and on the performance of broiler chicks at 28 days of age.

Materials and Method

This study was carried out at the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri, Imo State, Nigeria. Peeled cassava root meal, wet brewers' grain and palm kernel cake (PKC) were procured and mixed together in a ratio of 1.0:1.5: 0.5 and divided into three equal parts. The first part was sundried immediately after mixing while the second and third parts were separately packed inside black polythene bags, tied (air tight) to remove oxygen and stored for 7 and 14 days, respectively under room temperature. At the end of each ensiling period, the product was sundried for 2 to 3 days depending on the intensity of the sun. Samples of the non-ensiled and ensiled products were analyzed for their proximate compositions according to AOAC (2000). The gross energy values were determined using the bomb calorimeter.

Four experimental broiler starter diets were formulated such that diet 1 (control) contained 100% maize. Diets 2, 3 and 4 contained 50% of the 0, 7 and 14 day ensiled products as replacement for maize, respectively (table 1). One hundred and twenty (120) day-old broiler chicks of Cobb strains were used for the trial. The birds were divided into 4 groups of 30 birds each. Each group was sub-divided into 4 replicates of 10 birds, housed in a 1.4 x 1.4 m compartment. Wood shavings were used as the litter material. The pens were covered with black polythene for the first two weeks to control wind and heat. Each pen contained a feeder, drinker and a stove (to supply heat) for the first two weeks. The diets were randomly assigned to each of the pens in a completely randomized design (CRD). All the birds appeared healthy and active with no abnormalities. Feed and water were offered *ad libitum.* The birds were vaccinated against Infectious Bronchitis, New Castle Disease Virus and Infectious Bursitis (Gumboro) following the program applied in our Institution.

Table 1: Ingredient composition of broiler starter diets containing ensiled blend of peeled cassava root meal, wet brewers' grain and palm kernel cake

Ingredient (%)	Ensilage period			
	Control	0	7	14
Maize	55.00	27.50	27.50	27.50
EB-CBP	0.00	27.50	27.50	27.50
Others*	45.00	45.00	45.00	45.00
Total	**100**	**100**	**100**	**100**
Calculated analysis (%)				
Crude protein	21.21	21.70	21.56	21.86
Crude fibre	3.89	6.60	6. 60	6.77
Ether extract	8.53	10.46	9.36	9.91

*contains; 25%Soybean meal, 6% wheat offal, 5% PKC, 5% fish meal, 3% bone meal, 0.25% Lysine, 0.25% Methionine, 0,25% premix and 0.25% salt. EB-CBP: ensiled blend of cassava root meal, brewers' grain and palm kernel cake

The birds were weighed on arrival and weekly thereafter. Daily feed intakes were recorded while feed

conversion ratios and feed cost/ kg gain were calculated. Data generated were statistically analyzed using analysis of variance and means were separated using the R-cran programme of R Core Team (2014).

Results and Discussion

Data on the proximate compositions of ensiled blend of peeled cassava root meal, wet brewers' grains and palm kernel cake is shown in table 2. There were clear variations in the proximate compositions of the ensiled and non-ensiled products. The crude protein value was highest in the 7 days ensiled product while ether extract, crude fibre and ash values were highest in the 14days ensiled product. The gross energy value increased with increasing period of ensilage with 14 days ensilage period having the highest value. The crude protein values of the products were higher than that of maize in the proximate analysis and could therefore replace maize weight for weight in poultry diets.

Data on the performance of starter broilers fed diets containing ensiled blend of peeled cassava root meal, brewers' grain and palm kernel cake are shown in table 3. Weight gain, feed intake and feed conversion value of birds fed the ensiled and non-ensiled products were comparable to those fed the control diet. This was an improvement to earlier reports that inclusion of cassava root meal and brewers' grain in broiler diets reduced performance at a high level above 30% inclusion level (Ademosun, 1973; Akinfala, 2002; Buitrago *et al*., 2002). The performance may be attributed to the enhanced nutrient and reduced dustiness in the ensiled products.

Costs of feed consumed and feed costs/kg gain of birds fed the ensiled and non-ensiled products were comparable to those fed the control diet. However, inclusion of the zero, 7 and 14 days ensiled products in starter broiler diets caused ₦62.68, ₦61.42 and ₦58.32 reductions in the Costs of feed consumed and ₦137.75 , ₦106.43 and ₦83.65 reductions in Feed cost/kg gain, respectively. This benefit may be explained by the lower costs of the ensiled and non-ensiled products relative to that of maize.

Conclusion

The result of the study showed that ensiling a blend of peeled cassava root meal, wet brewers' grain and palm kernel cake reduced the dustiness in the final product, enhanced its nutritive and gross energy values, improved growth performance of broilers at 50% replacement level for maize with reduced feed cost and feed costs/kg gain. Consequently, ensiled or non-ensiled blend of peeled cassava root meal, wet brewers' grain and palm kernel cake should be considered as cost effective feedstuff in broiler ration formulation.

Table 2. Proximate Composition of ensiled cassava root meal, wet brewers' grains and palm kernel meal mixture

Days of ensilage	0	7	14
Parameter(%,DM)			
Dry matter	91.63	92.94	95.02
Crude protein	10.54	13.03	10.74
Ether extract	14.00	17.00	20.00
Crude fibre	19.31	12.18	20.79
Ash	2.00	1.98	5.00

Nitrogen free extract	46.66	49.04	39.02
Gross Energy (kcal/kg)	4685.90	4890.60	5050.92

Table 3: Performance of broilers fed ensiled blend of peeled cassava root meal, wet brewers' grain and palm kernel cake (0-28 days)

		Days of fermentation			
Parameters	Control	0	7	14	SEM
Initial Weight(g)	50.00	50.00	50.00	50.00	0.00
Final Weight(g)	602.21	637.27	586.41	559.91	16.12
Weight Gain(g)	552.21	587.27	536.40	509.91	16.12
Feed Intake(g)	1408.98	1255.66	1264.18	1286.33	36.86
Feed Conversion Ratio	2.59	2.15	2.37	2.53	0.11
Cost of feed consumed (N)	241.44	178.76	179.97	183.12	9.58
Feed cost/kg gain(N)	443.82	306.07	337.39	360.17	21.69

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PROXIMATE COMPOSITION AND FEEDING VALUE OF ENSILED BLEND OF CASSAVA ROOT MEAL AND WET BREWERS' GRAINS IN STARTER BROILER DIETS

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ABSTRACT

The proximate composition and feeding value of ensiled blend of peeled cassava root meal and wet brewer's grain in starter broilers diets were evaluated. Peeled cassava root meal and wet brewers' grain were mixed together in a ratio of 1.0:1.5, divided into 3 parts and ensiled for 0, 7 and 14days, respectively. The ensiled products were then sun dried and their proximate and gross energy values determined. Four experimental broiler starter diets were formulated such that diet 1(control) contained 100% maize. Diets 2, 3 and 4 contained 50% of the 0, 7 and 14days ensiled products as replacement for maize, respectively. One hundred and twenty (120) day old broiler chicks divided into 12 groups were randomly assigned to each of the four experimental diets in a completely randomized design, replicated three times. Feed and water were offered to the birds' *ad-libitum*. The 14 days ensiled product had higher crude protein, ether extract, crude fibre, ash and gross energy values than the 7days ensiled product. Body weight gain and feed conversion values were comparable with those of the control. Feed intake, cost of feed consumed and feed cost/ kg weight gain of the control birds were significantly ($p<0.05$) higher than the other treatment groups. It is concluded that mixing peel cassava root meal and wet brewers' grain before sun drying or ensiling and sun drying, enhanced the protein content, and reduced the dustiness in the feed and cost of production irrespective of the period of ensilage. The inclusion of 50% of the ensiled products should be considered as cost effective feedstuff in broiler ration formulation.

Key words: Cassava, brewers' grain, ensilage, broilers, performance

INTRODUCTION

Cassava is not necessarily a novel feed ingredient in some countries and regions, but it is novel to use it as feed in most countries (Morgan and Choct, 2016).Cassava roots contain a large amount of starch ranging from 70 to 85% DM which increases with the stage of harvesting (; Ly, 1998; Regnier, 2011). The fibre content is also extremely low (NDF less than 10% DM) which makes the cassava roots highly digestible in all livestock species. The metabolisable energy value of good cassava meal (72% starch) is equivalent to that of maize (Saawant *et al,* 2004). Low cassava (less starch, more fibre) has lower ME values and the ME of unpeeled cassava meal is reduced to about 85% that of maize (Agwunobi *et al,* 2000).

Cassava roots are considered as energy feed for poultry, however, their protein content (typically less than 3%) is lower than that of cereal grains. Hydrogen cyanide (HCN) content may or may not be a problem depending on the variety, processing and livestock species. Grinding cassava results in high levels of fine particles which can reduce feed intake and possibly irritate respiratory organs (Garcia *et al*, 1999). However, while there is no hard limit on the inclusion level of high-grade cassava in pelleted diets on grower to finisher broilers, the low protein content and fine particles of cassava limits its inclusion to 30 – 40% of dietary requirements.

Fermentation or ensilage has been reported to have caused reduction in the level of anti nutrients within the feed (Okpako *et al.,* 2008), improve bioavailability of minerals (e.g. phosphorus, calcium, magnesium and copper), increase proteins (lysine, histidine and methionine) and breakdown of indigestible carbohydrates (Missotton *et al.,* 2008). Silage is a good method of storing wet brewers' grain for a longer period particularly since ensiling does not alter their nutritive value (Gevon *et al.,* 2008). According to Blezinger (2003), packing and ensiling characteristics can be improved by blending the wet brewers' grains prior to ensiling with dry

materials such as molasses or cereal grains. This experiment was therefore conducted to determine the proximate chemical composition of ensiled blend of cassava root meal and wet brewers' grain and its efficacy on broiler performance at 28 days of age.

MATERIALS AND METHODS

This study was carried out at the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology Owerri, Imo State, Nigeria. Peeled cassava root meal and wet brewers' grain were mixed together in a ratio of 1.0:1.5 and then divided into three equal parts. The first part was sundried immediately after mixing while the second and third parts were separately packed inside black polythene bags, tied (air tight) to remove oxygen and stored for 7 and 14 days, respectively under room temperature. At the end of each ensiling period, the product was sundried for 2 to 3 days depending on the intensity of the sun. Samples of the non-ensiled and ensiled products were analyzed for their proximate compositions according to AOAC (2000). Four experimental broiler starter diets were formulated such that diet 1 (control) contained 100% maize. Diets 2, 3 and 4 contained 50% of the 0, 7 and 14 day ensiled products as replacement for maize, respectively (table 1).

Table 1: Ingredient composition of broiler starter diets containing ensiled blend of peeled cassava root meal and wet brewers' grain

Ingredient (%)	Ensilage period			
	Control	0	7	14
Maize	55.00	27.50	27.50	27.50
EB-CB	0.00	27.50	27.50	27.50
Others*	45.00	45.00	45.00	45.00
Total	**100**	**100**	**100**	**100**
Calculated analysis (%)				
Crude protein	21.21	21.70	21.56	21.86
Crude fibre	3.89	6.60	6. 60	6.77
Ether extract	8.53	10.46	9.36	9.91

*contains; 25%Soybean meal, 6% wheat offal, 5% PKC, 5% fish meal, 3% bone meal, 0.25% Lysine, 0.25% Methionine, 0,25% premix and 0.25% salt. EB-CB: ensiled blend of cassava root meal and brewers' grain

One hundred and twenty (120) day-old broiler chicks of Cobb strains were used for the trial. The birds were divided into 4 groups of 30 birds each. Each group was sub-divided into 3 replicates of 10 birds, housed in a 1.4 x 1.4 m compartment. Wood shavings were used as the litter material. The pens were covered with black polythene for the first two weeks to control wind and heat. Each pen contained a feeder, drinker and a stove (to supply heat) for the first two weeks. The diets were randomly assigned to each of the pens in a completely randomized design (CRD) replicated 4 times. All the birds appeared healthy and active with no abnormalities. Feed and water were offered *ad libitum.* The birds were vaccinated against Infectious Bronchitis, New Castle Disease Virus and Infectious Bursitis (Gumboro) following the program applied in our Institution.

The birds were weighed on arrival and weekly thereafter. Daily feed intakes were recorded by subtracting the quantity of feed that remained from the quantity given. Weekly weight gains were obtained from the differences between the weights of two successive weeks. Feed conversion ratios were obtained from the

quotient of the feed intakes and the weight gains. Data generated were statistically analyzed using analysis of variance and means were separated using the R-cran programme of R Core Team (2014).

RESULTS AND DISCUSSION

Proximate composition

Data on the proximate composition of ensiled blend of peeled cassava root meal and wet brewer's grains are presented in tables 2. Crude protein, crude fibre and ash values were higher in the 14 days than in the 0 and 7 days ensiled products. The gross energy and ether extract contents were reduced by ensiling. The crude protein values of the products were higher than that reported for maize and could therefore replace maize weight for weight in poultry diets.

Performance of the experimental birds

Data on the performance of starter broilers fed diets containing ensiled blend of peeled cassava root meal and brewers' grain are shown in table 3. Weight gain, and feed conversion value of birds fed the ensiled and non-ensiled products were comparable to those fed the control diet throughout the trial. Feed intake decreased significantly ($p<0.05$) in both the ensiled and non-ensiled products when compared with the control. The comparable weight gain and feed conversion ratio of birds fed the product diets with the control is an improvement to earlier reports that inclusion of cassava root meal and brewers' grain in broiler diets reduced performance at a high level above 30% inclusion level. (Akinfala *et al*., 2002. Buitrago *et al*., 2002).

Costs of feed consumed and feed costs/kg gain of birds fed the ensiled and non-ensiled products were significantly ($p<0.05$) decreased when compared with those fed the control diet. Inclusion of the 0, 7 and 14 days ensiled products in starter broiler diets caused ₦76.01, ₦76.07 and ₦69.80 reductions in the Costs of feed consumed and ₦134.44, ₦132.07 and ₦129.72 reductions in Feed cost/kg gain, respectively. This benefit may be explained by the lower costs of the 0, 7 and 14 days and ensiled products relative to that of maize.

Conclusion

The results of the study showed a decreased in the crude protein and gross energy values of the products at 7 days of ensilage and an increase in the values at the 14 days ensiling period. Weight and feed conversion ratio of the birds were not negatively affected by the treatments irrespective of ensilage period. The products also should beneficial effects in decreasing the costs of feed consumed and feed costs/kg weight gain. Consequently, ensiled or non-ensiled blend of peeled cassava root meal and wet brewers' grain should be considered as cost effective feedstuff in broiler ration formulation.

Table 2: Proximate composition of ensiled blend of peeled cassava root meal and wet brewer's grains

Days of ensilage	0	7	14	SD
Dry matter	92.50	93.10	92.61	0.32
Crude protein	12.75	12.14	13.36	0.61
Ether Extract	12.00	8.00	10.00	2.00
Crude fibre	11.88	11.88	12.50	0.36
Ash	1.99	1.98	2.01	0.02
Nitrogen free extract	56.08	61.09	57.09	2.65

Gross energy (kcal/kg)	4572.22	4350.50	4470.25	110.98

Table 3: Performance of broiler chicks fed diets containing ensiled blend of peeled cassava root meal and wet brewers' grain (0-28 days)

Parameter	Days of ensilage				SEM
	Control	0(T_1)	7(T_2)	14(T_3)	
Initial weight (g)	50.00	50.00	50.00	50.00	0.00
Final weight (g)	602.21	588.67	582.06	596.24	2.61
Weight gain (g)	552.21	538.67	532.06	546.24	12.61
Feed intake (g)	1409.22[a]	1227.05[b]	1226.71[b]	1273.20[b]	39.94
Feed conversion ratio	2.59	2.30	2.32	2.33	0.10
Cost of feed consumed (₦)	241.48[a]	165.47[b]	165.41[b]	171.68[b]	11.11
Feed cost per weight gain (₦/kg)	444.34[a]	309.90[b]	312.27[b]	314.62[b]	23.17

ab: means within rows with different superscript differ significantly ($p<0.05$).

SEM: Standard Error Means.

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EFFECT OF METHIONINE TYPES ON THE CARCASS CHARACTERISTICS OF BROILER FINISHER

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ABSTRACT

One hundred and ninety eight 7-day old broiler chicks were used to evaluate the effect of DL-Methionine and L-Methionine carcass characteristics of broiler chickens. The experiment was carried out at Hybrid Farms, Kaukau, Kaduna State. The DL-Methionine and L-Methionine were supplemented at 0.15, 0.20 and 0.25% levels of inclusion respectively. The birds were divided into six treatments and replicated three times with eleven birds per replicate in a 2 x 3 factorial arrangement in a completely randomized design (CRD). Feed and water were given *ad libitum.* At the end of the experiment two birds per replicate were used from each of the six treatments to evaluate carcass characteristics. Data generated during the study were analysed using GLM procedure of SAS (2002). Differences between means were compared for significance ($P<0.05$) using Duncan Multiple Range Test (Duncan, 1995). Methionine type had significant ($P<0.05$) effect on the carcass characteristics. Birds fed on L-Methionine had higher live weight, carcass weight than those on DL-Methionine. The prime cuts and organ parts in DL-Methionine were significantly ($P<0.05$) higher than that of L-Methionine. In conclusion, birds fed L-Methionine performed better in terms of liveweight and carcass weight while the prime cuts and organ parts of those fed on DL-methionine were significantly($P<0.05$) better than those on L-Methionine.

Keywords: Effect, Methionine, Carcass, Broiler Chickens.

INTRODUCTION

Poultry production has gained prominence in Nigeria today, due to short generation interval, relatively quick turn over on investment and high quality protein from poultry products. Poultry production is generally accepted as the fastest way of increasing animal protein consumption in developing countries of the world (Ogundipe, 1999). To cope with market demand for protein (meat), modern broilers are reaching market age sooner than previously (Kleyn and Chrystal, 2008).

All animals need to be well fed and healthy if they are to grow to their potential. The nutrition of an animal is therefore of great importance if this is to be achieved in practice. In the modern day livestock farming, the nutritional requirements of farm animals are well understood and all the requirements can be met through direct dietary supplementation of the limiting nutrient in concentrated form (Adeniji *et al.,* 2014).

Some amino acid cannot be synthesized by the animals themselves and must therefore be supplied in their diet; these are called essential amino acid. In avian specie methionine is one of the essential amino acids needed to improve performance and is considered to be the first-limiting amino acid in corn-soybean meal based poultry diets (Dilger and Baker, 2007). Adequate dietary level of this amino acid is needed to support optimum growth and carcass yield of fast-growing commercial broilers (Ojano-Dirain and Waldroup, 2002). Amino acids can exist as D- or L- isomer or mixture of the two products. The D- isomeris biologically inactive while L-form is commonly occurring in most of the tissues. However, birds possess the ability to utilize both D- and L-forms also called racemic mixture (Lesson and Summers, 2001).

Recently a fermentation approach was used to produce L-Methionine (Ikeda, 2003; Kumar and Gomes, 2005). During the fermentation process, L-Methionine precursor was obtained from microorganism strain,

and mixed with converting enzyme and methyl mercaptan which converted the L-Methionine precursor to L-Methionine (Kim *et al.,* 2015).

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at Hybrid Farms, Farm A, along Kaduna–Abuja Express way, Kaukau, Kaduna, Kaduna State. Kaduna is located on latitude 1031'23.160"N and longitude 726'25.008"E on an altitude of 704m above sea level. The annual rainfall ranges between 617–1365mm with an average of 1041mm between July and September (Ovimap, 2015).

Source of Experimental Birds

One hundred and ninety-eight Ross 308 day old chicks purchased from Agriculture International Tyrade Limited (Agrited), Ibadan, Oyo State were used for the experiment.

Source of Methionine

DL-methionine and L-methionine were purchased from Hybrid Feeds Ltd, opposite Total Petroleum Filling Station along Kachia road, Kaduna, Kaduna State.

Experimental Diets

Six diets devoid of synthetic methionine were formulated to meet the requirements (for protein, energy, calcium, phosphorus and lysine) of broiler starter birds based on NRC (1994) nutrients requirement. The DL-Methionine and L-Methionine were supplemented at 0.15, 0.20 and 0.25% levels of inclusion respectively

Management of Experimental Birds and Data collection

Chicks were brooded together for one week. Light (electricity) and heat (charcoal stove) were provided throughout the brooding period. After brooding, birds were allotted into six treatment groups and replicated three times. The pens were partitioned into replicates with wire mesh. Eleven birds were randomly allotted to each pen. Birds were housed in a deep litter system with water and feed provided *ad libitum.* Vaccination and medication programmes were carried out when due. The drinkers were washed on a daily basis and water changed twice a day.

Carcass Analysis

At the end of the feeding trial (at 8 week), two birds per replicate were used for carcass analysis. Birds were starved for 12 hours, weighed, sacrificed, defeathered and dressed as described by Odunsi *et al.* (1999). Parameters that were measured include; live weight, carcass weight, dressing percentage, prime cuts and organ parts. Primal cuts and organ weight were expressed as percentage of live weight.

Statistical Analysis

Data generated during the study were analysed using GLM procedure of SAS (2002). Differences between means were tested for significance using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Carcass Characteristics of Broiler Chicken Fed Dietary DL-Methionine and L-Methionine Supplements

Result on effect of methionine type on carcass characteristics of broiler finisher chicken (5-8 weeks) is shown in Table 1. Live weight, carcass weight, dressing percentage, prime cuts and organ parts except forthigh, gizzard and kidney were significantly ($P<0.05$) affected by methionine type. This result concord with the findings of Rahab (2014) who reported that methionine type had significant ($P<0.05$) effect on live weight of broiler chickens. This study agrees with findings of Chattopadhyay *et al.* (2006) who reported improved

dressing percent, thigh and breast yield in broilers with DL-Methionine supplementation at the rate of 15g/kg. Better performance in DL-Methionine could be due to the fact that DL-Methionine in poultry diet has been associated with the tendency to have less total body fat, improve growth performance both for meat and egg laying birds and reduce odor-related compounds in excreta (Rostagno *et al.,* 1995; Chavex *et al.,* 2004)**.**

Conclusion and Recommendations

Birds fed L-Methionine performed better in terms of live weight and carcass weight while the prime cuts and organ parts of those fed on DL-methionine were significantly better than those on L-Methionine but more research need to be done with more number of broilers and other avian.

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Table 1: Effect of methionine types on carcass characteristicsof broiler finisher chicken

	Types of Methionine			
Parameter	DLM	LM	SEM	LOS
Live weight (g)	2482[b]	2590[a]	37.36	*
Carcass weight (g)	1988.29[b]	2063.33[a]	35.10	*
Dressing %	80.12[a]	79.57[b]	0.48	*
Prime cuts expressed as percentage of live weight				
Back	11.15[a]	10.66[b]	0.27	*
Breast	25.50[a]	24.96[b]	0.14	*
Wings	8.05[a]	7.73[b]	0.11	*
Thigh	12.54	12.57	0.20	NS
Drumsticks	10.86[a]	10.50[b]	0.10	*
Organ parts expressed as percentage of live weight				
Liver	2.04[a]	1.72[b]	0.04	*
Heart	0.39[a]	0.34[b]	0.01	*
Gizzard	1.99	1.95	0.09	NS
Proventiculus	0.19[a]	0.17[b]	0.01	*
Spleen	0.09[a]	0.07[b]	0.01	*
Kidney	0.55	0.53	0.02	NS
Lungs	0.60[a]	0.56[b]	0.02	*
Abdominal fat	0.86[a]	0.96[b]	0.04	*

[abc]=Means in the same row having different superscripts are significantly different (P<0.05); NS=Not significant (P<0.05), DLM=DL-Methionine, LM=L-Methionine; *=Significant difference (P<0.05); SEM=Standard error of mean; LOS = Level of significant.

CARCASS CHARACTERISTICS OF RABBITS FED DIFFERENT FORAGES AS SUPPLEMENT

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Abstract

The experiment was carried out to determine the carcass characteristics of weaned rabbits fed selected forages as feed supplement. A total number of thirty-six weaned mixed breed of rabbits were allotted randomly to four treatments with nine rabbits and each treatment was replicated three times with three rabbit per replicate and designated as Control (T1) concentrate plus (+) amaranthus, (T2) concentrate plus (+) tridax, (T3) concentrate plus (+) fig leaves, (T4) concentrate plus (+) water melon waste. The experiment lasted for eight weeks. Data were obtained on carcass characteristics, internal organs, by-products. Results revealed that the value of carcass traits, internal organs and by-products were not significantly ($P>0.05$) different except in liver and lungs (internal organs) and pelts (skin) and hind legs (by-products) were not significantly different ($P>0.05$) for all the parameters obtained. Based on the findings, it can be recommended that T1 (Amaranthus), can be used as supplement to concentrate feed, because it was consumed more than other treatment groups.

Keywords: Rabbits, supplements, carcass, characteristics, forages

Introduction

Over the years, the world population has witnessed a drastic increase in human population especially in developing countries like Nigeria. This has led to an increased demand for food and protein of animal origin which is in short supply. FAO (2006) estimated the average protein consumption in Nigeria to stand at 8g/capita/day which is in sharp contrast to 38g/capita/day recommended for an individual per day (FAO, 2006). Feeding account for about 70 % total cost of production (Aduku and Olokoji, 2009). Hence the use of unconventional feedstuff is gaining ground in many developing countries and Nigeria in particular. The reduction of cost of using cheap and unconventional feed materials is an important aspect of commercial rabbit production (Muriu *et al*. 2002). This research work was aimed at evaluating the effects of different forage wastes as supplement on the carcass characteristics of rabbit meat.

Materials and methods

Location of the Experiment: The research work was carried out at the Rabbit Section of the Teaching and Research Farm of Ibrahim Badamasi Babangida University Lapai, Niger state.

Source of rabbits, test ingredient and management of rabbits

Thirty-six weaned rabbits of mixed sexes and breeds were obtained from Sultan Veterinary Consult Farm No 2, Samaru Street Hayindogo Samaru Zaria, Kaduna state. Four different forage wastes namely tridax procumbens, ammaranthus waste, fig leaves, and water melon wastes were collected from the surrounding environment in Lapai town, Lapai Local Government Area of Niger state, Nigeria. The rabbits were between 5-6 weeks and randomly allocated to four treatment groups with nine rabbits per treatment. Each treatment had three replicates of three rabbits per replicate. The same experimental diet was formulated with crude protein set at 23% for each. T1 was designated as concentrate with Amarathus, T2 concentrate and Tridax procumbens waste, T3 concentrate with fig leaves waste and T4 concentrate and water melon peels/wastes.

The rabbits were giving Ivermectin injection against both endo and ecto-parasite. Vitacox-plus and Neo-furaseryl-plus were adequately given as well. The cages were well clean and disinfected with Dettol and equipped with drinkers and feeders. Prior to the experiment, the animals were allowed adjustment period of one week to enable them get used to their various cages and diets. Fresh clean water was provided *ad-libitum*. The experiment lasted for 8 weeks. Data generated were subjected to analysis of variance (ANOVA) using statistical package for social sciences (SPSS, 1998). Means were separated using Duncan Multiple Range Test (DMRT) as described by Duncan, (1955).

Table 1: Composition of Experimental Diets

Ingredients	$T_{1:}$	$T_{2:}$	$T_{3:}$	$T_{4:}$
Maize	76.00	76.00	76.00	76.00
Fish meal	1.50	1.50	1.50	1.50
Groundnut cake	20.00	20.00	20.00	20.00
Limestone	1.00	1.00	1.00	1.00
Bone meal	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Total	100	100	100	100

Results and Discussion

The mean value of the carcass traits of rabbit fed different forages as supplement are shown in Table 2. There were no significant (P<0.05) differences in the parameters measured except for the dressing weight expressed as percentage live weight. The result appeared not to be in agreement with the observation by Taiwo *et al.* (2014) and *Naandam et al.* (2012) when rabbits were fed *stylothensis* and *sida acuta* as sole feed.

The result of internal organs (liver, kidney, lungs, intestine, heart and caecum) of rabbits fed different forages as supplements are presented in Table 3. There were no significant (p>0.05) differences in all the parameters considered. The result coincides with the finding of Esiegwu *et al.* (2013) who observed non-significant effects on internal organs weight when rabbits were fed with *Garcina kola* seed meal, but disagree with the findings of (*Naandam et al.*, 2012), where gut characteristics were affected by types of forages used.

The result of by-products (blood weight, pelt/skin, head weight, tail weight, fore leg and hind leg) of rabbits fed different forages as supplements are presented in Table 4. There were no significant (p>0.05) differences in the parameters determined except for pelt/skin and hind leg weight. This probably suggests that the dietary treatments result in negative metabolic reactions or disorders that could affect muscles growth, lipogenesis / lipolysis or osteolastic activity. (Taylor *et al*., 2003). Moreover, Aduku *et al.* (1986) reported that, skin, feet and some offals are not consumed in Europe and U.S.A; they only increased the dressing percentages of rabbit from 60-62 % and 50 % respectively and that head, skin and feet contributed about 18, 11 and 3 % respectively to the skinned carcass

Table 2: Carcass characteristics of rabbits fed different forages as supplements

Parameters	T1	T2	T3	T4	SED	LSD
Thoraxic (% LW)	46.20	47.13	49.93	38.63	6.98	NS
Fore limb	42.93	43.53	42.30	41.10	6.41	NS
Hind limb	86.97	91.57	76.60	62.66	13.12	NS
Dressing wt (% LW)	533.33	501.67[b]	533.33[b]	500.00[b]	84.16	*
Slaughter wt (g)	1066.67	1156.67	1050.00	1033.33	128.6	NS
Lumber sacral (% LW)	102.47	110.60	106.13	94.07	18.62	NS
Neck weight(%Lw)	13.40	15.27	15.47	13.00	3.51	NS

abc= means within the same row bearing different superscript differ significantly (p<0.05) ±= standard error of means (SEM) least significant difference (LSD)

T_1 = Concentrate plus Ammarathus (100 g), T_2 = Concentrate plus *Tridax procumbens* (100 g), T_3 = Concentrate plus Fig leaves (*Ficus carpensis*) (100 g), T_4 = Concentrate plus water melon waste (100g)

Table 3: Internal organs of rabbits fed different forages as supplements

Parameters	T1	T2	T3	T4	SED	LSD
Liver	15.87	17.23	15.13	13.20	1.04	NS
Kidney	4.70	5.47	4.70	4.33	0.29	NS
Lungs	3.53	3.97	4.70	2.80	0.240	NS
Intestine	79.80	82.07	71.60	80.87	5.69	NS
Heart	1.73	1.90	1.43	1.27	0.10	NS
Ceacum	26.53	32.07	29.87	34.30	2.11	NS

abc = means within the same row bearing different superscript differ significantly (p<0.05)NS= not significant difference (P>0.05) *=significant (P<0.05) SEM= standard error of means. least significant difference (LSD)

Key:T_1 = Concentrate plusAmaranthus(100g T_2 = Concentrate plus Tridaxprocumbeans(100g) T_3 = Concentrate plus Fig leaves (ficuscarpensis) T_4 = Concentrate plus Water Melon Waste

Table4: Table 4: By-products of rabbits fed different forages as supplements

Parameters			Treatments			
% live weight	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**	**LSD**
Blood weight	16.47	15.33	16.20	14.33	1.44	NS
Pelt/skin	75.33[a]	73.03[a]	52.60[b]	48.77[c]	4.48	*
Head weight	53.87	58.50	56.93	56.97	2.18	NS

Tail weight	2.63	2.83	2.17	2.20	0.12	NS
Fore leg	4.00	4.73	3.87	3.80	0.24	NS
Hind leg	9.13^{a}	8.73^{b}	8.13^{c}	7.73^{c}	0.65	*

abc = means within the same row bearing different superscript differ significantly ($p<0.05$)NS= not significant difference ($P>0.05$) *=significant ($P<0.05$) SEM= standard error of means. least significant difference (LSD)

Key: T_1 = Concentrate plus Ammarathus (100g) T_2 = Concentrate plustridaxprocumbens (100g)

T_3 = Concentrate plus Fig leave (fiscus carpensis) (100g) T_4 = Concentrate plus Water Melon Waste (100g)

Conclusion: The result of experiment showed that forages which are cheaply available in all parts of the country can be successfully used to supplement rabbits diet up to 100g without any side effect on carcass characteristics of growing rabbits.

Recommendation: Based on the findings, it can be recommended that T2 (Tridax), can be used as supplement to concentrate feed, because it was consumed more than other treatment groups.

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POTENTIALS OF RICE HUSK MEAL TREATED WITH DIFFERENT METHODS AS A SUBSTITUTE TO BREWER'S DRIED GRAIN ON THE PERFORMANCE OF FINISHER BROILERS

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Abstract

Generation of rice husk waste is currently increasing in Nigeria leading to piles of rice husk around rice mills. Production cost for broilers has increased due to factors including high cost of feed ingredients which Brewer's Dried Grain (BDG) is among. Rice husk has been identified as a feed ingredient, but it's high fibre and abrasiveness hindered its utilization. Certain treatments abound which can break the fibre and abrasive nature. We tried to apply different treatments - Bio fermentation, 4%NaOH and 8%NaOH on rice husk and then used each of them to replace BDG at 66.67% and 100% in a finisher broiler diet while the control diet contained 15% BDG. The diets were assigned to 210 marshal broilers of 28 days old in a complete randomized design of 7 groups of 10 broilers each replicated 3 times. The broilers were observed for 28 days. The performance of the broilers in the 4%NaOH and bio fermentation treatments groups were similar ($P > 0.05$) with the control while broilers in 8%NaOH groups reduced significantly ($P < 0.05$). There was no mortality. It was concluded that the three treatment methods were safe, while 4%NaOH treatment could yield best result.

Key words: Bio fermentation, Finisher broilers, NaOH treatment, Performance, Rice husk

Introduction

Rice husk is an agro waste product generated during the milling of rice grain. Rice husk is currently produced in large quantity in Nigeria due to the increasing level of rice production in the country. Disposing and evacuating the rice dumps is urgently necessary because of the impending environmental hazards, degradation and pollution it poses to the people and the environs (Haryana, 2018). Rice husk has long been identified as a feedstuff (Oyenuga, 1968, Jacquie, 2015) but its problem of high silica, high fibre and abrasive nature make its degradation difficult thereby limiting its utilization as feed ingredient for animals. Different degradation techniques abound which has the tendency of degrading materials thereby reducing its abrasiveness (Cobianchi *et al*., 2012; Jiaying *et al*., 2016). The current high cost of feeding animals especially the mono gastric animals, due to high cost of conventional feed ingredients has necessitated the need to intensify effort on the discovery of alternative feed ingredients in feeding the animals. Such earlier research led to the present use of Brewer's Dried Grain (BDG) in feeding animals whereas previously it was a heap of waste from brewery industries and these industries have to spend huge money for it to be evacuated. This study was therefore designed to determine the chemical composition of bio-fermented, 4%NaOH and 8%NaOH treated rice husk meal and to determine the effect of each of them on the performance of finisher broilers when used as replacement to BDG in finisher broiler diet.

Materials and Methods

The research was conducted at the Teaching and Research Farm, Department of Agricultural Technology, Akanu Ibiam Federal Polytechnic Unwana, Ebonyi State in tropical rain forest zone of Nigeria.

Biofermentation of rice husk was carried out according to the procedure described by Fasuyi and Olumuyiwa (2012). A mixture of rice husk, water and Blackstrap molasses syrup was made in the ratio of 60Kg to 60 liters to 3 liters respectively and was compressed into 150 liters capacity plastic container. The

mixture was compressed manually as it was poured in, till the container was about ¾ filled. To ensure anerobic condition, the container was carefully covered with thick nylon covering. The fermentation took place for twenty one days after which the container was opened and sun dried till to about 12% moisture content.

The degradation of rice husk using 4% NaoH and degradation of rice husk using 8% NaOH were carried out adopting the method of Ndazi *et al*. (2005). A solution of NaOH was formed at 4% w/v solution of 97% sodium hydroxide (NaOH) for 4% NaOH deradation and another solution of 8% w/v solution of 97% sodium hydroxide (NaOH) for 8% NaOH. 60Kg of the rice husk was soaked in 180 litres of each of the solutions in a container with lid. Each of the mixtures was stirred properly to allow for eveness, covered with the lid of the container and left for 24 hours under room temperature. After the treatment, the rice husk was rinsed thoroghly in water to remove unreacted NaOH before drying under the sun until it was well dried. Sample of each of the treated rice husk were analyzed for proximate composition as described by AOAC (2000) and then used for formulation of the diets.

Table 1. Ingredient composition of the experimental diets

Ingredients	Dietary levels (%)						
	T_1	Bio fermented (T_2)		4%NaOH (T_3)		8%NaOH(T_4)	
	Control	$T_{2A(10)}$	$T_{2B(15)}$	$T_{3A(10)}$	$T_{3B(15)}$	$T_{4A(10)}$	$T_{4B(15)}$
Maize (9%CP)	55.00	55.00	55.00	55.00	55.00	55.00	55.00
SBM (44%CP)	5.00	5.00	5.00	5.00	5.00	5.00	5.00
GNC (45%)	13.00	13.00	13.00	13.00	13.00	13.00	13.00
Rice husk (***)	0.00	10.00	15.00	10.00	15.00	10.00	15.00
BDG (27%CP)	15.00	5.00	0.00	5.00	0.00	5.00	0.00
F M (63%CP)	3.00	3.00	3.00	3.00	3.00	3.00	3.00
B M (77%CP)	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Bone Meal	5.00	5.00	5.00	5.00	5.00	5.00	5.00
**Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated nutrient composition of the experimental diets (%)							
CP	20.56	18.97	17.83	18.95	17.73	18.82	17.60
Crude fiber	4.16	6.72	8.00	3.45	3.09	3.41	3.03
Crude fat	4.82	4.48	4.26	4.15	3.81	4.15	3.81
*Met. energy	2945.	2842.4	2812.4	2940.8	2939	2941.3	2939.3

Note. CP = Crude protein, SBM = Soya bean meal, GNC = Groundnut Cake, BDG = Brewer's dried grain, FM = Fish meal, BM = Blood meal ***CP for rice husk (bio fermented = 4.22, 4%NaOH = 2.82 and 8%NaOH = 2.66) ** To provide the following per kilogram of feed; vit A 10,000IU; vit. D3 1,500 IU; vit. E 2 mg; riboflavin 3 mg; pantothenic acid 10 mg; nicotinic acid, 2.5 mg; choline 3.5 mg; folic acid 1mg; magnesium 56 mg; lysine 1mg; iron 20 mg; zinc 50 mg; cobalt 1.25 mg. *The metabolizable energy of the test ingredient was calculated using prediction equation as reported by Pauzenga, 1985 with the formula M.E = 37 X %CP + 81.8 X %EE + 35.5 X%NFE

A total of 7 experimental diets were formulated for the research. T_1 which was the control, contained no rice husk while BDG was included at 15%. Each of the treated rice husk [Biofermented (T_2), 4%NaOH (T_3) and 8% NaOH (T_4)] was used to formulate 2 diets represented by A and B. The different treated rice husk meal replaced Brewer's Dried Grain at 66.67% and 100% in the finisher diet and was included at 10% (for the As), and 15% (for the Bs) levels respectively on weight to weight basis. The ingredient composition of the experimental diets is presented in table 1.

A total of 210 Marshal breed of broilers of 28 days of age were used for the experiment. The broilers were randomly assigned to the 7 treatment goups in a Completely Randomized Design (CRD). Each treatment group was replicated 3times to obtain a total of 21 groups of 10 broiler each. Treatment 1 was the control group. Treatments 2, 3 and 4 were treatment groups fed with biofermented, 4% NaOH rice husk and 8 %NaOH degraded rice husk respectively. Treatments 2,3 and 4 were further divided into 2 groups of A and B to obtain a total of 7 groups. The broilers were randomly assigned to an experimental units of 1m by 1m each and raised in a deep liter system of management. Feed and water were given *ad-libitum* and proper routine management practices and medications adopted. The feeding trial lasted for 28 days.The broilers were weighed at the beginning and end of the experiment to obtain their weight gain. Feed intake was determined by subtracting the weight of the leftover feed from the weight of feed offered after 24 hours. The data obtained were subjected to statistical analysis using analysis of variance procedure and computed with GenStat analytical software.

Results and Discussion

The result of the proximate analysis of the rice husk degraded in different methods is presented in table 2. The result obtained from the present research for the NaOH treatments conformed with the report of Ndazi *et al*. (2005) while that of bio-fermentation comformed with the result of Fasuyi and Olumuyiwa (2012). Contrary to expectation, biofermentation with molasses did not improve the crude protein content of rice husk as obtained from the present research. A similar result was obtained in the work of Kanengoni *et al.* (2016). The treatments however reduced the crude fiber content of rice husk.

Table 2. Proximate Composition of untreated, bio fermented, 4%NaOH and 8%NaOH treated Rice Husk Meal

Nutrient	Proximate values of different kinds of rice husk (%DM)			
	Untreated	Bio-fermented	4%NaOH	8%NaOH
DM content	89.03	90	86.83	87.20
Crude Protein	5.24	4.22	2.82	2.66
Crude fiber	59.20	37.34	4.60	4.20
Ether extract	3.40	2.90	0.65	0.65
Ash content	16.35	17.68	3.30	3.38
NFE	5.74	27.86	75.46	76.31

Source: Field report. DM = Dry Matter. NFE = Nitrogen Free Extract

The performance of the broilers on the different treatment groups is presented in table 3. The result showed that the final body weight and the body weight gain of the broilers in the control group were similar ($P > 0.05$) with T2A, T2B, T3A and T3B but differ significantly ($P < 0.05$) from T4A, and T4B while the daily feed intake was lower for the control which was similar with T2A while T2B, T3A, T3B, T4A and T4B consumed more feed. There was no mortality in the course of the research. In the present research, the

Table. 3 Performance of Finisher Broilers Fed different levels of bio fermented, 4%NaOH and 8%NaOH Treated Rice Husk Meal

Parameters	Dietary levels (%)							
	Control	Biofermented (T_2)		4%NaOH (T_3)		8%NaOH (T_4)		SEM
	T_1	T_{2A}(10.00)	T_{2B}(15.00)	T_{3A}(10.00)	T_{3B}(15.00)	T_{4A}(10.00)	T_{4B}(15.00)	
LW(g)	759.52	738.97	728.57	740.95	764.29	733.34	761.90	4.70
FW(g)	2468.75^a	2416.67^a	2441.67^a	2441.67^a	2516.67^a	2269.08^b	2177.08^b	52.2
WG(g)	1709.23^a	1678.57^a	1713.10^a	1729.76^a	1752.38^a	1535.58^b	1415.18^b	42.3
DWG(g)	63.30^a	62.18^a	63.45^a	64.06^a	64.90^a	58.96^b	52.57^b	1.33
F. Intake(g)	128.34^b	134.93^b	144.21^a	140.15^a	142.92^a	143.37^a	137.80^a	4.44
FCR(f/WG)	2.03^b	2.18^b	2.28^a	2.19^b	2.20^b	2.24^a	2.61^a	0.09

Without subscript = Not significant. Means with different superscript within row differ significantly ($P < 0.05$). SEM = Standard Error Mean. LW = Live weight. FW = Final weight. WG = Weight gain. DWG = Daily weight gain. F. Intake = Feed intake. FCR= Feed Conversion Ratio.

broilers on the 4%NaOH treated rice husk, compared quite favorably with control in the final live weight and the daily body weight gain, followed by broilers on bio fermented rice husk while the broilers on the 8%NaOH treatment had the least performance. The result conformed with Ndazi *et al.* (2005). Hwang & Huynh (2015) postulated that 4%NaOH treatment on rice husk as the most ideal while increase in concentration of NaOH will result to excessive reduction in the strength of rice husk. This could have been the cause of the reduction in the performance of the broilers in the 8%NaOH treatment groups as obtained from the present research. The finding on bio fermentation is in line with the work of Fasuyi & Olumuyima (2012). No mortality was recorded in the course of the research which is an indication that none of the treatment methods introduced a lethal substance to the rice husk.

Conclusion and Recommendation

Based on the findings from this research, 4%NaOH treated rice husk meal was the most ideal to replace BDG at up to 100% followed by bio fermented rice husk meal while 8%NaOH treated rice husk ranked least. Despite these differences, all the tratment groups were found to be ideal in replacing BDG in finisher broiler diet as no toxicity or mortality was recorded in the course of the research.

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NUTRITIONAL COMPOSITION OF HOUSEFLY LARVAE MEAL: A SUSTAINABLE PROTEIN SOURCE FOR ANIMAL PRODUCTION – A REVIEW

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Abstract

The United Nations reported that, human population will increase from 7.3 billion to 9.7 billion by 2050, indicating an urgent need to increase food production. Livestock and fish products provide food of high nutritional value but nutrition has been a major constraint affecting the productivity of animals in Nigeria. Feeds alone accounts for 70 to 75 % of the total cost of animal production. Therefore the need to find alternative good quality and sustainable protein source that can replace or substitute current protein sources used in animal nutrition. Such an alternative protein source can be provided by insects. Among insects, common housefly (*Musca domestica*) larvae are particularly promising because they can be produced cheaply and rapidly on organic waste materials thereby converting low value waste into a high value product. Housefly larvae have the potential as a sustainable future protein source for diets of production animals (poultry, fish, and pigs). It has good nutritional value, cheaper and less tedious to produce than other animal protein sources. The dry matter and crude protein contents of housefly larvae meal (HFLM) ranged between 83.47 and 94.79 %, and 28.63 and 63.99 %, respectively. While crude fibre, ether extract and ash ranged between 3.14 and 9.95 %, 14.08 and 37.78 % and 4.50 and 10.68 %, respectively. Housefly larvae meal has a well-balanced essential amino acid profile, similar to the amino acids of fishmeal, and can thus provide high-value feedstuff. A good knowledge of the nutrient composition of HFLM with regards to its protein and amino acid contents will equip diet formulators with more definite data for correct placement and replacement of feed ingredients in ration formulation. Therefore, the use of HFLM as alternative to the expensive protein sources will help reduce the cost of production and boost livestock and fish productivity in Nigeria.

Key words: Housefly, Larvae, Sustainable, Protein, Animal

Introduction

In Nigeria, the bulk of the feed used in animal production, especially for poultry and fish, is imported and this has led to a high production cost of these animals. The rising cost of feed ingredients, especially fish meal, has retarded the growth of the poultry and aquaculture industries in the country. With the ever increasing demand for fish meal globally, it is expected that its cost will continue to rise in the world market (Aniebo *et al*., 2009). Commercial poultry and aquatic feeds have traditionally been based on fishmeal as the main protein source because of its high protein content and balanced essential amino acid profile (Ossey *et al*., 2014). Fishmeal is also a good source of essential fatty acids, digestible energy, minerals and vitamins. However, fishmeal is relatively expensive; its supply is limited and quality variable (Ruhnke *et al*., 2018). In addition, fishmeal is one of the most expensive ingredients in formulated feeds. In order to reduce feed costs, farmers need to replace fishmeal with alternative protein source (Ossey *et al*., 2014), which is cheaper to produce and sustainable. Such an alternative protein source can be provided by insects. Among insects,

common housefly (*Musca domestica*) larvae are particularly promising because they can be produced cheaply and rapidly on organic waste materials thereby converting low value waste into a high value product (Ogunji *et al*. 2006; Ruhnke *et al*., 2018).

Housefly larvae have the potential as a sustainable future protein source for diets of production animals (poultry, fish, and pigs).

Housefly larvae contain high amounts of energy, protein and essential amino acids, fatty acids and micronutrients (e.g. copper, iron, zinc). It is cheaper, has good nutritional value, and less tedious to produce than other animal protein sources. In general, HFLM contain high amounts of lysine, threonine and methionine, which are major limiting essential amino acids in low-protein cereal- and legume-based diets for livestock (Hwangbo *et al.,* 2009). The overall nutrient content viz: crude protein, lipid and essential amino acid content of HFLM are comparable with fishmeal. According to van Huis *et al*. (2013), rearing insect could be one way to enhance food and feed security considering that housefly larvae can feed on waste biomass including fruits and vegetable peels, food wastes, sewage, manure, slurry, etc transforming it into high value food and feed resources (Čičková *et al*., 2015). In addition to turning organic wastes into high quality feeds, residues from rearing insect larvae can be used as plant fertilizers (Oonincx *et al*., 2015, Lalander *et al*., 2015). Feeding HFLM to farm animals will not only contribute to animal feed security and a reduced competition between humans and animal farming for resources but will also have marked positive effects on environment, energy use and economy (Čičková *et al*., 2015). Therefore, this paper reviewed the nutritive value of housefly larvae meal as a sustainable protein source in the diets of production animals (poultry, fish and pigs).

Nutritional Composition of Housefly Larvae Meal

There are differences in nutrient composition of housefly larvae meal reported by various researchers. These variations may not be unconnected with the type of substrate used during the production process, age, processing, drying or storage methods used. Generally, housefly larvae meal has a well-balanced essential amino acid profile, similar to the amino acids of fishmeal, and can thus provide high-value feedstuff. A good knowledge of the nutritional composition of HFLM, with regards to its protein and amino acid contents will equip diet formulators with more definite data for correct placement and replacement of feed ingredients in ration formulation. The nutrient composition of HFLM as reported by various researchers is summarized in Table 1.

Table 1: Nutrient Composition of Housefly Larvae Meal

Nutrients (%)	A	B	C	D	E	F	G	H	I	J	K	L
DM	91.34	-	94.24	92.70	94.72	92.80	-	91.40	91.99	98.24	92.70	83.47
CP	39.16	37.20	28.63	47.10	63.99	51.30	60.38	42.50	42.00	59.97	55.40	33.29
CF	8.25	9.05	-	7.50	-	6.30	8.59	9.95	5.89	7.00	6.20	3.14
EE	20.76	35.50	23.30	25.30	24.31	23.40	14.08	31.50	28.95	22.27	20.80	37.78
Ash	6.15	7.15	9.65	6.25	5.16	6.24	10.68	8.15	8.10	8.50	6.83	4.50

A = Atteh and Ologbenla (1993); B = Adeniji (2007); C = Ogunji *et al*. (2008); D = Aniebo *et al*. (2008);

E = Hwangbo *et al*. (2009); F = Aniebo and Owen (2010); G = Pretorius (2011); H = Jonathan (2012);

I = Ossey *et al*. (2014); J = Obeng *et al*. (2015); K = Ukanwoko and Olalekan (2015);

L = Arong and Eyo (2017).

The reported dry matter content of HFLM varied from as high as 95 % (Hwangbo *et al*., 2009) to as low as 84 % (Arong and Eyo (2017). Similarly, Hwangbo *et al*. (2009) reported the highest (64 %) crude protein content in HFLM but Ogunji *et al*. (2008) reported the lowest value of 29 % CP. Crude fibre, ether extract and ash varied from as high as 10 % (Jonathan, 2012), 38 % (Adeniji, 2007) and 11 % (Pretorius, 2011), respectively. While the lowest values 3, 14 and 5 % for CF, EE and Ash were recorded by Arong and Eyo (2017), Pretorius (2011) and Arong and Eyo (2017), respectively. The differences observed in the nutrient composition of HFLM may not be unconnected with the type of substrate used during the production process, age, processing, and drying or storage methods used. However, the content of the essential fatty acid linoleic acid was between 16% (Hwangbo *et al*., 2009) and 26 % (Pretorius, 2011) of the total fat content for the housefly larvae.

Amino Acid Profile of Housefly Larvae Meal

Protein is a very important ingredient required for nutrition and for decades a lot of emphasis has been placed on the quality of proteins especially its composition of amino acid. Housefly larvae meal has a well-balanced essential amino acid profile, similar to the amino acids of fishmeal, and can thus provide high-value feedstuff. In general, housefly larvae meal contain high amounts of lysine, threonine and methionine, which are major limiting essential amino acids in low-protein cereal- and legume-based diets for livestock (Hwangbo *et al.,* 2009). According to Veldkamp *et al*. (2012), HFLM contains 9 essential amino acids with higher Cystine and similar levels of Lysine, Methonine, Threonine and Tryptophan as marine fishmeal. Table 2 summarizes the different amino profiles reported by different authors.

Table 2: Amino Acid Profile of Housefly Larvae Meal

Parameters (%)	A	B	C	D	E	F	G	H
Essential Amino Acids								
Arginine	4.20	4.60	5.80	3.63	2.18	6.06	4.90	3.17
Histidine	2.60	5.10	3.09	1.98	1.03	3.01	2.80	1.59
Isoleucine	3.50	1.70	3.06	1.46	1.82	3.05	3.20	1.84
Leucine	5.30	5.60	6.35	2.90	2.93	6.35	5.70	3.28
Lysine	5.20	4.40	6.04	5.22	3.03	4.23	6.90	3.85
Methionine	2.60	-	2.28	2.34	0.67	1.82	2.20	4.03
Phenylalanine	4.20	10.20	3.96	3.57	2.12	3.53	5.00	3.82
Threonine	3.40	7.60	2.03	2.27	2.09	2.09	3.30	-
Tryptophan	-	1.50	-	3.17	-	3.17	3.20	0.69
Valine	3.40	1.30	3.61	2.92	2.34	1.91	4.40	2.59
Non-Essential Amino Acids								
Alanine	2.86	4.40	2.86	4.85	2.70	3.84	-	2.91

Aspartic Acid	8.25	4.50	8.25	2.21	4.37	4.31	-	5.18
Cystine	0.52	-	0.52	0.42	-	1.20	0.70	0.78
Glutamic Acid	15.30	6.80	15.30	5.71	6.08	3.87	-	8.38
Glycine	4.11	0.90	4.11	3.27	2.24	2.76	-	2.22
Proline	2.85	-	2.85	1.58	-	1.58	-	2.44
Serine	3.23	3.30	3.23	5.63	1.99	3.14	-	2.25
Tyrosine	-	2.50	-	4.55	2.07	2.47	5.10	3.51

A = Calvert *et al*. (1969); B = Ogunji *et al*. (2006); C = Aniebo *et al*. (2008); D = Hwangbo *et al*. (2009);

E = Akpodiete *et al*. (2011); F = Jonathan (2012); G = Veldkamp *et al*. (2012); H = Hussein *et al*. (2017).

Jonathan (2012) reported higher values of Arginine (6.06%) followed by Aniebo *et al*. (2008). Highest values of Histidine (5.10%) were reported by Ogunji *et al*. (2006), while the lowest (1.03%) was reported by Akpodiete *et al*. (2011). Calvert *et al*. (1969), Veldkamp *et al*. (2012) and Hussein *et al*. (2017) reported higher Isoleucine, Lysine and Methionine (3.50, 6.90 and 4.03%), respectively compared to reports of other researchers. The differences observed in the essential amino acids could probably be due to differences in either the analysis procedures employed or the medium used to produce the HFLM. Both Aniebo *et al*. (2008) and Ogunji *et al*. (2006) hydrolysed the samples before analyses, but Ogunji *et al*. (2006) used high performance liquid chromatography (HPLC) equipment and Aniebo *et al*. (2008) used Technicon Sequential Multi sample amino acid analyser to determine the specific amino acid content. The high level of essential amino acids makes HFLM a potential replacement for fish meal in poultry diet and other monogastrics.

Conclusion

Judging from the nutritional composition and amino acid profile, housefly larvae meal is a potentially attractive alternative for use as a sustainable protein-rich feed ingredient for livestock and aquaculture operations. Additional research is recommended on its feeding value and inclusion levels in the diets of production animals.

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EFFECTS OF SUPPLEMENTAL SELENIUM AND α -TOCOPHEROL ON HEN PERFORMANCE AND EGG NUTRIENTS DEPOSITION

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Abstract

Effect of dietary supplement of selenium and α–tocopherol on hen performance and deposition of nutrients in egg was investigated in this trial. In a completely randomised design ISA brown pullets (n=192) at week 18 (early laying phase) of life were randomly assigned to six experimental diets*:* T1: Basal diet, T2: Basal diet with 0.5mg/kg selenium, T3: Basal diet with 1.0mg/kg selenium, T4: Basal diet with 1.5mg/kg selenium, T5: Basal diet with 20mg/kg α–tocopherol, T6: Basal diet with 40mg/kg α–tocopherol*.* Each treatment was replicated four times with eight birds per replicate. Performance parameters were not significantly influenced (P>0.05) by supplemental selenium and α–tocopherol. However, the results of the egg nutrients deposition showed that higher (p<0.05) selenium deposition in the egg (28.00) was recorded for hens on 40 mg/kg α-tocopherol while hens on 1.0 mg/kg selenium supplementation had lower value (16.00). Similarly, α-tocopherol deposition was significantly higher (p<0.05) in eggs from hens on 40 mg/kg α-tocopherol (3.38) while those on the those on the control diet recorded lowest deposition (1.51), 0.5 mg/kg selenium (2.06), 1.0 mg/kg selenium (2.16), 1.5 mg/kg selenium (2.61) and 20 mg/kg α-tocopherol (2.86). Therefore, dietary supplemental selenium and α–tocopherol could positively influence egg selenium and α–tocopherol deposition.

Keywords: Hen performance, Deposition, Nutrients, Selenium, α–tocopherol

Introduction

Nutrition of laying hen has direct influence on egg quality. Nutrients play important roles in animals and human health by activating harmful substances (Padh, 1991). Most important functions of selenium and α-tocopherol is their role as an antioxidant. Egg production of heat stress hens was increased with antioxidants supplementation. (Canan *et al*., 2007). Vitamin-enriched eggs are attractive as a means of providing consumers with nutrients that may be beneficial to health. Improvements in egg nutritional value may have direct positive implications for daily nutrient intake (Nys & Sauveur, 2004). However, requirement for selenium and α-tocoperol must be met through dietary supplementation. There is dearth of information on the effects of supplemental selenium and α-tocopherol on hen performance and egg nutrients deposition. Therefore, this study was aimed at evaluating the effects of supplemental selenium and α-tocopherol on hens' performance and egg nutrients deposition.

Materials and methods

Experimental location and animal allotment

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm, University of Ibadan, Ibadan. Point of lay ISA Brown pullets (n=192) at week 18 were randomly allotted 6 dietary treatments of α-tocopherol (20 and 40 mg/kg) and inorganic selenium (0.5, 1.0 and 1.6 mg/kg) each treatment was replicated 4 times with 8 birds per replicate. The experiment lasted 20 weeks. Number of birds and egg production was recorded daily to determine hen day egg production. Eggs were weighed to determine average egg weight. Feed intake was recorded on a weekly basis and eggs were analysed at the end of the experiment for nutrient deposition.

Statistical analyses

Data were subjected to analyses of variance (SAS, 2003) and means were separated using Duncan multiple range test option of the same software at $\alpha_{0.05}$.

Experimental diets

The gross composition of basal experimental diet fed pullets are shown in Table 1. The basal diet was supplemented with 20 and 40 mg/kg α-tocopherol and 0.5, 1.0 and 1.6 mg/kg inorganic selenium. Feed and water were supplied *ad libitum* to pullets during the experimental period.

Table 1: Gross composition of basal experimental diet fed to pullets

Ingredients	**Level of inclusion (%)**
Corn	50.80
Soybean meal	18.00
Wheat offal	27.85
Oyster shell	1.00
Bone meal	1.60
*Vitamin-mineral premix	0.25
Salt (Sodium Chloride)	0.30
DL-Methionine	0.10
L-lysine	0.10
Total	**100.00**
Calculated Nutrients	
ME (Kcal/kg)	2751.27
Crude Protein (%)	16.87
Crude Fibre (%)	4.55
Methionine (%)	0.37
Lysine (%)	0.98
Calcium (%)	1.07
Available Phosphorus (%)	0.42

***Vitamin-mineral premix - Vitamin A–10,000IU, Vitamin D_3–1800IU, Vitamin E–40mg, Vitamin K–1.43 mg, Vitamin B1–0.7mg, Vitamin B2–4mg, Vitamin B6–2.5mg, Vitamin B12–0.2mg, Niacin–10mg, Panthothenic–10,000mg, Folic acid –0.25mg, Biotin–100mg, Choline Chloride–300mg, Manganese–80mg, Zinc–60mg, Iron–40mg, Copper– 80mg, Iodine–0.8mg, Selenium–0.2mg, Cobalt–0.3mg, Antioxidant–100mg**

Results and discussion

Performance of laying hens fed diets supplemented with selenium and α-tocopherol is shown in Table 2. There were no significant difference ($p>0.05$) in all measured performance parameters. This observation was corroborated by the findings of Jemiseye *et al.* (2018) who reported that varied dietary inclusion of supplemental selenium and α–tocopherol had no significant effects ($P>0.05$) on all performance parameters examined at the late laying phase of hen. However, this result contradicts the report of Sahin *et al.* (2001) that higher levels of α–tocopherol resulted in a higher feed intake and higher dietary selenium inclusions caused an improvement in feed intake.

Table 2: Performance of laying hens fed supplemental selenium and α-tocopherol

		HDEP (%)	Feed Intake (g)	Egg weight (g)
Control	0.00	40.80	90.46	53.28
	0.5	36.98	96.88	57.77
Selenium (mg/kg)	1.0	43.88	92.63	51.98
	1.5	35.60	94.04	50.93
α-tocopherol (mg/kg)	20	46.34	94.38	53.69
	40	42.99	98.67	58.72
	SEM	1.79	1.38	1.56

HDEP –Hen Day Egg Production, SEM-Standard error of mean.

The effects of dietary supplement of selenium and α-tocopherol on selenium and α-tocopherol deposition in egg are shown in Table 3. Dietary treatment had significant influence ($p<0.05$) on selenium and α-tocopherol deposition in the eggs. The improvement in egg deposition of selenium and α-tocopherol with dietary supplementation of these nutrients emphasized their synergistic roles in the synthesis and deposition of one another. Higher selenium deposition (28.00) was recorded for hens on 40 mg/kg α-tocopherol while hens on 1.0 mg/kg selenium supplementation had lower value (16.00). However, α-tocopherol deposition was significantly higher ($p<0.05$) in eggs from hens on 40 mg/kg α-tocopherol (3.38) than control diet (1.51), 0.5 mg/kg selenium (2.06), 1.0 mg/kg selenium (2.16), 1.5 mg/kg selenium (2.61) and 20 mg/kg α-tocopherol (2.86).

Influence of dietary antioxidants on egg quality as well as performance of laying hens had been documented earlier (Scheideler *et al*., 2010). The authors observe that supplemental α-tocopherol improved deposition of α-tocopherol in the eggs while supplemental selenium increased yolk selenium but lowered α-tocopherol content of the eggs.

Table 3: Effects of supplemental selenium and α-tocopherol on selenium and α-tocopherol deposition in egg

		Selenium (µg/100g)	α-tocopherol (mg/100g)
Control	0.0	13.33[d]	1.51[c]
	0.5	14.00[d]	2.06[bc]
Selenium (mg/kg)	1.0	16.00[c]	2.16[bc]
	1.5	26.00[b]	2.61[ab]
α-tocopherol (mg/kg)	20	27.33[b]	2.86[ab]
	40	28.00[a]	3.38[a]
	SEM	0.61	0.32

[a,b, c]Means in the same column with different superscript are significantly different (P<0.05),

SEM-Standard error of mean.

Conclusion

Dietary supplemental selenium and α–tocopherol had no significant effect on performance of laying hens at the early laying phase. However, deposition of selenium and α–tocopherol in the eggs increased with increased dietary selenium and α–tocopherol supplementation.

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EFFECTS OF ENZYME COCKTAILS ON APPARENT METABOLISABLE ENERGY CONTENT OF RICE HUSK IN COCKEREL RATION

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Abstract

A feeding trial was conducted to compare the effects of cocktails of enzymes and individual enzymes on metabolisable energy value of rice husk using cockerel. Three exogenous enzymes were used in a completely randomized design comprising eight treatments with three replicates per treatment and one adult cockerel per replicate. The treatments were a control (rice husk with no enzyme), rice husk with either a xylanase , a multipurpose enzyme, a phytase, cocktail of xylanase and phytase, cocktail of xylanase and multipurpose, cocktail of phytase and multipurpose or cocktail of xylanase, phytase and multipurpose. The feeding trial was done using intubation procedure. Gross energy was determined using Gallenkamp ballistic calorimeter while apparent metabolisable energy was calculated. Values of apparent metabolisable energy were analyzed using the Statistical Analysis System while treatment means were separated using Duncan Multiple Range Test. Enzymes, individually and as cocktails, significantly increased the metabolisable energy of rice husk compared to the control except phytase enzyme which effect was not significantly different from the control. There were significant differences ($p<0.05$) between the individual enzymes in their effects on metabolisable energy. Cocktail of the three enzymes was significantly highest ($p<0.05$) among the treatments in their effects on metabolisable energy while the multipurpose enzyme gave the significantly highest effect among the individual enzymes. Each of the cocktails was significantly better than their respective enzymes except with multipurpose enzyme. It was concluded that cocktail of enzymes is better than individual enzymes in their effects on metabolisable energy of rice husk.

Key words: Enzymes, Metabolisable, Rice husk, Intubation, Cocktail, Cockerel

Introduction

The use of exogenous enzymes on high fibre feed stuffs has been and is still being investigated. Exogenous enzymes are used to aid digestion of substances that the poultry specie cannot digest. These substances include nonstarch polysaccharides and phytate. Adeniji and Jimoh (2007) observed that enzyme supplemented bovine rumen content can replace 37.5 % of maize in the diets of pullet chicks.

The most important factor that influences the feed intake of poultry species is energy content. Feed with high energy value leads to reduced feed intake while feed with low energy value leads to increase in feed intake. Energy is locked up in the fibre content of unconventional feed stuffs like rice husk, wheat offal and Brewers dried grains as they have almost equal gross energy content with highly digestible feed stuffs like maize, wheat and guinea corn. Addition of exogenous carbohydrase is known to increase the digestibility of the fibre fractions of such feedstuffs. Jimoh and Atteh (2015) observed that exogenous carbohydrases increase significantly ($p<0.05$) the *in vitro* digestibility of crude fibre and fibre fractions of wheat offal compared to the control. Therefore it can be postulated that digestibility of nonstarch polysaccharides will lead to release of energy that is locked up in the feed stuff. Exogenous enzymes are of different types based on their activity and units and whether enzyme combinations (cocktail) will produce better result than individual enzyme is still a subject of research. Furthermore, the negative effects of fibre and phytate on digestibility of other nutrients like protein, ether extract and carbohydrate has been well documented (Kies *et al.,* 2001; Ravindran *et al.,* 1995). Thus improvement in the degradation of these substances (phytate and fibre) is expected to elicit improvement in the digestibility of the affected nutrients.

Rice husk is the outermost hard protective covering of the grain during growing season. It is obtained during milling of the paddy rice and it is about 20 % of the paddy weight (Oyenuga, 1968). It's available in abundance in rice growing regions of Nigeria where it constitutes a nuisance to the environment (Belewu, 1998). Rice husk is highly fibrous with about 44 % crude fibre (of which over 90% is insoluble fibre) and 56.2 % cellulose. It has low crude protein (3%).Thus its utilization by monogastric animal is practically difficult. According to Shqueir et al. (1989), attempts at feeding it to poultry resulted in poor growth performance as a result of low nutritional quality, high fibre and lignin content. According to Adeniji (2010) addition of grit at 5% in the diets of chicks containing rice husk can improve nutrient retention and reduce feed cost. Alabi et al. (2014) observed that an increase in the dietary level of rice husk without commercial enzyme supplementation significantly decreased ($P<0.05$) weight gain, feed conversion ratio and nutrient digestibility. There was also hypertrophy of the pancreas and these effects were alleviated by the addition of commercial enzymes. Aderolu et al. (2007) reported that biodegradation with *Trichoderma viride* resulted in improvement in the metabolisable energy value of the treated samples when compared to the untreated in addition to improvement in proximate composition. This study was conducted to compare between individual enzymes and their cocktails in their effects on apparent metabolisable energy (AME) of rice husk using cockerel and also to investigate the effect of phytase on metabolisable energy of rice husk.

Results and Discussion

All the enzymes individually and as cocktail improved the metabolisable energy value of rice husk. The individual enzymes were significantly different ($P<0.05$) from each other in their effects on apparent metabolisable energy value of rice husk and the multipurpose enzyme had the highest effect (Table 1). This is also similar for the percentage increase in AME (Figure 1). However, cocktail of the three enzymes gave the highest effect on AME and this is significantly different ($P<0.05$) from other cocktails. Cocktails of xylanase and phytase and that of multipurpose and phytase were not significantly different ($P>0.05$) in their effects on AME and percentage increase in AME and they were also not significantly different from multipurpose enzyme in both cases (AME and increment). Phytase had the least effect on AME among the individual enzymes and its effect on AME was not significantly different ($P>0.05$) from the control.

Table 1: Effects of Enzymes on Apparent Metabolisable Energy Value of Rice Husk

	TREATMENTS								
PARAMETERS	NE	Xy	Mp	Ph	Xy+Mp	Xy+Ph	Mp+Ph	Xy+Mp+Ph	SEM
AME, Kcal/Kg	973.17^{e}	1016.00^{d}	1068.17^{c}	988.45^{e}	1137.33^{b}	1058.17^{c}	1072.17^{c}	1231.50^{a}	19.25
AME Increment (%)	0.00^{e}	4.40^{d}	9.76^{c}	1.57^{e}	16.87^{b}	8.73^{c}	10.17^{c}	26.55^{a}	1.98

AME=Apparent metabolisable energy, NE= No enzyme, Xy=Xylanase enzyme alone, Mp=Multipurpose enzyme alone, Ph=Phytase enzyme alone, Xy+Mp=Cocktail of Xylanase and Multipurpose, Xy+Ph=Cocktail of Xylanase and Phytase, Mp+Ph=Cocktail of Multipurpose and Phytase, Xy+Mp+Ph =Cocktail of Xylanase, Multipurpose and Phytase

a, b, c, d, e, f: means in the same row with same superscript are not significantly different ($P>0.05$)

Figure 1: Percentage Increase in Apparent Metabolisable Energy Value of Rice Husk Due to Enzymes

NE= No enzyme, Xy=Xylanase enzyme alone, Mp=Multipurpose enzyme alone, Ph=Phytase enzyme alone, Xy+Mp=Cocktail of Xylanase and Multipurpose, Xy+Ph=Cocktail of Xylanase and Phytase, Mp+Ph=Cocktail of Multipurpose and Phytase, Xy+Mp+Ph =Cocktail of Xylanase, Multipurpose and Phytase

One of the factors affecting metabolisable energy value of a feedstuff is the fibrous nature of the feed stuff. For energy to be derived from nonstarch polysaccharides, the polysaccharides like cellulose, xylans, arabinans must be broken down first to oligosaccharides and then to monosaccharides that are absorbable by the animal. Polysaccharides differ from each other in the identity of their recurring monosaccharide units, in the length of their chains, in the types of bonds linking the units and in the degree of branching (David and Michael, 2004).Both glycogen and cellulose consist of recurring units of D-glucose, but they differ in the type of glycosidic linkages and consequently have strikingly different biological properties and roles. Homopolysaccharides like amylose, amylopectin and cellulose are not branched and consist of 10,000 to 15,000 D-glucose units. However, the glucose residues in cellulose are linked by β (1→4) glycosidic bonds in contrast to α (1→4) bond of amylose, starch and glycogen. This difference in bond gives cellulose and amylose very different structures and physical properties (McDonald *et al*., 2010).The results of this study indicates that the enzymes individually and as cocktails are effective in the breakdown of this bond although in varying degrees of efficacy. Addition of enzymes to enhance the breakdown of the cell wall components can increase exposure of these nutrients to the digestive enzymes. Bedford and Schulze (1998) reported that degradation of cell wall NSP by both xylanases and glucanases is the main contributing factor to the greater digestion and absorption of nutrients. Nahm and Carlson (1985) observed that cellulase supplementation significantly improved the digestibility of cell wall components. The significantly higher performance of the multipurpose enzyme compared to the xylanase in this study may be attributed to the presence of the aforementioned enzymes. The multipurpose enzyme has cellulase, glucanase and xylanase compared to the single purpose xylanase with only xylanase activity. Atteh (2000) reported that increasing fibre concentration of feed causes decreased digestibility of all nutrients, reduced weight and increased feacal bulk. Enzyme supplementations efficiently break down the arabinoxylans in the feed stuff, thereby resulting in a decrease in intestinal viscosity, improved availability of nutrients. Results obtained in this study are similar to that of Alabi *et al*. (2014) where grindazyme (multipurpose enzyme) performed best among the trio of Xylanase, Phytase and grindazyme. Furthermore, according to Yoon *et al*. (1983) possibility exists that phytate can bind with starch through phosphate linkages and can decrease starch digestibility. Thus a breakdown of phytate by phytase will lead to an increase in digestibility of the carbohydrate and proteins. This may be responsible for the increase in AME attributed to phytase in this study. Complementary effects were also observed in this study. This effect may be attributed to several reasons. Endo-xylanase and exo-xylanase enzymes work synergistically. Endo-xylanase enzyme specialize in splitting the glycosidic bonds within polysaccharide thereby causing a decrease in viscosity and as well as production of smaller fragments of oligosaccharides each with a terminal reducing sugar. Exo-xylanase enzymes specialize in breaking down the terminal sugar molecule of the oligosaccharides and polysaccharides (Chesson, 1993). Also, the amount of enzyme unit can bring a complementary effect on the other. Thus, the increased AME due to cocktails over the individual enzymes may be attributed to complementary effects.

Conclusion and Recommendations

This study has shown that cocktail of enzymes is better than individual enzymes in their effects on digestibility of rice husk for poultry nutrition. It is recommended that cocktail of enzymes should be preferred to individual enzymes in the inclusion of rice husk in poultry nutrition. The AME values obtained in this study are practically useful when the respective enzymes and cocktails are available.

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EFFECTS OF FEATHER CLIPPING AND ASCORBIC ACID SUPPLEMENTATION ON PERFORMANCE AND SLAUGHTER TRAITS OF BROILERS RAISED UNDER HOT CLIMATE

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Abstract
Extremely high ambient temperature (HAT) induces heat stress in birds and affects profitability of poultry industry in hot climates. In this study, we investigated the effects of feather clipping (FC) and dietary ascorbic acid (AA) supplementation on performance and carcass traits of broilers raised under hot climate. A total of 100 day-old broiler chicks of mixed sex were allotted into five treatment groups (**G1, G2, G3, G4** and **G5**), each containing 20 chicks. The broilers in **G1** (positive control) were managed under controlled temperature (28-30°C), unclipped and fed on basal diets. In addition to managing the broilers in **G2, G3, G4** and **G5** under HAT (43.0 ± 2.0°C), **G2** were unclipped and fed on basal diets (negative control), **G3** were feather-clipped and fed on basal diets, **G4** were fed on diets supplemented with 200mg AA/kg and broilers in **G5** were feather-clipped and fed on diets supplemented with 200mg AA/kg. Data were subjected to ANOVA. The results showed that HAT depressed feed intake, fat deposition and breast muscle size significantly ($p<0.05$) but increased thigh muscle size in broilers. The birds in **G5,** treated with feather-clipping and ascorbic acid supplementation compared relatively significant ($p<0.05$) with **G1** in terms of feed conversion ratio (FCR) and weight gain. While HAT caused worst performance indices in the broilers kept under **G2** (negative control), the best two performances were recorded in broilers kept under G1and G5. Therefore, feather-clipping combined with 200mg/kg AA supplementation is recommended for ameliorating heat stress in broilers.

Key words: *Feather clipping, hot climate, broilers.*

Introduction

Heat stress is one of the most important environmental stressors challenging poultry production in the tropical regions worldwide (Lara and Rostagno, 2013). The Sahel savannah vegetation of the northwestern Nigeria is a relatively hot climate, with ambient temperature often measuring up to 43.0 ± 2.0 ^{O}C during the hot-dry season. These extremely high ambient temperatures exceed the thermo-neutral ranges (12°C to 26°C) reported by Holik (2009), and are thus capable of inducing heat stress in broilers. As behavioral responses, birds under hot climate exhibit frequent panting and elevation of wings away from their body in order to expose the skin to air (DEFRA, 2005).

Feathers play major roles in thermoregulation in birds. They are good insulators for heat conservation during cold weather but may prevent free heat dissipation from bird's body during hot weather (Hughes *et al.*, 1986). Full genetic potentials for growth and body weight are not attainable by birds under hot conditions due to feathers which hinder heat dissipation from their body (Cahaner *et al.* 2008). Heat stress effects are further aggravated in birds by high metabolic heat production due to high growth rate (especially in broilers) and lack of sweat glands. Common adverse effects of heat stress in broilers include high mortality, decreased feed intake, lower body weight, poor feed utilization efficiency and poor growth performance (Mack *et al.*, 2013). These depressions in performances of broilers eventually affect the profitability of poultry industry in hot climates. Moreover, management practices aimed at alleviating heat stress are quite expensive and hence not economically feasible in most developing countries. Effectiveness of dietary ascorbic acid supplementation in heat-stressed chickens has been reported (Sahin, 2003). This study therefore, investigated ameliorative effects of feather clipping alone or in combination with ascorbic acid supplementation on heat-stressed broilers.

Materials and Methods

Experimental birds and design

One hundred (100) broiler chicks of mixed sex were used for this study were randomly allotted into 5 groups (**G1-G5**). Birds in **G1** were kept in temperature-controlled pen, unclipped (Positive control) and fed on the basal diets, **G2** were exposed to HAT, unclipped and fed on the basal diets, **G3** were exposed to HAT, feather-clipped and fed on the basal diets, **G4** were exposed to HAT and supplemented with 200mg AA/kg diets and **G5** were exposed to HAT, supplemented with 200mg AA/kg diets and feather-clipped. Feathers were clipped on the third and the fifth week using method described by Adeyomo *et al.* (2011). Clipping was carefully done to avoid injury on the birds. Water and feeds were served *ad libitum* throughout the seven weeks of the study.

Experimental diets

Table 1. Composition of the experimental feeds

	Starter feed (kg)		Finisher feed (kg)	
Ingredients	**Basal diet**	**Supplemented diet**	**Basal diet**	**Supplemented diet**
Maize	42.03	42.03	50.34	50.34
Soybean	12.66	12.66	9.00	8.55
GNC	25.31	25.31	17.11	17.11
Wheat offal	15.00	15.00	19.00	19.00
Bone meal	2.50	2.50	2.50	2.50
Limestone	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25
*Premix	0.30	0.30	0.30	0.30
AA (200mg/kg)	-	0.0002	-	0.0002
Total	**100.00**	**100.0002**	**100.00**	**100.0002**
Calculated values				
Crude protein (%)	23.00	23.00	19.00	19.00
Energy (kcal/kg)	2753.73	2753.73	2780.21	2780.21

*Premix to supply Vitamin D (2,000mg), Vitamin K_3 (2,000mg), Vit. B_{12} (10,000mg), pantothenic acid (10,000mg), niacin (26,000mg), folic acid (1,000mg), biotin (100,000mg), choline (150,000mg), manganese (10,000mg), zinc (50,000mg), cobalt (250mg), iron (40,000mg), copper (6,000mg), iodine (500mg), selenium (100mg). **KEY: GNC:** Groundnut cake, **AA**: Ascorbic acid

Data collection, analysis and presentation

Data collected were subjected to analysis of variance (ANOVA) at 5% probability using the parametric analytical tools of InStat version 3.0 statistical software (d, Software, Inc., San Diego, CA USA). The data were presented in tables.

Results and Discussions

Feed intake reduced significantly ($p < 0.05$) in the groups (**G2-G5**) exposed to HAT ranging between 1290g/b and 1353g/b compared to 1560g/b in **G1** (Table 2). It was observed that birds in **G2** had similar feed intake (1290g/b) to those in **G3** (1320g/b), **G4** (1353g/b) and **G5** (1292g/b). Hughes *et al* (1986) has reported 15% increase in feed intake in poorly feathered birds. This depression in feed intake could be the cause of poor performance in the exposed groups. The best weight gain (1920 g/bird) was recorded in **G1**, which were kept under controlled temperature. This shows the positive impacts of cooler environment on performance indices of the broilers. The birds in **G5** had second best feed intake (1735 g/bird) and best FCR (0.74) indicating the ameliorative effects of feather-clipping and AA supplementation combination on the heat-stressed broilers.

The results on slaughter traits of the broilers are presented in Table 3. Feather-clipping and AA supplementation significantly ($p< 0.05$) decreased breast muscle size and abdominal fat deposition but increased thigh muscle insignificantly ($p>0.05$). The reduction in abdominal fat values in the groups (**G2**:0.48, **G3**:0.61, **G4**:0.87 and **G5**:0.90) exposed to HAT compared to its value in **G1** (1.12) shows that heat-stressed broilers poorly deposit fat. This findings agree with earlier reports that, exposure to chronic heat decreased fat deposition (Lu, *et al.,* 2007), and proportion of breast muscle, but increased thigh muscle in broilers (Zhang *et al*., 2012). The least values of liver (1.82), spleen (0.12), proventriculus (0.42) and abdominal fat (0.48) were also recorded in **G2** (negative control) indicating the negative effect of HAT on the broilers.

Table 2. Performance indices of broilers managed with feather clipping and ascorbic acid

Parameters	(28-30°C) G1 (PC)	Exposed to High Ambient Temperature (43.0 ± 2.0°C) G2 (NC)	G3 (FC)	G4 (AA)	G5 (AA+FC)	SEM
AIW (g/b)	30.00	30.00	30.00	30.00	30.00	0.00
AFW (g/b)	1950	1590	1580	1700	1765	0.01
AWG (g/b)	1920	1560	1550	1670	1735	0.01
AFI (g/b)	1560[a]	1290[b]	1320[b]	1353[b]	1292[b]	0.03
FCR	0.81[a]	0.83[a]	0.85[a]	0.77[b]	0.74[b]	0.02

ab: means in the same row with different superscripts are significantly (p<0.05) different.

KEYS: G1(PC): Positive control (Unclipped), **G2(NC):**Negative control **(**Unclipped**), G3(FC):** (Feather Clipped), **G4(AA):** (200mg AA/kg diet), **G5(AA+FC):** (200mg AA/kg diet + Feather Clipped), **AIW:** Average Initial Weight, **AFW:** Average Final Weight, **AWG:** Average Weight Gain, **AFI:** Average Feed Intake, **FCR:** Feed Conversion Ratio, **g/b:** Gram per bird

Table 3. Slaughter traits of broilers managed with feather clipping and ascorbic acid

Parameters (g)	G1	G2	G3	G4	G5
Live weight	1950	1590	1580	1700	1765
Dressed weight	1850	1510	1560	1675	1735
% Dress weight	**97.44**	**97.49**	**98.73**	**98.53**	**98.31**
Thighs	10.32	11.12	11.67	11.61	11.69[a]
Wings	3.84	3.94	3.35	4.32	5.04
Breast	23.12[a]	14.35[b]	15.00[b]	26.78[a]	26.78[a]
Lumber	9.32	5.65	6.45	6.94	8.13
Back	9.79	9.76	7.81	10.09	7.83
Neck	5.21	6.29	5.42	5.41	5.83
Liver	2.53	1.82	2.03	2.09	2.87
Spleen	0.26	0.12	0.16	0.16	0.17
Kidney	0.37	0.47	0.71	1.55	0.96
Heart	0.42	0.56	0.45	0.58	0.52
Gizzard	3.62	2.88	3.08	3.09	3.04
Proventriculus	0.53	0.42	0.58	0.58	0.78
Abdominal fat	1.12[a]	0.48[b]	0.90[b]	0.61[b]	0.87[b]

ab: means in the same row with different superscripts are significantly (p<0.05) different.

Conclusion and Recommendation

Extremely high temperatures have a much greater negative effects on the growing and highly feathered broilers. Therefore, exposure of broilers' skin through feather-clipping (for dissipating excess body heat) combined with ascorbic acid supplementation provided ameliorative effects in heat-stressed broilers. It is therefore recommended among small and medium scale poultry farmers.

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EFFECTS OF FEEDING GRADED LEVELS OF BAOBAB (*Adansonia digitata*) PULP MEAL ON APPARENT NUTRIENTS DIGESTIBILITY OF BROILER CHICKENS

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Abstract

The experiment was conducted to evaluate the nutrients digestibility and carcass characteristics of broiler chickens fed graded levels of baobab (Adansonia digitata) pulp meal (BPM). Three hundred broiler (Anak) chickens were allotted to five treatments replicated thrice with 20 birds per replicate in a completely randomized design (CRD). The inclusion levels of the BPM in the diets were 0, 5, 10, 15 and 20% for treatment 1 (Control), 2, 3, 4 and 5 respectively. The experiment lasted for four weeks each for the starter and finisher respectively. Data collected were subjected to analysis of variance and significant differences among treatment means were compared using the Dunnet Test. There were slight increases in the digestibility of all nutrients in birds fed diets containing BPM up to 15% and then slightly declined but no significant ($P<0.05$) differences were observed across the treatment groups in all nutrients except crude protein which was significantly ($P<0.05$) different in birds fed 15% BPM when compared with birds fed 0% BPM. It can be concluded that Baobab pulp can be included in finishing diets up to 20% but the optimum levels of inclusion was 5%.

Keywords: Baobab pulp, Carcass, Digestibility, Nutrients, Broiler chickens

Introduction

The broiler industry in Nigeria is characterized by high production cost which is the major constraint resulting in low profit margins. Most often in an attempt for producers to break even, the broiler products become so expensive that they are always unaffordable to majority of the citizenry. It is therefore necessary to look for cheaper and simple ways of getting animal protein required for normal body growth and function (Ayanwale *et al.,* 2006). Not much has been done in evaluating the potential feed value of some multipurpose tree products such as baobab *(Adansoniadigitata).* Medugu *et al.* (2011). These necessitated the present study, in order to replace the expensive ingredients in livestock feeds especially for the monogastric animals. The objective of the study was to; determine effect of feeding baobab (*Adansoniadigitata*) pulp on the carcass characteristicsof broiler chickens.

MATERIALS AND METHODS

Source of Baobab Fruit: Baobab fruits used for this experiment were harvested at mature stage which was indicated by the hard brown colour of the ectoderm from the trees using locally made equipment around Mamudo, Danchuwa, Alaraba and Mele in Potiskum Local Government area of Yobe State, Nigeria.

Processing: Dried baobab fruits were processed by cracking open the hard shell of the baobab fruits using a small hammer to remove the inner contents (epicarp), and pounded using a mortar and pestle while the seed and pulp were separated using a sieve. The pulp were slightly milled and separated from the unwanted coarse material using a fine mesh.

Experimental Site*:* The study was conducted at the Teaching and Research farm (Poultry Unit) of the Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University Zaria. Zaria is located within the Northern Guinea Savannah of Nigeria with an average annual rainfall, relative humidity and

temperature of 1,100 mm, 75% and 24.4^{O} C respectively, on Latitude 11^{o} 12'N and Longitude 7^{o} 33'E on an altitude of 610m above sea level (Ovimap, 2014).

Carcass measurement: At the end of the experiment (56th days), three birds representing the average weight were selected from each replicate (nine birds per treatment), labeled and then starved overnight but water was provided. The weights of the birds were recorded in the morning before slaughter. Birds were defeathered by dipping into hot water for few minutes to soften the feather for easy removal. The defeathered birds were eviscerated. The parameters measured were carcass weight, dressing percentage, prime cut and organs weighed were expressed as percentages of carcass weight.

Data Analysis: All data collected were subjected to analysis of variance (ANOVA) using the General Linear Model Procedure of SAS 9.2 (2002). Significant differences among treatment means were compared using Dunett multiple ranged in the SAS Package. The model for this design was as follows: $X_{ij}= \mu+ t_i + e_{ij}$
Where: Xij = any observation made in the experiment, μ = the population mean, t_i = Effect due to treatment added or treatment effect, Eij = Experimental error.

RESULTS AND DISCUSSION

Apparent nutrients digestibility of experimental birds is presented in Table 1. The digestibility ranged from 88.75 - 90.02%, 83.01 - 91.30%, 85.84 - 90.63%, 84.60 - 90.85%, 83.23 - 90.89 and 87.30 - 89.59% for the dry matter crude protein, crude fibre, ether extract, Ash and Nitrogen free extract respectively. The result of this experiment revealed that there were slight increases in the digestibility of all nutrients in birds fed diets containing BPM up to 15%. and then slightly declined but no significant (P> 0.05) differences were observed across the treatment groups in all nutrients digestibility except crude protein which was significantly (P> 0.05) different in birds fed 15% BPM when compared with birds fed 0% BPM control though found to be similar (P>0.05) with birds fed diets containing BPM. This implies that BPM increases nutrients digestibility due to its high solubility This agreed with the report of Rafiu *et al.* (2012) who reported significant (P<0.05) increase in nutrients digestibility when broiler chicken were fed graded levels of baobab pulp and seed meal and also pointed out that 20% inclusion was more digestible than other treatment groups, which was attributed to the soluble nature of baobab fruit pulp.

This agreed with the work of Oladunjoye *et al.* (2014) who reported that nutrients digestibility by the rabbits that received diets that contained baobab pulp and seed meal and the control diet were similar. The workers asserted that the anti-nutritional factors contained in baobab pulp and seed meal did not interfere with digestion.

Conclusion

It can be concluded that baobab pulp meal can be included in broiler chickens diets up to 20% without detrimental effects on carcass characteristic of broiler chickens.

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Table 1: Effects of feeding graded level of baobab pulp meal on nutrients digestibility of broiler chickens

	Inclusion levels of baobab pulp meal (% BPM)					
Parameter	**0**	**5**	**10**	**15**	**20**	**SEM**
Dry matter	88.79[b]	90.02[a]	88.88[b]	88.82[b]	88.75[b]	0.38
C/protein	89.29[ab]	83.01[c]	91.30[a]	90.01[a]	88.50[ab]	0.88
Crude fibre	87.52[bc]	89.72[ab]	90.63[a]	88.88[ab]	85.84[c]	1.28
E/ extract	84.60[c]	85.57[c]	89.28[ab]	90.85[a]	88.43[b]	0.86
Ash	84.31[c]	83.76[c]	87.79[b]	83.23[c]	90.89[a]	1.52
NFE	87.30[b]	87.91[b]	89.59[a]	89.57[a]	89.17[a]	0.41

abc, = Means within row with different superscript differed significantly (P<0.05).

C = Crude; E = Ether; NFE = Nitrogen Free Extract.

PERFORMANCE INDICES OF RABBITS FED DIFFERENT PROTEIN SOURCES

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Abstract

The aim of this study was to investigate performance indices of rabbits fed different protein sources. Fifteen, grower mixed breed rabbits were randomly allotted to three dietary treatments in a completely randomized design. The experimental diets contained soyabean meal, groundnut cake and sesame seed meal, respectively as protein sources. The study lasted for eight weeks. Parameters recorded were; initial weight, final weight, feed served and feed refusal, while weight changes, average weight change/week, total feed intake, average feed intake/week and feed conversion ratio were calculated. Proximate analysis was carried out using standard procedures. Data were analysed using descriptive statistics and ANOVA at $\alpha_{0.05.}$ Dietary reatments had significant effect ($P<0.05$) on; final weight, weight change, average weight change/week and total feed intake. Rabbits fed diet containing soybean cake had the highest values for final weight, average weight change/week and total feed intake when compared to values obtained for rabbits fed groundnut cake and sesame seed-based diets, respectively. Better feed conversion ratio was observed for rabbits on soybean meal-based diet than those on groundnut cake and sesame seed meal. The proximate analysis is presented in Table 3, parameters analysed were not significantly different ($P>0.05$). In conclusion, soybean cake can be effectively used as source of protein in rabbit's diet when compared with both sesame seed and groundnut cakes.

Keywords: Sesame seed cake, soybean cake, groundnut cake, growth indices

Introduction

With increasing population, the rate at which humans depend on animals for protein is increasing (Biobaku *et al.,* 2003). Rabbits possess attributes that make them advantageous over other livestock species. Rabbits can be produced on forage alone, although production can be improved on by addition of other feed supplements. Rabbits are highly prolific and have a short gestation period (28-32 days). They are also good converters of feed, easy to care for and they require low capital investment in rearing (Biobaku *et al.*, 2003). There is dearth of information on performance of grower mixed breed rabbits fed diets containing different sources of protein. The aim of this study therefore was to evaluate performance of grower rabbits fed different protein sources.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at Rabbit Unit Division of National Veterinary Research Institute, Vom, Plateau State, Nigeria.

Experimental animals and management

Fifteen grower rabbits of mixed breed were used for this study. The rabbits were weighed individually, randomly allotted to three dietary treatments with five replicates per treatment and rabbits were housed in individual metal cages. The experimental diets are presented in Table 1 with soybean meal, groundnut cake and sesame seed meal as the dominant protein sources.. The rabbits were fed twice daily (morning and evening). The study lasted for eight weeks.

Table 1. Composition of experimental diets (g/100g diet)

Ingredients	T1	T2	T3
Maize	45.00	44.00	44.00
Soybean cake	18.00	0.00	0.00
Groundnut cake	0.00	18.00	0.00
Sesame seed cake	0.00	0.00	18.00
Wheat offals	15.00	15.00	15.00
Rice offals	17.00	17.00	17.00
Fish meal	1.00	1.00	1.00
Bone meal	2.25	2.25	2.25
Limestone	1.00	1.00	1.00
Common salt	0.30	0.30	0.30
Premise	0.25	0.25	0.25
Methionine	0.10	0.10	0.10
Lysine	0.10	0.10	0.10
Total	100.00	100.00	100.00
Calculated Anaysis (%)			
Crude protein	15.85	15.98	15.75
Metabolizable energy	2524.10	2546.10	2553.48
Crude fibre	8.55	8.54	8.69

T1= Soybean cake , T2= Groundnut cake, T3= Sesame seed cake

Parameters measured

Parameters recorded were; feed served, feed refusal, initial weight and final weight, while weight changes, average body weight change/week, total feed intake, average feed intake/week and feed conversion ratio were calculated.

Proximate analysis was done using the methods described by AOAC (1990).

Experimental design and statistical analysis

Experimental design was a completely randomized design and data obtained were subjected to analysis of variance using SAS (2010). Means were separated using least significant difference.

Results and Discussion

Presented in Table 2 are the selected performance indices of rabbits fed different protein sources. Dietary treatment had significant effect (P<0.05) on; final weight, weight changes, average weight change/week and total feed intake. Rabbits on soybean cake based-diet had the highest values for; final weight, weight change, average body weight change/week and total feed intake when compared to rabbits fed groundnut cake and sesame seed meal. This result is similar to that obtained by Biobaku *et al.* (2003), who used soybean cake, groundnut bean cake and fish meal. The feed conversion ratio values of the rabbits in all the treatments were not significantly different. The proximate analysis is presented in Table 3. All parameters analysed were not significantly (P>0.05). The results obtained in this result are in agreement with the results obtained by Mbanya *et al.* (2005) and Biobaku *et al.* (2003). This could be due to fact that the protein sources used were all plant protein sources with almost similar chemical profile.

Table 2. Growth indices of rabbits fed different protein source

Parameters	T1	T2	T3	SEM
Final weight, (g)	1460.00[a]	1370.00[b]	1210.00[c]	36.56
Weight gained (g)	710.00[a]	570.00[b]	460.00[c]	36. 17
Weight gained/week	88.00[a]	71.25[b]	57.50[c]	4.56
Feed intake (g)	62.50[a]	58.20[b]	56.30[b]	1.08
Feed Conversion Ratio	0.08	0.10	0.12	0.01

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05

Table 3. Proximate analysis of diets fed to rabbits using different protein source

Parameters (%)	T1	T2	T3	SEM
Ash	7.50	4.87	6.50	1.80
Moisture content	6.72	7.50	6.40	1.76
Ether extract	2.82	2.20	2.82	0.59
Crude fibre	4.50	4.52	4.60	0.58
Crude protein	17.20	17.39	17.10	0.58
Carbohydrate	45.10	45.10	46.20	0.61

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05

Conclusion

In conclusion, soybean cake can be effectively used as source of protein in rabbit's diet when compared with both sesame seed and groundnut cakes.

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EFFECT OF FERMENTED AFRICAN STAR APPLE (*Chrysophyllum albidum*) KERNEL MEAL ON PERFORMANCE OF GROWING RABBITS

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ABSTRACT

The effect of fermented African star apple kernel meal (FASAKM) as substitute for maize on performance of growing rabbits was investigated. A total of forty eight weaner rabbits (mixed breed, average weight, and 590 g) were randomly allocated to four experimental diets containing 0, 5, 10 and 15 % FASAKM as substitute for dietary maize in a study that lasted for 12 weeks. The results showed that FASAKM influenced ($P<0.05$) average daily weight gain, feed conversion ratio, protein efficiency ratio, energy efficiency ratio and % mortality. Rabbits fed 0 % and 5 % FASAKM diets gained weight (16.24 g and 15.16 g) faster than those fed 10 % and 15 % FASAKM diets (11.42 g and 11.17 g). Feed conversion ratio was better for rabbits fed 0 % and 5 % FASAKM diets. It was concluded that FASAKM could be used up to 5 % to replace dietary maize in the diet of growing rabbits without compromising performance characteristics of the rabbits.
Key words: African star apple, kernels, nutrient, anti-nutrient, boiling, rabbits

INTRODUCTION

High cost feed ingredients for rabbit production in Nigeria has necessitated the search for alternative feedstuffs that are cheap and locally available. African star apple (*Chrysophyllum albidum*) popularly called "Agbalumo" among the Yoruba tribe of Western Nigeria is also known as "Agwaluma" and "Udara" in Hausa and Igbo languages respectively. It is primarily cultivated for its sweet fleshy fruits which had been reported as an excellent source of vitamin C, iron, thickener or jam and flavours to diets, and raw materials to some manufacturing industries such as resin (Adisa and Fajola, 2000). Star apple belongs to the *Sapotacae* family and is believed to have originated from the low-lands of Central America and West Indian. It is common in both urban and rural centres in Nigeria especially during the months of December through April. The ripe fruit is highly perishable, and deteriorate within five days of harvest (Adisa and Fajola, 2000). Several researchers (Edem and Miranda, 2011; Agbabiaka *et al*., 2013) have reported on the nutritional and medicinal importance of *Chrysophyllum albidum*. Apart from the report of Jimoh *et al.* (2014) on haematological changes in the blood of *Clarias gariepinus* fed *Chrysophyllum albidum* seed meal as energy source, there is dearth of information on the potential of African star apple seeds/kernels as alternative feed source. Therefore, this study was aimed at evaluating the effect of fermented African star apple (*Chrysophyllum albidum*) kernel meal on the performance of growing rabbits.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Rabbitry Unit of the Teaching and Research Farm of the School of Agriculture and Agricultural Technology of the Federal University of Technology, Gidan Kwano Campus (Permanent site), Minna, Niger State. The area falls within the Southern Guinea Savannah Vegetation zone of Nigeria with annual rainfall of between 1100 and 1600 mm and temperature range between 21^0C to 36.5^0C (Climatemp, 2016). Minna experiences two distinct seasons (dry, from November to March and wet or rainy season, from April to October).

Experimental design and management of experimental animals

A total of forty eight (48) weaner rabbits of composite breeds and mixed sexes, aged between 5 and 6 weeks were procured from the rabbit section of National Animal Production Research Institute (NAPRI), Shika – Zaria, Kaduna State, Nigeria. They were randomly divided into four groups of twelve (12) rabbits per treatment with each treatment replicated thrice (4 rabbits per replicate) in a completely randomized design. The rabbits were housed according to treatments in a well-ventilated room in hutches. The hutches were fitted with drinkers and feeders. The rabbits were pre-conditioned for two weeks, during which they were treated twice (once a week) against parasitic infestation with Ivermectin (0.5 ml) subcutaneously. They were given feed and clean water *ad libitum* during the twelve (12) weeks experimental period.

Experimental diets

Four experimental diets were formulated and designated as T1, T2, T3 and T4. Diet T1 served as control diet while Diets T2, T3 and T4 contained 5, 10 and 15 % FASAKM as substitute for maize in rabbit diets as shown in Table 1. A known quantity of the diets was served twice daily at 8.00 am and 4.00 pm and supplemented with 10 g of *Tridax procumbens* per animal per day.

Table 1: Gross Composition of Experimental Diets

	Control	**Replacement levels of fermented ASAKM**		
Ingredients (%)	**0%**	**5%**	**10%**	**15%**
Maize	40.00	38.00	36.00	34.00
Fermented ASAKM	0.00	2.00	4.00	6.00
Maize offal	25.00	25.00	25.00	25.00
Rice offal	18.00	18.00	18.00	18.00
Soyabean meal	2.00	2.00	2.00	2.00
Fish meal	1.20	1.20	1.20	1.20
Groundnut cake	10.00	10.00	10.00	10.00
Limestone	1.00	1.00	1.00	1.00
Bonemeal	2.00	2.00	2.00	2.00
Salt	0.20	0.20	0.20	0.20
*Premix	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10
Total	**100**	**100**	**100**	**100**
Calculated Nutrients				
Crude protein (%)	17.41	16.76	16.89	16.85
Energy (Kcal/kg ME)	2647.5	2600.0	2623.1	2604.0
Crude fibre (%)	10.35	10.01	10.18	10.05
Ether extract (%)	4.08	4.15	4.10	4.11

*Premix in diets provided per kg: Vit. A 10000 IU, Vit. B 2000 IU, Vit. E 13000 IU, Vit. K 1500mg, Vit. B12 10mg, Riboflavin 5000mg, Pyridoxine 1300mg, Thiamine 1300mg, Panthothenic acid 8000mg, Nicotinic acid 28000mg, Folic acid 500mg, Biotin 40mg, Copper 7000mg, Manganese 48000mg, Iron 58000mg, Zinc 58000mg, Selenium 120mg, Iodine 60mg, Cobalt 300mg, Choline 27500mg

Table 2: Nutrient and Anti-nutrient Compositions of Fermented African star apple kernels

Nutrients,%	Raw kernel	Fermented kernel
Dry matter	93.21	93.07
Crude Protein	12.03	8.08
Crude fibre	5.10	6.20
Ether extract	1.45	1.38
Ash	1.85	2.60
Nitrogen free extract	72.78	74.89
Gross energy (Kcal/100 g)	400.10	401.19
Metabolizable energy (Kcal/kg ME)	3147.23	3067.36
Saponin	5.00	2.02
Tannin	7.33	4.02
Oxalate	12.41	5.00
Phytate	10.06	3.33

Performance study

Rabbits were weighed individually at the beginning of the experiment and weekly thereafter for the duration of the experiment using weighing scale. Weighing was done before the morning feeding. The parameters determined for the evaluation of performance were initial weight (g), average feed intake (g), average weight gain (g) and feed conversion ratio. Weight gain for each animal was calculated by subtracting the initial weight (g) from the final weight (g), while the feed conversion ratio was calculated by dividing the average feed intake (g) by the average weight gain (g).

Chemical analysis

Proximate composition of roasted African star apple kernel and experimental diets were analysed using the methods described by AOAC (2006).

Statistical analysis

Data collected were subjected to analysis of Variance using SAS software (SAS, 2015) while significant means were separated with Duncan multiple range test at 5% level of significance.

RESULTS AND DISCUSSION

Table 2 shows the nutrient and anti-nutrient compositions of fermented African star apple kernels while Table 3 shows the result of the effect of fermented African star apple kernel meal on performance of growing rabbits. There were significant (P<0.05) differences in the daily weight gain, FCR, PER and EER of the rabbits. Daily weight gain and feed conversion ratio of rabbits fed 0 % and 5 % FASAKM diets were significantly (P<0.05) better than those fed 10 % and 15 % FASAKM diets. There was no significant (P>0.05) difference in the daily feed intake of rabbits. The depressed daily weight gain and poor FCR observed among rabbits fed 10 % and 15 % FASAKM could be due to the effect of anti-nutritional factors in the fermented kernels. Oxalates have been reported to form complexes with mineral particularly calcium thereby making them unavailable to the body, cause irritation of the gut and resulting in low feed intake, inhibit protein and energy utilisation in broilers (Okereke, 2012). Phytate impairs the utilization of protein and some minerals resulting in poor performance while tannins inhibits digestive enzymes and causes irritation of the gut. Not only does oxalate interfere with calcium absorption in the digestive tract, it also limits nitrogen retention (Hang and Binh, 2013). Rabbits fed 5 % FASAKM diet gained weight similar to those fed control diet. This is an indication that rabbits will tolerate up to 5 % FASAKM in their diets without adverse effect on the growth performance. Makinde *et al*. (2017) however reported that growing rabbits could tolerate up to 15 % boiled ASAKM in their diets without adverse effect on growth performance. The similarity observed in the average feed intake of rabbits across the treatment groups could be probably due to lack of variation in the nutrient content of the various diets fed. The results of this study revealed that 5 % FASAKM can be substituted for dietary maize in rabbit diet. Above this level, there appears to be a decrease in performance characteristics of the growing rabbits.

Table 3: Effect of fermented African star apple kernel meal on growth performance of growing rabbits

Levels, %	Initial weight, g	Final weight, g	Total weight gain, g	Daily weight gain, g	Daily feed intake, g	FCR	PER	EER
0	584.39	1948.60^{a}	1364.21^{a}	16.24^{a}	59.93	3.69^{a}	1.84^{a}	1.89^{a}
5	591.15	1864.25^{a}	1273.10^{a}	15.16^{a}	60.48	3.99^{a}	1.73^{a}	1.65^{b}
10	585.82	1545.28^{b}	959.46^{b}	11.42^{b}	62.05	5.50^{b}	1.35^{b}	1.47^{b}
15	592.46	1530.72^{b}	938.26^{b}	11.17^{b}	62.52	5.59^{b}	1.36^{b}	1.55^{b}
SEM	7.05	38.93	36.05	1.66	1.53	0.20	0.11	0.21
P-val	0.229	0.001	0.001	0.001	0.699	0.001	0.001	0.101
LOS	NS	**	**	**	NS	**	**	**

abc= means with different superscripts on the same column are significantly different (P<0.05*, P<0.01**), SEM= Standard error of mean, P = Probability value. LOS = Level of significant. NS = Not significant. FCR= feed conversion ratio. PER = Protein efficiency ratio. EER = Energy efficiency ratio

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EVALUATION OF PROXIMATE AND FIBRE COMPOSITIONS OF CAMEL'S FOOT (*Piliostigma reticulatum*. DC) PODS IN KEBBI STATE, NIGERIA

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Abstract

The study was conducted to evaluate the proximate and detergent fibre compositions of *Piliostigma reticulatum* pods obtained in the senatorial districts of Kebbi State. Three areas covering three grazing reserves were randomly selected from each senatorial district. In each area 50m x 50m plot size were measured and demarcated where there are uncultivated stands of the browse plant. Matured pods were harvested during the dry season of 2015 to 2016 (December to February) from selected plant stands in all the areas in each district and pooled together as a representative sample. Representative sample for each senatorial district were dried, milled and taken to the laboratory for proximate and fiber analysis. Data on the various components (crude protein, ether extract, ash, crude fibre, nitrogen free extract and fibre fractions) were subjected to analysis of variance using SPSS 20.0 (2015) software package. The results indicated that all the parameters measured for proximate composition were not significantly ($P>0.05$) affected by their locations. Kebbi North was significantly ($P<0.05$) higher compared to Kebbi South, while there was no difference ($P>0.05$) between Kebbi North and Kebbi South in Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) contents. The pods of *P. reticulatum* obtained across the senatorial districts of Kebbi State have nutritive value which livestock can effectively benefit in their diet.

Key words: proximate composition, camel's foot pods, senatorial districts, Kebbi state

Introduction

The difficulty of animal feed availability in terms of quantity and quality are more severe in rangelands of arid, semi-arid and tropical regions with scarce and erratic rainfall that limits the growth of herbaceous species in this region (Boufennara *et al*., 2012). The search for nutritionally balanced feed to make available to the livestock sector has stimulated investigation into many unusual sources of protein (Altschul, 1994). There is an increase interest in the rational utilization of potential livestock feed resources such as browse species that are adapted to tropical environments (Robles *et al*., 2008).

Although considerable information now exists on the nutrients composition of most well-known and easily cultivated legume crops in Nigeria (Jimoh and Oladiji, 2005), little or no information could however be obtained concerning the nutritional properties of Camel's foot pods which is not cultivated but well known and abundant in the grazing reserves and fallow areas of Kebbi State (Muftau, 2018). Camel's foot are useful sources of animal feeds (Akin-Osanaiye *et al*.,2009; Muftau *et al*., 2018) beside their multipurpose usage such as prevention of desertification, medicine, handcraft, allowing soil fixation and enhancing the restoration of rangelands (Robles *et al*., 2008).There is the need for continuous screening of indigenous browse plants in order to identify those with good potentials as livestock fodders which can thus serves as alternative to those conventional protein feed sources that have been evaluated (Adamu *et al*., 2013). The purpose of this work therefore is to chemically evaluate the proximate and detergent fibre compositions of *P. reticulatum* obtained in Kebbi State.

Materials and Methods

Study area

The study was conducted in three randomly selected areas in each senatorial district of Kebbi State (north, central and south) during the 2014/2015 dry season. The State lies at the extreme North West corner of Nigeria on latitudes 10^0 to 13^0 15^1 and longitude $3^0 30^1$ to 6^0 East. Annual rainfall ranges between from 550mm-650mm occurring between April and September. The mean temperature is 23^0c, maximum is about 38^0c and the minimum is about 18^0c. The relative humidity ranges from 21-47% and 51-79% during the dry and rainy seasons respectively (KARDA, 2006).

Collection of samples and laboratory analysis

Three (3) areas covering three grazing reserves were selected from each of the three (3) Senatorial districts of the State using a Stratified Purposive Random Sampling. In Kebbi north, Arewa, Shiko and Tsamia were selected. In Kebbi central, Dalijan, Hilema and Andarai were selected. In Kebbi south, Ribah, Birnin Yauri and Giron Masa were selected. A reconnaissance survey was conducted in the study areas to determine the population stands of camel's foot per hectare. Three sampled plots each measuring 50mx50m were randomly mapped out and demarcated on a 5km transect. Matured pods were harvested during the dry season of 2015 to 2016 (December to February) from selected plant stands in all the grazing reserves in each district, pooled and bagged together as a representative sample. Representative samples for each senatorial district after collection were dried, milled and taken to the laboratory for proximate and fibre fractions determinations according to the procedures of A.O.A.C (2006) and Van Soest (1991) respectively.

Data Analysis

Data generated were subjected to analysis of variance using SPSS 20.0 (2015) software package. Means were separated using the Duncan's New Multiple Range Test at P=0.05.

Results and Discussion

The results of the proximate and fibre fractions determination of *P. reticulatum* pods obtained from the Senatorial districts are presented in Table 1. The results indicated that all the parameters measured were not significantly different ($P>0.05$) between their means from one location to another. The CP contents obtained were 10.94% and 10.55 % in Kebbi South and Kebbi Central districts, respectively. The crude fibre contents were 38.01%, 37.92 % and 37.61% for Kebbi North, Kebbi South and Kebbi Central, respectively. On the other hand, ether extract contents recorded were 9.11% and 8.81 % in Kebbi South and Kebbi North, respectively. There was also no significant difference ($P>0.05$) in neutral detergent fibre (NDF) content. However, the Acid detergent fiber (ADF) was significantly ($P<0.05$) higher in Kebbi North (58.00 %) compared to Kebbi South (48.80 %), while the difference between Kebbi North and Central districts was not significant. Similarly, Kebbi North district (29.20%) had significantly ($P<0.05$) higher value in acid detergent lignin (ADL) content than Kebbi South (18.20%) and there was no significant ($P>0.05$) difference between Kebbi Cental and South Senatorial districts.

The crude protein contents of *P. reticulatum* pods obtained across the locations was within the range of earlier work of Nouhoun *et al*. (2013) who reported a range value of 7% to 13% CP for 17 preferred browse species by ruminants. The crude fibre recorded for all the values obtained in this work was higher when compared with those of most legumes seeds. High crude fiber content of *P. thonningii* seeds was also reported by Jimoh and Oladiji (2005). The values of the ether extract obtained in this work were lower than those reported by Akin-Osanaiye *et al*. (2009) who reported 27.9% in the seeds of *P. reticulatum.* This indicated that the pods of *P. reticulatum* are not oil fruits. The dry matter content of *P. reticulatum* in this study was higher than those of most legume seeds (Temple *et al*., 1991; Giani, 1993). This implies that the shelf life for this pod would likely be longer than those of most legume seeds. The ash contents (4.01%-4.52%) of the pods reported in this study were comparable with those of *P. reticulatum* seeds (4.0$\pm$0.1) as earlier reported by Akin-Osanaiye *et al*. (2009) whose values were however slightly higher than most legumes seeds reported by Elegbede (1998). While the nitrogen free extracts content of 37.12-38.03% was within the range of other legumes, 23% in groundnuts to 66% in Bambara nut (Apata and Ologhobo, 1994).

The values obtained for the NDF and ADF in this study were higher than those reported by Nouhoun *et al*. (2013) of 36.7% and 23.4% respectively. The ADL value reported was slightly higher than the mean of 17.5% for *P. reticulatum* pods (Nouhoun *et al*., 2013). The higher variations in the NDF and ADF of the pods in this study might be due to the differences in the stage of growth as earlier reported by McDowell *et al*. (1993). Seasonality, differences in plant species, nutrient composition of the soil and site differences are known to be the major factors affecting the nutritive value of native pasture plants (Mahala *et al*., 2009; Subhalaksami *et al*., 2011).

Table 1: Proximate and detergent fibre compositions of Camel's foot pods in the Senatorial Districts of Kebbi State

	Senatorial Districts			
Parameters (%)	Kebbi North	Kebbi Central	Kebbi South	SEM
Dry Matter	91.11	91.56	90.17	2.88
Crude Protein	9.88	9.55	9.94	0.59
Crude Fiber	38.01	37.61	37.92	2.60
Ether Extract	8.81	9.00	9.11	0.69
Nitrogen Free Extract	37.12	38.03	37.72	1.83
Ash	4.21	4.01	4.52	0.67
Neutral detergent fibre	59.20	53.90	54.10	2.66
Acid detergent fibre	58.00[a]	52.80[ab]	48.80[b]	2.37
Acid detergent lignin	29.20[a]	26.70[ab]	18.20[b]	3.09

ab: means in the same row followed by the same superscripts were not significantly (P<0.05) different

Conclusion

In view of this study, it could appear that *P. reticulatum* pods obtained across the grazing reserves in the senatorial districts of Kebbi State have nutritive value which livestock can effectively benefit in their diet. The pod is high in crude protein above the minimum required by ruminants which can be utilized as a cheap source of protein supplement for livestock especially during the dry season.

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EFFECT OF BOILING ON PROXIMATE COMPOSITION, MINERAL AND ANTI-NUTRITIONAL FACTORS OF *CASSIA TORA* SEEDS FOR POULTRY FEED PRODUCTION

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Abstract
Effect of boiling for different time durations on the proximate composition, mineral and anti-nutritional factors of raw *Cassia tora* seeds was investigated. Boiling lasted for three different time durations of 30, 60 and 90 minutes. The proximate composition, mineral and anti-nutritional factors of the seeds of the raw and boiled were determined. Results showed that the dry matter increased above 30 minutes of boiling. Crude protein was increased by boiling. Fibre, ash, ether extract, nitrogen free extract and gross energy were reduced ($P<0.05$). There was non-significant reduction in the mineral content. Boiling in general reduced ($P<0.05$) the anti-nutritional factors which recorded 15.21 – 68.62% reductions in tannins, HCN, saponins and phytate at the different boiling times. It was concluded that raw *Cassia tora* seed should be boiled at least for 30 minutes to reduce the anti-nutritional factors and improve its nutritive value especially the crude protein.

Keywords: *cassia tora*, proximate, mineral and anti-nutritional factors.

Introduction
Feeding constitutes an important part of animal, especially poultry production. Ukachukwu (2015) observed that developing countries have feed deficits, which is made complex and complicated by competition among human, the industry and farm animals for the same food items as either food for man, feed for animals or raw materials for the industry. The author however observed that one of the ways of getting round this problem is by looking for alternative feedstuffs, which have little or no dietary value for man and industry. There is however some unconventional legume seeds that are still under-utilized, which little are known about their chemical composition and nutritional values, like sickle pod (*Cassia tora)* seeds, hence, the need for this research. The objective of the study was to determine effect of boiling durations on the nutritive value and anti-nutrients of *Cassia tora seed*

Materials and Discussion

Experimental Site
The chemical analyses were carried out at the Department of Animal Science Laboratory, University of Nigeria, Nsukka.

Processing of Test Ingredient
Mature dried pods of *Cassia tora* were obtained from Bauchi State, Nigeria and were dehulled to release the seeds. The seeds were processed according to procedures of Ukachukwu and Obioha (2000). Boiling lasted for three different time durations of 30, 60 and 90 minutes. In each case, water was brought to boil at 100^{O}C. Thereafter, the seeds were poured in and allowed to stay for the respective time durations, starting from the time the seeds were poured in. At the end of the boiling, water was drained off. Thereafter, the boiled seeds were dried in forced drought oven at 60^{0}C for 12 hours and ground for analyses.

Proximate Analysis
The raw seeds and differently processed seeds were analyzed for proximate composition using the A.O.A.C. (1990) procedures. The gross energy was determined using adiabatic oxygen bomb calorimetric technique.

Anti-Nutritional Factors
Some of the anti-nutritional factors common with other legume species were investigated. Tannin and phytate in the samples were determined according to the method of Maga (1982). Knowles and Montgomery (1990)

method was used to determine the hydrocyanic acid while the method of Obadoni and Ochuko (2001) was used in determining saponin content of the processed seeds.

Results and Discussion

Effect of boiling for different time durations on the proximate composition, mineral contents and anti-nutritional factors of *Cassia tora* seeds are shown in Table 1. For proximate composition it was observed that dry matter, ash, fibre, crude protein, nitrogen free extract and gross energy were significantly (P<0.05) influenced by boiling at different durations. Boiling at 60 and 90 minutes increased the dry matter, while at all the boiling durations ash, fibre, ether extract, nitrogen extract and gross energy were reduced significantly(P<0.05). Boiling for 90 minutes reduced fibre content more. There were no significant differences (P<0.05) among the boiling durations in ether extract, crude protein, nitrogen free extract and gross energy.

Table 1: Effect of boiling for different time durations on the proximate composition, mineral content and anti-nutritional factors of *Cassia tora* seeds

		Boiling durations (minutes)			SEM
Parameters	**Raw**	**30**	**60**	**90**	
Proximate (%)					
Dry matter	88.50^{b}	88.00^{b}	91.50^{a}	90.00^{a}	0.51
Ash	5.00^{a}	4.00^{b}	4.00^{b}	4.00^{b}	0.16
Fibre	10.00^{a}	9.50^{b}	9.00^{b}	8.63^{c}	0.19
Ether extract	2.00^{a}	1.50^{b}	1.30^{b}	1.40^{b}	0.10
Crude protein	9.63^{b}	13.13^{a}	14.01^{a}	13.57^{a}	0.65
Nitrogen free extract	73.37^{a}	68.37^{b}	69.99^{b}	69.43^{b}	0.70
Gross energy (Kcal/g)	3.594^{a}	3.013^{b}	3.018^{b}	3.055^{b}	0.09
Mineral content (%)					
Calcium	0.58	0.58	0.56	0.50	0.03
Magnesium	0.72	0.68	0.66	0.62	0.06
Sodium	0.50	0.33	0.38	0.41	0.04
Potassium	0.27	0.23	0.16	0.23	0.02
Phosphorus	0.60	0.57	0.55	0.59	0.01
Anti-nutritional content					
Tannins (%)	0.087^{a}	0.044^{b}(49.42)*	0.049^{b}(43.67)	0.031^{c}(64.36)	0.01
HCN (Mg/g)	0.883^{a}	0.356^{b}(59.68)	0.277^{c}(68.62)	0.344^{b}(61.04)	0.09
Saponins (Mg/g)	0.994^{a}	0.548^{c}(44.86)	0.769^{b}(22.63)	0.608^{c}(38.83)	0.65
Phytate (%)	0.046^{a}	0.039^{b}(15.21)	0.034^{b}(26.08)	0.037^{b}(19.56)	0.01

^{a,b,c} Means with different superscripts in the same row are significantly different (P<0.05).
*Figures in parenthesis are % reduction as compared to values of raw seeds.

The increase in the crude protein of the boiled seeds could be that the decanted water contained testa of seeds, which softened and got detached during cooking and in the course of decanting water and drying, they were lost. The crude protein values for the boiled seeds however compared with 13.79% by Adamu *et al.* (2013). This present result confirmed the result of Ukachukwu (2000) who subjected *Mucuna cochinchinensis* to different boiling durations and observed higher CP compared to raw seeds. The result of crude fibre showed significant difference (P<0.05) between the raw and those boiled for different time durations. This could be as a result of loss of testa of the seeds in the course of cooking and decanting of water. The high percentage reduction in crude fibre observed in boiled *Cassia tora* seeds is in agreement with Akinmutimi (2004), who reported 50% reduction of CF in sword bean when subjected to cooking. Emiola *et al.* (2002) reported highest percentage reduction in crude fibre when kidney bean was subjected to cooking. The result of CF aligned with Ukachukwu (2000), who reported that after 30 minutes boiling, crude fibre of *M. cochinchinensis* seeds were

significantly (P<0.05) reduced. The value of CF observed in the boiled seeds was similar to 9.20% by Okoye *et al.* (1980) for raw baobab seeds. The reduction effect of boiling on ether extract agreed with Ukachukwu (2000), that dehulling effect of boiling of *M. cochinchinensis* must have pre-disposed the seeds to some kind of solubilization and leaching out of its fats and oils.

There were no significant differences (P<0.05) in all the minerals detected in the *C. tora*.. The non-significant effect of boiling on mineral content was in variance with Haytowitz and Matthews (1983) who reported that cooking caused great mineral losses with 30% of potassium lost, Copper 17% and iron 10%. Also Longe (1983) reported losses of 30% copper and 23% magnesium from mature cowpeas when cooked. The result showed that apart from potassium and calcium, the values of other macro minerals were higher than 0.07% sodium, 0.27% for magnesium and phosphorus reported for boiled *M. sloanei* seed meal, 0.06% for sodium, 0.20% for magnesium and 0.22% for phosphorus for *M. sloanei* seeds boiled with sodium sespioxide (locally called potash or 'akanwu') (Ewa, 2015).

It was further observed that boiling *Cassia tora* for 30, 60 and 90 minutes resulted in significant reductions (P<0.05) in tannins, saponins, hydrogen cyanide and phytate contents of the boiled seeds. It was observed that boiling the seeds for 90 minutes resulted in drastic reduction (P<0.05) effect in anti-nutritional factors. It recorded 64.36%, 68.62%, 44.86% and 19.56% reductions in tannins, HCN, saponins and phytate respectively. The reduction of HCN in the processed seeds, according to Oke *et al.* (1996) can be attributed to its volatile nature and its low melting point. This agreed with Udedibie and Nkwocha (1990) that when cooking time was increased to 90 minutes, a higher degree of improvement in the nutritive value of jack bean was observed. This result also agreed with Ukachukwu (2000) that boiling seeds of *M. cochinchinensis* for 90 minute gave the best result in terms of proximate composition and anti-nutritional factors, resulting in 45%, 21% and 48% reduction in trypsin inhibitor, tannin and cyanide levels over the raw seeds.

CONCLUSION

The proximate composition of raw seeds of *Cassia tora* showed promising results. Processing the raw seeds by boiling improved the nutritive value and reduced the anti-nutritional factors. Therefore it is recommended to boil the raw seeds before use for feed production.

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PHYTOGENICOLOGY: A NOVEL STUDY FOR EFFICIENT USE OF PHYTOGENICS IN MONOGASTRIC NUTRITION

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Abstract

In this commentary a case for scholarly study of bioactive plants (Phytogenicology) used in monogastric animal feeds is made. Plants and their extracts have for decades been used by man in food and medicine. Spices such as black pepper and thyme have been used to improve acceptability of human foods. These plant materials contain certain substances that make them potent and beneficial in some aspects of human nutrition and health. Their potency has made them to be regarded as phytogenics exhibiting antimicrobial and antioxidant properties. Human being share certain things in common physiologically, biochemically and nutritionally with monogastrics and having similar gut architecture. The success story of phytogenics in human nutrition has led to the current surge in their use in monogastric nutrition. Incorporating Phytogenicology as part of the curriculum in the study of animal science, animal production or animal husbandry is important to unveil their growth and health promoting potentials, possible implications of their application and their sustainable use.

Keywords: bioactive plants, monogastric animal, phytogenicology, spices.

Introduction

Phytogenicology or Phytogenical Science is a word coiled by Ndelekwute*et al*. (2017) which means the study of spices, plants parts, and plant extracts in relation to their application in farm animal nutrition and nutrition-related health challenges. This entails the study and use of extracted bioactive molecules in plants or plant parts in processed form to solving nutrition and nutrition-related health challenges in farm animals. These biologically active products which are regarded as phytogenics include herbs, roots, barks, woody parts, flowers, seeds, fruits and pods of plants that are medicinal. Some are pungent in nature such as spices (Windisch *et al*., 2008). According to Sharifi *et al*. (2013) there have been strong interests recently in use of these products in animal feeds especially the monogastric types (swine and poultry). This interest according to Ndelekwute *et al*. (2017) needs to be sustained through integrated approach. ranging from:

* Scientific study to determine their active ingredients.

* Determining their properties and the behaviour of the active molecules at certain conditions (temperature, interaction with feed components etc.)

* Determination of toxic substances in them and their toxic levels in feeds.

* Massive feeding trials using different animals including pets in determining their effect on farm animal productivity.

* Determining the possibility of using them in curbing some nutrition challenges in animal

nutrition and health.

* Cultivation of such plants in commercial quantities.

* Good processing and packaging of the products for commercial purposes.

The tropical ecosystem of Africa, Asia, South and Central America is blessed with massive natural green biomass which could be explored. Use of medicinal plants and spices in human health and nutrition has been

recognized and is advancing in many countries. In developing countries such as in Africa, the knowledge and interest is increasing. In Nigeria for instance, herbalists or traditional medicine experts (phytotherapists) use herbs, roots and tree barks to manage human infections caused by bacteria, fungi, helminthes and protozoa - the same organisms confronting swine and poultry. In human also, digestive disorders and conditioning of the digestive system of nursing mothers are managed using some of these products like spices such as *Xylopiaaethiopica* (Omodamiro, 2012) and plant extracts (Sharifi *et al*., 2013).

Information and knowledge derived from human experience could be a necessary tool in developing a framework for studying, developing and utilizing these products in feeding of farm animals, especially swine and poultry which have similar gut architecture and digestion pattern as human. This can be achieved through collaborative efforts involving different experts in agriculture such as the animal nutritionists, animal physiologists, veterinary pathologists, biochemists, agronomists, traditional phytotherapists and knowledge from pharmacognosy. Apart from their biochemical make up, knowledge of their microbiological, serological, histopathological, endocrinological, immunological enzymological, metabolic and reproductive effects are important. Best agronomic practice for their cultivation, their processing, storage and packaging should also be scholarly studied. Their use in monogastric nutrition is growing because of certain performance challenges such as lipid oxidation, gut microflora, digesta fermentation, flatulence and reduced nutrient digestion and absorption in the face of global withdrawal of dietary antibiotics in farm animals. The objective of this work is to intensify efforts in the search for alternative bioactive plant materials to replace antibiotics in animal nutrition by advocating for the study of Phytogenicologyas a core area of the search and not only by feeding trials.

Nutritional challenges and current solutions adopted to mitigate them

Performances of farm animals both in health and productivity needs to be enhanced through proper utilization of nutrients contained in the feed. Improper utilization of nutrients due to inadequate digestion and absorption could undermine the health status and productivity of farm animals Choct (2009). Digestion and absorption of nutrients by the intestine are key processes leading to nutrient utilization. These important processes could be undermined or hampered due to the presence of fibre, non-starch polysaccharides, anti-nutritional factors, mycotoxins, rancid feed, gut pathogens, poor endogenous secretions by young chickens and piglets such as hydrochloric acid (Lee *et al*., 2004;Kroismayr 2008; Odetallah, 2016).

Judging from the above mentioned challenges in monogastric animal nutrition, which enzymes, antibiotics and good processing of feedstuffs have been used to reduce to some extent, the official withdrawal of antibiotics from animal feeds has opened up another chapter in the “challenge” debacle. Antibiotics are known to modulate the gastro intestinal tract (GIT) of swine and poultry. Their withdrawal has been reported to lead to proliferation of microorganisms in the GIT with the attendant nutrient fermentation, poor nutrient absorption and poor productivity (Dibner, 2004). The GIT must be in good health condition to be able to process feed, even when enzyme is added. The question could be;

Can the GIT be in good condition to respond appropriately in antibiotic-free state? Considering the fact that enzymes will only break down feed, a product with multi - dimensional efficacy is required which will modulate and prepares the gut for effective absorption of nutrients. Phytogenicssuch as organic acids, essential oils, spices etc. could achieve this feat (Canibe *et al*., 2008). This assertion could be supported by the following facts about phytogenic materials.

* They have complex and mixed molecules that are bioactively important such as phenols, organic acids, essential oils, lycopene, flavonoids, sulphorephene, tocopherol, carotene which act as antioxidants and antibiotics.

* They are naturally renewable. Their natural sources (plants) could be cultivated on farms at commercial level.

* Their active ingredients such as essential oils and organic acids are well metabolized by the liver and report of negative residual effect is scarce.
* They are environment friendly because environmental toxicity has not been established for their use in feeds. Hence environmental contamination which is for instance associated with phosphorus and protein is not likely. This could positively attract commendation from environmentalists who have been pushing for sustainable environment in animal production.
* Bacteria resistance resulting from their inclusion in feeds has not been reported.
* Aromatic phytogenic materials such as spices have sensory qualities, and add flavour to feeds which improve palatability (feed acceptance by animals).
* With the campaign for organic agriculture which is in the increase, these products are good window to achieving that.
* Their recognition in animal nutrition, could lead to increase in employment in tropical environments, through cultivation of such plants, processing, packaging and marketing.

The Potency of Phytogenics

Naturally, bioactive plants and their products are embedded with numerous organic compounds ranging from carotenoids, flavonoids, organic acids, phenols and essential oils. All these compounds have different and similar properties and mode of action. This means that when they are added to feed, challenges such as fat oxidation, nutrient fermentation in the gut, flatulence, poor digestion and absorption can be mitigated. Synergy between the bioactive compounds could lead to better results of improved growth, feed efficiency and general productivity which have been reported by Windisch *et al*. (2008). This synergy could also be improved when more than one phytogenics are combined, each contributing its different bioactive compounds, thereby generating positive interactions.

Essential investigations that are necessary

Though phytogenics have been recognized to have the potential to improve productivity in animal agriculture it is important that their mode of actions and their likely dietary implications be studied. In this regard, their study should also be centered on their;

Microbiological effect in the feed and in the gastro intestinal tract.

Serological effect, determining their impacts on the blood cells, serum protein and liver enzymes.

Histopathological effect noting their impact on internal organs such as the liverand kidney.

Endocrinological effect, understanding how they affect the release of hormones such as insulin, thyroxin, glucagon, sex hormones, reproductive hormones and their activities.

Immunological effect studying their stake on immune system in the area of mucus secretion and production and activation of antibodies especially immunoglobulin (IgA).

Enzymological effect knowing their place in secretion, activation and activities of enzymes of digestion (pepsin, trypsin, chemotrypsin, amylase, sucrase, lipase etc.).

Metabolic effect, determining whether they have significant role in biosynthesis (e.g. protein accretion) and breakdown of organic compounds (e.g. energy generation) in the body such as having similar role as cofactors and coenzymes.

Gut anatomy influencing the number of villi, height of villi, crypt depth and gut length.

Reproductive effect noting their impact on oogenesis, ovulation, feotus implantation, spermatogenesis, semen quality (volume, colour, viscosity), erection, sperm count and sperm morphology.

Muscular effect, inquiring whether they act as stimulants.

Uterine effect studying their effect on feotal development and their relationship with oxytocin and vasopressin.

Mammary effect unveiling their effect on milk synthesis and milk letdown. Their relationship with oxytocin.

Product quality effect investigating their impact on egg quality (shell colour, shell thickness, yolk colour, albumen height), nutritive value and organoleptic property of meat, milk quality (taste, colour, nutritive value).

Conclusion

Phytogenic substances have shown great potentials in tackling some of the problems posed by anti-nutritive factors in some feedstuffs and the challenges of official withdrawal of antibiotic feed additives in feeds for farm animals. These substances have bioactive compounds in complex forms which exert synergic action in animals. Their great advantage is that they abound naturally in our ecosystems especially in tropical green environment, they can be cultivated which could lead to sustainable productivity of farm animals. Their comprehensive study and inclusion in curriculum of Animal Science is vital to critically and fully harness their potentials.

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EFFECT OF WEIGHT ASYMMETRY ON GROWTH INDICES AND COST BENEFITS OF GROWING PIGS

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Abstract

Twenty seven, ten weeks old Large White pigs with average body weight of 15.33 ± 0.2 kg were randomly assigned to three treatments (heterogeneous, homogenous light and heavy weight groups) in order to investigate the impacts of weight asymmetry on growth indices and cost benefits of growing pigs. Each treatment consisting of three replicates of three pigs each. Growth parameters and cost indices data were obtained on weekly basis throughout the experimental period. Data generated were subjected to a 1- way analysis of variance using SAS (2000). The results showed that homogenous light weight pigs had higher feed intake and total feed cost per pigs compared to other values noted for pigs on other treatment groups. Heterogeneous weight pigs recorded better feed conversion ratio, lower feed cost per kilogram weight gain and higher gross margin values compared to their homogenous counterparts. Hence, unevenly weight growing pigs can be managed together in order to obtain higher production efficiency.

Key words: Asymmetry, growth, homogenous, heterogeneous, pig

Introduction

Welfare issues pertaining to pig production and management are essential factors to be looked into since pigs indicate a suffering level especially when their fundamental needs and freedoms are not met. At weaning and growing phases, pigs of different weight groups from different pens are pooled together and managed collectively in order to maximize floor spaces and labour. This practice of mixing unfamiliar and uneven weight groups of pigs may result in high incidence of aggressive behaviour which may affect the growth rate and compromise carcass yield and quality due to physiological stress and pathological responses to the stimuli that may reduce the immunity of the pigs (Arey and Edward, 1998; Nakanishi *et al*., 1993; Mench *et al.*, 1990). The magnitude of the aggressive behaviour exhibited between the individuals could be determined by the degree of familiarity and weight differences among the pigs (Bostami *et al*., 2015). Studies have been conducted in order to establish practical approaches in the management of this aggressive behaviour in pigs. The suggested approaches include the use of sedative drugs or other chemicals, putting them in neutral pens or masking their body odours (Bostami *et al*., 2015). Most of these measures prove abortive as aggression resumes at full peak when the acute effects of the agents disappears (Bostami *et al*., 2015). It can be hypothesized that homogenous weight pigs reared on weight group basis promotes welfare, improved management, reduces aggressive behaviours, and enhances growth rate, nutrient digestibility and carcass quality. To this, the present study was aimed at investigating the effects of weight asymmetry on growth parameters and economy of production of growing pigs.

Materials and Methods

Experimental Pigs and Management

The experiment was carried out at the Piggery Unit of the Directorate of University Farms, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. Twenty seven Large White pigs with body weight range of 14.44-16.22 kg were bought from a commercial farm within Abeokuta metropolis. The pigs were grouped based on their body weight into 3 treatment groups (homogeneous heavy weight group, homogenous light weight group and heterogeneous weight group) with three replicates of three pigs per replicate. Heavy weight group can be defined as a group of pigs at a certain age had weight which is significantly above the weight of the mean group. While light weight group is a class of pigs at a certain age have a body weight which is significantly below the weight of the mean group. Three pigs in a replicate were housed together in a naturally ventilated pen with floor dimension of 4 m by 3 m, equipped with concrete feeding and drinking troughs. Routine management practices were done on daily basis, with fresh water supplied *ad libitum* throughout the experimental period. The pigs were fed formulated ration that contained 18% crude protein, 4.30% ether extract, and 8.59% crude fibre and 2474.39 KJ/Kg metabolizable energy.

Data Collection

Growth performance

Data were collected on daily feed intake and weekly weight gain of the growing pigs while feed conversion ratio was calculated. The initial weight of the animals was taken at the commencement of the experiment and subsequently on weekly basis to determine change in their body weight. Weight gain (kg) = Final weight – Initial weight. Feed intake was determined by taking the difference between the quantities of feed offered to the animals and feed leftover. Feed Intake (kg) = Feed offered – Feed leftover. While Feed conversion ratio was determined by relating the feed intake to the weight gained of the animals.

Economic Benefit Analysis

The prevailing market price of the ingredients at the time of study was used to calculate:

$$Cost\ per\ kg\ feed = \frac{\text{Summation of price per kg of feed ingredients x their proportion in the ration}}{100}$$

Statistical Analysis

Data were processed by one-way analysis of variance using SAS (2000) package. Significantly ($p < 0.05$) different means among variables were separated using New Duncan's Multiple Range Test as contained in the same package.

Results

Effect of weight asymmetry on growth performance and cost benefits of growing pigs

The effect of weight asymmetry on growth performance and cost benefits of growing pigs is shown in Table 1. The results obtained from the study indicated that weight asymmetry had significant ($p < 0.05$) influence on initial weight, total feed intake, daily feed intake, feed conversion ratio, feed cost per pig, feed cost per kilogram weight gain and gross margin of the growing pigs. The initial weight was higher in homogenous heavy weight group compared to the statistically similar values documented for homogenous light weight and heterogeneous weight groups. The feed intake of homogenous heavy weight pigs and their heterogeneous weight counterparts was statistically similar but differed significantly ($p < 0.05$) from the value noted for homogenous light weight grouped pigs. The homogenous weight groups (heavy and light weights) had similar feed conversion ratio values which was significantly ($p < 0.05$) higher than the value documented for the heterogeneous weight group. Significantly higher cost of feed per pig was recorded for homogenous light weight pigs compared with the values obtained for homogenous heavy weight and heterogeneous weight groups that did not differ ($p > 0.05$) significantly. Homogenous heavy and light weights pigs had comparable feed cost per kilogram weight gain values that differed significantly ($p < 0.05$) compared to the heterogeneous group. Homogenous heavy weight pigs and heterogeneous weight group had comparable gross margin mean values that were significantly ($p < 0.05$) higher than homogenous light weight pigs. Other growth performance and cost benefit parameters considered were not significantly influenced by weight asymmetry.

Table 1: Effect of weight asymmetry on growth indices and cost benefits of growing pigs

Parameters	Heterogeneous weight	Homogeneous light weight	Homogeneous heavy weight
Initial weight (kg)	13.83 ± 0.57[b]	11.00 ± 1.08[c]	18.22 ± 1.02[a]
Final weight (kg)	47.00 ± 2.23	41.22 ± 1.79	45.11 ± 3.04
Total weight gain (kg)	33.61 ± 2.21	30.21 ± 2.65	26.90 ± 3.74
Daily weight gain (g)	480.16 ± 31.54	442.06 ± 37.84	384.13 ± 53.37
Total feed intake (kg)	113.23 ± 5.90[b]	130.89 ± 4.62[a]	109.53 ± 6.53[b]
Daily feed intake (kg)	1.62 ± 0.08[b]	1.87 ± 0.07[a]	1.57 ± 0.10[b]
Feed conversion ratio	3.41 ± 0.13[b]	4.39 ± 0.23[a]	4.59 ± 0.52[a]
Total feed cost per pig (₦)	17030.97 ± 967.10[b]	19685.43 ± 857.38[a]	16468.87 ± 1042.19[b]
Feed cost per kg weight gain (₦)	509.76 ± 14.12[b]	658.60 ± 39.95[a]	683.63 ± 71.66[a]
Revenue per pig (₦)	22560 ± 1521.70	19785 ± 892.79	21652.8 ± 1139.57
Gross margin (₦)	5525.00 ± 351.83[a]	100.70 ± 253.21[b]	5183.13 ± 665.85[a]

[abc] Means on the same row with different superscripts are significantly ($p < 0.05$) different

Discussion

In pig production venture, selection of beneficial behaviours is essential for successful management, performance, profit maximization and overall pig welfare. Pig behaviour is the aggregate of pig actions and reactions in response to internal and external stimuli. In this study, the growth performance data indicated that weight asymmetry influenced the initial weight, feed intake and feed conversion ratio of growing pigs. The significant difference noted in the initial weight of the growing pigs used in this present study resulted from the grouping method adopted, since individual pig to be selected as heavy weight must possess weight that should be significantly above the mean weight of the pigs at a certain age. The significant initial weight values with the homogenous heavy weight pigs commanding the highest value and the homogenous light weight pigs with the least value were cancelled out at final weight of the pigs which indicated that heterogeneous weight pigs had the highest numerical value compared to the values noted for pigs with uniform weights (heavy and light). The non-significant final weight values could be linked to less aggressive behaviours (homogenous light and heterogeneous weight groups) that could have induced stress in the pigs

leading to poor growth performance. The less aggression must have initiated better nutrient utilization in this set of pigs as observed in this present study. This present observation disagreed with earlier assertion of Arey and Edward (1998) who concluded that the management of pigs with different weight together led to increased aggression that resulted to poor growth and reproductive performances of the pigs. Likewise, it is in variance with the observation of Bostami *et al*. (2015) and Francis *et al*. (1996) that showed that weight gain of uniformly weight grouped pigs tends to be higher than their heterogeneous weight counterparts. Data from this present study indicated that homogeneous light weight pigs consumed more feed than homogenous heavy and heterogeneous weight pigs. The observed higher feed intake in the homogenous light weight pig that did not translate to better feed conversion ratio points to the facts that higher social and behavioural stresses occurred in this set of pigs as they could not evaluate the relative fighting ability of each other. Game theory model states that evenly matched opponents have difficulties in evaluating relative strength or fighting ability unlike with large weight differences (Anderson *et al*., 2000). The significantly better feed conversion ratio observed in heterogeneous weight pigs over the homogenous weight pigs is in variance with the study of Francis *et al*. (1996) that observed significantly lower feed conversion ratio in pigs with homogenous weight compared to the value obtained for their heterogeneous weight counterparts. The fight to ascertain a dominance hierarchy in the heterogeneous weight pigs must have been brief as the subordinate pigs easily appreciate the superiority of the pigs with higher body dimensions, leading to the better feed conversion ratio as less energy is invested in establishing this social order in the heterogeneous groups unlike the amount of energy investment in the homogeneous weight groups where prolonged fighting may have occurred. Bostami *et al*. (2015) observed that the process in which social ranking occurs in group housed pigs is essential process since it has long run effect on productivity of the pigs. Economic analysis indicated that weight asymmetry had positive impact on total feed cost per pig, feed cost per weight gain, gross margin. English *et al*. (1988) found out that large group sizes of livestock resulted to high difficulty in management, increased aggression, potential loss of animal performance and impaired animal welfare. Heterogeneous weight group in this study had relatively lower feed cost, better feed cost per kilogram weight gain and higher gross margin; these must have resulted from improved productivity gotten from less agonistic behaviours. Although behavioural observation was not part of this study, there must have been an increase in the fighting behaviour in homogenous weight groups as the process of establishing ranking order must have been prolonged due to inability of the pigs to evaluate the fighting ability or strength of each other. Thereby, resulting to physiological stress that has detrimental effect on productivity and the amount of energy invested (Bostami *et al*., 2015; Cornea *et al*., 2006). Homogenous light weight pigs despite the fact that it consumed more feed than other groups had the least gross margin. The pigs must have utilized the extra energy intake in maintaining the level of physical activities involved in establishing social hierarchy rather than converting it into muscle.

Conclusion

The results of this study revealed that weight asymmetry had positive impact on feed intake, feed conversion ratio, feed cost per kg weight gain and gross margin. Hence, application of weight asymmetry as a management tool in pigs raised in tropical environment can serve as a means of obtaining uniform slaughter weight rather than improving the productivity of growing pigs.

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THE EFFECT OF PINEAPPLE (*Ananas comosus*) WINE SEDIMENT ON THE HEMATOLOGY OF WEANER PIGS

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ABSTRACT

A 35-day feeding trial was conducted to determine the effect of pineapple wine sediment meal (PWSM), an industrial by-product from the winery, on the hematology of weaner pigs. In the study, 32 large white x landrace strains of pigs with average initial weight of 10.5±0.4kg were assigned to four treatment diets coded T_1, T_2, T_3 and T_4 replicated 3 times were formulated to replace maize at 0%, 5%, 10% and 15% levels respectively and the study lasted for 35 days. The result of the experiment indicated that lymphocytes increased significantly ($P< 0.05$) with increase PWSM level among the different treatment groups and increase in lymphocytes helps animals build up disease resistance or immunity. Based on the result of the study, it is recommended that PWSM be included at 10% level for normal functioning of hematological parameters.

Key words: Pineapple wine sediment, Hematology, Weaner pigs.

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INTRODUCTION

Livestock production on sustainable level can be used to bridge the animal protein deficit gap of the rural populace in Sub-Saharan African (SSA) countries. With rising demands for animal protein and continuous challenges in availability and composition of feed raw materials, the need for the use of industrial by-products in sustainable animal production rapidly increases. In Nigeria, where the use of orthodox ingredients has the tendency of reducing producer's profit margin especially in pig production, the use of agro-industrial by-products like pineapple wine sediment to cushion the cost of production becomes vital.

Pineapple wine sediment (PWSM) is a residue obtained from wine industry (Nkwocha *et al.,* 2018). The ingredient is a conglomeration of pineapple pulp, brewer's yeast slurry, glycerin, residual sugar, caramel, acetic acid, tannin, stabilizers and bentonite. Pineapple wine sediment (PWS) does not contain any anti-nutritional factor (ANF), hence it possesses the potential as an ingredient in pig feed formulation .Since this by-product is not utilizable by man, the study will therefore be a crossroads to sustainable pig production in Africa.

MATERIALS AND METHODS

Location of study

The study was conducted at the Teaching and Research Farm of the Imo State University, Owerri which lies within the humid tropical rainforest zone of South Eastern Nigeria. The climatic data of Owerri obtained from NIMET, (2015) Official Website (nimet.gov.ng/content/nimet-weather) showed that Owerri lies within latitudes 5°45'N and 7°15'N, and longitude 6°50'E and 7°25'E with an annual rainfall range of 2400-2500mm and annual temperature range of 26°C- 29°C with relative humidity of 70-78% annually.

Experimental Animals

Thirty- two (32) commercial strains of cross-bred Large White x Landrace weaner pigs were used for this experiment, comprising of both male and female pigs of average initial live weight of 10.5±0.4kg.

Experimental Diets

The wet pineapple wine sediment (PWS) used for this experiment was obtained from Jacobs Wines, Ltd. Mgbidi, Imo State. The product, on collection, was stored in air-tight containers to avoid oxidation and reduction reaction which if allowed, would reduce the nutritional quality of this ingredient. After collection and storage, the sediment was air-dried for five days and then pulverized before incorporation into the experimental diet. Four experimental diets were formulated and designated as T_1 (0%), T_2 (5%), T_3 (10%) and T_4 (15%) respectively (Table 1).

Table 1: Percentage composition of the weaner pigs ration containing graded levels of PWSM

	Dietary treatments			
Ingredients	T_1	T_2	T_3	T_4
Pineapple wine sediment meal	0.00	2.50	5.00	7.50
Maize meal	50.00	47.50	45.00	42.50
Groundnut cake	20.00	20.00	20.00	20.00
Wheat offal	10.00	10.00	10.00	10.00
Rice milling waste	6.50	6.50	6.50	6.50
Fish meal	3.00	3.00	3.00	3.00
Palm kernel cake	7.00	7.00	7.00	7.00
Bone meal	3.00	3.00	3.00	3.00
Salt (Nacl)	0.25	0.25	0.25	0.25
Vit/min. premix	0.25	0.25	0.25	0.25
Total	100	100	100	100

* Composition per 2.5kg: Vitamin A 10000000IU, Vit.D 2000000IU, Vit E 20000IU, Vit K 2250mg, Thiamine 1750mg, Riboflavin 5000mg, Pyridoxine 2750 mg, Niacin 27500mg, Vit B12 15mg, Pantothenic acid 7500mg, Folic acid 7500mg, Biotin 50mg, Choline chloride 400gm, Antioxidant 125g, Manganese 80g, Zinc 50g, Iron 20g, Copper 5g, Iodine 1.2g Selenium 200mg, Cobalt 200mg.

Blood Sample Collection

At the end of the 5 weeks feeding trial, two pigs were randomly selected from each replicate for haematological and serum biochemical assay. 10ml blood sample were collected from each pig through the

vein at the ham section with a 10ml sterile syringe. Five (5) ml of blood samples were collected into Bijon bottles containing ethylene diaminetetraacetic acid (EDTA) for haematological assay.

Statistical analysis

All data obtained from the study were subjected to Analysis of Variance (ANOVA) of statistical analysis software (SAS, 2012). Where significant differences were observed, treatment means were compared using Duncan's New Multiple Range Test (DNMRT) as outlined by Obi, (2002).

RESULTS AND DISCUSSION

The result of haematological parameters of weaner pigs on graded levels of PWSM is presented in table 2. The packed cell volume (PCV) values obtained from the study indicated that the concentration followed a definite trend thus directly proportional to dietary inclusion of PWSM. The highest value was recorded from weaner pigs in T_4 (15%) followed by T_2 (10%). Moreover, it was observed that haematological parameters notably Hb, RBC, WBC, and PCV, increased significantly ($P< 0.05$) with increase in dietary level of PWSM (Wang, 2009, Ogbuewu *et al*., 2008).

There was a trend toward reduced clotting time ($P< 0.05$) in T_2 (5%) when compared with the control diet, while T_3 (10%) and T_4 (15%) has higher values comparatively ($P< 0.05$) than the control (Fig 1). Pigs with reduced clotting time are an indication of anti-hemorrhagic property and high build up of vitamin K in the blood of experimental stocks. The result obtained showed that the lymphocytes increased significantly ($P< 0.05$) with increase PWSM level among the different treatment groups. Increase in lymphocytes helps animals build up disease resistance or immunity (Jimoh *et al.*, 2014).

Table 2: Haematological values of weaner pigs fed PWSM

PARAMETERS	T_1	T_2	T_3	T_4	SEM
Hb (g/dl)	10.65^{b}	11.00^{a}	10.40^{d}	10.54^{c}	0.07
PCV (%)	32.80^{b}	33.45^{a}	32.00^{c}	33.64^{a}	0.22
RBC ($X10^6$/l)	12.75^{b}	13.05^{a}	12.35^{d}	12.50^{c}	0.08
WBC ($X10^3$/l)	10.10^{b}	11.00^{b}	12.30^{ab}	13.30^{a}	1.00
MCV (C-u)	25.50^{b}	25.56^{b}	25.45^{b}	26.50^{a}	0.53
MCH (Pg)	8.10^{a}	8.20^{a}	8.25^{a}	8.30^{a}	0.10
MCHC (%)	32.95^{b}	33.00^{a}	33.02^{a}	31.70^{a}	0.63
CT (Sec)	50.40^{a}	44.98^{b}	52.42^{c}	52.50^{c}	3.53

^{abcd} Mean along the row having different letters differ significantly $_P$<0.05

SEM = Standard error of the means

HB = Hemoglobin; PCV – Packed cell volume, RBC = Red Blood Corpuscles; WBC = white blood Corpuscles, MCV = Mean Corpuscular

Volume, MCH = mean Corpuscular Hemoglobin; MCHC = Mean Corpuscular Hemoglobin concentration; BT = Blood Clotting time.

Fig 1: Clothing time (sec) of weaner pigs fed varying levels of PWSM

CONCLUSION AND RECOMMENDATIONS

The data obtained in this experiment have indicated a strong promise for the utilization of PWSM in swine feeding. Pineapple wine sediment enhances stable metabolism and this was showcased from the positive hematological result obtained which is an indication that this unconventional feed ingredient can permeate stable physiology and normal cellular metabolism in the body of weanlings.

Based on the result of the study, it is recommended that PWSM be included at 10% level for normal functioning of hematological parameters.

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Nkwocha, G.A . , Anukam K.U., Ahaotu, E.O. and O.I. Prudent (2018). Performance and Haematological profile of broiler chicks on toasted tiger nut (*Cyperus Esculentus*) treated with bakery yeast. Proc. 43rd Conf. of NSAP, March 18th -22nd 2018, FUT, Owerri.

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SERUM BIOCHEMICAL ESTIMATES OF BROILER STARTER CHICKS FED TIGERNUT (*Cyperus esculentus*) MEAL TREATED WITH BAKERY YEAST

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ABSTRACT

A 28-day feeding trial was carried out to determine the serum biochemical parameters of broilers starter chicks fed toasted Tiger nut treated with bakery yeast. A total of one hundred and twenty unsexed day-old broiler chicks obtained from a commercial hatchery at Ibadan were randomly assigned to four dietary treatments replicated three times with 10 birds per replicate in a General linear Model Procedure using SPSS (Statistical Package for Social Scientist) Design. The results of the study revealed that total protein, albumin and globulin concentration increased as the dietary levels of tigernut increased in the diets. The findings of this experiment suggested that tiger nut meal should be included in the ration of broiler starter chicks as partial replacement for maize at 50% level for optimum performance, production efficiency and stable physiology and normal cellular metabolism in the body of broiler chicks.

Keywords: Serum biochemical estimates**,** Broiler chicks, Tiger nut, Bakery yeast

Introduction

Poultry production globally plays vital role in supplying the population with animal protein and boosting income generation in the rural populace. In Nigeria, the industry is fast gaining ground and achieving optimum nutritional standard and food security (Nkwocha *et al*., 2014). According to World Food Programme (WFP), (2015), poultry production is a reliable antidote to malnutrition and hence a sine quo non for Sub-Saharan Africans to fast track food security.

Tigernut "*Cyperus esculentus*" is an underutilized tuber belonging to the family *Cyperaceae*, which produces rhizomes from the base of the tuber that is somewhat spherical (Gambo and Da'u, 2014).

Tiger nut and its products are rich in carbohydrate, mono-di and polysaccharides (TTSL 2005, Moore, 2004). They contain relatively high levels of protein, Oleic acid (Monounsaturated) fatty acid which has a bigger resistance to chemical decomposition) and fat (TTSL, 2005). Tiger nuts have excellent nutritional quality with a fat composition similar to olive oil and rich mineral content, especially phosphorous and potassium (FAO, 2008; Moore, 2004). Tiger nut oil has a mild, pleasant flavor and is considered as food oil similar but superior in quality to olive oil. The study is therefore aimed at determining the serum biochemistry of broiler starter birds fed toasted tigernut meal treated with bakery yeast.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the poultry section of Imo State Polytechnic Teaching and Research Farm, Umuagwo-Ohaji, Imo State in South Eastern Nigeria. The climatic data of the area showed that annual rainfall ranges between 2000-2500mm. The institution is situated on latitude 6^0N and longitude 7^0E of the

equator with the temperature ranging from (26.5-32^{0}c) and humidity of (70-80%) (Nimet, 2015).

Experimental Birds and Design

One hundred and twenty (120), day old Agrited broiler chicks were bought from a commercial hatchery at Ibadan, Oyo State, Nigeria, certified to be of good health and physical stability. The chicks were acclimatized for 3 days and fed control diet. Kerosene stoves and lanterns were used to provide the heat needed to keep the temperature within optimum range/between 33^{o}c to 35^{0}c).The birds were raised in a deep litter system measuring 4.8 x 3.0m whose floor was covered with wood shavings and feed was provided throughout the experimental period *adlibitum*. Standard management practices were strictly observed. The broiler chicks were randomly allocated to 4 (four) dietary treatments and replicated three times with each replicate having ten (10) birds in a General Linear Model Procedure using SPSS version 20 (SPSS, 2014). The routine management and prophylactic measures were observed accordingly.

Feed preparation and feeding

Tiger nut seeds (*Cyperus esculentus*) was purchased from the local market in Owerri, Imo State. The tiger nut was toasted, passed through hammer mill which crushed the nuts into tiger nut meal. Proximate analysis was carried out to determine the proximate composition of the tiger nut seed meal (AOAC, 2005) as shown in Table 1. The tiger nut was then treated with bakery yeast few days before use in feed formulation to enhance digestibility and biotransformation of organic synthesis. Four isonitrogenous (24±0.24 CP) diets were formulated such that tiger nut replacing maize at 0%, 25%, 50% and 75% dietary levels respectively, the control diet (0%) contained no tiger nut meal (table 2).

Table 1: Proximate composition of tiger nut seed meal (% dry matter)

Parameters	Composition (%)
Dry matter	89.40
Crude protein	7.46
Ether extracts	8.61
Crude Fibre	25.33
Ash	8.27
NFE	39.73
Metabolizable Energy	2390.985kcal/kg

Metabolizable energy calculated; ME (Kcal/kg) =37 x %CP +81 x %EE +35.5 x %NFE (Pauzenga, 1985)

Table 2: Ingredient composition of experimental diets fed to starter broilers

	Dietary levels of tigernut meal			
Ingredient	0%	25%	50%	75%
Maize/ meal	50	12.5	25.00	12.50

Tigernut meal	-	37.5	15%	37.00
Soya bean meal	15	15	20	15
Groundnut cake	20	20	5	20
Wheat offal	5	5	5	5
Fish meal	5.5	5.5	5.5	5.5
Palm kernel cake	5	-	-	-
Salt	0.25	0.25	0.25	0.25
Bone meal	3.00	3.00	3.00	3.00
Bakery yeast	0.50	0.50	0.50	0.50
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total	100	100	100	100
CP	24.88	24.37	24.37	24.37
ME	2839.20	3119.325	3025.95	3119.33

500g of bakery yeast contains 100mg of ascorbic acid; 100mg of sorbitan monostereate (E-44), and natural yeast

Blood Sample Collection

At the end of the 4 weeks feeding trials, three birds were randomly selected from each replicate, and 5ml blood sample was collected through the wing vein with a 5ml sterile syringe. The blood collected was used for the analysis of serum parameters (albumen, total protein, glucose, cholesterol, urea, etc).

Data analysis

All data obtained were statistically analyzed using the General linear Model (GLM) procedure of SPSS version 20 (SPSS, 2014) while differences in treatment means were separated using Duncan's Multiple Range Test from the same software package.

Results and Discussion

The proximate composition of tiger nut is shown in Table 1, while the ingredient composition of experiment diets fed to starter broilers are on Table 2, while the serum biochemical estimates are summarized on Table 3 respectively.

Table 3: Serum biochemistry of broiler starter chicks fed graded levels of tiger nut treated with bakery yeast.

Parameters	T_1	T_2	T_3	T_4	SEM
	0%	25%	50%	75%	

Urea mg/dl	6.60	6.70	6.90	7.20	0.15
Creatinine Mg/dl	5.30	5.50	5.65	5.70	0.13
Glucose Mg/dl	37.60[a]	42.30[b]	46.00[c]	51.00[d]	4.66
Cholesterol Mg/dl	52.20[a]	55.00[b]	58.60[c]	62.00[d]	3.27
Total protein g/dl	54.00[a]	57.50[b]	59.70[b]	64.50[c]	3.50
Albumin g/dl	20.30[a]	22.10[b]	22.70[b]	24.25[c]	1.98
Globulin g/dl	33.70	35.40	36.80	42.25	2.85
SGOT iu/l	9.40[a]	9.80[a]	10.30[b]	10.50[b]	0.45
SGPT iu/l	12.40[a]	12.70[a]	13.10[b]	13.40[b]	0.33

[abcd] Mean along the row having different letters differ significantly P<0.05

The serum biochemistry of the starter birds revealed that total protein, albumin, serum glutamate pyruvate transferase (SGPT), Serum glutamine oxaloacetic transferase (SGOT), glucose, cholesterol and globulin concentrations increased as the dietary levels of tigernut increased in the diets. High level of blood serum globulin is an indent of growth since new protoplasm is added to the cell.

Normally glucose level in the blood is necessary for the metabolic activities of the body and it appears that the tigernut meal builds or promotes blood by supplying the necessary blood forming metabolites like Magnesium, Iron, Copper, etc which enhances effective transportation of oxygen, glucose and other feed nutrients in the animal body.

The implication of the above result is that tigernut meals are richly utilized by broilers at relatively higher dietary inclusions. Moreover, the effect of feeding high dosage of tigernut which contained relatively high fibre compared with maize perhaps, was the reflection of high creatinine values but not significantly different (P>0.05) between the control group. The high creatinine values in the serum indicated poor utilization of nutrient due to muscles wastage (Udoyong *et al*., 2010).

CONCLUSION AND RECOMMENDATIONS

From all indications, tigernut based diets promoted highest values in virtually all the serum biochemical estimates notably Urea, Glucose, Total protein, Albumin, Globulin, SGOT and SGPT.

In view of the above experimental results, Tigernut meal should be included in the ration of broiler starter chicks as partial replacement for maize at 50% level for optimum performance and production efficiency.

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GROWTH AND HAEMATOLOGICAL RESPONSES OF BROILER FINISHER BIRDS TO DIETS WITH GRADED LEVELS OF GINGER

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Abstract

A feeding trial of 28 days was conducted to determine the effect of inclusion of graded levels of ginger in broiler finisher diets on the growth and haematological parameters. Five diets were formulated such that they all have the same levels of ingredients with graded levels of ginger meal supplemented at 0 (T_1), 15 (T_2), 30 (T_3), 45 (T_4) and 60 g/Kg (T_5) respectively. One hundred and five, 28 days - old "Fidan" broiler birds were randomly assigned in a completely randomized design (CRD) experiment to the five diets with twenty one birds per treatment. Each treatment was replicated thrice with seven birds per replicate. The finisher phase lasted for 28 days. Results showed that ginger inclusion levels significantly ($P< 0.05$) influenced the average feed intake, final live weight, and average weight gain, feed conversion ratio, haemoglobin (Hb) concentration and packed cell volume (PCV). All parameters tended to improve with the increased dietary level of ginger meal. Ginger levels did not significantly ($P > 0.05$) influence the red blood cell (RBC) and white blood cell (WBC) counts. The study concluded that ginger meal should be included at 45g/kg feed to improve feed utilization, growth performance and haematological parameters of broiler finisher birds.

Key words: Ginger, growth, blood, broiler, nutrient

Introduction

Expensive and substandard feed is commonly a major constraint in poultry business. Many farmers have advocated the use of antibiotics as a way of augmenting these effects. However, according to Guo *et al.* (2004) continuous feeding of antibiotics as growth stimulants to chickens resulted in a decreased growth response. Therefore there is need to explore possible alternatives to ensure sustainable productivity. Spices are not just health stimulants, they are known to have many health promoting properties among which is the improvement in gastro –intestinal micro – environment of birds leading to enhancement in nutrients utilization and ultimately increase in productivity (Chatterjee and Agrawala, 2002). A spice that can be exploited in this direction is ginger, which is high in calcium, iron, magnesium, manganese, potassium, selenium, vitamins B_6, C and E (Franklin *et al*., 2009). It is also rich in protein and dietary fibre (Lynn and Truc, 2010). Ginger has been shown to be used in several therapeutic applications such as anthelminthic, laxative, anti -anorexic and anti - inflammatory (Frankie *et al*., 2011). In the food industry, it is used as a flavouring agent and a preservative (Lynn and Truc, 2010). This study was therefore designed to investigate the effect of graded levels of ginger meal in broiler finisher diets on the growth parameters and haematological indices.

Materials and Methods

Location of study

The study was carried out at the Poultry Unit of the Teaching and Research Farm, University of Calabar, Calabar, Cross River State. Calabar is located within the tropical rainforest zone of Nigeria on latitude 4^0 15^1N

and longitude 8^{0} 25^{1}E of the Greenwich meridian (Akpan *et al*., 2006). It has an average daily temperature between 24 and 25^{0} with a mean annual rainfall of 1,830mm and relative humidity of 70% (NMA, 2018).

Preparation of ginger

Fresh ginger rhizomes were purchased from Watt market Calabar, Cross River State, Nigeria .They were washed and air- dried for two weeks, thereafter milled into 1 mm sieve size with a hammer mill and kept in an air tight container .

Animals and their management

Five treatments were formulated, all with the same quantity of ingredients but the dietary treatments were supplemented with graded levels of ginger meal at 0, 15, 30, 45 and 60 g/kg of feed for diets T_1, T_2, T_3, T_4 and T_5 respectively. A total of 105, 4weeks old "Fidan" broiler birds were randomly assigned to the five treatments, such that each treatment had 21 birds, which were further subdivided into three replicates with each replicates having 7 birds. The birds were given feed and water *ad libitum* for 28 days .The crude protein and metabolizing energy of the diets were 21.07% and 3,100.20 Kcal/kg respectively (Table 1).

Collection of blood samples

At the end of the experiment, blood samples were collected through the jugular vein of the birds (after the birds were without feed for 12 hours but were allowed access to water) into ethylene diamine tetra-acetate (EDTA) bottles, to determine the packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC) and white blood cell (WBC) counts respectively using standard laboratory procedures.

Data analysis

All data were statistically analyzed using the analysis of variance procedure of Steel and Torrie (1980). Significant means were separated using the Duncan's New Multiple Range Test (Duncan, 1955).

Results and Discussion

The feed intake (Table 2) increases ($P< 0.05$) significantly as the dietary levels of ginger meal increased in the diets. This observation agrees with the report of Frankie *et al*. (2009); Lynn and Truc (2010), who reported significant increment in feed intake of birds, fed diets containing ginger; which they attributed to the improvement in appetite and flavor as a result of ginger meal inclusion. The average daily weight gain and the final live weight showed similar trend with feed intake as both parameters significantly ($P< 0.05$) improved as the dietary levels of ginger increased across dietary treatments. The improvements in final live weight and average weight gain of birds in diets with ginger also agrees with the observation of Borazjani - Zadeh *et al*. (2011); which was attributed to the anti-helminthic and antibacterial properties of ginger. Reduction in negative intestinal bacteria improves feed utilization and ultimate growth in broiler birds (Nsa *et al*., 2010). However, birds in diets with 45 and 60 g/kg did not show any significant differences. Feed conversion ratio improves significantly ($P<0.05$) with increase in dietary ginger levels, this could be due to the good condition of digestive tract (walls) which ginger is known for (Nsa *et al*., 2009) due to improvement in feed utilization, where negative bacteria were reduced in intestinal walls of birds. Among the haematological parameters, Hb and PCV showed significant differences ($P< 0.05$), the values increased with

dietary levels of ginger. However, they were within values recommended for healthy birds; likewise red blood cell and white blood cells though they did not show any significant (P> 0.05) difference but were within the ranges recommended for healthy birds. This observation could be so because the feed were balanced in nutrients. Dietary deficiency of iron, copper, vitamins and amino acids are associated with decrease in the quantity of haemoglobin (Frandson, 1981).

Conclusion

The results of this study revealed that ginger meal could be included in broiler finisher diets. However, the inclusion level should not be more than 45g/kg of feed as above this level they might not show any significant improvement in the growth and haematological parameters.

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Table 1: Gross composition of experimental diets

Ingredients	Inclusion levels of ginger meal				
	T_1(Control-0g/kg)	T_2 (15g/kg)	T_3 (30 g/kg)	T_4 (45g/kg)	T_5 (60g/kg)
Maize	60.00	60.00	60.00	60.00	60.00
Soybeans	26.50	26.50	26.50	26.50	26.50
Wheat offal	7.50	7.50	7.50	7.50	7.50
Fish meal	2.50	2.50	2.50	2.50	2.50
Bone meal	2.70	2.70	2.70	2.70	2.70
Salt	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20
Vit/min premixes	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Crude Protein %	21.07	21.07	21.07	21.07	21.07
ME(kcal/kg)	3100.20	3100.20	3100.20	3100.20	3100.20

Note: Ginger meal was added as a supplementary feed additive to the respective diets at 0, 15, 30, 45 & 60 g/kg.

Table 2: Growth and haematological responses of broiler birds fed diets containing graded levels of ginger rhizome meal

Parameters	T_1(Control)	T_2	T_3	T_4	T_5	SEM
Initial weight(g)	570.22	571.00	568.20	566.90	570.10	3.65
Final Live Weight(g)	2118.66^{c}	2122.00^{c}	2308.16^{b}	2481.45^{a}	2490.08^{a}	6.90
Ave. Daily Weight gain(g)	87.60^{c}	91.46^{c}	98.15^{b}	106.55^{a}	108.70^{a}	2.32
Ave. Daily feed intake(g)	189.22^{b}	192.17^{b}	201.44^{ab}	206.72^{ab}	208.91^{a}	1.98
Feed Conversion Ratio	2.16^{a}	2.10^{a}	2.05^{a}	1.94^{b}	1.92^{b}	0.11
Mortality (%)	1.00	0.00	0.20	0.00	0.01	0.01
Haematological indices						
Hb (g/dl)	14.08^{e}	14.91^{d}	15.02^{c}	15.26^{b}	15.89^{a}	1.11
PCV (%)	40.01^{e}	46.23^{d}	49.15^{c}	52.69^{b}	56.00^{a}	3.89
RBC ($x10^{12}$/L)	12.13	15.66	11.25	11.05	10.99	4.56
WBC ($x10^{9}$/L)	11.55	10.62	10.81	11.05	10.99	1.87

$^{a,b\ldots d}$Means on the same row with different superscripts differ significantly (P<0.05).

GROWTH PERFORMANCE, BLOOD PROFILE AND COST BENEFITS OF FINISHER BROILER CHICKENS FED DIETS CONTAINING SWEET POTATO TUBER MEAL AS PARTIAL SUBSTITUTE FOR MAIZE

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Abstract

A total of 180 broiler chickens were used to determine the effects of sweet potato tuber meal (SPTM) as partial substitute for maize on growth performance, blood profile and cost benefits of finisher broiler chickens. The birds at four weeks of age, were balanced for weight and distributed into three dietary treatments (control, 10 and 15% SPTM as partial replacement for maize) each replicated four times with 15 birds per replicate laid out in a completely randomized design. The birds were managed intensively throughout the experimental period until they attain seven (7) weeks of age. Data collected were subjected to one way analysis of variance. Results revealed that the inclusion of SPTM up to 15% in diets of finisher broiler chickens did not significantly (P>0.05) influenced the growth performance indices and most of the blood indices measured except albumin which shows significant (P<0.05) variation ranging from 1.35 g/dl (15% SPTM) to 1.90% (control). Significant difference was also obtained in the cost benefit as the lowest significant (P<0.05) cost (₦129.73) per kg feed was recorded in birds fed diet containing 15% SPTM relative to ₦136. 63 per kg feed in birds fed the control diet. The study concluded that, incorporation of sweet potato tuber meal up to 15% in diet of finisher broiler chickens resulted to no detrimental effect on growth performance with marked reduction in cost per kg of broiler finisher diet.

Key words: Broilers chickens, sweet potato, performance and cost benefits

Introduction

Broiler chicken production is the fastest means of providing animal protein to the teeming world population due to the birds' efficient feed utilization, rapid weight gain, and short generational interval. Despite the potential of broiler chickens production in ameliorating animal protein malnourishment in a developing country such as Nigeria. It is still challenged with increased production cost attributed to the cost of feeding. High cost of conventional feed ingredients has already sent lot of poultry farmers out of business as cost of feeding alone account for 60-75% of the total production cost in Nigeria. Maize is the most commonly used energy source in poultry feeds, there is however an increasing demands on its use by human population as food and commercial livestock feed millers for the manufacture of feed, coupled with the price of maize which varies with the season of the year in the tropics. This contributes to scarcity and increase in the unit cost of maize, making it unavailable all year round energy source for livestock feeding. Therefore, to compensate for scarcity and fluctuating price of maize, there is the need to consider alternative sources of energy like starchy roots and tubers such as sweet potato, cassava for the production of poultry feed at a comparatively cheaper rate. Sweet potato (*Ipomea batata*) belongs to the morning glory family (*Convolvulaceae*) and previous studies have been reported to indicate the positive influence of sweet potato meal in the diet of broiler as replacement for maize: Shoremin and Job (2000) found that sweet potato at a substitution of 45% can safely replace maize in pullet mash. Okereke *et al.* (2009) reported that orange fleshed sweet potato tuber meal can be included up to 25% in diet of laying hen without any deleterious effect on egg quality. However, due to dearth of information on the utilization of whole tuber (unpeeled) of sweet potato as an alternative energy source in poultry feeding. This study investigated the growth performance, blood profile and cost benefits of finisher broiler chickens fed diets containing whole tuber of sweet potato meal as partial replacement for maize.

Materials and methods

Study location, experimental bird and management: the experiment was undertaken at the Poultry unit of the Teaching and Research farm, and the Animal Products and Processing Laboratory of the Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. A total of 180 finisher broiler chickens were purchased from a reputable farm in Ogun State and used for the study for a period of 3 weeks. The birds were intensively managed with the provision of compounded diets containing sweet potato tuber meal as partial replacement for maize (Table 1).

*Sourcing and processing of sweet potato (Ipomea batata) tuber meal***:** tubers of sweet potatoes were purchased from a local market in Odeda Local Government Abeokuta Ogun state. These tubers were washed, sliced into smaller portions without peeling and sun dried for a week until they were brittle. Slices of the sun dried sweet potato were then ground to make sweet potato tuber meal (SPTM).

Experimental treatments description and design: the experiment consists of three (3) experimental diets which are: diet 1 (control); diet 2 (containing 10% SPTM as replacement for maize) diet 3 (containing 15% SPTM as replacement for maize). The experiment was laid out in a completely randomized design.

Data collection and analysis: the feed intake and body weight gain were measured on weekly basis while the feed conversion ratio and mortality percent were calculated. At 7 weeks of age, blood and serum samples were collected for the determination of haematological and serum biochemical parameter using standard procedures (Schalm *et al.*, 1975; Peters *et al.* 1982). Prevailing market costs of feed ingredient at the time of the experiment were used to calculate the cost benefit parameters. Data were subjected to one way Analysis of variance using the general linear model at 5% level of significance as contained in MINITAB17 and significantly different means were separated using Tukey Test.

Results and Discussion

The effect of sweet potato tuber meal as partial replacement for maize on growth performance and cost benefits of finisher broiler chickens is presented in Table 2. Varying inclusion levels of sweet potato tuber meal did not significantly ($P>0.05$) influence any of the growth performance indices considered. The statistically similar ($P>0.05$) results in the growth performance indices indicated that the utilization of sweet potato tuber meal as partial replacement for maize in broiler finisher diets up to 15% did not negatively affect the growth rates (as it stimulate similar growth responses in the finisher broiler chickens). This result is similar to the reports of Ayuk and Essien 2009 and Agwunobi (1999) who observed no significant differences in the growth performance of broiler chickens fed diets containing sweet potato as replacement for maize. Lowest significant ($P<0.05$) feed cost (₦129. 73) per kg diet was obtained in birds fed diet containing 15% SPTM as against the highest feed cost per kg diet of ₦136. 63 noted in birds fed control diet. Variation observed in the feed cost per kg diet is adduced to differences between the price per kg of ₦150.00 and ₦104.30 for maize and sweet potato tuber meal (SPTM). Table 3 shows the influence of sweet potato tuber meal on haematological and serum biochemical parameters of finisher broiler chickens. All the haematological indices evaluated revealed no significant ($P>0.05$) variations as a result of the dietary treatments. The ranges of haematological indices recorded in the study were within the normal reference values stipulated in literatures for domestic poultry (Mitruka and Rawnsley 1977; Simaraks *et al.,* 2004) and this suggests that replacing maize with sweet potato tuber meal up to 15% did not predispose the finisher broiler chickens to any health challenge throughout the period of the experiment as normal haematological parameters of an animal are direct indication of absence of disease (Olafedehan 2010). With exception of serum albumin, no significant differences were observed in other serum biochemical indices as a result of the utilization of sweet potato tuber meal. Highest serum albumin value of 1.90 g/dl was obtained in birds fed the control diet as against 1.35 g/dl recorded in birds fed diet containing 15% SPTM. The range of value obtained for serum albumin is consistent with that of Bounus *et al* (2000) for normal healthy chickens (1.1 to 2.1 g/dl).

Conclusion and Recommendation

Results from the study revealed that the incorporation of sweet potato tuber meal up to 15% in diet of finisher broiler chickens has no negative implications on growth performance and health status as well as and contributing significantly to reduction in cost per kg of feed for finisher broiler chickens. Hence, utilization of SPTM as partial replacement for maize has the potential of enhancing the economy of broiler chickens production.

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Table 1: Gross composition of experimental diet (Finisher phase)

Ingredients (%)	Diet 1 (Control)	Diet 2 (10% SPTM)	Diet 3 (15% SPTM)
Maize	57	47	42
Sweet potato(USPM)	-	10	15
Soyabean meal	16	16	16
Fish meal (72%)	1	1	1
Groundnut cake	13	13	13
Breweries dried grain	4.5	4.5	4.5
Wheat offal	5	5	5
Salt (Nacl)	0.25	0.25	0.25
Bone meal	1.5	1.5	1.5
Oyster shell	1	1	1
Premix (finisher)	0.25	0.25	0.25
Lysine	0.25	0.25	0.25

Methionine	0.25	0.25	0.25
Total	**100**	**100**	**100**
Calculated composition			
ME (Kcal/Kg)	2906.75	2898.58	2894.50
Crude protein (%)	20.79	20.17	19.87
Ether extact (%)	4. 62	4.64	4.65
Crude fibre (%)	4.04	3.81	3.70
Ash (%)	2.80	2.67	2.61

SPTM = sweet potato tuber meal

Table 2: Effect of sweet potato tuber meal on growth performance and cost benefits of finisher broiler chickens

Parameter	Diet 1 (Control)	Diet 2 (10% SPTM)	Diet 3 (15% SPTM)	SEM	p-value
Initial weight (g/bird)	913.33	915.56	912.22	1.43	0.317
Final weight (g/bird)	1819.20	1724.40	1762.40	48.70	0.435
Weight gain (g/bird/day)	43.14	38.51	40.48	2.30	0.417
Feed intake (g/bird/day)	120.87	126.87	123.34	2.24	0.244
Feed conversion ratio	2.80	3.29	3.05	0.18	0.220
Mortality (%)	1.48	2.22	0.74	1.21	0.708
Feed cost/kg (₦)	136.63[a]	132.03[b]	129.73[c]	0.00	0.000
Total feed cost/bird (₦)	346.80	351.74	336.01	6.19	0.262
Daily feed cost/bird (₦)	16.514	16.749	16.000	0.29	0.262
Feed cost/kg gain (₦)	382.56	434.38	395.67	24.0	0.321

Means with different superscripts on the same row are significantly different (p<0.05); SPTM: Sweet potato tuber meal

Table 3: Effect of sweet potato tuber meal on haematological and serum metabolites of finisher broiler chickens

Parameter	Diet 1 (Control)	Diet 2 (10% SPTM)	Diet 3 (15% SPTM)	SEM	p-value
PCV (%)	30.00	31.00	33.50	3.07	0.733
Hb (g/dl)	9.65	10.00	10.40	0.83	0.827
RBC (x 10^{12} l)	2.25	2.10	2.20	0.29	0.934
WBC (x 10^{9} l)	11.85	11.55	11.70	1.20	0.985
Heterophils (%)	27.00	27.50	34.00	7.10	0.759
Lymphocytes (%)	73.00	69.50	63.50	7.34	0.686
Eosinophils (%)	0.00	1.00	1.00	0.58	0.465
Basophils (%)	0.00	0.50	0.50	0.41	0.650
Monocytes (%)	0.00	1.50	1.00	0.30	0.074
Total protein (g/dl)	3.55	3.05	2.60	0.47	0.460
Albumin (g/dl)	1.90[a]	1.45[b]	1.35[b]	0.07	0.023
Globulin (g/dl)	1.65	1.60	1.25	0.41	0.776
Glucose (g/dl)	149.00	155.00	118.00	13.90	0.277
ALT (U/l)	25.00	27.00	27.00	4.80	0.945
AST (U/l)	63.50	60.00	57.50	6.72	0.828

Means with different superscripts on the same row are significantly different (p<0.05); SPTM: Sweet potato tuber meal

BIOAVAILABILITY OF SELECTED MACRO-MINERALS IN BLOOD OF CROSSBRED WEANED PIGS FED CASSAVA STARCH EXTRACT PULP

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Abstract

Minerals constitute a small percentage of swine diets, but their importance to growth, health and productivity of the pig cannot be over-emphasized. Cassava starch extract pulp were purchased from Psaltry Farm International (a cassava processing factory) located in Ado-Awaye of Iseyin Local Government Area of Oyo State, processed into meal by sundrying for two weeks to reduce the toxic substances in cassava namely hydrocyanide acid. The sundried cassava starch extract pulp was included in diets at 0%, 25%, 50% and 75% in a complete randomized design experiment using eight weeks old crossbred weaned pigs. Blood was collected from two animals per treatment from the heart using syringe and needle very early in the morning before feeding into plain bottle for macro mineral analysis. Water was supplied *ad libitum*. Bioavailability and utilization of macro minerals in sundried cassava starch extract pulp in diets by the pigs were determined comparing with those on the control diet. The availability and utilization of the macro – minerals Calcium, sodium, phosphorus, potassium and magnesium similarly gave values on the sundried cassava starch extract pulp diets that were comparable or even superior to values on the control diet ($P<0.05$). Based on the findings of this study, it was concluded that inclusion of sundried cassava starch extract pulp in diet at 75% has no adverse effects on bioavailability and utilization of macro minerals in the crossbred weaned pigs.

Key words: Cassava starch extract, macro, mineral availability and utilization, pulp, sundried, weaned pigs

Introduction

Inadequate macro nutrients poses a serious nutritional and public health problems. Macro- minerals are inorganic substances present in all living and non-living things including animals, human beings, soil and rocks and every form of life requires these inorganic elements for normal life processes (Ozcan, 2003). Macro nutrients deficiencies are known to impair the body functions and to accelerate the severity of many diseases and infections in animals. In monogastric animals like pigs and poultry, feed ingredients account for between 65 to 70% of the total cost in an intensive production system in Nigeria (Tewe, 1997). Energy source constitutes between 45 and 60 percent of finished feeds for these animals (Tewe and Egbunike, 1992) and at present maize is the commonly used source of energy in livestock feeds (Olurin *et al.,*2006).The increasing demand on the use of maize by man and livestock feed millers coupled with the cost of maize which flunctuate with the time of the year thus making the cereal grain to be either scarce or expensive, stimulate the use of alternative sources of energy that are locally available, particularly the starchy roots and tubers that abound in many areas of humid tropics. Dried cassava pulp is a by- product of cassava starch factory processing contain a large quantity of starch. Cassava pulp is the solid, moist by-product of cassava starch manufacture and it represents approximately 10 to 15% of the original root weight. As cassava starch production increases, so does the large volume of waste by-product generated. This study was therefore conducted to evaluate the bioavailability of selected macro – minerals in blood of crossbred weaned pigs fed sundried cassava starch extract pulp.

Materials and Methods

The experiment was carried out at the .piggery unit of the Teaching and Research Farm, Oyo State College of Agriculture and Technology, Igboora, Nigeria. The experimental area was located in savanna forest zone on latitude$7^0$43N and longitude $3^0$28E in an elevation of 140m above the sea level. Sixteen (16) crossbred Largewhite x Landrace weaned pigs in their 8th weeks of age was obtained from the piggery unit of the Teaching and Research Farm. The pigs were dewormed and fed 4% of their body weight as feed per day at the beginning of the experiment and increases as the animals age increased while water was supplied *ad libitum.* The pigs were randomly assigned to four dietary treatments comprising (0% control), 25%, 50% and 75%) of sundried cassava starch extract pulp. Each treatment was replicated twice with two pigs per replicate. The pigs were housed in pens equipped with individual feeding and drinking facilities. The design of the experiment was completely randomized design and the experiment lasted for eight weeks. The cassava starch extract pulp was purchased from sundried for two weeks based on intensity of the sun and environmental temperature after which it was milled using hammer mill. Proximate analysis of the test ingredient was carried out by the methods of AOAC, (2006). At the end of the feeding trial, blood sample were collected from two pigs per treatment from the heart with the use of syringe and needle. 5ml of blood was collected in the morning before feeding from each pig into sample bottle vials without Ethylene Diamine Tetra Acetic (EDTA) Acid for the determination of macro elements. Sodium and potassium were determined using the standard flame emission photometer (AOAC, 1984). Phosphorus was determined calorimetrically using the spectronic 20 (Gallenkamp, UK) as outlined by Pearson (1976) with KH_2PO_4 as standards. Data collected were subjected to one way analysis of variance (ANOVA) and where differences exist between the means Duncan Multiple Range Test was used to separate the means at 5% level of probability (Duncan, 1955).

Table 1: Macro Mineral in weaned pigs fed sundried cassava starch extract pulp

Parameters	T1 0%	T2 25%	T3 50%	T4 75%	SEM
Calcium (mg/dl)	7.40	7.40	7.60	7.50	0.03
Sodium (mg/dl)	139.00	140.00	137.00	135.00	0.79
Phosphorus (mg/dl)	5.50	5.70	5.30	5.60	0.06
Potassium (mg/dl)	6.25	5.60	5.40	5.70	0.19
Magnesium (mg/dl)	2.80	3.50	2.60	2.80	0.55

[a,b,c,] means on the same row with different superscript differ significantly ($p<0.005$).

Results and Discussion

The results of the macronutrients status in the blood of crossbred weaned pigs maintained on sundried cassava starch extract pulp are presented on Table 1. The values recorded for calcium were significantly ($P < 0.05$) different across the dietary treatments with the highest value (7.60 mg/dl) recorded in pig fed diet 3 with 50% cassava starch extract pulp as a replacement for maize while the lowest value (7.40 mg/dl) were obtained in diets 1 and 2 (0% and 25% levels of cassava starch extract pulp respectively. The values of

sodium ranged from (140.00mg/dl) in diet 2 to (135.00mg/dl) in pig fed diet 4. Phosphorus was highest (5.70 mg/dl) in pig fed diet 2 while the least value (5.30 mg/dl) was recorded in pigs fed 50% replacement level of cassava starch extract pulp. Pigs fed the control diet had the highest value (6.25 mg/dl) of potassium while the least value (5.40 mg/dl) was obtained in the pigs fed diet 3.Magnessium values range from (3.50 mg/dl) in diet 2 to (2.60 mg/dl) in pigs fed diet 3. Calcium values on the test diets 3 and 4 were even higher (7.60 and 7.50 mg/dl respectively) than that on the control diet ($P<0.05$). Fleck (1976) reported that calcium in combination with magnesium, phosphorus, manganese and chlorine are involved in bone mineralization and formation. Calcium is also required for membrane permeability and involve in muscle contraction, normal transmission of nerve muscle and neuromuscular activity (Murray *et al.,* 2000). The content of sodium in blood of weaned pig fed sundried cassava starch extract pulp was not different from that recorded on the blood of groups receiving the control diet suggesting that the sundried cassava starch extract pulp could meet the sodium requirement of the weaned pigs fed the experimental diet. Sodium is known to maintain osmotic pressure, regulate acid – base equilibrium and control water metabolism in the body. Amino acid and glucose uptake are dependent on sodium and sodium – dependent phosphate transporters have been isolated from avian jejunum and kidneys (Huber *et al.*, 2006). Phosphorus is the second most abundant mineral in the animal body and about 80% is found in the bones and teeth. It is also required for the formation of the organic bone matrix as well as the mineralization the matrix. Phosphorus is a component of deoxy and ribonucleic acids which are essential for cell growth and differentiation (Karn, 2006).Phosphorus also plays a vital role in a host of metabolic functions, including energy utilization and transfer via adenosine triphosphate with implications for gluconogenesis, fatty acid transport, amino acid and protein synthesis and activity of the sodium/potassium ion pump. Potassium is involved in nerve – muscle function, electrolyte balance and is part of the sodium – potassium pump in many cells. The decrease in the value obtained for potassium as level of inclusion of sundried cassava starch extract pulp increased indicated hypocalcaemia which is low level of serum potassium and this manifested as diarrohea, metabolic alkalosis and familiar periodic paralysis (Hay and Swenson, 1985). Potassium is also involved in ammonium ion excretion by the kidney, regulation of heart rate and preventing tetany in skeletal muscle. Magnesium is part of the mineral make-up of bone and is a co-factor in several enzymes. The significant ($P< 0.05$) effects of magnesium content in the blood of crossbred weaned pigs may be the body ability to absorb magnesium (Merck, 1986). Magnesium is associated with the microsomes and facilitate the union of substrate and enzyme.

Conclusion and Recommendation

The blood composition of the crossbred weaned pigs fed sundried cassava starch extract pulp presented adequate values on the macro – minerals evaluated thus sundried cassava starch extract pulp could be used in nutrition of pigs without compromising the minerals status in the body, Extensive cultivation of cassava is recommended as alternative energy source and their by – products such as pulp and peels could be use as livestock feeds to prevent environmental pollution, soil degradation and waste.

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ECONOMICS OF PRODUCTION OF GROWING COCKERELS FED MIXED SAW DUST AS A SUBSTITUTE FOR WHEAT OFFAL

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Abstract

A total of 96 day- old cockerel chicks were obtained and allocated into 6 brooding units of 16 birds and replicated twice in a complete randomized design experiment. At the 9th week the birds were moved to the rearing units which housed 16 Cockerels chickens per treatment and were offered one of the three dietary treatments for the duration of the experiment. Experimental diets were introduced from 9-12 weeks. Three substitution levels of mixed saw dust substituting wheat offal at 0, 50 and 100% levels respectively. The results showed that there were significantly ($p<0.05$) difference across the dietary treatments. The lowest values (₦124.57) for the cost of feed in (₦/kg) was obtained in growing cockerels fed diet 3 while the highest value (₦130.97) was obtained for the cost of feed in ₦/kg in growing cockerels fed diet 1. The result obtained in this research showed that the lowest cost (₦12,457.00) was recorded for the production of 100kg of feed for growing cockerels fed diet 3 while the highest cost (₦13,097.00) was recorded for the production of 100kg of feed for growing cockerels fed diet 1. It could be concluded that the use of mixed saw dust as a substitute for wheat offal resulted in a decreased in the cost of growing cockerel and thereby increased the profitability of cockerel farmers/producers.

Introduction

Poultry make a significant contribution to human nutrition and economic sustenance. They provide substantial amount of high quality protein in form of meat and table eggs. According to Okorie (1983) and Oluyemi and Roberts (1988) poultry yield the quickest returns of investment compared to other livestock species. Poultry provide useful by-products for manufacturing industries. Among the poultry birds, the cockerels and turkeys are considered as the meat type bird, the cockerels are regarded as hatchery wastes at the point of hatching in the developed countries and are hence recycled as livestock feed components. However, the emerging potentials for the cockerels birds in the developing countries as meat-type birds especially when reared beyond sixteen weeks of age to target the festive periods like the Christmas and the Easter seasons. Consumers have reported cockerel meat to be firmer in consistency, tastier and less fatty than that of cockerels. It is also relatively cheaper to raise cockerels to 2kg body weight than cockerels because of lower cost of feed and medication and the hardiness of the cockerel birds. Harnessing these inherent potentials in cockerel production will therefore go a long way in ameliorating the shortage of proteins, particularly those of animal origin that is prevalent in most African countries reputed with low consumption of animal proteins (FAO, 1986). This study aims to examine the cost effectiveness of production of growing cockerels fed mixed saw dust as a substitute for wheat offal.

Materials and Methods

Experimental site: The experiment was carried out in the poultry unit of Teaching and Research Farm of Oyo State College of Agriculture and Technology, Igboora.

Experimental Ingredient: The saw dust used in the experiment was obtained from the local saw mill at Igboora, Oyo State.

Experimental birds and management

A total of 96 day- old cockerel chicks were obtained from Obasanjo Farm Nigeria Limited. The birds were allocated into 6 brooding units of 16 birds and were offered one of the three dietary treatments such that there were 2 replicates assigned to each dietary treatment in a complete randomized design experiment. The birds were fed *ad-libitum* throughout the experimental period. The birds were managed under a deep litter system of management with wood shavings as bedding materials. At the 9th week the birds were moved to the rearing unit which house 16 cockerel chickens per treatment and they were offered one of the three dietary treatment for the duration of the experiment.

3.6 Experimental Diets

Three experimental diets were formulated for the finisher (9-12weeks) phase. The diets were introduced from 9-12 weeks and fed for the duration of the experiment. Three substitution levels of mixed saw dust substituting wheat offal at 0, 50 and 100% levels respectively.

Table 1: Gross Composition of Experimental Diet (Grower phase)

Ingredient	T1 (0%)	T2 (20%)	T3 (40%)
Maize	50.0	50.0	50.0
Soyabean	11.50	11.50	11.50
Wheat offal	20.0	16.0	12.0
Saw Dust	0.00	4.00	8.00
Limestone	2.60	2.60	2.60
Bone meal	2.30	2.30	2.30
Grower premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Methionine	0.05	0.05	0.05
Lysine	0.10	0.10	0.10
Palm kernel cake	13.0	13.0	13.0
Total	100	100	100
ME	2684.25	2736.83	2789.41
C.P	15.92	15.66	15.40

ME- Metabolizable energy, CP- Crude protein

A kg premix contains vitamin A; 110,000,000iμ Vitamin D; 2,500,00iμ, Vitamin E; 20,000mg Vitamin K_3; 3000mg, Vitamin B_3; 3.00mg Vitamin B_2; 7000mg, Vitamin B_6; 500mg Vitamin B_{12}; 25mg, Panthotenic acid; 10,000mg, folic acid; 800mg, Biotin; 50mg, Manganese; 80,000mg, Iron; 40,00mg, Zinc; 60,000mg, Copper; 800mg, Cobalt; 250mg, Iodine; 1,000mg, Selenium (1%); 150mg, Chlorine, 200,000mg and Anti oxidant; 100,00mg.

Table 2: Cost of growing cockerels feed

Ingredient (kg)	Price/kg (#)	T1(0 %)	T2 (20%)	T3 (40%)
Maize	150.00	7500.00	7500.00	7500.00
Soyabean	200.00	2300.00	2300.00	2300.00

Wheat offal	90.00	1800.00	1440.00	1080.00
Saw Dust	10.00	--------	40.00	80.00
Limestone	20.00	52.00	52.00	52.00
Bone meal	50.00	115.00	115.00	115.00
Grower premix	850.00	212.50	212.50	212.50
Salt	50.00	12.50	12.50	12.50
Methionine	1500.00	75.00	75.00	75.00
Lysine	1200.00	120.00	120.00	120.00
Palm kernel cake	70.00	910.00	910.00	910.00
Total cost/100kg	---------	13097.00	12777.00	12457.00

Parameters to be measured

The following are the economy of production parameters to be measured on growing cockerels fed experimental diets: final weight (g/bird), weight gain (g/bird), feed intake (g), cost of feed on (₦/kg), cost of 100kg of feed in (₦), cost of weight gain in (₦/kg).

Statistical Analysis: Data collected were subjected to statistical analysis of variance (ANOVA) and means were separated using Duncan multiple range test**.**

Result and Discussion

Economy production of growing cockerel

Table 3 shows the economy of production of growing cockerels fed mixed saw dust as a substitute for wheat offal. It was discovered that the values obtained were significantly ($p<0.05$) difference across the dietary treatments. Cockerel on treatment 3 recorded the lowest values for cost of feed (₦124.57) While the highest value of (₦130.97) was recorded for the cost of feed in ₦/kg in growing cockerels fed diet 1. The result obtained in this research showed that the lowest cost (₦12,457.00) was recorded for the production of 100kg of feed for growing cockerels fed diet 3 While the highest cost (₦13,097.00) was recorded for the production of 100kg of feed for growing cockerels fed diet 1. The highest cost (₦94.98) of weight gain in (₦/kg) was obtained in growing cockerels fed diet 1. While the lowest cost (₦83.30) of weight gain in (₦/kg) was noticed in growing cockerels fed diets 3. The lowest cost (₦540.38) of feed/bird in ₦/kg was recorded in growing cockerels fed diet 3. While the highest cost (₦572.11) of feed/birds in ₦/kg was noticed in growing cockerels fed diet 1.

Table 3. Economy of production of growing cockerels (9-12 weeks) fed mixed saw dust as a substitute for wheat offal.

Parameters	T1	T2	T3	SEM
Final live weight (kg)	13215.00^{a}	1210.10^{b}	1132.00^{c}	21.94
Weight gain (kg)	725.20^{a}	713.00^{b}	668.20^{c}	14.02
Feed intake (kg)	4368.28^{a}	4368.22^{ab}	4337.96^{c}	8.24
Cost of feed (₦/g)	130.97^{a}	127.77^{b}	124.57^{c}	1.51

Cost of 100kg	13097 .00[a]	12777.00[b]	12457.00[c]	150.85
Cost of weight gain (₦/g)	94.98[a]	91.10[b]	83.30[c]	2.80

The highest (₦130.97) cost of feed in (₦/kg) was recorded for growing cockerel fed diet 1 While the lowest (₦124.57) of feed in (₦/kg) was noticed in cockerel fed diet. The result of this study was in agreement with the finding of Ojewola *et al*., (2004) who reported the lowest cost/kg feed in ₦49.66 for broiler fed diet 5 (100% cashew nut meal and 0% soya bean meal) based diet. The highest cost (₦94.98) of weight gain in (₦/kg) was obtained in growing cockerel fed diet 1 (0% substitution level of mixed saw dust for wheat offal). The lowest cost of (₦83.30), weight gain in (₦/kg) was obtained in growing cockerel fed diet 3. This result confirmed the finding of Ogungbenro *et al*., (2013) who reported the least cost ₦206.70 of feed consumed/weight gain in (₦/kg) in turkey poult fed 30% replacement level of cashew nut meal for maize. It could be concluded that the use of mixed saw dust as a substitute for wheat offal resulted in a decreased in the cost of production of growing cockerel and this resulted in an increase in the profitability of growing cockerel production.

Conclusion

It could be concluded that the use of mixed saw dust as a substitute for wheat offal resulted in a decreased in the cost of growing cockerel and thereby increased the profitability of cockerel farmers/producers.

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Proximate, amino acid profile and mineral composition of fresh and shade-dried *Moringa oleifera* leaves grown in Gwagwalada, Abuja.

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ABSTRACT
Proximate and mineral composition of fresh and shade-dried moringa leaves were determined using the procedures of Association of Official Analytical chemists AOAC, (1990) while their amino acid profiles were determined using methods described by Benitez (1989). Results on proximate showed that shade-dried moringa leaves have higher levels of crude protein (CP), crude fibre and ash while fresh moringa leaves has higher ether extract and moisture content. Amino acid results showed that shade-dried leaves had higher values of both essential and non-essential amino acids that were identified. Mineral composition values were also observed to be higher in shade-dried leaves than in fresh leaves.

Key words: Proximate, Amino Acid profile, Mineral composition, Analysis.

INTRODUCTION
According to Kakengi *et al*.(2001), the scarcity of animal feed is one of the major constraints to livestock production in the tropics particularly during the dry season where farmers rely on crop residues and low quality hay to feed their animals. The energy and protein intake of animals raised on such feeds cannot sustain adequate levels of animal performance. Studies have shown that multipurpose trees like *Moringa oleifera* can be used as cheap supplements to improve voluntary intake, digestibility and overall performance in animal production (Kakengi *et al*., 2001).

Over the years, a high degree of renewed interest has been placed on the nutritional properties of moringa in most countries (Oduro *et al.,* 2008). Since every animal has its nutrient requirement for optimal growth and productivity and feeding therefore becomes crucial to the animal system, it becomes very important not to give feed on a trial and error basis without a basic knowledge of the exact nutrient in such feed. Hence, this research aims at knowing the nutrient composition in moringa leaves and also to ascertain the levels of such components in the leaves before and after shade-drying.

MATERIALS AND METHODS
Collection of Plant Materials
The moringa leaves were harvested from moringa farms in Gwagwalada, Abuja. The leaves were properly washed and divided into two; one part was analysed fresh while the other was shade-dried appropriately before analysis.

Chemical Analysis for Proximate, Amino Acid Profile and Mineral Composition
Crude protein determination was carried out using the micro Kjeldahl method while crude fibre and fat were determined using standard scientific procedures according to AOAC (1990).The Amino Acid profile of the sample was determined using methods described by Benitez (1989). The sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon sequential Multi-Sample Amino Acid Analyzer (TSM) and then analyzed. The atomic absorption method according to AOAC (1990) was used to determine the mineral composition.

RESULTS AND DISCUSSION
Proximate analysis of Fresh and Shade-dried *Moringa oleifera* Leaves
The results for proximate analysis of fresh and shade-dried leaves of *Moringa oleifera* are presented in Table 1. The crude protein value (36.50%)obtained for dried leaves is lower than the 39.14% for moringa leaf protein concentrate reported by Sodamade *et al*. (2013). ThisCP valueis however higher than those reported by Gidamis *et al*. (2003) and Sarwatt *et al*.,(2004) who reported lower values of

16 and 22.42% respectively.The results also show an appreciable ash level (10.89%) in dried leaves which is higher than 7.64% and 6.0% reported by Moyo*et al*., (2011) and Sodamade*et al*. (2013), respectively. These levels of crude protein and ash are of nutritional significance as they can meet the protein and mineral requirements of various animals and boost their immune system against diseases.The level (7.58%) of crude fibre obtained for dried moringa leaves in this study is higher than the 5.43% reported by Sodamade *et al*. (2013) but lower than the value (9.25%) reported by (Ibok *et al.,* 2008). It was observed that nutrient values are higher in dried leaves than in fresh ones with the exception of ether extract and moisture. Drying the leaves help to concentrate the nutrients and also facilitate conservation. This is advantageous in animal nutrition as feed can be made available for the animal during periods of scarcity.

Amino Acids Profile of Fresh and Shade-dried *Moringa oleifera* Leaves

Table 2 shows the amino acid profile of fresh and shade-dried moringa leaves. 17 amino acids were identified in both fresh and shade-dried moringa leaves which included; lysine, arginine, histidine, threonine, phenylalanine, valine, methionine, leucine, isoleucine, tyrosine, aspartic acid, serine, glutamic acid, proline, glycine, alanine and cystine. In this study, only tryptophan was not detected from the common ten essential amino acids. It was observed that amino acid profile showed that values for both essential and non-essential amino acids were higher in shade-dried leaves than in fresh ones and this agrees with the reports of Anhwange *et al*. (2004). According to Brisibe *et al*.(2009), amino acids are building blocks of proteins and are required for; the production of enzymes, immunoglobins, hormones, growth, repair of body tissues and also forms the structure of the red blood cells.

Mineral composition of Fresh and Shade-dried *MoringaOleifera* Leaves

Table 3 shows the mineral composition of fresh and shade-dried moringa leaves used in this study. It was observed that shade-dried moringa leaves had high concentration of both macro and micro mineral elements than fresh leaves. Even though the result from this study differ from the report of Makker and Becker, (2001), the dried leave values are similar to the values reported by Moyo *et al*., (2011). The results obtained for mineral composition in this study is a good indication that moringa leaves has significant nutritional, medicinal and therapeuticvalues.

Conclusion

The results obtained in this study indicate that moringa leaves are rich in nutrients like minerals, proteins and amino acids. The shade-dried leaves were found to be higher in these nutrients than the fresh ones. Moringa leaves can therefore be used as feed component especially when shade-dried to meet up the nutritional requirement of most livestock, thus, serving as alternative raw material in animal feeding. The development of *Moringa oleifera* as a plant in the farming systems of the tropics could be the panacea for the much needed alternative feed material for increased livestock productivity.

Table 1- Proximate composition of both fresh and dried leaves of *Moringa oleifera*

Nutrient (%)	Fresh Leaves	Shade-dried Leaves (in DM)
Moisture	61.00	6.59
Crude protein	8.90	36.50
Crude fibre	3.24	7.58
Ash	4.16	10.89
Ether extract	13.76	7.10

Table 2: Amino acid profile of fresh and shade-dried Moringa oleifera leaves

Amino acid	Fresh leaves	Shade-dried leaves
Lysine*	3.30	4.56
Histidine*	1.78	2.03
Arginine*	4.25	5.95
Aspartic acid	7.32	9.34
Threonine*	2.95	4.03
Serine	2.29	3.88
Glutamic acid	8.24	10.80
Proline	2.09	3.83
Glycine	4.30	9.62
Alanine	3.23	5.14
Cystine	0.76	1.11
Valine*	3.65	7.30
Methionine*	1.34	2.20
Isoleucine*	3.91	6.13
Leucine*	4.58	9.04
Tyrosine	2.81	3.97
Phenylalanine*	3.52	5.54

*General essential amino acids.

Table 3: Mineral composition of fresh and shade-dried *Moringa oleifera* leaves

Minerals	Fresh leaves	Dried leaves
Macro minerals (%)		
Calcium	2.08	3.61
Phosphorus	0.16	0.30
Magnesium	0.12	0.42
Potassium	0.90	1.48
Sodium	0.10	0.17
Ssulphur	0.28	0.60
Micro minerals (mg/kg)		
Zinc	29.00	31.01

Copper	7.32	8.20
Manganese	74.5	85.7
Iron	360	483
Selenium	130.06	363
Boron	40.32	49.93

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Effects of replacing maize with threshed rice head supplemented with and without enzyme on the nutrient digestibility of weaner rabbits

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ABSTRACT
A feeding trial was conducted to investigate the effect of replacing maize with threshed rice head (TRH) supplemented with and without enzyme on the nutrient digestibility of weaner rabbits. Fifty four rabbits were randomly allotted to six dietary treatments of three replicates. There were three rabbits per replicate in a 2 x 3 factorial experimental design. There were three inclusion levels (0, 7.5 and 15%)supplementedwith and without enzyme in the diets. The response on TRH without enzyme inclusion showed that all the parameters measured (dry matter, crude protein, crude fibre, ether extract and ash) were significantly (P<0.05) affectedby the test dietsexcept nitrogen-free extract digestibility.The results of TRH levels (0, 7.5 and 15%) with enzyme supplementation had significant (P<0.05) effecton the coefficient of crude protein and crude fibre digestibility. The study indicated that TRH can be included in the diet of rabbit up to 15% with enzyme supplemention.

Key words: Rabbits, digestibility, Rice threshed head, maize

INTRODUCTION

There is a resultant increase in the demand for animal protein due to the rapid growth of human population in developing countries like Nigeria. Biobaku and Dosumu (2013) reported that this observed low animal protein consumption may be attributed to the declining animal protein production in the country. Rabbit, as a micro-livestock, is an economic animal that can bridge the wide gap between dietary protein production and consumption in Nigeria. This is because rabbit has peculiar digestive physiology which permits the use of forages and agro-industrial by-products thus making it non competitive specie with man for cereal and legume grains. According to Obeidat *et al*.(2009), sourcing for alternatives to the inadequate and expensive energy and protein feed stuffs like maize and soybean has become imperativesince reducing production cost in order to maximize profit is the main objectives of farmers. Researches have shown over the years that different rice parts during and after harvesting contain various nutrients that favours their use as animal feed. Proximate analysis of threshed rice head revealed relatively good values of crude protein (8.06%), crude fibre (13.15%), ash (4.18%), ether extract (2.68%), nitrogen free extract (66.41%) and metabolizable energy (2259.70kcal/kg) at 92.48% dry matter content.

MATERIALS AND METHODS

Experimental Animals, Design and Management

A total of fifty fourhealthy five weeks old weaner rabbits were used in this study. They were randomly selected and allotted to six experimental diets in a 2 x 3 factorial design. There were three replicates per treatment and each replicate had threerabbits, comprising of nineanimals per treatment. The rabbits were housed in a cage with wire meshed hutches. The cage was raised above the ground in a well ventilated pen. Feed and water were supplied *ad-libitum*

Sources and Processing of Threshed Rice Head (TRH)

The threshed rice head was collected from rice farms in Gwagwalada, Abuja. After drying, the threshed rice head were thencrushed in a feed mill and sample was taken for proximate analysis before inclusion into diets.

Experimental Diets

Six experimental diets were formulated with the threshed rice head (TRH) with and without enzyme supplementation at different levels of replacement.Diets 1, 3 and 5 contained 0, 7.5 and 15% TRH without enzyme while diets 2, 4 and 6 contained 0, 7.5 and 15% TRH with enzyme supplementation. Maxi grain enzyme was used in this study.

Digestibility Study

At the end of the 8th week feeding trial, nutrient digestibility study was conducted. Rabbits closest to the average mean weight in each replicate were selected for the study. The rabbit were housed in a metabolic cage. Wire mesh was used to separate the faeces and the urine was collected from the tray beneath the cage. Faecal samples were collected for a period of seven days. The faeces were separated from feeds and other extraneous materials, sundried and bulked. The dried samples were then weighed,grinded and taken to the laboratory along with samples of feed for proximate analyses.Samples were analyzed for crude protein, crude fibre, ether extract, ash and nitrogen free extract. Nutrient retention was calculated with the formlula: Nutrient intake-Nutrient output divided by nutrient intake multiplied by 100.

Data Analysis

Data collected were subjected to statistical analysis using general linear model according to SAS (2001). Significant differences were separated using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The data for nutrient digestibility of rabbits fed diets containing Threshed Rice Head (TRH) with and without enzyme supplementation as partial replacement for maize are presented in Table 1.

Rabbits fed 15% TRH level had higher coefficient of crude protein, crude fibre, ether and ash digestibility than those fed 0 and 7.5% TRH levels. Rabbits fed 0 and 15% levels of TRH had similar dry matter digestibility which were significantly ($P<0.05$) higher than that of 7.5% TRH level. However, there was no significant ($P<0.05$) difference in the Nitrogen free extract digestibility across all TRH levels. Results on CP digestibility contradicts the reports of Adeniji (2008) who fed bovine rumen content to rabbits and attributed the low CP digestibility to the high fibre content of the feed.The increased digestibility of ether extract and total ash absorption with increased levels of TRH in the diets of the rabbits also disagrees with the result of Igwebuike*et al*. (1998) who reported that increased crude fibre levels in rabbit diets depresses ether extract digestibility and total ash absorption. Nitrogen free extract digestibility was not significantly affected by the test material in the diets, thus, suggesting efficient utilization of soluble carbohydrates in all the diets. The result of this study is in line with the findings of Onifade *et. al.,* (1999) who reported high digestibility of readily available carbohydrates by rabbits in a feeding trial involving alternative tropical energy feed resources in rabbit diets.Generally, the results of this study disagree with the submission of Alawa and Amadi (1991) who reported that nutrient digestibility significantly decreases with increasing levels of dietary crude fibre. The results obtained in this study might be due to the fact that gut micro organisms in the digestive tract of the rabbits helped to properly degrade the fibrous content of the feed thereby making the nutrients available to the experimentalanimals.

The observed improvement in crude protein and crude fibre digestibility due to enzyme supplementation in this study is in line with the results of Gidenne and Jehl (2000) who reported that enzyme supplementation reduces intestinal viscosity thereby improving contact between nutrients and digestive enzymes, thus, leading to improved digestibility coefficients. The enzyme supplementation result of this study is probably due to the enhanced effect of the exogenous enzymes on gut micro-flora and volatile fatty acids production thus resulting in improved nutrient digestibility**.** Even though Biobaku and Dosumu (2013) earlier reported that enzyme supplementation had no effect on fibre digestion in rabbits, the higher crude protein and crude fibre digestibility in this study is in agreement with the report of Abaza and Omara (2011) who observed similar results in fibre digestibility when corn cobs were supplemented with enzyme in the diet of growing rabbits.

Adeyemo *et al*. (2014) also recently reported improved crude protein and crude fibre digestibility in rabbits fed enzyme supplemented diets.

Conclusion

It can be concluded that weaner rabbits can efficiently utilize TRH up to 15% in their diets especially when supplemented with enzyme.

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Table 1 Apparent nutrient digestibility of rabbits fed diets containing graded levels of threshed rice head with and without enzyme supplementation as partial replacement for maize

	Dry matter (%)	Crude protein (%)	Crude fibre (%)	Ether extract (%)	Ash (%)	NFE (%)
TRH Levels						
0%	75.75^{a}	84.90^{b}	75.30^{b}	80.70^{b}	82.70^{c}	69.80^{a}
7.5%	74.70^{b}	82.10^{c}	75.00^{b}	78.60^{c}	84.50^{b}	69.40^{a}
15%	75.50^{a}	86.55^{a}	79.00^{a}	87.00^{a}	85.65^{a}	69.90^{a}
SEM	0.25	0.23	0.19	0.19	0.20	1.27
LOS	S	S	S	S	S	NS

Enzyme Level						
No enzyme	75.36[a]	83.60[b]	76.10[b]	82.03[a]	83.46[b]	64.90[a]
Enzyme	75.26[a]	85.43[a]	76.76[a]	82.16[a]	85.10[a]	63.83[a]
SEM	0.13	0.19	0.15	0.15	0.16	1.22
LOS	NS	S	S	NS	S	S
Interaction	S	S	S	S	S	S

[a, b, c]: means with different superscripts within the same row differ significantly (P < 0.05); NFE-Nitrogen free extract; TRH-Threshed rice head; SEM-Standard error of means; LOS-Level of significance; NS-Not significant; S-Significant

Table 1 Apparent nutrient digestibility of rabbits fed diets containing graded levels of threshed rice head with and without enzyme supplementation as partial replacement for maize

	Dry matter (%)	Crude protein (%)	Crude fibre (%)	Ether extract (%)	Ash (%)	NFE (%)
TRH Levels						
0%	75.75[a]	84.90[b]	75.30[b]	80.70[b]	82.70[c]	69.80[a]
7.5%	74.70[b]	82.10[c]	75.00[b]	78.60[c]	84.50[b]	69.40[a]
15%	75.50[a]	86.55[a]	79.00[a]	87.00[a]	85.65[a]	69.90[a]
SEM	0.25	0.23	0.19	0.19	0.20	1.27
LOS	S	S	S	S	S	NS
Enzyme Level						
No enzyme	75.36[a]	83.60[b]	76.10[b]	82.03[a]	83.46[b]	64.90[a]
Enzyme	75.26[a]	85.43[a]	76.76[a]	82.16[a]	85.10[a]	63.83[a]
SEM	0.13	0.19	0.15	0.15	0.16	1.22
LOS	NS	S	S	NS	S	S
Interaction	S	S	S	S	S	S

[a, b, c]: means with different superscripts within the same row differ significantly (P < 0.05); NFE-Nitrogen free extract; TRH-Threshed rice head; SEM-Standard error of means; LOS-Level of significance; NS-Not significant; S-Significant

PERFORMANCE AND COST BENEFIT ANALYSIS OF STARTER BROILERS FED *Jatropha tanjorensis* LEAF EXTRACTS

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Abstract

The growth performance and cost-benefit analysis of starter broilers fed *Jatropha tanjorensis* leaf extracts was evaluated using 180 Oba Maeshal strain broilers. The birds were randomly assigned to five groups of 36 chicks each. Each treatment was replicated three times in a completely randomized design experiment. Five levels of *Jatropha tanjorensis* leaf extracts were served to the animals which contained 0ml, 10ml, 20ml, 30ml and 40ml per litre of water and designated as T_1, T_2, T_3, T_4 and T_5, respectively. Feed and water were offered *ad libitum*. Parameters assessed were performance indices and economics of production. Results showed that *Jatropha tanjorensis* leaf extracts had significant ($p<0.05$) effect on weight gain, feed conversion and protein efficiency ratios of the birds. Birds fed 20ml, 30ml and 40ml *Jatropha tanjorensis* leaf extracts recorded significantly ($p<0.05$) higher body weight gain and superior feed conversion and protein efficiency ratios than the control birds. There were significant ($p<0.05$) differences in feed intake and water intake of the birds among the treatments. 20ml, 30ml and 40ml *Jatropha tanjorensis* leaf extracts significantly ($p<0.05$) increased feed and water intakes of the birds. Result on economic analysis showed that *Jatropha tanjorensis* leaf extract treated groups were more profitable than control group. It could be concluded that *Jatropha tanjorensis* leaf extract at 20ml, 30ml, and 40ml per litre of drinking water caused significant improvement in weight gain, feed and protein efficiency. *Jatropha tanjorensis* leaf extract can be used as growth promoters in the poultry diets with better production performance.

Keywords: Cost-benefit, *Jatropha tanjorensis,* performance, starter broilers,

Introduction

Jatropha tanjorensis Ellis & Saroja (*Euphorbiaceae*) is a common weed of field crops, bush re-growth, road sides and disturbed places in the higher rainfall forest zones of West Africa. It is commonly called 'hospital too far', catholic vegetable, 'Iyana-Ipaja' or 'lapalapa' (Iwalewa *et al*., 2005). In some parts of Nigeria the leaves of *Jatrophatanjorensis* are locally consumed as vegetable added to daily meal. J*atropha tanjorensis* has received a lot of attention due to its potential health benefits, availability and affordability (Omoregie and Osagie, 2007; Omobuwajo *et al*., 2011). Phytochemical screening of *J. tanjorensis* leaf revealed that it contains bioactive principles such as alkaloids, flavonoids, tannins, cardiac glycosides, anthraquinones, and saponins (Ehimwenma and Osagie, 2007). In Southern Nigeria the leaves of *Jatrophatanjorensis* have been used for the treatment of Diabetes mellitus as it is said to possess anti hyperglycaemic effect (Olayiwola *et al.*, 2004)**]**. The leaf extract has hypoglyceamic and antioxidant properties that make it a popular remedy for the treatment of diabetics, malaria and hypertension in this region. *J. tanjorensis* have also been shown to exhibit antibacterial activity (Iwalewa *et al*., 2005). In fact, earlier reports have shown that *J. tanjorensis* is rich in antioxidant nutrients like phosphorus, selenium, zinc and vitamins C and E (Omobuwajo *et al*., 2011).

However, to the best of our knowledge no research has been carried out to determine the effect of *Jatropha tanjorensis* on the performance of broilers. Therefore, the present study was undertaken to investigate the influence of *jatropha tanjorensis* leaf extracts on the performance and economics of production of starter broilers

Materials and Methods

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki. Freshly harvested *Jatropha tanjorensis* leaves were dried at room temperature for one week, after which the dried leaves were ground with a grinding machine. The extracts were prepared by soaking 100g dried *Jatropha tanjorensis* leaf powder in one litre of water and allowed to stay for 24 hours and then sieved with a filter paper to make *Jatropha tanjorensis leaf extract*. One hundred and eighty, day old Oba Marshal strain broilers chicks were allowed to acclimatize for seven days in the experimental pen. After acclimatization they were randomly allotted to five treatment groups in a completely randomized design (CRD) experimemt. Each treatment groups was further sub divided into three replicates of 12 birds each. They were randomly assigned to five experimental extracts designated as T_1, T_2, T_3, T_4 and T_5. *Jatropha tanjorensis* leaf extracts were administered to the chicks in their drinking water at a dose of 0ml, 10ml, 20ml, 30ml and 40ml /litre of water for T_1, T_2, T_3, T_4 and T_5 respectively. The birds were fed commercial broiler starter diets. Water and feed were made available to the birds *ad libitum*. All groups had uniform environmental and nutritional conditions. Vaccination and other routine poultry management practices were maintained. Chicks were weighed at the beginning of the experiment to obtain their initial body weight and on weekly basis thereafter. Data on daily feed, weight gain, feed conversion ratio, protein efficiency ratio, water intake and economics of production based on the prevailing market conditions at the time of the experiment were recorded. At the end of the study, data thus collected was subjected to statistical analysis using completely randomized design model. The differences in the means were compared by least significance difference test (Steel and Torrie (1996).

Results and Discussion

Results on the growth performance of finisher broilers fed *Jatropha tanjorensis* leaf extracts are presented in Table 1.

Table 1: The Effect of *Jatropha tanjorensis* leaf extracts on the performance of starter broilers

Parameters	T_1(0ml)	T_2(10ml)	T_3(20ml)	T_4(30ml)	T_5(40ml)	SEM
Initial body weight (g)	126.89	120.86	123.81	123.08	125.31	1.46
Final body weight (g)	1011.67^{b}	1051.53^{b}	1111.40^{b}	1102^{a}	1277.07^{a}	10.43
Body weight gain (g)	884.78^{b}	930.67^{b}	987.58^{b}	978.92^{a}	1151.75^{a}	10.86
Daily weight gain (g)	31.59^{b}	33.23^{b}	35.27^{a}	34.96^{a}	41.13^{a}	0.39
Total feed intake (g)	1824.40^{b}	1814.26^{b}	1851.18^{a}	1857.62^{a}	1884.94^{a}	4.72
Daily feed intake (g)	65.15b^{b}	64.79^{b}	66.11^{a}	66.34^{a}	67.31^{a}	0.17
Feed conversion ratio	2.06^{a}	1.95^{b}	1.88^{b}	1.90^{b}	1.64^{b}	0.23
Daily protein intake	13.68^{b}	13.61^{b}	13.88^{a}	13.93^{a}	14.14^{a}	0.04
Protein efficiency ratio	2.31^{b}	2.44^{b}	2.54^{a}	2.51^{a}	2.91^{a}	0.03
Total water intake(ml)	3974.47^{b}	4003.62^{b}	4125.37^{a}	4083.04^{a}	4116.78^{a}	22.81
Daily water intake(ml)	141.94^{b}	142.98^{b}	147.33^{a}	145.82^{a}	147.03^{a}	0.81
Feed water ratio	1:2.18	1:2.20	1:2.23	1:2.20	1:2.29	0.02

$^{a, b,}$ Means with different superscripts along the same row are significantly (P<0.05) different.

There were significant (P<0.05) differences in all the parameters but for feed water ratio There were significant (P<0.05) differences in the weight gain of the birds among the treatments. A significant growth promoting effect was observed from birds fed 20ml, 30ml and 40ml leaf extracts than birds fed 10ml and

0ml. These results might be due to the good health status of the birds, which may be caused by the bioactive compounds present in *Jatropha tanjorensis. Jatropha tanjorensis* leaf extracts may have promoted the performance of the intestinal flora thereby improving digestion and enhancing the utilization of nutrients, leading to improved growth. Similar, observations were made by Onu and Aja (2011), in their study on weaned rabbits. They noted that herbal plants may have controlled and limited the growth and colonization of numerous pathogenic and non pathogenic species of bacteria in the gut leading to improved translation of feed to meat. Our results are in accordance withthat of Asif *et al.*(2011), Bhattacharyya *et al.* (2013), Alam *et al*. (2016) and Monika *al*. (2017) who reported higher body weight gain when birds were treated with medicinal plants. his might be due to the anti-bacterial and anti-oxidant properties of the extracts. Feed intake, water and protein intake increased significantly ($P<0.05$) within treated group with birds fed 20ml, 30ml and 40ml leaf extracts recording the highest. There was no significant difference between birds fed 0ml and 10ml leaf extracts. The higher intakes of T_3, T_4 and T_5 birds is evidence to suggest that herbs, spices, and various plant extracts have appetizing-stimulating properties Similar increase in feed intake of broiler chicken supplemented with herbal extract of *Allium sativum* (Sultan *et al*., 2009) and aqueous extract of *Zingiber officinale* (Rajab *et al*., 2013) have also been reported. Significant variations were also observed in the feed conversion and protein efficiency ratios of the birds Better feed conversion ratio of the broilers fed *Jatropha tanjorensis* leaf extract may be attributed to the antibacterial properties of these supplements, which resulted in better absorption of the nutrients present in the gut and finally leading to improvement in feed conversion ratio of the rations. Our findings are also in agreement with that of Jegede *et al*. (2006) and Rajput *et al*. (2013), whom stated that all natural feed additives used in his experiment significantly improved feed conversion ratio as compared to control. These findings reaffirmed the previous reports of Jacela *et al*. (2010) and ToshiWati *et al*. (2015) that phytogenic feed additives improve feed intake of birds.

Cost-benefit analysis

The cost effectiveness of feeding *Jatropha tanjorensis* leaf extracts to starter broilers is presented in Table 2

Table 2: Economic efficiency of feeding aqueous *Jatropha tanjorensis* leaf extracts to starter broilers

Parameters	T_1	T_2	T_3	T_4	T_5
Cost of bird procurement (₦)	160.00	160.00	160.00	160.00	160.00
Cost of feed/kg (₦)	112.00	122.00	112.00	112.00	112.00
Total feed consumed/bird (g)	1824.40	1814.26	1851.18	1857.62	1884.94
Medication and miscellaneous (₦)	34.10	34.10	34.10	34.10	34.10
Final weight gain (g)/bird	1011.67[b]	1051.53[b]	1111.40[b]	1102[a]	1277.07[a]
Cost of feed consumed/bird (₦)	204.33	203.20	207.34	208.05	211.11
Feed cost /kg weight gain/bird(₦)	201.98	193.24	186.56	188.79	165.31
Total cost of production (₦)	398.43	397.30	401,44	402.15	405.21
Cost of meat/kg (₦)	900.00	900.00	900.00	900.00	900.00
Revenue generated /bird (₦)	910.50	946.38	1000.26	991.80	1149.36
Net return/bird (₦)	512.07	549.08	589.82	589.65	744.15
Cost benefit ratio	0.78	0.72	0.67	0.68	0.65

The results of economics of production evaluation of feeding *Jatropha tanjorensis* leaf extract is presented in Table 2. Results revealed that feeding 20ml, 30ml and 40ml of *Jatropha tanjorensis* leaf extract reduced the cost of feed/kg weight gain, increased the revenue generated and the net return from the treated birds. However, birds in T_5 (40ml) recorded the least cost of feed/kg weight gain, highest revenue generated and the best net return. Results showed that *Jatropha tanjorensis* leaf extract treated groups were more profitable than control group. Increase in the profit margin of the birds fed rations containing herbal growth promoters may be attributed to the better efficiency of feed utilization, which resulted in more growth and better feed to gain ratio, ultimately leading to higher profit margin in the broilers reared on *Jatropha tanjorensis* leaf extract. Our findings are in line with that of Jahan *et al*. (2008), Narahari (1995) and Prajapati (1997) who reported extra profit/bird by using medicinal plants as growth promoters in broiler chicken production.

Conclusion

From the findings of the present study it can be concluded that starter broilers fed *Jatropha tanjorensis* leaf extract at 20ml, 30ml, and 40ml per litre of drinking water caused significant improvement in weight gain, feed and protein efficiency as compared to that of control group of broilers. Thus *Jatropha tanjorensis* leaf extract may be useful for the safe, economical and efficient production of broiler and could be used as an alternative to commercial growth promoters.

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EFFECTS OF PARTIAL REPLACEMENT OF SOYABEAN MEAL WITH CASHEW NUT MEAL ON HAEMATOLOGICAL PARAMETERS OF WEANER RABBITS

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Abstract

Effects of partial replacement of soyabean meal with cashew nut meal on haematological indices of weaner rabbits was investigated using 30 cross bred weaner rabbits with average initial weight of 150-200 g . The rabbits were allocated to 5 dietary treatments. Treatment was replicated thrice using two rabbits per replicate in a completely randomized design experiment. Five diet were formulated which contained 0% (control), 5, 10, 15 and 20% of cashew nut meal. The experiment lasted for four (4) weeks. The result showed that the partial replacement of soyabean meal with cashew nut meal resulted in a significant ($P<0.05$) difference in all the haematological parameters measured across the dietary treatments. Rabbits on T3 recorded the highest value of Pack Cell Volume (42%) while the lowest value for PVC was noticed for rabbits on T5 (25.50). Rabbits on T1 recorded the highest value of WBC (5.10%) while the lowest WBC (4.85%) was obtained for rabbits on T4. It can be concluded that the inclusion of cashew nut meal in rabbits was found to be effective without adverse effect on haematological indices of weaner rabbits.

Keywords: **haematology, cashew nut meal, weaner rabbit, White Blood Cell, Red Blood Cell.**

Introduction

Animal protein is one of the most important components of human diet and its consumption varies from country to country (Okai *et al.*, 2005). It has become imperative to turn attention to the exploitation of other legumes, particularly those indigenous to the tropics that are non-conventional, relatively cheap and available when compared with conventional feed stuff like groundnut cake, Soyabean which are the main plant protein source for monogastric and are very expensive due to competition between man and livestock (Tuleun and Patrick, 2007). However, there is the need to urgently incorporate non-conventional feed stuff in rabbit diet for optimum performance and reduction in cost of production to make rabbit consumption viable and solve the problem of scarce and expensive conventional feed stuff. According to Fetuga *et al*. (1974) only about 60-65% of the total cashew production in Africa is utilized while the rest are discarded Assay of livestock suggest the physiological disposition of animals to their nutrition. Haematological constituent reflect the physiological response of animal to its internal and external environment which include feed and feeding (Esonu *et al.,* 2001).

Materials and Methods

Experimental Site and test Ingredient

The experiment was carried out in the Rabbitary Unit of Teaching and Research Farm of Oyo State College of Agriculture And Technology, Igboora .

Collection of sample: Cashew nut was procured from the cashew nut processing company limited Ilorin, Kwara State and sundried for one week.

Experimental Animal, Management and Design: A total of thirty (30) weaner rabbits were allocated to five dietary group of six (6) animals in a completely Randomized design (CRD), each group was divided into three replicate of two rabbits each. The diets were formulated such that diet 1 had 0% CNM, diet 2 had 5% CNM, diet 3 had 10% CNM, diet 4 had 15% CNM and diet 5 with 20% CNM.

Table 1: Gross composition of experimental animal diets (CNM)

		Replacement	Levels		
Percentage	0%	5%	10%	15%	20%
	T1	T2	T3	T4	T5
Ingredients					
Maize	44.0	43.07	42.1	41.16	40.23
Soybean meal	19.25	18.29	17.32	16.36	15.40
Wheat offal	1.51	1.51	1.51	1.51	1.51
CNM	0.00	1.89	3.83	5.73	7.64
Rice bran	24.59	24.59	24.59	24.59	24.59
PKC	6.5	6.5	6.5	6.5	6.5
Bone meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.65	1.65	1.65	1.65	1.65
Salt	0.25	0.25	0.25	0.25	0.25
Grower premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Determined analysis					
Crude protein (%)	15.51	15.42	15.34	15.25	15.17
Crude fibre (%)	12.03	12.04	12.05	12.053	12.06
Ether extract (%)	5.67	5.67	5.67	5.67	5.67
Calcium (%)	0.100	0.102	0.093	0.093	0.098
Phosphorus (%)	0.300	0.318	0.341	0.370	0.394
Ash (%)	4.37	4.35	4.34	4.32	4.29
Energy (MEkal/kg)	2524.67	2533.85	2544.00	2554.05	2564.08

Key: CNM- Cashew nut meal, PKC-Palm kernel cake

Blood collection

At the end of the 4th week, two rabbits per treatment were randomly selected for haematological indices. Blood samples (3ml) were collected using sterilized needle and syringe through the heart (left side) of the

animal into sample bottles containing Ethylene Diamine Tetra Acetic Acid (EDTA) for haematological and are transported to laboratory.

Statistical analysis

Data collected were subjected to Analysis of Variance (ANOVA) using SAS (1999) version means were separated by Duncan's Multiple Range Test.

Results and Discussion

Table 2 showed the haematological indices of weaner rabbits fed cashew nut meal as a partial replacement for soybean meal. There were significant (P<0.05) difference in the haematological parameters measured across the dietary treatments. The highest PVC (42.0%) and RBC (7.2%) were obtained for rabbits on T3 while rabbits on T5 recorded the lowest value (25.50% and 4.25%) for PVC and RBC respectively.

The neutrophil and lymphocytes values obtained were significantly (P<0.05) difference across treatment means, the value obtained were within the normal range for rabbits (35.02-43.2) and (53.5-65.8). (Mitruka and Rawnsley, 1997). The higher values of haematological indices observed in this study is an indication that the animals did not pose to any disease condition and this also tends to indicates a better utilization of cashew nut meal by the rabbits.

Table 2: Haematological parameters of weaner rabbits fed cashew nut meal

Parameters	T1	T2	T3	T4	T5	SEM
PVC(%)	33.00^{b}	27.00^{d}	42.00^{a}	31.00^{bc}	25.50^{e}	2.60
HB (g/dl)	11.70^{b}	8.60^{e}	14.90^{a}	10.50^{bc}	9.20^{d}	0.10
RBC(10^{6}u/l)	5.22^{b}	4.31^{cd}	7.29^{a}	4.67^{c}	4.25^{e}	0.50
WBC (10^{3}u/l)	5.10^{a}	2.50^{cd}	4.98^{ab}	1.60^{e}	2.85^{c}	0.62
Lymp (%)	66.00^{a}	55.00^{e}	62.50^{c}	64.00^{b}	59.00^{cd}	1.74
Neutrol (%)	39.00^{b}	41.50^{a}	33.00^{de}	34.00^{d}	37.00^{c}	1.40
Mono (%)	1.00^{b}	3.00^{a}	1.00^{b}	3.00^{a}	3.00^{a}	0.44
EOS(%)	4.00^{a}	2.00^{c}	3.00^{b}	1.00^{d}	1.00^{d}	0.52
Platelet *(10^{3}/ul)*	103.00^{b}	69.50^{cd}	121.50^{a}	63.50^{e}	71.00^{c}	10.10

abcde: means on the same row but with different superscript as significantly difference(P< 0.05)

WBC = White blood cell, RBC = Red blood cell, PVC = Pack cell volume, HB = Haemoglobin, EOS = Eosinophils, Mono = Monocytes, Lymp = Lymphocytes, Neutro= Neutrophil

Conclusion

It could be concluded that cashew nut meal can replace soyabean meal up to 20% replacement level without any adverse effect on the haematological indices of weaner rabbits

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GROWTH PERFORMANCE AND HAEMATOLOGICAL INDICES OF BROILER FINISHER BIRDS FED DIETS CONTAINING *Saccharomyces cerevisiae*

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ABSTRACT

A study was conducted to evaluate the growth performance and haematological indices of broiler finisher fed varying levels of *Saccharomyces cerevisiae*. One hundred and twenty (120) four weeks old broiler birds were used for the experiment, The one hundred and twenty (120) birds were weighed and randomly allocated into four (4) treatment groups (T1, T2, T3 and T4) having thirty (30) birds per treatment. Each treatment was replicated three (3) times with ten (10) birds per replicate. Treatment 1 served as the control and did not contain any *Saccharomyces cerevisiae* supplement, while treatments 2, 3 and 4 contained 0.7, 1.2 and 1.7 g/kg of basal diet respectively of *Saccharomyces cerevisiae* supplement. The experiment lasted for four weeks. Results showed that there were no significant ($p>0.05$) differences among treatments in initial body weight and average daily feed intake while significant ($p<0.05$) differences among treatments existed in the final body weight, average daily weight gain, and feed conversion ratio. The study also revealed that there were no significant ($p>0.05$) differences among treatments in haemaglobin concentration, packed cell volume, white blood cell count, red blood cell count, mean corpuscular volume, mean corpuscular haemaglobin, and mean corpuscular haemaglobin concentration. Based on the results obtained in this study, it was concluded that any of the treatment groups T2, T3 and T4 is recommended to enhance broiler production.

Keywords: *Saccharomyces cerevisiae*, growth performance, haematological indices, broilers.

Introduction

There is a public and scientific concern about the widespread use of antibiotics and the possibility for transfer of antibiotic resistance to human pathogenic bacteria (Parvez *et al*., 2006). In addition, the presence of antibiotic residues in the meat may have deleterious effect on human consumers. For these reasons the European Union banned the use of antibiotics for non-therapeutic purposes in January 01, 2006. It is therefore imperative to find safe alternatives to the use of antibiotics. Hence, non-antibiotic alternatives like probiotics are being used in poultry feed to improve growth and production performance. *Saccharomyces cerevisiae* , one of the most widely commercialized types of yeast, has long been fed to poultry. It has been reported (Hana *et al*., 2015) that feeding yeast to chicks improves body weight gain and feed/gain ratio. *Saccharomyces cerevisiae* is a rich source of protein, vitamin B complex and trace minerals.

Lutful Kabir (2009) stated that the yeast acts by (i) maintaining normal intestinal microflora by competitive exclusion and antagonism (ii) altering metabolism by increasing digestive enzyme activity and decreasing bacterial enzyme activity and ammonia production (iii) improving digestion, and (iv) stimulating the immune system. The study was designed to evaluate the effect of dietary inclusion of *Saccharomyces cerevisiae* on growth performance and haematological indices of broiler birds.

Materials and Methods

The study was carried out at the poultry unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. The study lasted for four weeks. One hundred and twenty 4 weeks old commercial broilers were used for the study. The birds were weighed and randomly allocated into four (4) treatment groups having thirty (30) birds per treatment in a completely randomized design. Each treatment was replicated three (3) times with ten (10) birds per replicate. Treatment 1 served as the control and did not contain any *Saccharomyces cerevisiae*, while treatments 2, 3, and 4, contained 0.7, 1.2, and 1.7 g/kg of basal diet. Commercial broiler finisher diet was used. Clean water and feed were provided *ad libitum*. The required drugs and vaccinations were administered appropriately according to the vaccination routine for broilers. The experimental diets were assayed for proximate composition (Table 1) by the method of the Association of Official Analytical Chemist (AOAC, 1990).

The birds were weighed at the beginning of the experiment to determine their initial body weights. Body weights of the birds were taken on a weekly basis. Daily feed intake was obtained from the difference between the quantity of feed offered and that of the left over from the previous day divided by the number of birds per replicate. Feed conversion ratio (FCR) was then calculated as quantity (gram) of feed consumed per unit (gram) weight gained over the same period.

At the end of the experiment, six birds were randomly selected from each treatment. Five mls of blood was collected from the wing vein of each bird using a sterilized syringe and emptied into sterilized sample bottles containing the anti-coagulant Ethylene Diamine tetra acetic acid (EDTA) for laboratory analysis to determine hematological indices. The packed cell volume (PCV) was determined by the microhematocrit method (Thrall and Weiser, 2002). The haemoglobin concentration (HbC) was determined by the cyanomethaemoglobin method (Higgins *et al*., 2008). The red blood cell (RBC) and the total white blood cell (WBC) counts were determined by the haemocytometer method (Thrall and Weiser, 2002). The mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) were calculated using the standard formula (Schalm *et al*., 1975).

Data collected were subjected to analysis of variance in a completely randomized design as described by Steel and Torrie (1980). Significant differences between treatment means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

Table 1: Proximate Composition of the broiler finisher diet

Components (%)	
Dry matter	91.05
Crude protein	20.05
Crude fibre	5.52
Ash	6.13
Ether extract	2.95
Nitrogen-free extract	56.40

Results and Discussion

The effects of different levels of dietary inclusion of probiotics (*Saccharomyces cerevisiae)* on growth performance of broiler finisher are shown in Table 2. Significant ($p<0.05$) differences existed in the final body

weight, average daily weight gain, and FCR while there were no significant (p>0.05) differences among the treatments in initial body weight, and average daily feed intake.

The final body weight values for T2 (0.7g/kg), T3 (1.2g/kg) and T4 (1.7g/kg) (3.0, 2.97 and 3.05 kg), respectively were similar but these were significantly (p<0.05) higher than that (2.56kg) of T1 (control). The average daily weight gain values for T2, T3 and T4 (76.31, 73.10 and 77.50 g), respectively were similar but these were significantly (p<0.05) higher than that (59.76g) of T1. The FCR values for T2, T3 and T4 (2.15, 2.17 and 2.18), respectively were similar but these were significantly (p<0.05) lower than that (2.84) of T1.

Table 2: Growth performance of broiler finisher fed varying dietary levels of *Saccharomyces cerevisiae*

PARAMETERS	T1 (control)	T2 (0.7g/kg)	T3 (1.2g/kg)	T4 (1.7g/kg)	Probability
Initial body weight(kg)	0.89	0.88	0.92	0.88	0.45
Final body weight (kg)	2.56[b]	3.0[a]	2.97[a]	3.05[a]	0.04
Average. daily weight gain (g)	59.76[b]	76.31[a]	73.10[a]	77.50[a]	0.05
Average. daily feed intake (g)	167	164	159	167	0.23
Feed conversion ratio	2.84[a]	2.15[b]	2.17[b]	2.18[b]	0.03

[ab]Means on the same row with different superscript are significantly different (p<0.05).

The result of the present study agrees with Shanmuga and Saravana (2013) who reported that yeast culture supplementation in the diets of broilers improved body weight gain. However, the result obtained in this study is in contrast with Adebiyi *et al*. (2012) who reported that yeast inclusion in broiler diet did not affect body weight gain. Significant higher body weight gain in the yeast supplemented groups observed in this study might be due to beneficial effects of probiotic in the gut, which might have increased the activities of digestive system, resulting in improved digestibility and feed utilization.

The better FCR observed in the current study agrees with Hana *et al.* (2015), who reported that FCR was better in broilers fed diet supplemented with yeast compared to control. The better FCR observed in yeast supplemented group in this study might be due the vital role of yeast in the establishment of favourable microbial environment in the gut which had resulted in better utilization of feed and better absorption of nutrients.

The effects of different levels of dietary inclusion of probiotics (*Saccharomyces cerevisiae)* on haematological indices of broiler finisher are shown in Table 3. There were no significant (p>0.05) differences among the treatments in MCH, MCHC, MCV, PCV, RBC, HbC and WBC counts. The result of the present study agrees with Al- mansour *et al.* (2011) who reported no significant (p>0.05) effect in Hb, RBC count, MCV and MCH when broilers were fed diets supplemented with yeast culture as compared to control. However, the result obtained in this study is in contrast with Onifade (1997) who reported that yeast inclusion in the broiler diet affected RBC and PCV.

Table 3: Haematological indices of broiler finisher birds fed varying dietary levels of *Saccharomyces cerevisiae*

PARAMETERS	T1 (control)	T2 (0.7g/kg)	T3 (1.2g/kg)	T4 (1.7g/kg)	Probability
Hb (g/dl)	11.02	11.72	11.57	10.75	0.81^{NS}
MCHC(g/dl)	33.23	33.13	33.21	33.25	0.57^{NS}
MCH(pg)	9.55	9.55	9.86	10.04	0.95^{NS}
MCV(fl)	2.87	2.88	2.97	3.02	0.95^{NS}
PCV (%)	33.17	35.17	34.83	32.33	0.82^{NS}
RBC Count(10^6/µl)	1.16	1.22	1.19	1.07	0.35^{NS}
Total WBC count(10^3/µl)	9.15	9.82	8.42	8.30	0.75^{NS}

Conclusion and Recommendations

It was concluded that any of the treatment groups T2 (0.7g/kg), T3 (1.2g/kg) and T4 (1.7g/kg) is recommended to enhance broiler production.

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A SMALLHOLDER POULTRY FEED APP FOR SUPPLEMENTARY FEEDING: THE DEVELOPMENT, APPLICATION AND UTILIZATION

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ABSTRACT
The African Chicken Genetic Gain-Nigeria (ACGG-NG) project decided to develop a feed App because the available (foreign) feed Apps were either too complex for smallholders to operate or the feed library could not be edited. Locally available feed resources in the project states were compiled into a feed library by the ACGG-NG Feed Task Group. The ACGG-NG App formulates rations for growers and layers using 50% of their full-feed crude protein requirements. Calculations are done by Pearson Square, enhanced by machine learning. The web version of the App is available at http://acggng.com.ng/, while the Windows, iOS and Android versions are available at the respective App stores. The App is interactive and offers to formulate lower target quantity when the available quantity of an ingredient is not sufficient. A 10-weeks feeding trial was conducted involving 24 households in Ifetedo and Oloki-Ede villages in Osun State where scavenging birds receiving App-formulated supplementation (SAS) were compared with those on farmer supplementation (SFS) or without supplementation (SNS). The control were birds in confinement fed proprietary diets (CPD). Growers on SAS had average daily gain that were 49, 121 and 510 per cent compared to those on CPD, SFS and SNS.

Key words: smallholder-poultry, feed-App, scavenging-supplement

Introduction
Smallholder poultry has been described as a flock of less than 100 birds, of unimproved or improved breed, raised in either extensive or intensive systems (Sonaiya, 1990). They make important contributions to the livelihoods of the rural poor (Sonaiya and Swan, 2004; Kryger *et al*., 2010). In the extensive system, poultry can quickly develop vitamin deficiencies and most of the materials available for scavenging contain high levels of crude fibre (Sonaiya 1995), thus necessitating the need for supplementation. Obi and Sonaiya (1995) reported average grain supplementation to be 35g per bird per day. During the field testing of six improved tropically adapted breeds (iTAB) among 2100 farmers in five states (Kwara , Rivers , Imo, Nassarawa and Kebbi States), ACGG-NG decided to develop a feed App for formulating supplementary feed for scavenging birds because the available poultry feed formulation softwares were unsuitable (Afolayan and Afolayan, 2003). Usually they had a feed library which could not be updated with locally available feed resources (LAFR). This paper reports the development of the ACGG-NG smallholder poultry feed App for supplementary feeding and the test with small holder poultry farmers.

Materials and Methods
The local available feed resources library: The LAFR library was to be prepared in two concurrent stages: the collection of samples from various agro-ecological zones for analyses and categorization and a desk review of LAFR in the literature. Due to the severe variation between the five states in collection, curating and handling of the samples, the LAFR library was developed largely from the literature with cross referencing and standardization of the names of individual ingredients from collections from the five project states. Out of a total of 153 ingredients initially collated, the factors of relevance and availability were used to select the final 96 (Energy Sources - 43, Plant Protein Sources -19, Animal Protein Sources 9, High Fibre/Industrial By-Products Sources - 19 and Minerals Sources - 6) (Table 1).
The App: The web version was developed using Hypertext Preprocessor (PHP) scripting language while the mobile versions were developed using the Ionic Framework, a cross-platform App development environment which allows an App to be deployed across multiple platforms (android, iOS and Windows). Pearson Square

method was selected instead of linear programming because it does not require the user to specify the prices of the ingredients. Machine learning was incorporated into the framework and operation of the App so that it can run iterations and make intelligent decisions during the feed formulation process. The App formulates diets to meet 50% of the CP requirements of growers (8%) and layers (8.5%). It optimizes using ingredients with lower CP than those with higher CP. To run the App: i) at least, one specified ingredient must have CP lower and another ingredient greater than 8% (or 8.5%); ii) if all the energy sources have CP greater than 8%, a ration cannot be formulated.

How the Smallholder Poultry Feed App works: Figure 1 is a schematic diagram showing how the App works. The operation of the App is broadly divided into 2: the User input and the App operation. The user provides inputs to the App at 2 main points: 1) specifying the ingredients available, their respective quantities, the target quantity to be formulated and the class of bird; and 2) instructing the App on whether or not to perform certain operations, particularly in Step 5 below. The App operates as described below and in Figure 1:

Check for the CP of the specified ingredients from the LAFR Library and group the specified ingredients based on their CP contents.

Check to ensure that at least one of the specified ingredients belong to each of the nutrient groups for energy and protein.

Return an error message if there is not at least one ingredient in energy or protein group.

Proceed to the next step if both groups have at least 1 ingredient.

Run Pearson Square

Check if the quantities available for all the ingredients would be sufficient for what is required for the formulation

If all ingredients are available in sufficient quantities, stop the process, calculate the nutrient content of the formulation and show the result.

If the quantity of at least 1 ingredient is not sufficient, reallocate proportions to the groups.

Iterate Steps 3 – 4 for all possible proportions

If at least 1 ingredient is not sufficient for any iteration, offer to reduce the target quantity to a value for which all available ingredients are sufficient

If the user accepts the offer, make a formulation for the nearest whole target quantity for which all available ingredients are in sufficient quantities and show the result.

If the user rejects the offer, show the result based on the user-specified target quantity and indicate the additional quantity(ies) of the insufficient ingredient(s) that should be added to the formulation.

Field Application: A field test of the App was conducted in a study that included 24 households raising smallholder chickens in Ifetedo and Oloki-Ede, both in Osun State. Four types of feeding regimes were offered to growers of an iTAB: i) confined to proprietary diet (CPD); ii) scavenging with farmer's supplementation (SFS); iii) scavenging with App-formulated supplementation (SAS); and iv) scavenging without supplementation (SNS). The performance of the birds was monitored over a period of 10 weeks.

Results and Discussion

The Smallholder Poultry Feed App is available free of charge as a web App and as a mobile App. The web App is accessible at www.acggng.com.ng while the android, iOS and Windows versions are available at their respective App store. Since free ranging birds obtain 10.5 to 14.2% CP from scavenging (Rashid *et al*., 2005; Mwalusanya *et al*., 2010), supplementary feed containing 8% CP can ensure the protein requirement of the birds is met. The App presents the calculated nutritional content (ME, CP, phosphorus and calcium) of the formulation and alerts the user if there are calcium and phosphorus deficiencies in layer diets. From the field test, growers on SAS had average daily gain that were 49, 121 and 510 per cent compared to those on CPD, SFS and SNS (Table 2).

Table 2. Six to sixteen weeks performance of grower birds on the field test in villages of the App formulated supplementary feed

Treatment	Initial body weight (g)	Average daily gain (g)	Average daily feed intake (g)	Feed conversion ratio
CPD	421	29.7	106	4.06
SAS	374	14.6	88	7.04
SFS	392	12.1	84	8.46
SNS	399	2.9	-	-

Conclusion and recommendations

The Smallholder Poultry Feed App helps rural poultry farmers to utilise LAFR around them. In order to maximise the potentials of the App, volumetric equivalents of the standard weights of ingredients should be determined using the common measures used in the local markets. This will facilitate the use of these measures in place of weights.

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EFFECT OF REPLACING MAIZE WITH GRADED LEVELS OF SWEET POTATO VINE – CASSAVA COMPOSITE MEAL (SPV-CCM) ON PERFORMANCE AND ECONOMICS OF PRODUCTION OF WEANED RABBITS

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Abstract

The study was carried out to determine the effect of replacing maize with graded levels of sweet potato vine – cassava composite meal (SPV-CCM) on performance and economics of production of weaned rabbits. Five (5) treatment diets were formulated to contain SPV-CCM inclusion levels of 0% (control), 25%, 50%, 75% and 100%. Thirty (30) weaned rabbits of mixed breeds and sexes were used for the experiment. They were randomly allocated to five dietary treatments with one rabbit as a replicate in a Completely Randomized Design (CRD). Feed and water were provided *ad libitum*. The result showed that there was no significant difference (P>0.05) effect on final weight, total weight gain, daily weight gain and feed conversion ratio across the dietary treatments. A high cost of feeding, cost per kilogram diet and production was recorded in Treatment one and low cost of feeding, cost per kilogram diet and production in Treatment five. The result showed that maize could be replaced by SPV-CCM up to 100% without any adverse effect on performance of weaned rabbit. However, the optimum performance was observed when 75% SPV-CCM replaced maize in the diet. Replacement of maize with SPV-CCM has relative cost advantage over the control diet and so should be incorporated in the diet of rabbit up to the level considered in this study.

Keywords: Rabbit, Sweet potato vine, Cassava, Unconventional, Performance

Introduction

Rabbits have been recognized to play very important role in the supply of animal protein to Nigerians especially in the rural and peri-urban areas. They are good converters of feed to meat and can utilize up to 30% crude fibre as against 10% by most poultry species (Egbo *et al.,* 2001). The major hindrance to animal production in developing countries such as Nigeria is high cost of feedstuffs. Feeds account for about 70-80% of the cost of animal production (Akinmutimi, 2001; Shaahu *et al.,* 2017). This has been attributed to escalating prices of conventional feed ingredients especially the energy sources such as maize, sorghum etc. (Akinmutimi, 2006), which also serve the role of human food staple (Shaahu *et al.,* 2008). Maize grain has remained the major source of energy in rabbit feeds in Nigeria (Mohammed *et al.,* 2008), maize usually accounts for over 40% of the total diets of rabbits and is expensive (Adegbola and Okonkwo, 2002). There is therefore an urgent need to develop alternatives to these conventional livestock feed resources, so that the production and consumption of animal products may continue in the desirable path of rapid growth (Shaahu *et al.,* 2017). Nutritious animal feed is essential for full development and productivity of animals. Since farmers go into animal production for profit, they need to obtain feed at low prices in order to make reasonable profit.The study was therefore aimed at evaluating the performance and economics of production of rabbit cassava roots and sweet potato vines as partial replacement for maize.

Materials and Methods

The study was conducted at the Rabbit Unit of Livestock Teaching and Research Farm, University of Agriculture, Makurdi, Benue State. Thirty weaned rabbits (between six to eight weeks of age) of both sexes,

mixed breed were obtained from a Farm within Makurdi metropolis and used for the study. The rabbits were balanced for weight, and weighed between 225-500 g. The 30 rabbits were randomly allocated to five dietary treatments with each treatment having six rabbits with one rabbit as a replicate in a Completely Randomized Design. Each treatment had three males and three female rabbits. The feeding trial lasted for 84 days and the rabbits were housed individually in cages. . During the feeding trial, the rabbits were fed once a day with experimental diets but fresh water was served *ad-libitum.* Cassava tubers were harvested and washed to remove sand and to reduce silicate. The unpeeled cassava tubers were chipped and sundried to reduce hydrogen cyanide level in the tuber. The sweet potato vine was air dried in a shade to maintain its nutritive content. Sundried chipped cassava root meal were crushed separately, the sundried chipped cassava root meal and sweet potato vine were mixed in a ratio of 2.65:1 and 1% palm oil was added to reduce dustiness and also boost the energy level. The mixture of crushed cassava root meal and sweet potato vines formed sweet potato vine-cassava composite meal (SPV-CCM). Five experimental diets were formulated with treatment one (T_1) being the control diet with maize as the major energy source. T_2, T_3, T_4 and T_5 diet had maize replaced with composite cassava meal at graded levels of 25%, 50% 75% and 100% respectively.

Table 1: The Composition of the Diets and their Proximate Compositions (%)

Ingredients	T_1 (0% SPV-CCM)	T_2 (25% SPV-CCM)	T_3 (50% SPV-CCM)	T_4 (75% SPV-CCM)	T_5 (100% SPV-CCM)
Maize	38.66	28.04	18.69	9.34	-
SPV-CCM	-	9.34	18.69	28.04	37.38
FFSB	32.59	32.87	32.87	32.87	32.87
B/Ash	3.00	3.00	3.00	3.00	3.00
Palm Oil	-	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50
V/Premix	0.25	0.25	0.25	0.25	0.25
Rice Offal	25.00	25.00	25.00	25.00	25.00
Total	100.00	100.00	100.00	100.00	100.00
	Calculated	**Proximate**	**Composition**		
CP	16.81	17.41	18.25	18.84	19.65
CF	11.07	12.59	13.60	14.61	15.61
EE	8.27	8.55	8.84	5.83	6.13
Ash	11.93	11.57	11.38	11.20	5.27
Moisture	5.58	6.14	5.56	5.95	6.12
ME (kcal/kg)	2402.28	2325.95	2284.26	2242.57	2200.93

ME = Metabolizable energy, SPV-CCM= Sweet Potato Vine-Cassava Composite Meal, CP=Crude Protein, EE=Ether Extract, CF=Crude Fibre, BDG=Brewer Dried Grain, FFSB=Full Fat Soya Bean

Results and Discussion

The results of the performance of weaned rabbits to the experimental diets are presented in Table 2 while the economics of production of rabbits fed the experimental diets are presented in Table 3

Table 2: **Effect of Replacing Maize with Graded Levels of Sweet Potato Vine-Cassava Composite Meal on Performance of Weaned Rabbits**

Parameters	T_1 (O% SPV-CCM)	T_2 (25% SPV-CCM)	T_3 (50% SPV-CCM)	T_4 (75% SPV-CCM)	T_5 (100% SPV-CCM)	SEM	P-value
Initial weight (g)	559.33	452.50	443.00	434.17	457.33	18.47	0.99
Final weight(g)	1319.0	1388.20	1263.0	1521.70	1276.20	52.21	0.49
Total weight gain (g)	759.67	935.70	820.00	1087.50	818.87	49.52	0.15
Daily weight gain (g)	9.04	11.14	9.76	12.94	9.75	0.59	0.17
Daily feed intake(g)	66.28	71.32	77.90	83.24	74.99	2.22	0.12
Feed conversion ratio	7.33	6.40	7.98	6.43	7.69	0.36	0.15

SEM= standard error of the mean. SPV-CCM= Sweet Potato Vine-Cassava Composite Meal

The result showed that there was no significant difference (P>0.05) effect on final weight, total weight gain, daily weight gain and feed conversion ratio across the dietary treatments. The final weight gain which range from (1276.20 – 1521.70g) was superior to that (1220.60 – 1288.60g) of Olabanji *et al.* (2007) who fed weaned rabbits with different levels of wild sunflower leaf blood meal mixture and lower compared to (1544.83-2088.83g) of Tiough *et al.* (2016) who fed rabbit with diet containing cassava root-forage composite meals.

Daily feed intake did not differ among the treatments, however T_2, T_3 T_5 and T_4 had the highest daily feed intake (83.24) and T_1 had lowest intake of (66.28), this may be as a result of palatability of the experimental diet at 75 percent inclusion. The daily feed intake range from 66.28-83.24 was higher than that of 48.24-74.36 reported by Shaahu *et al.* (2017). This may be as a result of the palatability of the experimental diet.The daily weight gain of the rabbit had no significant difference among the dietary treatments (P>0.05). Rabbit fed diet T_4 had the highest daily weight gain, the daily weight gain which ranged from 9.04 – 12.94 was higher than that of 4.95-5.23 reported by Uchegbe and Iyeghe-Erakpotobor (2015) who fed rabbit with sweet potato vine-based diet supplemented with methionine and lysine. This may be as a result of high consumption and conversion of the experimental diet (SPV-CCM) than when sweet potato vines were supplemented with methionine and lysine. The daily weight was also higher than 2.31-9.72 reported by Shaahu *et al*. (2014). Feed conversion ratio across the dietary treatments had no significant difference (P>0.05) among the treatments. The feed conversion ratio range of (6.40-7.90) was poorer than that of (2.67-8.73) reported by Shaahu *et al*. (2014). The significantly better feed conversion ratio for the rabbits may be attributed to lower feed intake and higher weight gain of the rabbits.

Table 3: Effect of Replacing Maize with Graded Levels of Sweet Potato Vine-Cassava Composite Meal on Rabbit Economics of Production

Parameters	**T_1 (0% SPV-CCM)**	**T_2 (25% SPV-CCM)**	**T_3 (50% SPV-CCM)**	**T_4 (75% SPV-CCM)**	**T_5 (100% SPV-CCM)**

Cost of feeding (₦)	595.84	590.58	590.03	571.61	462.04
Total feed intake(g)	4454	5990.60	6544	6992.17	6299.40
Cost/kg diet (₦)	133.79	98.58	90.17	81.75	74.17
Total weight gain(g)	759.67	935.70	820.00	1087.50	818.87
Cost/kg weight gain (₦)	784.34	631.16	719.55	525.86	564.24
Other cost of production(₦)	300	300	300	300	300
% cost of weaner rabbit	59.20	59.35	59.36	59.86	63.04
% cost of feed	27.13	26.96	26.94	26.32	22.40
Total cost of production (₦)	2195.34	2190.58	2190.03	2171.61	2062.04
Profit (₦)	179.76	308.18	83.37	567.45	235.12

SPV-CCM= Sweet Potato Vine-Cassava Composite Meal,

A high cost of feeding was recorded in T_1 (₦595.84) and low cost of feeding in T_5 (₦462.04). High cost per Kilogram diet was observed in T_1 (₦133.79) and lowest cost per Kilogram diet in T_5 (₦74.17). The cost per kilogram weight gain do follow a definite trend as high cost was observed in T_1 (₦ 784.34) and lowest in T_4 (₦525.86). A high total cost of production was observed in T_1 (₦2195.34) and low total cost of production in T_5 (₦2062.04). It can be observed from the recorded data that as percentage inclusion of the test ingredients increased across the treatment, the cost of feeding, cost per kilogram diet and total cost of production decreased across the experimental treatment. The reduction in feed cost observed from the sweet potato vine-cassava composite diets was due to the relatively little or minimal cost incurred in obtaining the feed ingredients. This means that cheaper feeds can be produced with SPV-CCM without adverse effect on the growth performance of rabbits. This finding corroborates the report of Tiough *et al*. (2016) that the cost of cassava products is more economical and better to use. The profit observed may be due to the high total cost of production which is as a result of percentage cost of weaned rabbit, but is highest with treatment T_4 whose cost of production even though slightly higher than T_5 yields more profit and therefore more economical.

Conclusion and Recommendation

Based on the study, it was concluded that maize could be replaced by sweet potato vine-cassava composite meal up to 100% without any adverse effect on performance and with better economics of production. However, optimum performance was observed when 75% cassava composite meal replaced maize in the diet. Replacement of maize with cassava composite meal has relative cost advantage over the control diet and so should be incorporated in the diet of rabbit as a major source of energy up to the level considered in this study.

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GROWTH PERFORMANCE AND HAEMATOLOGICAL PROFILE OF BROILER BIRDS SERVED DIETARY INCLUSION OF PROBIOTICS (*SACCHAROMYCES CEREVIASAE*) AND ENZYME (BIO-ENZYME)

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Abstracts
This study was conducted to evaluate the growth performance and haematological profiles of broiler birds served dietary inclusion of probiotics (*Saccharomyces cereviasae*) and enzyme (Bio-enzyme). One hundred and twenty day-old broiler chicks of Agrited strain were used for the study. The birds were randomly allotted to four dietary treatments. Each treatment contained 30 birds replicated three times to contain 10 birds per replicate in a completely randomized design experiment. The four dietary treatments wereT1 Control (no probiotics and enzyme), T2 (had both probiotics and enzyme), T3 (probiotics only) and T4 (Enzyme only). The birds were given fed and water *ad-libitum* and the quantity of feed consumed each day was determine through weigh back techniques. The birds were weighed weekly throughout the experimental period and the experiment lasted for eight weeks. At the end of the experimental period, two birds were randomly chosen from each replicate for haematological profiling. Blood samples were collected into EDTA containers with the aid of sterile syringes and needles and taken to the laboratory for analysis. The results showed significant ($p<0.05$) differences in the final body weight, total weight gain, average daily weight gain, total feed intake, average daily feed intake and feed conversion ratio. Birds on treatment 2 had the highest final body weight of 3011.57g and seemed to have performed better than other dietary treatments. Similar trend was observed in the haematological profile as treatment two were highest in value across the treatments and parameters measured except in packed cell volume where the highest value (36.33 %) was recorded in treatment 4. It was concluded from the study that treatment two which contained both probiotics and enzyme performed better and thus, recommended to farmers for broiler production.

Keywords: Broilers,growth performance, haematology, probiotics and enzyme.

Introduction

Poultry production plays an important role in animal protein supply most effectively within the shortest possible time (Hossinzadeh and Jahanian, 2010), this is because of their short generation intervals, high prolificacy and fast growth rate. According to Nworgu (2004), high cost of feed is the major problem of poultry farmers in Nigeria. Adene (2004) reported that feed accounts for 65-80 % of the total cost of production. Due to the high cost of poultry feed ingredients; farmers have alternatively chosen agro by-products of poor quality and less nutritive value in rearing their birds. Nutritive feed stuffs are either not available or not cost effective, and sometimes, the nutrients are not readily accessible to the birds.

From series of research results over the past decades, poultry nutritionists have come up with different types and levels of growth promotants aimed at improving efficiency of chicken production by increasing growth rate and feed conversion ability (Miranda *et al*., 2014). Some of these promotants of growth ever in use included hormones (natural and synthetic) that are specific receptors in their target tissues. They also included antimicrobial compounds that change the population of micro-organisms in the gastrointestinal tract of healthy animals, resulting in improved animal performance. Probiotics present a potential alternative to the prophylactic use of antibiotics in feed animals. Also known as direct-fed microbials, probiotics are classified as live nonpathogenic microorganisms that are capable of maintaining a normal gastrointestinal microbiota (Ohimain and Ofongo, 2012). Probiotic, meaning "for life" in Greek, has been defined as "a live microbial feed supplement, which beneficially affects the host animal by improving intestinal balance". Probiotics can be composed of one or many strains of microbial species, with the more common ones belonging to the genera *Lactobacillus*, *Bifidobacterium*, *Enterococcus*, *Bacillus*, and *Pediococcus* (Gaggia *et al*., 2010). Enzymes are now being routinely used in poultry feeds to improve digestibility of feed ingredients. In general, feed enzymes are available which act on carbohydrates, plant bound materials and proteins. Commercial and academic studies have shown that the judicious use of enzymes can ameliorate inconsistency in nutritional value of maize, thereby improving body weight in birds (Cowieson, 2005). Therefore, this study was aimed at

evaluating the growth performance and haematological profiles of broiler birds served dietary inclusion of probiotics (*Saccharomyces cereviasae*) and enzyme (Bio-enzyme).

Materials and Methods

Study location

The experiment was conducted at the Poultry Unit, Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. Nsukka is in Enugu State, Nigeria.

Experimental design, animals and management

The study was conducted to evaluate the growth performance and haematological profiles of broiler birds served dietary inclusion of probiotics (*Saccharomyces cereviasae*) and enzyme (Bio-enzyme). One hundred and twenty day-old broiler chicks of Agrited strain were used for the study. The birds were randomly divided into four groups and assigned to the four dietary treatments. Each treatment contained 30 birds replicated three times to contain 10 birds per replicate in a completely randomized design. The four dietary treatments were T1 Control (no probiotics and enzyme), T2 (had both probiotics and enzyme), T3 (probiotics only) and T4 (Enzyme only). The birds were given fed and water *ad-libitum* and the quantity of feed consumed each day was determined through weigh back techniques. The birds were weighed weekly throughout the experimental period and the experiment lasted for eight weeks. Vaccination and medications were provided as when due and other routine management practices were provided accordingly. At the end of the experimental period, two birds were randomly chosen from each replicate for haematological profiling. Blood samples were collected into EDTA containers with the aid of sterile syringes and needles and taken to the laboratory for analysis.

Table 1: The percentage composition of the experimental diets of the broiler chickens

Parameters	**Treatments**			
	T1 (Control)	**T2 (Probiotics and Enzyme)**	**T3 (Enzyme only)**	**T4 (Probiotics only)**
Maize	53.00	53.00	53.00	53.00
Wheat offal	10.00	10.00	10.00	11.00
Palm kernel cake	5.50	5.50	5.50	5.50
Groundnut cake	15.00	15.00	15.00	15.00
Soya bean meal	10.00	10.00	10.00	10.00
Fish meal	1.50	1.50	1.50	1.50
Bone meal	4.00	4.00	4.00	4.00
Salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Vit-Premix	0.25	0.25	0.25	0.25
Probiotics	-	0.80	-	0.80
Enzyme	-	0.02	0.02	-
Total	100.00	100.00	100.00	100.00
Calculated composition				
CP%	20.12	20.01	20.11	20.04

Energy (MJME/kg)	3.68	3.81	3.75	3.71

Proximate and Statistical analysis

Proximate analysis of feeds was done according to AOAC (1990). Data collected were subjected to analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS, 2013) version 19.00. Significant different means were separate using Duncan's new multiple range test (Duncan, 1955).

Results and Discussion

Table 2 shows the effect of probiotics and enzyme inclusion on the growth performance of broiler birds.

Table 2: Effect of probiotics and enzymeinclusion on the growth performance of broiler birds

Parameters	Treatments			
	T1 (Control)	T2 (Probiotics and Enzyme)	T3 (Enzyme only)	T4 (Probiotics only)
IBW (g)	40.62±1.24	40.17±0.17	45.33±3.03	42.02±3.33
FBW (g)	2138.87±3.17^{d}	3011.57±2.89^{a}	2923.67±3.59^{b}	2696.58±2.86^{c}
TWG (g)	2098.37±2.20^{d}	2971.41±3.02^{a}	2881.67±37.47^{b}	2654.57±25.71^{c}
ADWG (g)	38.19±0.06^{d}	53.78±0.05^{a}	52.27±0.64^{b}	48.15±0.51^{c}
TFI (g)	4598.73±82.42^{c}	4426.40±12.92^{d}	5025.65±15.09^{a}	4808.78±24.47^{b}
ADFI (g)	82.69±1.02^{c}	79.01±0.21^{d}	89.74±0.27^{a}	85.87±0.44^{b}
FCR	1.16±0.02^{a}	1.47±0.03^{d}	1.72±0.03^{c}	1.78±0.02^{b}

IBW = Initial body weight, FBW = Final body weight, TWG = Total weight gain, ADWG = Average daily weight gain, TFI = Total feed intake, ADFI = Average daily feed intake, FCR = Feed conversion ratio.

The results indicated no significant difference ($p>0.05$) in the initial body weight across the treatments and the values ranged from 40.17 to 45.33 g. However, there were significant differences in the final body weight, total weight gain, average daily weight gain, total feed intake and feed conversion ratio across the treatments. Treatment 2 had the highest final body weight value while treatment 1 (Control) had the lowest values of 3011.57g and 2138.87g, respectively. Total weight gain and average daily weight gain followed similar trend but in total feed intake and average daily feed intake, treatment 3 had the highest value whereas treatment 2 had the least values. Birds in treatment 2 were best in feed conversion ratio (1.47) and recording the highest final body weight (3011.57g). The significant ($p<0.05$) increase in final body weight recorded in treatment 2 may be attributed to the activities of the probiotics which may have elaborated the digestive enzymes such as sucrose and phytase that helped in nutrient digestion thereby promoting growth. This was supported by Cowieson *et al*. (2004) who reported that hydrolysis of phytate by phytase is essential to liberate the bound nutrients in the GIT for absorption. Selle and Ravindran (2007) in agreement with that opinion stated that adding microbial phytase to diets enhances the bird's growth performance and mineral digestibility, and reduces nutrient excretion to the environment. The beneficial effect of probiotic supplementation to broiler diet in terms of increased body weight and body weight gain is well documented in a study by Bandy and Risam (2001).

Table 3: Effect of probiotics and enzymes inclusion on the haematological profile of the broiler chickens

Parameters	T1 (Control)	T2 (Probiotics and Enzyme)	T3 (Enzyme only)	T4 (Probiotics only)
PCV (%)	29.67±0.33^{d}	32.33±0.32^{c}	34.00±0.58^{b}	36.33±0.33^{a}
Hb (g/dl)	6.90±0.06^{c}	10.70±0.12^{a}	10.07±0.03^{a}	8.70±0.06^{b}
RBC ($x10^{9}/mm^{3}$)	180.00±2.89^{c}	261.67±1.67^{a}	251.67±4.41^{a}	210.00±5.77^{b}

WBC ($x10^3mm^3$)	1840.00±13.80[c]	4800.00±0.00[a]	3513.33±15.11[b]	4783.33±16.67[a]

a,bc,d = Significant means, PCV = Packed cell volume, Hb = Haemoglobin concentration, RBC = Red blood cell, WBC = White blood cell.

The results of the effect of the inclusion of probiotics and enzymes on the haematological profile of the broiler chickens are presented in table 3. The result showed that there were significant ($p<0.05$) differences in the PCV, Hb, RBC and WBC across the treatments. Birds on treatment 4 had the highest value of PCV (36.33%), followed by bird in treatment 3, but the least value of PCV (29.67 %) was obtained from the birds in the control (T1). Treatment 2 had the highest value of haemoglobin concentration, red blood cell count and white blood cell count (20.70g/dl, $261.67x10^9/mm^3$ and $4800x10^3/mm^3$ respectively), whereas the control had the least values s (14.90g/dl, $180.00x10^9/mm^3$ and $1840x10^3/mm^3$ respectively). The percentage PCV (32.33 %) obtained in treatment 2, combination of probiotics and enzyme, was the same with the result (32.50%) recorded by Rahman *et al*. (2013) who also included probiotics and enzyme in broiler's diets. On the contrary, Rahman *et al*. (2013) recorded (8.70g/dl) in haemoglobin concentration which was significantly $p<0.05$) lower than 10.70g/dl obtained in this study, on similar bioactive ingredient treatment. Ogunwole *et al*. (2017) who fed broilers with acidified blood meal diets obtained Hb values ranging from 9.85g/dl to 10.66g/dl which are similar to some values obtained in this study. The results in RBC are also in agreement with the results of Ogunwole *et al*. (2017). There were significant differences ($p<0.05$) across the treatments in WBC.

Conclusion and Recommendation

It was concluded from the study that treatment 2 which contained both probiotics and enzyme performed better and thus, recommended to farmers for broiler production.

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GROWTH PERFORMANCE OF GROWER RABBITS FED DIETS SUPPLEMENTED WITH DRIED CITRUS (*Citrus sinensis* L.) PULP AS REPLACEMENT FOR MAIZE

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Abstract
A 56-day study was carried out to investigate the growth performance of grower rabbits fed diets containing graded levels of dried citrus pulp as replacement for maize. Seventy-two crossbred grower rabbits weighing 1400±0.11 g were randomly allocated to four experimental groups replicated thrice with 6 rabbits each. The control treatment (CTRL) was a standard rabbit ration. The other treatments contained 10, 20 and 30% ground dried citrus pulp designated as DCP10, DCP20 and DCP30 respectively as replacement for maize. Fresh forages were provided to supplement dietary fibre levels. Water and the diets were administered *ad libitum*. Feed intake and final body weight were measured on daily basis and FCR was calculated. The CTRL, 10 and 20% replacement of maize had equal final body weight (1770 g) which was significantly ($P<0.05$) heavier body weights than other treatment groups while CTRL (1770 g) had heavier ($P<0.05$) body weight than 30% replacement (1550 g). 30% replacement had the least ($P<0.05$) feed intake, final body weight but the best FCR (2.7). Replacing 20% of maize in the diet of grower rabbits with DCP is recommended since it gives higher body weight.

Keywords: rabbits, dried citrus pulp, agro-industrial byproduct, growth performance, waste-to-wealth

Introduction

Nigerians face the challenge of low animal protein intake due to high livestock production costs leading to expensive animal products that limits their accessibility. This prompts the need to increase meat production by exploiting livestock species that are yet to play a major role in animal protein supply in Nigeria (Owen *et al*., 2008). Akinmutimi and Onwukwe (2002) recommended focusing on exploring highly prolific animals with fast growth rate and short generation intervals like the rabbit. Rabbits are an ideal alternative for meat production on small scale family farms to enhance animal production trends in developing countries. Rabbit production is a veritable way of alleviating animal protein deficiency in Nigeria and it is encouraged as a means of improving the daily protein intake of individuals and income (Taiwo *et al*., 2005).

Dried citrus pulp (DCP) is by-product of citrus consumption or processing, which improves the productive performances of livestock species but which otherwise constitutes environmental nuisance (Hon *et al*., 2009). It is a sustainable feed resource readily available from roadside dealer and processing plants. Mashed or pelleted DCP is a highly desirable feedstuff, which could replace maize in rabbit ration at 20% inclusion level of inclusion or less (Arthington *et al*., 2002). Different inclusion levels of DCP improve the growth performance, meat quality and blood parameters of weaners rabbits (Jingzhi *et al*., 2017). Rabbits adapt quickly to diet containing 20% DCP (Crawshaw, 2004) and 30-40% dietary inclusion for fattening rabbits does not impair growth performance or carcass traits (Caparra *et al*., 2007). Thus, the objective of this study was to evaluate the effect of dried citrus pulp on the growth performance of grower rabbits since there is already overwhelming literature on the weaners.

Materials and methods

Experimental site

This 56-day experiment was conducted at the Rabbit Research Facility of Teaching and Research Farm, Department of Animal Science, Ebonyi State University, Abakaliki. Abakaliki is situated within 07° 30' E

and 08° 30'E latitude and 5° 40'N and 6° 45'N longitude (Nwakpu, 2008) in the derived Savannah zone of South-East agro-ecological zone of Nigeria. Annual rainfall and temperature range between 1500 to 1800 mm p.a. and 21°C to 30°C respectively (Osakwe and Ekwe, 2007).

Experimental materials

The crossbred grower rabbits of twelve weeks old were procured from the Experimental Farm of College of Medicine, University of Calabar, Calabar, Nigeria, while the citrus for the pulp was sourced from Abakpa Market in Abakaliki, Nigeria.

Experimental animal, diet, design and procedure

The leftover of juice extraction from sweet orange (*Citrus sinensis*) was chopped into pieces and sundried to reduce the moisture content, then ground into a mash with hammer mill and incorporated into the formulated diet. CTRL was basal diet with 0% DCP as control diet, the others contained CTRL supplemented with 10, 20 and 30% DCP and designated as DCP10, DCP20 and DCP30 respectively. The rabbits were reared intensively in hutches fitted with aluminum feeders and drinkers. They were acclimatized for one week before commencing the experiment. Water was served to the animals *ad libitum* as well as forages (Guinea grass and centrosema to supplement for fibre content of the diet. 18 crossbred grower rabbits of both sexes were randomly allocated to four experimental groups replicated thrice with 6 rabbits each. The feed composition and calculated nutrient composition of the dietary treatments is presented in the Table 1.

Data collection and statistical analysis

The initial weights, body weight, feed intake were obtained using a digital weighing balance while the FCR was calculated from the feed intake and body weight gain. Data collected were subjected to one-way ANOVA in Completely Randomized Design. Differences between statistical means were separated using Fisher's Least Significant Difference (F-LSD) (Steel and Torre 1980) as modified by Obi (2010).

Table 1: Feed composition and calculated chemical composition of the experimental diet (g/kg)

Ingredients	**CTRL**	**DCP10**	**DCP20**	**DCP30**
Maize	400	300	200	100
Dried citrus pulp	0	100	200	300
Soybean	50	50	50	50
Wheat offal	300	300	300	300
Palm kernel cake	230	230	230	230
Bone meal	3	3	3	3
Lysine	5	5	5	5
Methionine	5	5	5	5
Salt	3	3	3	3
Premix	4	4	4	4
Total	1000	1000	1000	1000
Calculated chemical composition				
Crude protein (%)	15.41	15.25	15.01	14.80
Crude fibre (%)	6.5	6.5	6.3	6.0
Energy (ME) (kcal/kg DM)	3200	3150	2900	2800

Results and Discussion

The result of the growth performance indices of the grower rabbits fed diets containing graded inclusion levels of dried citrus pulp is presented in Table 2.

Table 2: Growth performance indices of grower rabbits fed diets containing graded levels of dried citrus pulp

Parameters	CTRL	DCP10	DCP20	DCP30	±SEM
Initial body weight (g)	1400	1400	1400	1400	0.11^{NS}
Final body weight (g)	1700^{b}	1770^{a}	1770^{a}	1500^{c}	63

Body weight gain (g)	300[a]	310[a]	370[a]	230[b]	97
Total feed intake (g)	4950[c]	5510[b]	6330[a]	4040[d]	61
Mean daily intake (g)	88b	98b	113a	72[b]	12
FCR	2.91[c]	3.11[b]	3.58[a]	2.70[d]	0.19

a, b = Means on the same row with different superscripts are statistically significantly (P<0.05).
SEM = Standard error of the mean.

At 10 and 20% replacement of maize DCP there were no significant (P>0.05) differences in body weight. However, the body weights of the two treatments were significantly (P<0.05) heavier than that of control and those fed a diet in which 30% of maize was replaced with DCP. Total feed intake of all treatment groups differed significantly (P<0.05). Varying the inclusion levels of DCP resulted in feeds that were neither isocaloric nor isonitrogenous. Increasing levels of DCP led to decreasing energy, protein and fibre levels in the diets. Increasing the dietary inclusion of DCP from 10 to 20% replacement of maize did not significantly (P>0.05) increase the body weight though the rabbits from both treatments had consumed significantly (P<0.05) more feed than those in the control treatment, and those fed diet with 30% replacement of maize. It rather increased feed intake with a corresponding body weight gain (Arthington *et al.*, 2002) whereas 30% replacement appeared to have affected the taste of the feed thus significantly (P<0.05) reducing feed intake with a correspondingly lower (P<0.05) weight gain. FCR differed significantly (P<0.05) among treatments. Despite a more efficient feed utilization, those fed a diet with 30% replacement had significantly (P<0.05) less feed intake and body weight gain. This finding contradicts Caparra *et al.*, (2007) who reported that 30 - 40% inclusion levels did not impair growth performance. Perhaps, the astringent taste of the essential oils in DCP reduced feed intake. Essential oils contain bioactive compounds that have the potential to act as multifunctional feed supplements for animals including effects on growth performance, digestive system, pathogenic bacterial growth and lipid oxidation (Simitzis, 2017). Thus, the essential oil, which had a higher concentration per unit intake as inclusion levels increased up to 20% apparently impacted positively on the gut microflora thus improving feed efficiency. However, at 30%, it seems to impact positively on FCR despite reduced feed intake occasioned apparently by the essential oils.

Conclusion and Recommendation

All the inclusion levels tested appeared to impart some benefit on the rabbits. A diet with 10 and 20% replacement of maize with DCP gave heavier body weight with more feed intake. On the other hand, those fed diets with 30% replacement gave better feed utilization with less feed. Thus, a diet in which 20% of maize is replaced with DCP is recommended as it will ease the pressure of competition for maize. However, further study is recommended to evaluate the effect of DCP on the gut microflora of rabbits and cost benefit analysis to determine cost efficiency of 30% replacement. This will boost the economy as the dried citrus pulp in rabbit diet will improve the environment by converting citrus waste to wealth, create a citrus value chain and reduce the pressure of competition for maize.

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EFFECT OF REPLACING SOYABEAN MEAL WITH MORINGA OLEIFERA LEAF MEAL ON HAEMATOLOGICAL AND SERUM BIOCHEMISTRY OF FINISHER BROILERS

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ABSTRACT

The experiment evaluated the effects of *Moringa oleifera* leaf meal (MOLM) on the haematology and serum biochemistry of broilers. Seventy two broilers were used for the study and the birds were randomly distributed into four treatment groups and three replicates with six birds in each replicate. The moringa leaf was included to replace soyabean at 0, 15, 30 and 45% levels to form T1, T2, T3 and T4 diets respectively. Finisher diet was provided for the birds. At the end of the experiment, blood samples were collected for haematological and serum biochemical analysis. Results showed that the effect of replacing soyabean with *Moringa oleifera* leaf meal were not significant (P>0.05) on the haematological parameters. There were significant (p<0.05) differences in AST, ALT, Alb, GLB, Urea and creatinine levels. There was an increase in creatinine which indicated that the animals fed the treatment diets had problems with the quantity of protein in the test feedstuff which affected the growth performance of the birds. The results of the experiment therefore suggest that up to 3% *Moringa oleifera* should not be included in broiler diets.

Keywords; haematology, *Moringa oleifera*, replacement, serum biochemistry, soyabean

INTRODUCTION

The poultry industry in developing countries is facing serious challenges due to high cost of protein and energy feed ingredients. Poultry production is capable of bridging the gap in protein deficit among developing countries where average daily consumption is far below recommended standards (Onyimonyi *et. al.,* 2009). One possible source of cheap protein for poultry is the leaf meal of some tropical legume plants, of which *Moringa oleifera* is one. The high and essential nutrients content of Moringa leaves such as vitamin A and B, calcium, iron, copper, sulphur and protein and its ability to absorb and neutralize toxic elements in food could justify its significance as one of the major local feedstuffs for replacing soyabean meal in non ruminant diets (Nuhu, 2010). Haematological parameters have been observed as good indicators of the physiological status of animals and its changes are important in assessing the response of animal to different physiological situations (Khan and Zafar, 2005). *Moringa oleifera* leaves with high protein and nutrient content can however replace soyabean which is an expensive protein ingredient and help improve the growth and health status of broilers.

MATERIALS AND METHODS

Experimental site and duration of study

The study was carried out at the Poultry Unit of the Teaching and Research Farm of the Department of Animal Science and Technology, Faculty of Agriculture, Nnamdi Azikiwe University, Awka. The location lies between latitude 6.24^{0}N & 6.28^{0}N and longitude 7.00^{0}E and 7.08^{0}E on the south eastern part of Nigeria. The experiment lasted for 28 days.

Experimental birds and management

Seventy two broilers in their fifth week were used for the experiment. The birds were raised on floor pen with wood shavings that served as litter. They were randomly divided into four treatment groups and three replicates with six birds per replicate. Feed and water were given *ad libitum*. Vaccines against infecious

diseases were given. At the end of the experiment, blood samples were collected for haematological and serum biochemical evaluation.

Experimental diets and analysis

Harvested moringa leaves were dried under shade until they were crispy to touch, while it still retained the green colouration. The dried leaves were milled and used to form four experimental diets designated Diet 1, Diet 2, Diet 3 and Diet 4 with 0, 15, 30 and 45% replacement levels for soyabean respectively. Table 1 shows the composition of the experimental diets.

Table 1: Composition of Experimental Diet for Broiler Finisher.

Ingredients (%)	D1	D2	D3	D4
Maize	49	47	45	43
Wheat offal	9	9	9	9
Rice bran	6	6	6	6
Soyabean meal	20	17	14	11
Moringa oleifera	-	3	6	9
Fish meal	4	4	4	4
Groundnut cake	4	6	8	10
Oyster shell	3	3	3	3
Bone meal	3	3	3	3
Salt	0.5	0.5	0.5	0.5
Premix	0.5	0.5	0.5	0.5
Methionine	0.5	0.5	0.5	0.5
Lysine	0.5	0.5	0.5	0.5
Total	100	100	100	100
Calculated composition				
Crude Protein (%)	20	20	20	20
Energy (Kcal/kg)	2643.40	2444.53	2499.80	2490.50

Experimental design and Statistical analysis

Completely randomized design was used for the experiment. Data collected was subjected to Analysis of variance (ANOVA) and significant treatment means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Effect of diets containing *Moringa oleifera* on the haematological indices of broiler birds

The haematological indices of broiler chicken fed moringa leaf based diet are presented in Table 2. There were no significance differences ($p>0.05$) on the haematological indices of the broiler birds. It indicates that there was no effect of moringa leaf on the haematological indices of the broiler birds. This was partially in

line with (Hassan *et. al*. 2016), who reported that there were no significant differences (p>0.05) among treatments in RBC and Hb but there were significant differences in PCV and lymphocyte.

Table 2: Haemotological values of broiler fed diets containing Moringa leaf meal

PARAMETERS	T1	T2	T3	T4
Pcv (%)	24.67±6.03	28.33±2.08	21.67±3.21	28.33±3.06
Haemoglobin (g/dl)	8.20±2.01	9.43±0.67	8.53±3.11	9.40±1.75
Rbc ($x10^6$/l)	2.57±0.19	2.40±0.19	2.13±0.61	2.23 ±0.32
Wbc ($x10^6$/l)	65333.33±681.84	14186.67±617.47	18144.00±634.64	18666.67 ±563.72
Monocytes (%)	10.00±2.00	14.67±0.58	14.67 ±4.73	15.33±12.74
Lymphocytes(%)	90.00±2.00	85.33±0.58	85.33±4.73	84.67±12.74

Pcv=packed cell volume, Rbc= red blood cell, Wbc= white blood cell

Effect of diets containing *Moringa oleifera* on the serum biochemistry of broiler birds

The serum biochemistry indices of broiler chicken fed moringa leaf based diet are presented in Table 3. The result showed that there were significant differences (p<0.05) in AST and ALT among the treatments. T1 was significantly (p<0.05) higher in AST and ALT than the other treatment groups which implies that the *Moringa oleifera* leaf meal included in the diet had no negative effect on the liver of the animals. This result is supported by the works of Hassan *et. al.* (2016), who reported that *Moringa oleifera* leaves have a beneficial effect to enhance the immune response**s** and improve intestinal health of broilers. This could reflect a protective influence of MOLM supplementation on liver tissues. T1 was also significantly (p<0.05) higher in total protein than the other treatment groups. The decreased total protein level implies that there was no effect of moringa leaf on protein metabolism. This contradicts the work of Teye *et. al*. (2013), who reported that increased levels of MOLM in the diet of broiler significantly elevated the plasma total protein. The result showed that T1 was significantly (p<0.05) higher in ALB than the other treatment group which are T2, T3 and T4. The decreased albumin level observed in broiler birds fed moringa leaf confers a negative result as albumin is responsible for delivering nutrients to body cells and also prevents cell damage. The depressive effect of the MOLM could be attributed to the adverse influence of the Moringa phytotoxins like tannins, nitrite, oxalate and phytate (Odetola, 2012). Treatment 3 and T4 were significantly (p<0.05) higher in GLB than T1 and T2 but T3 and T4 were statistically the same (p>0.05). There was increased globulin which indicated better disease resistance. The results showed that T3 was significantly (p<0.05) higher in urea than the other treatment groups. The result shows that T4 was significantly (p<0.05) higher in creatine than the other treatments. There was an increase in the creatinine which indicated that the animals fed the treatment diets had problems with the quantity of protein in the test feedstuff and this in line with the observation of Tijani *et al*, (2006). There was no significant difference (p>0.05) in platelet across the treatment groups.

Table 3: Serum biochemical values of broiler chicken fed with Moringa leaf meal

PARAMETERS	T1	T2	T3	T4
AST (u/l)	$280.00±1.00^a$	$236.00±1.00^d$	$250.00±1.00^c$	$271.00±1.00^b$
ALT (u/l)	$30.00±1.00^a$	$11.00±1.00^d$	$15.00±1.00^c$	$20.00±1.00^b$

Total protein (g/l)	50.00±1.00[a]	30.00±1.00[d]	39.00±1.00[b]	35.00±1.00[c]
ALB (g/l)	18.00±1.00[a]	15.00±1.00[b]	16.00±1.00[b]	12.33±0.58[c]
GLB (g/l)	1.26±0.01[b]	1.10±0.10[c]	1.67±0.01[a]	1.72±0.01[a]
Urea (mg/dl)	28.30±1.00[c]	22.13±0.58[d]	35.00±1.00[a]	33.40±0.53[b]
Creatinine (mg/d)	0.23±0.06[c]	0.26±0.01[bc]	0 31±0.01[ab]	0.35±0.01[a]
Platelets	152.33±22.81	101.00±26.06	139.67±41.00	111.00±34.07

Conclusion

The results suggest that it is not good to replace soyabean meal with moringa leaf meal at 15, 30 and 45% level in the diets of broilers because it has adverse effects on their performance and blood serum biochemistry.

Recommendation

It is recommended that moringa leaf should not be used to replace soyabean meal at 15, 30 and 45% in broiler feed because it has negative effects on them.

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EFFECT OF GRADED LEVELS OF RICE MILLING WASTE AND SUPPLEMENTARY ENZYME ON NUTRIENT INTAKE AND APPARENT RETENTION BY FINISHER BROILERS

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Abstract

A four-week study was conducted to evaluate the nutrient intake and utilization by finisher broiler birds fed graded levels of rice milling waste (RMW) supplemented with exogenous enzyme Roxazyme G2®. A total of one hundred and twenty 28-day old finisher broilers were randomly allocated to eight groups of 15 birds each. The groups were randomly assigned to 8 isocaloric (2.85Mcal/kg ME) and isonitrogenous (22.00% crude protein) diets in a 4x2 factorial arrangement involving a control (0%), three levels 10, 15, and 20%) of RMW and two enzyme levels (0 and 0.05%). Each group was replicated 3 times with 5 birds per replicate in a completely randomized design (CRD). The birds were provided feed and water *ad libitum* for the period of the study. Data were collected on nutrient intake and utilization. Results showed that there were significant ($p< 0.05$) differences among the treatments in the intake and retention of nutrients - dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), nitrogen-free extract (NFE) and gross energy (GE). Increasing levels of RMW significantly ($p<0.05$) increased the intakes of DM, CP, EE, NFE and GE but decreased ($p>0.05$) the intake of fibre. Increasing level of RMW beyond 15% significantly ($p < .05$) decreased DM retention and CF digestibility. There were significant ($p<0.05$) RMW X enzyme interactions in the intakes and retentions of DM, CP, EE, NFE, and GE. It was concluded that up to 20% RMW and exogenous can be included in finisher broiler diets without adverse effect on the intake and nutrient retention on the digestive organs of broilers but rather would improve nutrient intake and utilization by broiler finishers.

Introduction

Animal protein is essential in human nutrition in order to solve the problem of kwashiorkor which is a resultant effect of malnutrition (Oladeebo *et al.,* 2007). With the ever-increasing cost of poultry and poultry products, there is the need to explore the use of alterative and non-conventional feed ingredients that are locally available and cheaper. Rice milling waste (RMW) is one of such alternative feed ingredients. In broilers, the use of RMW is limited because of its high fibre content and high fibre limits the amount of intake of the available energy by the birds and also results to the secretion of excessive nutrient (Kung and Grueling, 2000). Due to the fact that poultry cannot fully utilize high fibre diets as a result of the lack of the digestive framework that digests large amount of fibre, it is therefore necessary to incorporate exogenous enzymes into their diets to enhance the breakdown of the non-starch polysaccharides (NSPs) present in fibre. This study therefore investigates the effect of rice milling waste and supplementary-enzyme (RoxazymeG2®) on nutrient intake and retention by finisher broilers.

Materials and Methods

The study was carried out at the Department of Animal Science Teaching and Research Farm, University of Nigeria Nsukka. One hundred and twenty (120) 28 day-old finisher broilers (Anak strain) were randomly divided into eight groups of 15 birds each. The groups were randomly assigned to 8 isocaloric (2.98Mcal/KG ME) and isonitrogenous(20.00% CP) diets in a 4x2 factorial arrangement involving a control (0%), three levels (10, 15 and 20%) of RMW and two enzymes levels (0 and 0.05%) as shown in table 1. Each treatment was replicated three times with five birds per replicate placed in 2.6 x 3m deep litter pens with fresh wood shavings. Feed and water were offered *ad libitum* every morning from 7.00am -8.00 am and the birds were properly vaccinated. The proximate analysis was carried out according to the procedures of AOAC (2006). Data collected were subjected to analysis of variance as described for completely randomized design (Steel and Torrie, 1980) and differences between treatment means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

Results and Discussion

Table 2 and 3 shows the effect of rice milling waste and supplementary enzyme on nutrient intake and utilization by finisher broilers. All the parameters measured differed significantly ($p<0.05$) among treatments in the intakes of (DM), (CP), (CF), (EE), (NFE) and (GE). Birds fed diet 8 had significantly ($p<0.05$) higher intakes of DM CP, CF, EC and EI compared to birds fed diets 1 and 2 which was significantly decreased ($p>0.05$) but similar ($p<0.05$) to birds fed diets 5,6 and 7. Enzyme supplementation improved DM, CP, NFE at all the RMW inclusion levels; and increased ($p<0.05$) EE intake and GE intake at 15 and 20% RMW inclusion levels. The DM, CP, CF and GE the intakes decreased significantly ($p>0.05$) at 10% RMW inclusion level without enzyme supplementation. The result is in line with the findings of Apata and Ojo (2003), who in a similar study observed that inclusion of enzyme in broiler diet increased nutrient consumption by the finisher broiler, and also shown that exogenous enzymes compliment the digestive enzymes of poultry by hydrolyzing the non-starch polysaccharides (NSPs). The decrease in the nutrient intakes of finisher broiler could be attributed to the high content of fibre in the diets especially at 20% RMW inclusion level.

Table 3 shows the effect of RMW and supplementary enzyme on apparent nutrient retention by finisher broilers. All the parameters measured differed ($p>0.05$) significantly among the treatments. The DM, CP,CF,EE,NFE and GE retention of birds fed diet 7 and those fed diet 8 were significantly decreased ($P>0.05$) compared to all other treatments. Birds fed diets 1 and 2 had the highest ($p<0.05$) DM, CP, CF, EE, NFE and GE retention. The nutrient retentions by the finisher broilers were significantly decreased with the increase in RMW in the diet beyond 10% inclusion level. The observed decreased in nutrient retention may be due to the increased dietary fibre. This result is in agreement with the report of Ani *et al.,* (2012), who reported similar depression and attributed that which is attributed in apparent nutrient digestibility to higher rate of passage of digesta in animals fed of high fibre diets. Fibre contributes to excessive nutrient excretion and tends to limit the amount of intake and the retention of the available energy (Kung and Grueling, 2000).

Conclusion

The result of the study obtained that up to 20% can be included in finisher broiler diet without any deleterious effect on nutrient intake and utilization.

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Table1. Percentage composition of finisher broiler diets

	Treatment							
Parameter	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
RMW level (%)	0	0	10	10	15	15	20	20
Enzyme level (%)	0	0.05	0	0.05	0	0.05	0	0.05
Maize	50.00	50.00	40.00	40.00	35.00	35.00	30.00	30.00
Wheat offal	8.00	8.00	7.50	7.50	7.00	7.00	6.50	6.50
Rice milling Waste	0.00	0.00	10.00	10.00	15.00	15.00	20.00	20.00
Fixed Ingredients*	41.00	41.00	41.00	41.00	41.00	41.00	41.00	41.00
Palm oil	1.00	1.00	1.50	1.50	2.00	2.00	2.50	2.50
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Crude protein	20.07	20.07	20.09	20.09	20.11	20.11	20.10	20.10
Crude fibre	4.26	4.26	7.36	7.36	9.02	9.02	10.68	10.68
Energy Mcal/kg	2.97	2.97	2.98	2.98	2.98	2.98	2.99	2.99
Dry matter (%)	95.60	95.58	95.72	95.71	95.65	95.67	95.73	95.74
Crude protein (%)	20.32	20.35	2.22	20.20	20.21	20.20	20.22	20.24
Ether Extract (%)	10.21	10.23	14.00	13.74	20.10	22.10	24.30	25.40
Crude fibre (%)	6.78	7.79	6.55	5.23	7.25	5.24	5.27	5.26
Nitrogen-free extract (%)	40.50	40.71	35.75	35.65	32.81	32.83	28.40	28.42
Ash (%)	17.80	16.50	19.20	20.08	15.28	15.30	17.54	16.42
Gross energy (Kcal /kg)	3.10	3.11	3.15	3.14	3.20	3.18	3.16	3.15

*Fixed ingredients: 6% soybean meal, 18% groundnut cake, 10% PKC, 2% fish meal, 4% bone meal, 0.25% methionine, 0.25% Vit-min Premix, 0.25% lysine and 0.25% iodized salt.

2: Effect of rice milling waste and supplementary enzyme on nutrient intake of finisher broilers

RMW (%)	0	0	10	10	15	15	20	20	
Enzyme level (%)	0	0.05	0	0.05	0	0.05	0	0.05	
Treatments/Parameters	1	2	3	4	5	6	7	8	SEM
Dry matter intake (g)	107.92^{c}	119.83^{c}	135.42^{bc}	143.89^{b}	149.43^{ab}	156.06^{ab}	165.8^{a}	175.94^{a}	4.58
Crude protein intake (g)	22.80^{cd}	25.52^{cd}	28.61^{c}	30.35^{b}	31.58^{b}	32.95^{ab}	35.02b	32.95^{ab}	0.91
Crude fibre intake (g)	11.46^{d}	12.82^{d}	17.44^{c}	18.57^{c}	24.23^{b}	25.01^{b}	32.47^{ab}	34.48^{a}	1.67
Ether extract intake (g)	5.83^{d}	6.49^{c}	7.38^{c}	7.86^{b}	8.24^{b}	8.55^{ab}	9.13^{ab}	9.67^{a}	0.26
Nitrogen- free extract intake (g)	45.44^{b}	51.04^{a}	49.19^{b}	52.23^{a}	50.17^{b}	53.55^{a}	50.55^{b}	53.55^{a}	0.69
Energy intake (K cal/g)	347.79^{c}	394.05^{c}	445.69^{bc}	471.81^{b}	499.95^{b}	518.74^{ab}	547.35^{ab}	578.87^{a}	15.64

Table 3: Effect of rice milling waste and supplementary enzyme on apparent retention (% of intake) of finisher broilers

RMW (%)	0	0	10	10	15	15	20	20	
Enzyme level (%)	0	0.05	0	0.05	0	0.05	0	0.05	
Treatments/Parameters	1	2	3	4	5	6	7	8	SEM
Dry matter (%)	79.4^{a}	81.42^{a}	74.00^{ab}	77.39^{ab}	71.53^{b}	74.00^{ab}	63.29^{bc}	66.35^{bc}	1.32
Crude protein (%)	78.01^{ab}	80.95^{a}	64.10^{b}	64.23b	71.53^{ab}	63.33^{b}	74.83^{ab}	60.36^{b}	2.65
Crude fibre (%)	82.92^{a}	88.05^{a}	76.13^{ab}	83.52^{a}	71.43^{b}	73.25^{b}	60.15^{c}	64.24^{c}	2.07
Ether extract (%)	73.33^{b}	88.29^{a}	77.50^{a}	79.5^{a}	78.47^{a}	78.29^{a}	69.05^{b}	72.97^{b}	1.88
Nitrogen- free extract (%)	77.99^{ab}	80.50^{a}	75.54^{a}	77.01^{ab}	71.70^{b}	73.42^{b}	55.73^{b}	64.22^{bc}	1.73
Gross energy	74.00^{ab}	80.53^{a}	74.83^{a}	76.83^{ab}	71.53^{b}	73.3^{ab}	59.83^{b}	64.26^{bc}	2.75

RESPONSE OF GROWING TURKEYS TO DIETS CONTAINING VARYING LEVELS OF TOASTED BAMBARA NUT (*Voandzeiasubterrenea L*) WASTE

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Abstract

The study was conducted to investigate the response of growing turkeys to diets containing varying levels of toasted bambara nut (Voandzeiasubterrenea L) waste. A total of 40 ten-week- old turkeys (Meleagrisgallopavo) were randomly divided into four groups of 10 birds each. The groups were randomly assigned to four treatments of diets involving four levels (0, 10, 20 and 30%) of toasted bambara nut waste for 56 days. Each treatment was replicated two times with 5 birds per replicate. The experimental model used was a completely randomized design (CRD). In the experiment, the daily feed intake increased as the level of inclusion of the toasted bambara nut waste in the diet increased. There were significant ($p<0.05$) differences among treatments in the final body weight gain, total weight gain, average daily weight gain , feed conversion ratio, protein efficiency ratio and in feed cost per kg weight. Also there were significant ($p<0.05$) differences in body length, shank length, neck length and thigh diameter of turkeys feed toasted bambara nut waste. It could be observed and concluded that the performance of turkeys on treatment 4 (30% TBNW diet) in terms of total body weight gain, daily weight gain, feed conversion ratio, protein efficiency ratio and feed cost per kg gain was superior to that of turkeys on the control diets.

Key words: Bambaranut waste, growing turkey, growth performance, cost, body characteristics

INTRODUCTION

The most pressing problem facing poultry industry in Nigeria is the high cost of feed ingredients. The cost of feed accounts for 70-75% of the total cost of production and this has invariably led to a high cost of production (Esonu*et al.,* 2006).This had led the animal nutritionist to search for alternative ways of inclusion using some of the affordable and available non-conventional waste ingredient, in order to minimize the cost of production. Bambara nut waste has been useful in this regards. According to Enwere (1998) Bambara nut has the following composition. Moisture content 9.7%, crude protein 16.0%, crude fat 5.9%, and ash 2.9% total carbohydrate 64.9%. It is fairly rich in calcium and iron but poor in phosphorus. It has been reported by Enwere (1998) that bambara nut is mainly processed into flour which is prepared and consumed in form of "okpa" popularly known among the Ibos of Nigeria. In the production of the flour, the seed coats are partially removed by splitting the seeds in mill, winnowing to remove loosened test and converting the cotyledon into fine flour by milling several times in a hammer mill followed by sieving, using sieves with 1mm pores. Processing of bambara nut result in fairly large edible protein called bambara nut waste. This study therefore aimed at evaluating the potency of the bambara nut waste as feed stuff in feeding growing turkeys.

MATERIALS AND METHODS

Location and durtion of the study: The experiment was carried out at the Poultry Teaching and Research Unit of the Department of Animal Science Research Farm, University of Nigeria, Nsukka. The study lasted for a period of seven weeks.

Procurement and Processing of Bambara nut waste: The bambara nut wastes were purchased from food grinding and processing plants in ObolloAfor Market and Ogige Market, Nsukka. Other feed materials and ingredients were sourced from chidera feed mill at onuiyi, Nsukka. The bambara nut wastes were heated while being stirred in a large frying pan over burning firewood for about 5 – 10 minutes until a toasting aroma was perceived consistently, in order to remove some anti-nutritional factors like tannin and cyanogenic glycosides.

Experimental Animals and Management: A total of forty 10 weeks old turkeys were randomly divided into four groups of 10 birds each. The groups were randomly assigned to isocaloric (11.30 MJ /Kg ME) and isonitrogenous (20% crude protein) diets in a completely randomized design (CRD). Each treatment was replicated 2 times with 5 birds per replicate placed in 2.6m x 3m deep litter pens of fresh wood shavings. Feed and water were supplied ad *libitum* to the birds. Vaccinations and other management practices were strictly followed.

Parameters Measured: The following parameters were measured and determined: Average daily feed intake (g/bird/day), Average daily weight gain (g/bird/day), Feed conversion ratio and body characteristics.

Statistical Analysis: Data collected were subjected to analysis of variance using (ANOVA) of SPSS (version 20 of 2011).

RESULTS AND DISCUSSIONS: The result of Performance of growing turkeys fed graded levels of toasted bambara nut waste is presented in table 1: There were significant ($p<0.05$) differences among treatments in the daily feed intake of the birds. The daily feed intake for T_4 (3005g) was significantly ($p<0.05$) higher than T_1 (2609g), T2 (2394g) and T_3 (2774g). T_4(2394g) showed significant ($p<0.05$) increase in value of total weight gain than turkeys on T1 (1915g), T2 (1725g), and T3 (2128g). Turkeys on T4 also showed significant ($p<0.05$) increase in average daily weight gain compared to turkeys on T1, T2 andT3. There were also significant ($p<0.05$) differences in the average daily weight gain. The results also showed that T2 (2.45) had a significant ($p<0.05$) higher value in food conversion ratio than T1 (2.05), T3 (1.90) and T4 (1.95). The result revealed that turkeys on T1 (2.45), T3 (2.70), and T4 (2.55) were significantly ($p<0.05$) higher in values in protein efficiency ratio than turkeys on treatment 2. Turkeys on T4 (243.36) showed significant ($p>0.05$) decrease in feed cost per kg than turkeys on treatments 1(295.71), 2(355.52), and 3(246.81).

Table 1: Performance of growing turkeys fed graded levels of toasted bambara nut waste

Parameters	Control T_1	10% T_2	20% T_3	30% T_4	SEM
Initial body wt(g)	693	668	664	671	11.9
Daily feed intake (g)	70.60^{d}	76.40^{c}	82.20^{b}	88.00^{a}	1.72
Final body wt (g)	2609^{bc}	2394^{c}	2774^{ab}	3005^{a}	67.37
Total wt gain (g)	1915^{bc}	1725^{c}	2128^{b}	2394^{a}	73.33
Av daily wt gain (g)	34.20^{bc}	30.80^{c}	38.00^{b}	42.75^{a}	1.31
Feed conversion ratio	2.05^{b}	2.45^{a}	1.90^{b}	1.95^{b}	0.26
Protein efficiency ratio	2.45^{a}	2.05^{b}	2.70^{a}	2.55^{a}	0.08
Feed cost per kg weight gain(₦ per kg)	295.71^{b}	355.52^{a}	246.81^{c}	243.36^{d}	17.20

Results from this study showed that turkeys fed the diets containing 30% of toasted bambara nut waste had the highest final body weight, total weight gain, average daily weight gain and had the least feed conversion ratio. The enhanced performance of the growing turkeys on treatment 4 with reference to those on the control diets might be as a result of the ability of the turkeys to efficiently digest, absorb and utilize their feed more than those on the control diets. It is also probable that the common processing techniques for bambara nut such as grinding and heat treatment employed in this study have the ability to modify the nutritive availability to the turkey. This view is in harmony with the report of Onyimonyi and Okeke, (2007) that common processing techniques such as grinding, heat treatment, pelleting etc could modify the nutritive value of diets. The better performance could also be attributed to high protein content of bambara nut. Enwere (1998) reported that dry bambara groundnut seeds contained 21.13% crude protein, while the raw bambara nut waste contained 16.19% crude protein (Okeke, 2000). This findings was in agreement with the finding of Ani, *et al.,* (2012), Ani and Nnamani (2013), who showed that the performance of cockerel growers on (30% raw bambara nut offal diets without enzyme) in terms of total body weight gain, daily weight gain, feed conversion ratio, protein intake, protein efficiency ratio and feed cost was superior to that of birds on the control diet and other treatments. The result contradicts that reported by Ngwu, (2010) which showed that the final body weight, feed conversion ratio and protein efficiency ratio of broiler finishers fed diets containing 10% toasted bambara

nut waste were the best, although the differences among the results could be as a result of species differences, since different species of birds have different ability to digest, absorb and utilize their feed.

Table 2 showed the body characteristics of turkeys fed graded levels of toasted bambara nut waste. The table revealed that the mean body length of turkey placed on treatment3 (43.10cm) showed significant ($p<0.05$) increase in value than turkey placed on treatments 1(41.25cm) and 2(41.05cm).The table also showed that the mean value of shank length of turkeys on treatment 3(8.60cm) was significantly ($p<0.05$) higher than turkey on treatment 2(7.85cm). Treatments 3(15.60cm) and 4(15.70cm) were significantly ($p<0.05$) higher in value of mean neck length than treatment 2(15.05cm). Finally turkeys on treatment 3(8.85cm) was significantly ($p<0.05$) higher than turkeys on treatments 1(8.45cm), 2(8.10cm) and 4(8.35cm) in thigh diameter.

Table 2: Body characteristics of turkeys fed graded levels of toasted bambara nut waste

Parameters	**Control**	**10%**	**20%**	**30%**	
	T1	**T2**	**T3**	**T4**	**SEM**
Body length(cm)	41.25^{b}	41.05^{b}	43.10^{a}	42.25^{ab}	0.27
Shank length(cm)	8.25^{ab}	7.85^{c}	8.60^{a}	8.20^{bc}	0.09
Neck length(cm)	15.25^{ab}	15.05^{b}	15.60^{a}	15.70^{a}	0.09
Keel length(cm)	7.95	8.10	7.90	7.95	0.06^{NS}
Thigh length(cm)	13.15	12.85	13.20	12.85	0.07^{NS}
Thigh diameter(cm)	8.45^{b}	8.10^{c}	8.85^{a}	8.35^{b}	0.08

The results from this study showed that turkeys on treatments 3 and 4 had a progressive increase in body characteristics. The progressive increase in their body characteristics were an indicative that the test diet at 20% and 30% inclusion level resulted in good performance of the turkey. This supports (Fetuga *et al*, 1995) who proposed that Pig's performance in terms of rate and efficiency of gains is closely related to the nutrient intake levels, especially protein and energy. This ability to utilize dietary nutrients resulted to increase in superior body characteristics of the turkeys.

CONCLUSION: From the results obtained in this present study, up to 30% levels of toasted bambara nut waste can be included in turkey diets for optimum performance, normal growth and cost effective of the production of turkey.

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RESPONSES OF BIOCHEMICAL INDICES OF GROWING TURKEYS FED GRASSHOPPER MEAL AS A SUBSTITUTE FOR FISH MEAL

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Abstract
Fifty grower turkeys were randomly assigned into five dietary treatments and replicated three (3) times. The turkeys were fed diets containing 0%, 2.25%, 4.50%, 6.75% and 9.00% grasshopper meal. The experimental diets and clean drinking water were supplied *ad libitum* throughout the experimental periods of 10 weeks. All data generated were subjected to one-way analysis of variance in a completely randomized design. The result showed a significant difference due to treatments on urea, cholesterol, globulin and creatinine. Non-significant difference was recorded on glucose, total protein and albumin. The urea (mmol/L) levels recorded on T1 (3.00), T2 (2.95), T3 (3.08) and T4 (3.00) were statistically ($P<0.05$) higher than values recorded on treatment T5 (2.90). The cholesterol (mmol/L) and globulin (g/L) contents of T and T5 were similar and significantly ($P<0.05$) higher compared to other treatments. The result for creatinine (mmol/L) indicated ($P<0.05$) higher values in T4 (36.25) and T5 (36.00) compared to T1 (32.50). All these values were still within the recommended range for healthy turkey; hence, it was concluded that inclusion of grasshopper meal in the diet of turkey grower up to 9.00% had no adverse effect on their blood profile.

Key words: Responses, Biochemical, Turkeys, Diet and Grasshopper Meal

Introduction

Turkey (*Meleagris gallopavo)* is one of the poultry birds whose potentials as an alternative source of animal proteins have not been effectively exploited in Nigeria. Turkey has been around for a long time, its domestication dates thousands of years. It is eaten in the course of large feast during Christmas as well as other religious activities, yet, turkey production is limited by cost of feed and poor growth relative to local chicken (HTRT, 2009).Turkey feeding was based on rations with higher crude protein content compared to that fed to local chicken. The addition of a protein rich concentrate such as fishmeal is common to raise the level of protein in poultry diet. Turkey of ten weeks age requires a ration containing about 23% crude protein (Payne, 1990).

Grasshopper (*Zonocerus variegates*) is a major pest of food and tree crops and it is common to Sudan and Sahel savannahs of West Africa. It feeds on plant parts especially the leaves, stem and fruits. The level of availability of grasshopper species during the rainy season signifies its potential as a source of protein in place of fishmeal. The crude protein level in dried grasshopper was reported as 64.32% (Njidda and Isidahomen, 2010). The nutritional significance of grasshopper meal in Turkey diet especially in terms of growth performance, carcass quality, Nitrogen balance, blood parameters and nutrients digestibility need to be determined (Ojebeyi *et al.,* 2007). The study was aimed to determine the effect of grasshopper meal on biochemical parameters of Turkey.

Materials and Methods

The experiment was conducted at the University Farm (Poultry section) of Bayero University Kano located at Ungogo Local Government Area of Kano State. The State is located within longitude $90^{o}31^{'}$ and $130^{o}30^{'}$ North and latitude $90^{o}31^{'}$ and $90^{o}42^{'}$ East (KNARDA, 2001) and falls within Sudan savanna vegetation zone (Olofin, 1985). The area has a wet and a dry season with the wet season spanning from May to September and dry season coming between October to April (Olofin, 1987). The annual rainfall of the area ranged from 787mm to 960mm while temperature is between 21 and 40^{o}C (KNARDA, 2001).

Experimental diets were formulated such that grasshopper meal was included at 0% (control), 2.25%, 4.50%, 6.75% and 9.00% levels for diets T1, T2, T3, T4 and T5 respectively, as shown in Table 1 The ingredients for formulating the feed were acquired from Abubakar Rimi Market in Kano Metropolis, and Sheka Market in the Suburbs of Kano Metropolis.

A total of fifty (50) local breeds of turkey birds at eight weeks age were randomly allocated into 5 treatment groups. Each treatment had ten turkeys, which was replicated with 5 turkeys per replicate. The birds were managed under deep litter system with wood shaving as litter materials. The pen was cleaned and disinfected using recommended disinfectant (7% Tar Acid Phenol and 2% Cresylic Creosote) to avoid microbial contamination. Routine management was carried out as described by Oluyemi and Roberts (2000). Experimental feed and fresh clean water were provided *ad-libitum*. The feeding trial lasted for ten weeks.

At the end of the trial, two birds per replication were randomly selected, 6 ml of blood was collected from each bird via the wing vein using sterilized syringes and needles; 2 ml was transferred into an Ethelyne Diamine Tetra Acetic Acid (EDTA) container for haematological parameters analyses while the remaining 4 ml was transferred into Lithium Heparin containers for biochemical analyses. The blood samples for the biochemical analyses were arranged in sample trays at right angle and allowed to sediment for 2 hours. Automated pipettes and tips were used to collect the already separated sera and transferred into a micro-tube for biochemical analysis using Automated Chemistry Analyser (Selectra Junior Pro-S). Parameters determined included urea (mmol/L) cholesterol (mmol/L), glucose (mmol/L) total protein (g/dl), globulin (mmol/L), creatinine (mg/dl) and albumin (g/dl).

Data collected were subjected to one way analysis of variance using the SAS system (1999). Least significant difference test was used to determine difference among means of the treatment as described by Steel and Torrie (1980).

Table 1: Ingredient Composition of the Experimental Diet

Ingredients	Treatment				
	T1	T2	T3	T4	T5
White Maize	60.00	60.00	60.00	60.00	60.00
Wheat Offal	12.65	12.55	12.50	12.45	12.40
Grasshopper Meal	0.00	2.25	4.50	6.75	9.00
Groundnut Cake	12.00	12.00	12.00	12.00	12.00
Bone Meal	5.00	5.00	5.00	5.00	5.00
Fish Meal	9.00	6.75	4.50	2.25	0.00
Common Salt	0.10	0.10	0.10	0.10	0.10
*Premix	0.25	0.25	0.25	0.25	0.25
Palm Oil	1.00	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00	100.00

* Premix=Vitamin A 12,000,000 I.U; Vitamin D_3 3,000,000 I.U ; Vitamin E 30,000mg; Vitamin K_3 2,500mg; Folic acid 1,000mg; Niacin 40,000mg; Calpan 5,000mg; Vitamin B_2 5,000mg; Vitamin B_{12} 20mg; Vitamin B_1 2,000mg; VitaminB_6 3,500mg; Biotin 80mg; Antioxidant125,000mg;Cobalt 250mg; Selenium 250mg; Iodine 1,2000mg; Iron 40,000mg; Manganese 70,000mg; Copper 8,000mg; Zinc 60,000mg; Choline Chloride 200,000mg

Table 2 shows the result of blood chemistry of turkey fed graded level of grasshopper in replacement for fishmeal.

Table 2: Blood chemistry of turkey fed graded levels of grasshopper meal in replacement of Fishmeal

Parameter	Treatment					
	T1	T2	T3	T4	T5	LSD
Urea (mmol/L)	3.00^{ab}	2.95^{ab}	3.08^{a}	3.00^{ab}	2.90^{b}	0.17*
Cholesterol (mmol/L)	3.43^{a}	3.30^{ab}	3.20^{b}	3.20^{b}	3.40^{a}	0.22*
Glucose (mmol/L)	1.28	1.38	1.28	1.28	1.40	0.19^{ns}
Total protein (g/dL)	33.50	32.25	32.75	33.25	33.00	1.31^{ns}

Globulin (g/L)	9.75^{a}	8.75^{b}	9.50^{ab}	9.00^{ab}	9.75^{a}	0.89*
Creatinine (mmol/L)	32.50^{b}	34.75^{ab}	35.25^{ab}	36.25^{a}	36.00^{a}	2.79*
Albumin (g/L)	23.75	24.00	23.50	23.00	23.50	1.50^{ns}

Results and Discussion

The result showed a significant difference due to treatments on urea, cholesterol, globulin and creatinine. Non-significant difference was recorded on glucose, total protein and albumin. The urea levels recorded on T1 (3.00), T2 (2.95), T3 (3.08) and T4 (3.00) were statistically ($P<0.05$) higher than values recorded on treatment T5 (2.90). The cholesterol contents of T1 (3.43) and T5 (3.40) were similar and significantly ($P<0.05$) higher than other treatments (T2, T3 and T4). The globulin contents of T1 (9.75) and T5 (9.75) were similar and significantly ($P<0.05$) higher compared to T2 (8.75) which was the least. The result for creatinine indicated ($P<0.05$) higher values in T4 (36.25) and T5 (36.00) compared to T1 (32.50).

The serum biochemical indices observed were all within normal range as reported by Dukes (1975). Creatinine content has been shown to depend upon quantity and quality of feed and environmental temperature (Ewuola *et al.*, 2004). The lower values of urea obtained support the quality of the feed. According to Iyayi and Tewe (1998) blood urea level depend on both the quality and quantity of the protein supplied in the diet and higher level of urea in the blood could be attributed to the presence of some anti-nutritional factors which might have lowered the quantity of the protein indicating imbalance of amino acid in the diet and caused elevated blood urea concentration.

Globulin and albumin are important component of blood plasma (Guache *et al.*, 1991). The values of Albumin, Globulin and Total Protein in this research agree with the findings of Al-Homidan (2005), Ademola *et al.* (2009), Nweze and Ekwe (2012) and Wafaa *et al.*, (2012). Total Protein, Albumin and Globulin have been reported to be directly responsible to protein intake and quality (Onifade *et al.*, 1999).

Conclusion

Grasshopper meal can be used to replace fishmeal in the diet of turkey without any adverse effect on the health of Turkey.

Recommendation

Similar experiment should be conducted for turkey of age 0-8weeks.

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HAEMATOLOGICAL PARAMETERS AND NUTRIENTS DIGESTIBILITY OF RED SOKOTO GOATS FED GMELINA AND FICUS LEAVES SUPPLEMENT WITH CASSAVA PEELS AND COWPEA HUSKS

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Abstract

The experiment was conducted to determine the nutrient digestibility and haematological parameters of goats fed two different plant leaves, (Gmelina and Ficus based diet supplement with cassava peels and cowpea husk). The experimental feeds contains the combination of Gmelina leaves + cassava peel and Gmelina + Cowpea husks, Ficus leaves + Cassava peels and Ficus leaves + cowpea husks in designed treatment as T1, T2, T3 and T4 respectively. After the adaptation period of two weeks, the goats were randomly allotted to four treatment components with four replicates each. Data was collected for nutrient digestibility and haematological parameters were subjected to analysis of variance using Statix 9.0. The result of nutrient digestibility was significant ($P<0.05$) with the highest(81.45%) crude protein level and lowest (52.09%) in T2 and T1 respectively, while the dry matter content was significantly highest (83.22%) in T4 and lowest (27.34%) in T1.There was no significant differences observed for all the blood indices and among the four treatment components, except for PCV, where T3 and T4 were significantly ($P<0.05$) different from T1and T2.This finding therefore show that all the feeds components supports the health status of the animals. In conclusion browse plants and crop by-products should be encouraged among the farmers in order to improve the ruminant performance.

Key words: Nutrient, Digestibility, Haematological, Supplement, Cassava, Cowpea, Gmelina and Ficus

Introduction

Poor nutrition is one of the major constraints of small ruminant livestock productivity in tropics. Even where the forage resources are abounds, seasonal fluctuation in their nutritive value make substantial gains in production from good management and disease controlled programme unrealistic (Sanusi *et al* 2011). The shortage of good quality feed needed to sustain livestock growth especially during dry season months has been a perennial problem which can be reduced or eliminated by finding alternative sources of protein and energy concentrated mixture given to animal. It was reported that an inverse relationship exists between nutrient consumption and digestibility (McDonald *et al.,* 2002). That nitrogen excreted in urine depends on urea recycling and efficiency of utilization of ammonia produced in the rumen by microbes for microbial protein synthesis. Therefore the percentage nitrogen digestibility and retention decrease with increase in the level of roughage and decrease in the level of crude protein in diet. Blood analysis is important because it contains a myriad of metabolites and other constituents which provide a valuable medium for clinical investigation and nutritional status of human beings and animals (Abegunde, 2008). According to Yusuf *et al* (2012) the blood profile of animals often reflect their nutritional adequacy or otherwise. Therefore, dietary components have measurable effects on blood constituents, such that significant changes in their values can be used to draw inference on the nutritive values of feeds to animals.The objective of this paper was designed to assess the haematological parameters and nutrient digestibility of Sahel goats fed Gmelina and Ficus leaves supplemented with cassava peels and cowpea husks

Materials and methods

Study area

The experiment was carried out at the small ruminant unit of teaching and research farm of the federal polytechnic Bali, Taraba state. Bali is situated at latitude $7^{0"}$12N to 12^{0}00" North of the equator and longitude

$10^0$00 "N to $12^0$00" east of Green Which Meridian(GWM) at an altitude of 450mm above sea level and lies within the guinea savannah zone of Nigeria (TSD. 2008).

Experimental layout and Animal management

Sixteen Red Sokoto goats of an average age of eight months and mean weight of 7 kg were sourced from local market around Bali environment. Their ages were determined through their dental formulae. The animals were quarantined for two weeks during which they were fed the experiment diet for adaptation. They were dewormed with Albendazole and vaccinated against PPR and CCBP. At the end of the adaptation period, the animals were tagged, randomly allocated to treatments and balanced on weight bases for all treatments. They were weighed to get the Initial weights before embarking data collection. Toward the end of the experimental period of three months, the animals were individually housed for digestibility trials for the period of one week.

Experimental diet

There were four treatments replicated four times, making a total of sixteen experimental animals. The experimental diet consists of: T1 (Gmelina arborea leaves+ 1.2 kg of cassava), T2 (Gmelina arborea leaves+1.2 kg of cowpea husk), T3 (Ficus sycamores leaves+1.2kg of cassava peels), T4 (Ficus sycamores leave +1.2kg of cowpea husk). The cassava peels and cowpea husk were the supplement portions and were fed to the animals at 300g/head/day. The Gmelina and Ficus leaves formed the base diet and fed *ad- libitum*. Randomized complete Block Design (RCBD) was employed in the study.

Parameters measured

Parameters determined are, digestibility of the treatments diets and haematological indices. Proximate compositions were determined using the methods described by AOAC (2005).In determining the digestibility; the diets were given to the animals in a known amount. Faecal outputs were collected weighed daily. The proximate compositions of faeces were determined using the method described by AOAC (2005).

Haematological parameters were determined by drawing 5mls of blood from a jugular veins of each animal into a sample bottle containing anti- coagulant; Ethylene Diamante Tetra Acid (EDTA). The samples were used for the determination of the packed cell volume (PVC), Haemoglobin (Hb) concentration, Red Blood cell counts (RBC) and White blood cell counts (WBC). Packed cell volumes (PVC) were measured for each animal using the micro haematocrit method. Haemaglobin concentration was also measured using shale's (acid haematin), Oni *et al* (2010). Red blood cells were determined with acid of Neubauer counting chamber (Haemocytometer). Blood smears were used for total white blood cell (WBC) counts determination.All data obtained were subjected to analysis of variance (ANOVA) using Statix 9.1 package, means were separated using LSD.

Result and Discussion

The effect of the experiment diets on the digestibility of goats are presented on Table 2.The results indicate that goats fed the combination of FL+CH (T4) and FL+CP significantly had better nutrient digestibility than the goats that were fed GL+CP (T1) and GL+CH (T2) the result obtained also agree with reports of Bankole *et al*., (2004), that feeding browse plant has become an essential practice especially in the dry season when herbaceous forage are soirees animal feeds. In a similar development the use largely in agreement with Lufedaju *et al* (1992), who also identified the importance of feeding ruminant animals with cereal residence from sorghum, maize and millet it is evident in this study, that the ruminant and animals utilizes low pea husk more efficiently than cassava peels

Table 1: Nutrient Digestibility Sahel) of Goats fed Gmelina and Ficus leave as Basal diet Supplement with Cassava peels and Cowpea Husks.

Parameter	

	Treatments			
	T1 (GL+CP)	**T2 (GL+CH)**	**T3 (FL+CP)**	**T4 (FL+CH)**
Dry matter	27. 335[c]	62.415[d]	70. 645[a]	83.220[a]
ASH	58.225[b]	75.520[a]	77. 400[a]	83.220[a]
Crude protein	52.090[b]	81.450[a]	60.230[b]	75.915[a]
Ether m tract	93.410[a]	93.945[a]	95.575[a]	93.215[a]
CF	25.450[b]	70.875[a]	50.855[a]	76.975[a]
ADF	62.380[a]	76.765[a]	58.135[a]	79.095[a]
NDF	36.915[b]	73.490[a]	55.040[b]	76.875[a]

a,b.c = means in the same row with different superscripts are significantly different (P<0. 5)

.The haematological parameters for the goat, those in T_4 had the highest values (20.250, 60. 750, 12.078, 8.965 and 5.100) for HB, PCV RBC, WBC, and MCV respectively. However the same T_4 did not differ significantly from these in T_2&T_3 for PCV, and WBC and T_3 for RBC. Those in T_1 were significantly (P<0.05) higher (0.43) for MCHC than those in the other treatment, while MCH did not differ significantly from each other among treatment groups.

From the result it can be deluded that all the feed components has the ability to support the physiological activities of the animals. However where there is an inclusion of cowpea husk gives higher haematological values compared to cassava peals. This finding is in consonant with the work of Ogunborijo (2009), who report that good feeds also influences the blood constituents, which is a vital tools that helps to detect any deviation from normal animals body. However the WBC obtained in the animals fed the experimental diets was within the range of 4.0-12.0×10^3 mm^{-1} for goats (Byanet *et al.*, 2008).

Table 2: Haematogical Analysis of Sahel goats' Fed Crop Residues and Browse plants

Parameter	**Treatments**				
	T_1 (GL+CP)	**T_2 (GL+CH)**	**T_3 (FL+CP)**	**T_4 (FL+CH)**	**SEM**
HB	14. 250[c]	16. 500[b]	17. 250[ab]	20.250[d]	2.7031
PCV	36.500[b]	49.500[ab]	49. 750[ab]	60. 750[a]	8.3540
RBC	8.253[b]	9.932[b]	10.053[a]	2.078[a]	1.5771
WBC	5.806[b]	7.268[ab]	7.973[ab]	8.965[a]	0.9961
MCH	1.728[a]	1.653[a]	1.633[a]	1.640[a]	0.0718
MCHC	0.431[a]	0.333[b]	0.327[b]	0.333[ab]	0.0346
MCV	4.422[b]	4.958[b]	4.990[b]	5.100[a]	3.6378

a = means in the same row with the same superscripts are not significantly different (P>0. 5)

Conclusions

The result of this study reveals that animal fed the combination of Gmelina leaves + cowpea husk, Ficus +cassava peels and Ficus leaves + cowpea husk, maintained good feed utilization by the animals as well as normal hematological indices, thereby keeping all animals on healthy condition. Hence feeding goats, with

browse plants and crop by –produces should be encouraged among farmers in order to improve ruminant performance.

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EVALUATION OF THE PERFORMANCE OF JAPANESE QUAIL (*Cortunix cortunix japonica*) FED GRADED LEVELS OF DRIED SWEET ORANGE PEEL MEAL (*Citrus sinensis*)

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ABSTRACT

This study was conducted to evaluate the growth performance of Japanese quails (*Coturnix coturnix japonica*) fed graded levels of dried sweet orange peel meal (DSOPM). A total of one hundred and eighty (180) birds were used for this study. A total of six experimental diets was formulated with inclusion levels of DSOPM at 0%, 2.5%, 5%, 7.5%, 10% and 12.5% respectively. Data was collected on feed intake, weight gain and feed conversion ratio. Data collected on performance parameters was subjected to analysis of variance and means was considered different at $P < 0.05$. There was no significant ($P > 0.05$) difference in the mean initial body weight but in parameters such as the mean final body weight, mean body weight gain and feed conversion ratio, the result revealed significant ($P < 0.05$) differences and this was also observed for feed intake of quail birds fed the experimental diets. The study concluded that the performance of birds on inclusion diets of 0.5% - 10% Dried Sweet Orange Peel Meal (DSOPM) was similar but lower, compared with the higher values in the control diet. The study recommends that 10 – 15% inclusion may be considered since adult unsexed quails fed with the diets had an average weight which fell within the recommended average weight of adult quails (100-160g)

Keywords: Dried sweet orange peel, feed intake, feed conversion ratio and growth performance

INTRODUCTION

In order to meet the increasing worldwide demand for poultry and maintain its profitability, it is important to find new ways to stay competitive within the industry and decrease the cost of production as much as possible while achieving a high quality for consumers. High cost of conventional protein feedstuffs has contributed to the poor performance or productivity of many animals in Nigeria and this has led to a shortage in the availability of animal protein to the citizenry (Adeniji and Jimoh, 2007). Efforts to reduce the high cost of feeds and therefore the cost of poultry products have concentrated on the use of cheaper and locally available alternative agro-by products especially those that have no nutritional value to mankind (Onu, 2007, Onu and Otuma, 2008, Okonkwo *et al.*, 2008, Oladunjoye and Ojebiyi, 2010).

In poultry production, feed cost also claims the largest share of the total expenses involved in the production process. Feed alone accounts for over 75% of the total cost of production, out of which 50% is expended on protein and energy sources (Ahaotu *et al.*, 2012). In the recent years, poultry nutritionists have aimed their researches towards the use of non-conventional feed ingredients in partial or total replacement of the conventional costly ingredients. One of such feed ingredients is the sweet orange peel meal, a by-product of sweet orange (*Citrus senensis*) fruits which is not in competition with man's dietary needs.Incorporation of such products in animal feed would help in alleviating the problem of scarcity of feed supply that is having a negative effect on livestock industry most especially monogastric animal production. Its usage will also reduce environmental pollution problems. Orange peels are primary by-product produced by the fruit processing industry, and were used meal as natural feed additive, and even as medicinal supplement for animals (Callaway *et al.*, 2008). Chemically, sweet oranges are valuable source of vitamin c as well as energy (Hasin *et al.*, 2006, Yang *et al.*, 2011).

The shortage of good quality feeds needed to sustain livestock growth, especially during the dry season has been a major challenge to the industry in the developing countries. A number of agro-based products such as the peel, Peel, seeds etc. are generated from fresh citrus after the main products of interest have been removed or extracted during processing or peeled for direct human consumption as in the case of developing countries. The use of non-conventional feed stuff in poultry diet such as orange peel is necessary in combating the rising

feed and production costs, as well as decreasing environmental pollution. Therefore this study was aimed at evaluating the growth performance Japanese quails (*Coturnix coturnix japonica*) fed graded levels of dried sweet orange peel meal.

MATERIALS AND METHODS

Location of the study

This experiment was carried out at the poultry unit of the University of Abuja Teaching and Research Farm which is located along Airport Road FCT-Abuja. Having geographical location of Latitude 9°4'N longitude 7°28'E of about 1500mm (59.1in) rainfall annually, temperature range between 18.45°C (65.21°F) to 36.9°C (98.4°F), of relative humidity at 0900 GMT (percent) was at level of 68.7%.

Experimental Animals and Management

A total of one hundred and eighty birds was used for this study and these birds is obtained from Nigeria Veterinary Institute, Jos, Platuea State. The management of the young chicks was include with the provision of supplementary heat for 4 weeks under 24 hours lighting, and thereafter 9 to12 hours light and 6 to 8 hours dark cycle. Indoor air temperature for the chicks will be maintained at 36°C. The birds was divided into six treatment groups including the control group and birds were fed *ad-libitum* with the control and experimental diets for each treatment group. Battery cage system was used

Experimental Diets

A total of six experimental diets was formulated and fed as recommended by Dafwang, (2006) for this study to contain 23% CP and 2839kcal/kg of M.E respectively as shown in table 2. Diet 1 was the control group without inclusion level of DSOPM while diets 2, 3, 4, 5 and 6 had inclusion levels of DSOPM at 2.5%, 5%, 7.5%, 10% and 12.5% respectively.

Table 1 Experimental Diets

INGREDIENT	1	2	3	4	5	6
Maize	53.10	50.60	48.10	45.45	42.72	39.95
DSOPM	0.00	2.50	5.00	7.50	10.00	12.50
GNC	26.10	26.10	26.10	26.25	26.50	26.75
Soyabean Cake	10.00`	10.00	10.00	10.00	10.00	10.00
Fish Meal	3.50	3.50	3.50	3.50	3.50	3.50
Rice Offal	2.70	2.70	2.70	2.70	2.70	2.70
Lime Stone	0.50	0.50	0.50	0.50	0.50	0.50
Bone Meal	3.00	3.00	3.00	3.00	3.00	3.00
Lysine	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00

Data Collection

Data was collected on feed intake and weight gain. The primary data (Feed Intake and Weight Gain), was used to calculate feed conversion ratio. Initial live weight and final live weight was recorded at the onset and end of the experiment, respectively.

Statistical Analysis

Data collected on performance parameters was subjected to General Linear Model (GLM) procedure of SAS (2001) for analysis of variance (ANOVA). Significant differences among treatment means was separated using the Duncan's Multiple Range Test (Duncan, 1955) Means was considered different at $P < 0.05$.

RESULTS

Productive performance of Quail fed graded level of DSOPM

The productive performance of Japanese quails fed diets containing Dried sweet orange Peel meal is presented in Table 2. The results of this study revealed that there was no significant ($P > 0.05$) difference in the mean initial body weight but in parameters such as the mean final body weight, mean body weight gain and feed conversion ratio, the result revealed significant ($P < 0.05$) difference and this was also observed for feed intake of quail birds fed the experimental diets. The results of the present study revealed that feed intake of Japanese quail was significantly affected by the inclusion levels of DSOPM. The lowest feed conversion ratio of the control showed that this diet was better than DSOPM based diets. Among DSOPM based diets, diets 2-5 (2.5 – 10%) had similar values of feed conversion ratio which were significantly better than diet 6.

Table 4.2 Productive performance of Quail fed graded level of DSOPM

	Inclusion Levels of DSOPM						
	0%	2.5%	5.0%	7.5%	10%	12.5%	
Parameters	T1	T2	T3	T4	T5	T6	SEM
Mean Initial body Weight (g/bird)	52.93^{a}	53.13^{a}	53.12^{a}	52.92^{a}	53.64^{a}	52.92^{a}	0.911
Mean final body Weight (g/bird)	146.79^{c}	129.86^{b}	117.70^{ab}	122.37^{ab}	111.37^{a}	111.60^{a}	0.167
Total Feed Intake (g/bird)	468.05	470.17	513.80	464.18	433.25	436.85	
Mean body Weight Gain (g/bird)	93.86^{b}	76.73^{a}	64.58^{a}	69.45^{a}	57.73^{a}	57.68^{a}	0.283
Feed conversion ratio	4.99^{c}	6.13^{bc}	7.46^{a}	6.68^{ab}	7.50^{a}	7.75^{a}	0.079

Means having the same superscripts in the same row do not differ significantly ($p>0.05$)

DISCUSSION

There was significantly higher final weight and weight gain observed in birds fed the control diet T1, as compared to other diets DSOPM T2, T3, T4, T5 and T6 (Dried Sweet Orange Peel Meal) and the observable weight gain could be due to good nutrient utilization traceable to effectiveness of processing by drying and grinding of the orange peel. This result is in agreement with the report of Omeje (1999) and Kaankuka *et al.* (2000) who reported that processing improves the utilization of proteins and energy contained in fruits.

The feed intake of Japanese quail which was significantly affected by the inclusion levels of DSOPM was inagreement of what was reported by Edache *et al.,* (2005), when they fed graded levels of yam peels to quail. They reported significant ($p < 0.05$) differences in feed intake in quails fed diets containing yam peel meal compared to the control. However, the aforementioned results agree with those of Adesiji *et al.,* (2012) who reported no significant difference for Japanese quails fed graded levels of *Detarium microcarpum* seed meal based diets.

The feed conversion ratio diets 2-6 (2.5 – 12.5%) which had similar values of feed conversion ratio was due to the fact that increase in inclusion level of DSOPM increased the fiber level of the diet. Therefore, Japanese quails could not utilize above 5% DSOPM effectively as earlier reported by Florou-Paneri *et al.,* (2001) that using up to 6% dried citrus Peel in laying quails diets had no significant adverse effect on performance. Increase in the inclusion level of DSOPM had effects on the utilization of the diets by reducing absorption of nutrients. The observation on the FCR is also in line with the findings of Gebhart and Kabanov (2001) who reported that better feed conversion ratio signified that more feed was retained in the animals and less waste to the environment.

Conclusion

Collectively, the performance of birds on inclusion diets of 0.5% - 10% Dried Sweet Orange Peel Meal (DSOPM) was similar but lower, compared with the higher values in the control diet, but hence, can adequately replace maize in quail nutrition at this level without any negative effect on growth performance. the study recommends that since the performance response of the birds at 0.5-10% inclusion level were statistically similar but lower than the control diet, it is recommended that 10 – 15% inclusion may be considered since adult unsexed quails fed with the diets had an average weight that fell within the recommended average weight of 100 – 140g (adult male) and 120 – 160g (adult female) as reported by Randall and Bolla (2008)

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APPARENT NUTRIENT DIGESTIBILITY OF BROILER STARTER FED VARYING LEVELS OF PROCESSED TARO COCOYAM (COLOCASIA ESCULENTA) MEAL BASED DIET.

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Abstract

A ten-week feeding trial was conducted at the poultry unit of the Livestock Teaching and Research Farm of Agricultural Science Education Department, Adeniran Ogunsanya College of Education, Oto/Ijanikin, Lagos State, Nigeria to evaluate the apparent nutrient digestibilty of (120) broiler starter fed varying levels of Parboiled sundried taro cocoyam (Colocasia esculenta) meal (PSCM). Four treatments were formulated with diet one containing 100% maize as control, while in diet two, three and four parboiled sundried cocoyam meal (PSCM) replaced the percentage proportion of maize in diet one at 50, 75 and 100% inclusion level respectively. Thirty (30) birds were randomly assigned to the four treatment diets in a complete randomized designed (CRD) each treatment group contained three replicates with ten (10) birds each. Ground fed feed and voided faecal samples collected after a 4-day feeding in a metabolic cage were analyzed for their respective proximate constituent. Apparent nutrient digestibility revealed that crude fibre was significantly($P<0.05$)higher in diet 4,crude ash was significantly ($P<0.05$) higher in control.digestible ether extract and NFE was significantly ($P<0.05$) higher among birds placed on 50%PSCM. It is therefore concluded that parboiled sundried taro cocoyam meal (PSCM) could replace 50% of maize in broiler starter diet without any deleterious effect however, substituting with parboiled sundried taro cocoyam meal at 50% replacement level for maize resulted in an improved nutrient digestibility and is hereby recommended for poultry farmers.

Keyword:Broiler Starter, Taro Cocoyam, Nutrient digestibility, Parboiled-Sundried

Introduction

Inadequate poultry and livestock feed supply and nutrition had been identified as the major constrain to poultry and livestock production in Nigeria. This is so because the conventional livestock feedstuffs sources have been very expensive especially in monogastrics diets such as poultry, pigs and rabbits. However, the search for locally available feedstuffs that can substitute these conventional energy/ protein feed ingredients at cheap cost is imperative. The need to boost animal production to produce the much needed protein for the ever increasing human population in the developing countries cannot be over emphasized. (FAO, 2007). This has therefore forced animal nutritionists to intensify research efforts into the feeding value of potentially useful, alternative, cheaper and readily available protein and energy sources of unconventional feed stuffs. Recently, effort has been geared towards the use of unconventional feed stuff such as agro-industrial by products and root tubers like yam, cocoyam etc. Several reseachers their success stories on the use of unconventional feed ingredients. Okosun and Eguaoje, (2017) also reported that Cassava grit at 66.6% level of inclusion with 5% moringa leaf meal supplementation resulted in better biological performance in cockerel chickens. Consequently, this present study is

focused on the use of cocoyam meal as basal diet in poultry diet. There is limited reference work on the utilization and inclusion of taro cocoyam as an alternative energy source in poultry production. This present study is therefore aimed at evaluating the apparent nutrient digestibility of starting broiler fed graded levels of parboiled sundried taro cocoyam meal based diet.

Materials and Methods

The research was conducted at the poultry unit of the Livestock Teaching and Research Farm of Agricultural Science Education Department, Adeniran Ogunsanya College of Education,

Oto/Ijanikin, Lagos State, Nigeria for the period of eight weeks. The cocoyam used for the study was chopped into aliquots of about 1mm and parboiled for about 15mins, drained, air dried overnight and later sundried for 7-14 days to reduce the moisture content to about 10% or less. It was milled and kept in an airtight polythene bag and taken to the laboratory for proximate analysis using the method described by AOAC (1990) as presented in table 1.

Table 1: Proximate composition of taro cocoyam and maize

Components	PSCM	Maize
Dry matter	87.62	89.80
Crude protein	7.87	8.94
Crude fibre	4.57	2.76
Ether extract	0.76	4.34
Crude Ash	6.05	2.01
Metabolizable Energy (Kcal/kg)	3214.91	3325.42

*Analyzed

PSCM: Parboiled sundried Cocoyam meal

Experimental Animals, Design and Management

One hundred and twenty (120) day old broiler chicks were purchased from a reputable hatchery. The design of the experiment was a completely randomized design (CRD) comprising of four (4) treatment diets. Treatment one control contained 100% maize as energy source, while treatments 2, 3 and 4 contained parboiled sundried Taro cocoyam meal (PSCM) at 50, 75 and 100% respectively as replacement for maize. Each treatment diets had thirty birds of ten birds per replicate. All broiler chicken were allowed assess to feed and clean drinking water ad-libitum and routine medication and vaccination was adhered to. All the diets (1 to 4) were formulated to be isonitrogenous (21%) and isocaloric (2885 ME Kcal/kg) as reflected in Table 2

Table 2: Percentage composition of broiler starter diets

	Inclusion levels of PSCM (%)			
	0	50	75	100
			Diets	
Parameters	1	2	3	4
Maize	48.00	24.00	12.00	0.00
PSCM	0.00	24.00	36.00	48.00
Soya bean meal	35.00	35.00	35.00	35.00
Wheat offal	7.50	7.50	7.50	7.50
Fish meal	5.00	5.00	5.00	5.00
Dicalcium phosphate	2.50	2.50	2.50	2.50
Palm oil	1.00	1.00	1.00	1.00
Premix	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00
Crude protein	21.03	21.02	21.04	21.09
ME (Kcal/kg)	2885	2885	2882	2880

Apparent digestibility of nutrients

At the expiration of the experiment, two birds per replicate were randomly selected and housed individually in a metabolic cage. A 5-day acclimatization period were allowed prior to a 4-day collection period; thereafter the birds were fed the specific quantities of the treatment diets. Daily excreta voided per bird were collected and dried over night at 600c for 12 hours and kept frozen (-200C) until it's ready for analysis. Prior to analysis, Excreta sample was dried at 650C in an air-tight oven to a constant weight and ground through a 1mm screen for proximate analysis according to the (AOAC, 1990).

$$\text{Apparent nutrient digestibility} = \frac{\text{Nutrient in feed} - \text{Nutrient in feaces}}{\text{Nutrient in feed}} \times 100$$

Statistical Analysis

All the data collected were subjected to a one way analysis of variance (ANOVA) and differences between means and treatments were determined using Duncan's multiple range test (DMRT) at 5 percent level of probability. All statistical procedures were according to (Steel and Torrie, 1990) with the aid of SAS 1999 package.

Results and discussion

Table 3 revealed that dry matter content was statistically similar (P>0.05) with higher value of 67.21% recorded from birds on 50% PSCM while least mean value of 66.40% was recorded among birds fed the control diet. Apparent digestible crude protein was also similar with higher value of 55.80% recorded from birds on 50% PSCM while lowest mean value of 54.24% was recorded among birds fed the control diet and 100% PSCM. Apparent digestible crude fibre was significantly (P<0.05) highest with an average value of 70.03% in birds fed 100% PSCM while lowest value of 61.26% was recorded in birds placed on the control. Apparent digestible ether extract was significantly (P<0.05) highest with an average value of 85.26% in birds fed 0% PSCM, comparable to 84.62% from those placed on 50% PSCM while lowest value of 76.44% was recorded in birds placed on 100% PSCM. Apparent digestible crude ash was significantly (P<0.05) with an highes value of 49.83% in birds fed 50% PSCM, followed by 47.44% from those placed on the control diet while lowest value of 43.63% was recorded in birds placed on 75% PSCM. Nitrogen free extract value was also significantly (P<0.05) higher among birds maintained on 50% PSCM with an average value of 57.16% , followed by 52.44% from those placed on 100% PSCM while lowest value of 50.63% was recorded in birds placed on the control diet.

Table 3: Apparent Nutrient digestibility of broiler chickens fed parboiled sundried cocoyam meal

	Inclusion levels of PSCM (%)				
	0	50	75	100	
			Diets		
Parameters	1	2	3	4	SEM±
App. Digestible dry matter	66.40	67.21	66.52	66.83	0.32
App. Digestible crude protein	54.26	55.80	54.64	54.26	0.45
App. Digestible crude fibre	61.26d	65.21b	68.33b	70.03a	6.25
App. Digestible crude ash	85.26a	84.62a	78.43b	76.44c	5.36
App. Digestible ether extract	47.44ab	49.83a	42.63c	46.26b	3.30
App. Digestible NFE	50.63d	57.16a	51.26c	52.44b	7.32

abc: means in the same row with varying super script differ significantly (P<0.05),

Discussion

Dry matter content though not significantly (P>0.05) influenced but highest value was recorded in birds placed on 50% parboiled sundried taro cocoyam meal (PSCM). This is in tandem with the report of Eguaoje and Okosun, (2017) who reported a no significant difference in the dry matter content of the birds fed cassava grit supplemented with moringa leaf meal. The highest digestible crude fibre recorded among birds fed 100% parboiled sundried taro cocoyam meal could be as a result of the high fibre content of the basal diet as cocoyam is known to be high in fibre (Apata and Babalola, 2012). This finiding is in line with the report of Aguihe et al., (2015) who reported a significant variation in the digestible crude fibre of broiler chickens fed cassava peel meal based diet with enzyme Maxigrain® supplementation. Higher ash content recorded in control comparable to those on 50% PSCM may be attributed to the presence of minerals, indicating that PSCM may be a potential source of minerals. This observation agreed with the reports of Gernah et al.,(2007) who reported that LBP was a good source of minerals required by the body. The significant variation in the ether extract content with higher value recorded among birds on 50% PSCM comparable to those on control could be due to the high energy value of the basal diet and maize. The finding is supported by the report of Aguihe et al., 2015. The better apparent digestibility of NFE recorded among birds placed on 50% PSCM may be due to the high energy content of the dietary treatment which agrees with the report of (Eguaoje and Okosun, 2017).

Conclusion

It is therefore concluded that parboiled sundried taro cocoyam meal (PSCM) could replace 50% of maize in broiler starter diet without any deleterious effect on nutrient utilization.

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FEED INTAKE AND APPARENT NUTRIENT DIGESTIBILITY OF SORGHUM (*Sorghum bicolor*) HUSKS AND COWPEA *(Vigna unguiculata)* HAULMS BY TWO GOATS BREEDS

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Abstract

A 2x2 factorial experiment involving two breeds of goats (Red Sokoto and Red Sokoto X Sahel goat which last for eight (8) days was conducted to determine the effects of breeds on feed intake and digestibility of sorghum husk(SH) and cowpea haulms(CH). Eight goats with an average weight of 18-23kg were arranged in completely randomized design. The animals were divided into four treatments (T) groups. T1 comprising of Red Sokoto (RS) goats fed soghum husk while T2, T3 and T4 were Red Sokoto X Sahel (RSXS) goats fed sorghum husk, RS fed cowpea haulms and RSXS goats fed cowpea haulms respectively. Chemical (dry matter, crude protein(CP), ether extract and Ash contents, Non fibre carbohydrates(NFC), Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent lignin (ADL) Hemicellulose and Cellulose) analysis and apparent digestibility coeffeicients of the forages were determined according to appropriate procedures A.O.AC (2000) and Van Soest *et al.* (1991) respectively. The results of chemical analysis showed significant ($P<0.05$) difference in all the parameters examined, except on dry matter, acid detergent fibre (ADL) and Cellulose components between the two forages. The digestibility results of the forage (Sorghum husk and Cowpea haulms) showed no significant ($P>0.05$) difference among the breeds parameters measured except on NFC, Ash, CP and Hemicellulose. The study concluded that there is no significant effect of breeds on digestibility parameters except hemicelluloses where RSXS goat recorded significantly higher values over RS goats. RS goats have better digestibility sorghum crude protein over the RSXS.

Keywords: Goats, Breed, Digestibility, Sorghum, Cowpea

Introduction

One of the challenges in the availability and utilization of forages for livestock production is their high fibrous nature and lower values of protein, energy mineral and vitamin components which results to decrease in their intake and digestibility (Bello and Tsado, 2014). The role of cowpea as a fodder in animal diets can never be over-emphasized because of their role as an available high quality legume hay in livestock diets in the whole world (Coulibaly *et al*., 2009).Cowpea residues utilization as supplemental fodder in animal production was reported by Singh et al., (2006). Sorghum husk or crop residues is the by –product left after the seeds are collected. The residues are usually burned out in the field in order to clear and clean the land from possible pest infestation hazard in the residues. (Abdalla and Yagoup,1997). The variations on the ability of different goat breeds to digest feed resources had necessitated a research with the objective of determining the effects of breed on feed intake and apparent nutrient digestibility values of Sorghum husks and Cowpea haulms.

Materials and Methods

Study area, sample collection and processing

The study was conducted at the Teaching and Research Farm and Laboratory of the Department of Animal Production, Federal University of Technology Minna. Minna is located at the Southern Guinea Savanna zone on latitude 9^o 31 and 9^o 42 North and Longitude 6^o 29 and 6^o 41 East with annual rainfall range f 1,200 – 1,300 mm and temperature range of 38^0 – 40^0 C. the area has an altitude of 1,475m above sea level, and is characterized by two seasons, the wet season (April – October) and dry season)Novermber - March)

(NSADP, 1995). The samples of Sorghum husk and Cowpea haulms were collected from the farms around University, cleaned, sundried and milled to pass 1mm sieve for chemical analysis.

Chemical analysis

Proximate composition: The dry matter, crude protein, ether extract and Ash contents of the milled grass sample were determined according to A.O.A.C. (2000). Non-fibre carbohydrate was calculated as NFC = 100 - (CP+Ash+EE+NDF)**.**

Fibre fraction analysis: Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent lignin (ADL) of the milled grass sample were determined with the procedure of Van Soest *et al.* (1991). Cellulose content was taken as the difference between ADF and ADL while hemicellulose content was also calculated as the difference between NDF and ADF.

Experimental design

A 2x2 Factorial experiment involving two breeds of goats (RS and RSXS) and two forages (Sorghum husk and Cowpea haulms) was arranged in a Completely randomized design using A totoal number of Eight (8) goats of average weights of 18-23kg. The animals were allotted into four treatment groups and fed with the diets at 4% of their body weight. There were two goats per treatment and one goat per replicate. T1 comprises of Red Sokoto (RS) fed soghum husk while T2, T3 and T4 were Red Sokoto X Sahel (RSXS) fed sorghum husk, RS fed cowpea haulms and RSXS fed cowpea haulms respectively.

Nutrient digestibility trial

The animals were introduced into metabolism crates for an eight (8) day digestibility trial. The collection of faecal samples from each was done for five (5) days after three (3) days of adaptation period in the metabolism crates. During the collection period, the quantity of feed not consumed was subtracted from the quantity of feed given. The voided faeces were collected, weighed and well labeled recorded for each animal daily for chemical analysis. After five (5) consecutive days faecal samples from each goat were pooled and then oven dried at 105^0C for twenty four (24) hours until constant weights are obtained from the samples. Ten (10) percent of each sample were taken and store in polythene bags. The pooled samples of dried faeces were ground and screened through a 1 mm sieve and awaiting chemical analysis.

$$\text{Apparent nutrient digestibility (\%)} = \frac{\text{Nutrient in feed} - \text{Nutrient in Faeces}}{\text{Nutrient in feed}} \times 100$$

Statistical analysis

Data generated from proximate compositions was analysed using student t. test while those on apparent nutrient digestibility were subjected to analysis of variance (ANOVA) procedure of SAS (2008). Significant Means were separated using Duncan Multiple Range Test (Duncan,1995) of the same software package.

Results and discussions

Table 1 revealed the proximate and fibre compositions of sorghum husk and cowpea haulms fed to RS and RSXS. The results showed significant ($P<0.05$) differences in all the parameters examined, except on dry matter, acid detergent fibre (ADL) and Cellulose components of the forages. Cowpea haulms had significantly ($P<0.05$) higher Crude protein (CP), Ether extract (EE), Ash contents than sorghum husk. Meanwhile, the non fibre carbohydrates (NFC) acid detergent fibre(ADF) and hemicelluloses contents of sorghum husk is significantly higher than cowpea haulms (table 1). The higher crude protein values of cowpea haulms emphasized the importance of cowpeas in ruminant diets as they are seen as nitrogen and mineral supplement to enhance fermentative digestion and microbial growth efficiency in the rumen of ruminants fed on poor quality forage (Leng *et al.* 1992).

Table1: Proximate and fibre compositions of sorghum husk and cowpea

haulms fed to Red Sokoto (RS) and Red Sokoto X Sahel (RSXS) goats

Parameters (%)	Sorghum husk	Cowpea haulms	SEM	LOS
Dry matter	95.17	93.00	0.72	NS
Crude protein	5.15[b]	21.30[a]	2.44	**
Ether extract	5.00[b]	8.83[a]	0.67	**
Ash	5.67[b]	8.17[a]	0.45	**
NFC	23.18[a]	18.04[b]	1.14	**
NDF	61.00[a]	43.67[b]	2.68	**
ADF	36.33[a]	33.00[b]	0.75	**
ADL	11.33	9.00	0.67	NS
Hemicellulose	24.67[a]	10.67[b]	2.27	**
Cellulose	25.00	24.00	0.70	NS

ab= means on the same row having different superscript differs significantly($P<0.05$); SEM= standard error of means; LOS= level of significance; NS= not significantly different ($P>0,05$); NFC= non fibre carbohydrates; NDF= neutral detergent fibre; ADF= acid detergent fibre; ADL= acid detergent lignin

Total feed intake and digestibility of sorghum husk and cowpea haulms by Red sokoto (RS) and Red Sokoto X Sahel (RSXS) goats is presented in table 2. The digestibility results of the forage (Sorghum husk and Cowpea haulms) showed no significant ($P>0.05$) difference in all of the parameters measured among the two breeds except in NFC, Ash, CP and hemicellulose. However, RSXS was observed with significant ($P<0.05$) higher values of digestible NFC of sorghum over the Red Sokoto goats. Similarly, the digestibility values of hemicellulose component of cowpea showed significant higher values in the RSXS goats over the RS goats. This variation could be attributed to the effects of breeds. The CP digestibility of Sorghum had significantly higher values in RS than RSXS goats. this possibly could be due to the inherent breed differences or environmental adaptation as have earlier been reported by Tuah *et al*. (2005). The lower feed intake and digestibility values recorded in animals that were fed Sorghum husk may be attributed to the presence of an antinutritional factor. Olomu (1995) and D'Mello, (2000) reported that dhurrin is a cyanogenic glucoside located mainly in the aerial shoot of sorghum plant which on enzyme action readily yields hydrogen cyanide (HCN).

Table 2: Total feed intake and digestibility of sorghum husk and cowpea haulms by Red sokoto (RS) and Red Sokoto X Sahel (RSXS) goats

Parameters	T1	T2	T3	T4	SEM	LOS
Total feed intake(g/kg)	2696.42	2797.90	3493.78	3355.06	153.50	NS
Dry matter(%)	77.06[b]	81.40[b]	87.53[a]	89.32[a]	1.29	**
Crude protein(%)	80.60[b]	64.91[c]	93.81[a]	92.54[a]	2.51	**
Ether extract(%)	81.00[b]	84.61[b]	92.06[a]	93.89[a]	1.41	**
Ash(%)	39.69[b]	71.34[a]	66.98[a]	72.17[a]	3.67	**
NFC(%)	80.57[c]	85.38[b]	92.79[a]	91.21[a]	1.24	**
NDF(%)	78.82[c]	82.28[bc]	86.91[ab]	89.69[a]	1.14	**
ADF(%)	78.24[b]	80.37[b]	86.39[a]	87.51[a]	1.15	**
ADL(%)	75.14[b]	84.68[ab]	83.29[ab]	86.21[a]	1.78	**
Hemicellulose(%)	79.52[c]	84.96[bc]	87.76[b]	97.37[a]	1.72	**

Cellulose(%)	79.26[b]	78.15[b]	86.95[a]	87.74[a]	1.15	**

abc= means on the same row having different superscript differs significantly(P<0.05); SEM= standard error of means; LOS= level of significance; NS= not significantly different (P>0,05); NFC= non fibre carbohydrates; NDF= neutral detergent fibre; ADF= acid detergent fibre; ADL= acid detergent lignin; T1=Red Sokoto fed on Sorghum husk; T2= Red Sokoto X Sahel goat fed on Cowpea haulms; T3=Red Sokoto fed on Cowpea haulms and T4=Red Sokoto X Sahel goat fed on Cowpea haulms

Conclusion

Based on the results of this research, it can be concluded that

The digestibility of the various components of cowpea haulms were not significantly affected by breeds except on hemicelluloses where RSXS differs significantly over RS.

RS is found with significantly better digestibility of crude protein over the RSXS.

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SENSORY AND QUALITY EVALUATION OF CHEVON FROM RED SOKOTO BUCKS FED DIFFERENT PROTEIN SOURCES

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Abstract
Sensory attributes and meat quality from red Sokoto bucks fed various protein sources including cotton seed cake (CSC), poultry litter (PL), rossel seed cake (RSC) and brewers dried grains (BDG) based diets were determined in this study. Meat from the experimental animals were sampled and cooked unseasoned to determine their quality and sensory attributes these include: colour, flavour, texture, juiciness, tenderness and overall acceptability. Untrained panelists were used to assess the meat samples using nine-point scoring scale and subjected to analysis in a complete randomized design. Sensory panelist scores indicated that meat from bucks fed CSC based diet ranked ($P<0.05$) highest in terms of all the sensory attributed studied, which was followed by the other protein sources, while the aroma sensorial characteristic, CSC was significantly ($P<0.05$) higher, followed by those fed PL and BDG, which were similar and the least was in the treatment fed RSC diet (3.52). Meat from bucks fed CSC was rank ($P<0.05$) highest, followed by those fed RSC and PL and the least was those fed BDG in terms of acceptability. Oil seed cakes based diet had high ($P<0.05$) meat color, followed by those fed PL and BDG also fatness followed similar pattern. While for the firmness, CSC and RSC had similar and higher ($P<0.0$) values, which was followed by BDG and the least was in bucks fed PL. Textural evaluation revealed that both CSC and RSC had higher ($P<0.05$) values, which were similar, followed by those fed BDG and the least was recorded in PL. From the result of this study, it has shown that diet has effect on the quality of meat from farm animals. CSC in this study has affected the quality of the meat over the other protein sources.
Keywords: meat quality, protein sources, red Sokoto

Introduction
The demand for quality meat is growing due to increase in both the total human population and per capita consumption of meat due to the improvement in the living standard of many people worldwide (Sharaf Eldin *et al*., 2013). The use of various alternative feed protein sources have been reported by (Partida *et al*., 2007) to have a significant effect on tenderness, fibrosity, and acid flavour. Also Françozo *et al*. (2013) replaced corn by glycerin diet and found that replacement failed to affect beef color, texture, cooking loss, chemical composition and percentage of fatty acids.

Françozo *et al*. (2013) reported a complicating result, when corn was replaced by glycerin in diet of cattle and found that replacement failed to affect beef color, texture, cooking loss, chemical composition and percentage of fatty acids. This study aimed at evaluating sensory and Quality of Red Sokoto Bucks meat (Chevon) Fed Different Protein Sources.

Materials and Methods
Experimental site
The study will be carried out in the Teaching and Research Livestock Farm (Small Ruminant Unit) and Animal Product Laboratory (for the meat product components) of the Department of Animal Science at Ahmadu Bello University Zaria, located between latitude 11` and 12` on an altitude of 640m above sea level (GPS, 2018). The area falls within the Northern-Guinea Savannah zone of Nigeria, having an average annual rainfall of 1100mm. the maximum temperature varies from 26^0C to 35^0 C depending on the season, while the mean relative humidity during the harmattan period and the wet season are 21% and 72% respectively (IAR, 2018)
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Experimental Animals and Management

Red Sokoto bucks fed dietary treatment of protein from different sources cotton seed cake (CSC), poultry litter (PL), rossel seed cake (RSC) and brewers dried grains (BDG) (Table 1), which at the end of the feeding trial were evaluated for carcass characteristic traits. The animal management was based on the care and handling procedures approved by the Ahmadu Bello University Committee on Animal Use and Care (ABUCAUC) which strictly adheres to the International Standards on Animal Use and Care (Amenan *et al.,* 2018).

Table1. Gross composition of diets fed to red Sokoto bucks

Ingredients	CSC	PL	RSC	BDG
Maize offals	27.75	30.75	30.75	27.75
Protein sources	23	20	19	23
Rice offal	17	17	17	17
Cowpea shell	30	30	30	30
Common salt	0.5	0.5	0.5	0.5
Bone meal	1.5	1.5	1.5	1.5
Premix	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**

Slaughtering and Sampling

At the end of the experiment, all the bucks were tagged and transported to Animal Science Department Animal Product Laboratory. Animals were slaughtered after a 12 h fast according to the Halal procedure, to evaluate carcass characteristics and meat quality. The animals were processed by trained personnel using standard slaughter procedures (Abdullah *et al.,* 1998). Fasted live weight was recorded immediately before slaughter and hot carcass weight was recorded after slaughter. Meat samples were collected from the each of the treatments by cutting approximately 2 kg from rump of one left side of the halved carcasses for the sensory evaluation. All samples were cut into chops of approximately and cooked in water without seasoning.

Sensory and Quality Evaluation

A total of forty semi-trained individual panelists were of mixed sex (males and females) and of unequal numbers. The panelists rated each of the meat samples using an 9-point hedonic scale; (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much and 1 = dislike extremely) (AMSA, 1978) for meat quality attributes; flavor, moistness, appearance, tenderness and overall acceptability using a well-structured consumer sheet.

Statistical analysis

All data collected were transformed and subjected to analysis of variance (ANOVA) using (SAS 2008) and treatment mean that will be significant will be compared using DMRT of the SAS package. The following Model will to be used

$$\mathbf{Y_{ij} = \mu + T_i + e_{ij}}$$

Where Y_{ij} = Any dependent variable, μ = Overall mean, T_i = Effect of treatment (protein sources CSC, PL, RSC, BDG), e_{ij} = Random error.

Results

Table 2 shows the sensorial characteristics of meat obtained from red Sokoto bucks fed different protein sources. Sensory panelist scores indicated that meat from bucks fed CSC based diet ranked ($P<0.05$) highest in

terms of all the sensory attributed studied, which was followed by the other protein sources, while the aroma sensorial characteristic, CSC was significantly (P<0.05) higher, followed by those fed PL and BDG, which were similar and the least was in the treatment fed RSC diet (3.52). In terms of acceptability, meat from bucks fed CSC was rank (P<0.05) highest, followed by those fed RSC and PL and the least was those fed BDG.

Table 2. Meat sensory attributes from bucks fed protein from different sources

Protein Sources	Tenderness	Juiciness	Aroma	Acceptability
Cotton Seed Cake	4.00[a]	4.0[a]	4.30[a]	3.37[a]
Poultry Litter	3.10[b]	3.95[a]	3.77[b]	3.30[ab]
Rossel Seed Cake	3.22[b]	3.70[b]	3.52[c]	3.175[b]
Brewers Dried Grain	3.25[b]	3.17[c]	3.87[b]	2.90[c]
SEM	0.038	0.032	0.03224	0.03

[abc] Mean with different superscript along column differ significantly 0.05%, SEM = standard error of means

Subjective evaluation of meat quality is presented in Table (3). Meat from bucks fed oil seed cakes based diet had high (P<0.05) meat color, followed by those fed PL and BDG also for the fatness it follow similar pattern. While for the firmness, CSC and RSC had similar and higher (P<0.0) values, which were followed by BDG and the least was in bucks fed PL. Textural evaluation revealed that both CSC and RSC had higher (P<0.05) values, which were similar, followed by those fed BDG and the least was recorded in PL.

Table 3. Meat quality attributes from bucks fed protein from different sources

Protein Sources	Colour	Texture	Firmness	Fatness
Cotton Seed Cake	3.70[a]	3.32[a]	3.87[a]	3.75[a]
Poultry Litter	3.25[b]	2.60[c]	3.72[c]	3.42[b]
Rossel Seed Cake	3.62[a]	3.15[a]	3.90[a]	3.67[a]
Brewers Dried Grain	3.25[b]	3.05[b]	3.82[b]	3.37[b]
SEM	0.049	0.036	0.03	0.032

[abc] Mean with different superscript along column differ significantly 0.05%, SEM = standard error of means

Discussion

The higher juiciness of meat from the CSC based diet could be attributed to the increased fat content of the muscle. Similar result has been reported by Sharaf Eldin *et al*., 2013) in cattle. The result of this study shows that feed influence aroma, Resconi *et al.* (2010) revealed that beef flavour intensities are influenced by the content of the diets and that species-specific flavours were associated with the concentrates proportion in the diet of farm animals, however this is at variance with the earlier findings of (Hedrick *et al*., 1969) who reported that flavour intensity could be more affected by sex rather than fatness or age. The acceptability of the meat from the CSC based is in line with the report of (Conforth, 1994), who observed that consumers use meat colour to assess meat quality and acceptability.

The more bright color of meat from the CSC and RSC as compared with meat from the other protein sources could be due to the increased fat disposition content, as can be seen in the level of fatness in the oil seed cake group as fat increases brightness of meat color. Similar result has been reported by (Sharaf Eldin *et al*., 2013) in cattle. The reason for the higher score for the CSC texture is because of the fatness, as increased muscle fat content was reported to dilute the connective tissue content of the muscle and thus increasing its tenderness

(Lawrie, 1991). Also the result of the fatness in this study agrees with the findings of (Raes *et al*., 2003), who reported fatness to be due to the influence of nutritional as well as genetic factors

Conclusion and Recommendation

From the result of this study, it has shown that diet has effect on the quality of meat from farm animals. CSC in this study has affected the quality of the meat over the other protein sources. It therefore recommend that when choosing feed ingredients for feed formulation by feed miller and farmers, it is therefore highly important to consider differences in intrinsic factor among feed ingredients, some will impact negative effect on product. Also it is highly important to consider differences among consumers.

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PERFORMANCE EVALUATION OF STARTER BROILERS FED PALM KERNEL SHELL ASH AS A MINERAL SUPPLEMENT

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ABSTRACT

This study was carried out to determine the effect of partial replacement of bone ash with palm kernel shell ash (PKSA) supplementation on broilers at their starter stage. Ninety six Arbor Acre day old chicks were randomly assigned in triplicates of eight birds per replicate to four experimental diets containing graded levels of PKSA at 0, 5, 10 and 15kg/ton of feed corresponding to T1-T4 respectively as partial replacement for bone meal. Proximate and mineral compositions of the experimental feeds were evaluated while performance characteristics were determined at 28 days (starter phase). Results obtained showed that all the growth performance characteristics evaluated were similar up to T3 beyond which a decline was recorded. Thus, PKSA supplementation up to 10kg/ton of feed as partial replacement for bone meal gave similar results as the control diet and could therefore serve as potential sources of absorbable mineral supplements in commercial diets offered to broilers.

Key words: Palm kernel shell, plant ash, performance.

INTRODUCTION

Several studies have suggested that the adoption of non- conventional feed resources (NCFR) as feed ingredient in livestock nutrition, may be the panacea to the increasing cost of feeds and animal protein due to the over dependence of the industry on conventional feed resources. However, while most of the researches on alternative feed resources have focused majorly on protein and energy contents, limited efforts have been made towards identifying alternative mineral sources especially calcium and phosphorus for poultry. Minerals are dietary essential to all classes of livestock and therefore perform structural, physiological, catalytical and reproductive functions in animals (Suttle, 2010). Despite the advantages associated with the use of rock or inorganic mineral substances (calcium phosphates, phytase etc.), as additives for intensively farmed poultry, their high costs unfortunately makes them unavailable and not readily accessible to small-holder farmers that make up the bulk of poultry farmers in low income countries like Nigeria (Ohanaka *et al.*, 2018b). Other sources such as bone meal, oyster shell, and even eggshell although cheaper, are not readily available due to its low output (Alu, 2013).

Plant ash from different sources have lately been reported as good source of absorbable mineral supplement in the diets of pullets (Okoli *et al*., 2014) and in growing rabbits (Iwu *et al*., 2013). Similarly, charcoal and (Majewski *et al*., 2011), and even firewood ash (Saccomani *et al*., 2016) have been reported to successfully replace limestone in broiler diets.

Palm kernel shell is a readily available agricultural industry residue that has found limited application in the Nigerian industry. It is currently used as biofuel in palm oil processing operations and the ash residue is discarded as waste material. Recent studies using ash derived from palm kernel shell have highlighted its potentials as a mineral supplement in broiler production which caused increased GIT development in chicks (Ohanaka *et al*., 2017; Ohanaka *et al*., 2018a) and improved intestinal uptake of Ca, Na, Mn, Fe and P as reflected by their reduced concentrations in the faeces (Ohanaka *et al.*, 2018b).

It is therefore expected that PKSA will be a potential mineral source and may successfully replace intact plant, animal and rock mineral sources in the broiler diets when properly processed.

MATERIALS AND METHODS

Collection and Preparation of Palm Kernel Shells

The palm kernel shells (PKS) were collected from a local oil mill, washed with water, sun – dried, weighed and ashed in a bread oven after which the resultant product was ashed again using a porcelain pot till the ash produced became red hot (Iwu *et al*., 2013).

Experimental animals, diets and design

96 Abor acre day old chicks were purchased from a reputable local hatchery and were divided into four groups of 24 birds with each of the group further replicated three times with 8 birds per replicate in a completely randomized design. The birds were managed intensively as practiced at the Teaching and Research Farm of Federal University of Technology Owerri. The birds were assigned to four treatment diets containing graded levels of PKSA at 0, 5, 10 and 15kg/ton of feed corresponding to T1-T4 respectively to partially replace graded levels of bone meal in the diets. Each sample of the diet was subjected to mineral analysis using the method of AOAC, (1995).

Table 1: Nutrient composition of the PKSA based diet for broiler chicks

Ingredients g/100g	T1	T2	T3	T4
Maize	52.00	52.00	52.00	52.00
Soya bean meal	12.00	12.00	12.00	12.00
Groundnut cake	20.00	20.00	20.00	20.00
Palm kernel cake	2.95	2.95	2.95	2.95
Fishmeal	4.00	4.00	4.00	4.00
Wheat offal	4.00	4.00	4.00	4.00
Bone meal	4.00	3.50	3.00	2.50
Salt	0.30	0.30	0.30	0.30
Vitamin Premix	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25

PKSA	0.00	0.50	1.00	1.50
Total	100	100	100	100
Calculated chemical	composition	of diets		
Crude Protein	22.64	23.14	22.86	22.74
Ether Extract	4.66	5.01	5.36	5.71
Crude fibre	4.56	4.56	4.56	4.56
Calcium	1.73	1.91	2.09	2.29
Phosphorus	1.25	1.34	1.41	1.46
Metabolisable energy (ME, kcal/kg)	3175.09	3118.20	3011.92	3128.00

Vitamin premix contains the following per kg of feed: Vit A = 5,000,000IU, Vit D3 = 1,000,000IU, Vit E = 1875IU, Vit K = 1255gm, Thiamin (B1) = 0.6255gm, Riboflavour = 1.875gm, Calcium panthothenate = 2.8kg, Nicotinic acid = 5.625gm, Pyridoxin = 0.625gm, Vit B12 = 5gm, folic acid = 0.31gm, Biotin = 0.1gm, Cholin chloride = 150gm, methionine = 75gm. Manganese = 5gm, Iron = 10gm, Copper = 1.5gm, Iodine = 0.5gm, Cobalt = 1.0gm, Selenium = 0.05gm, Antioxidiane 50gm, Antimold = 7.5gm, Nigrovin = 10gm, lysine = 75gm.

Table 2: Proximate and Mineral Compositions of PKSA based Diets in Starter Broiler Feeds

Parameters	**T1**	**T2**	**T3**	**T4**	**Mean**	**SD**	**CV(%)**
Dry matter content (%)	82.30	86.00	82.80	87.70	84.70	2.58	3.04
Moisture content (%)	17.70	14.00	17.20	12.30	15.30	2.58	16.86
Crude protein (%)	21.51	20.07	23.94	22.50	22.00	1.63	7.41
Ether Extract (%)	0.51	1.26	0.56	0.67	0.75	0.35	46.66
Ash (%)	7.59	5.44	6.22	6.74	6.50	0.90	13.84
Crude fibre (%)	9.3	5.32	10.33	9.33	8.57	2.21	25.78
ME kcal/kg	2081	2428	2124	2295	2232	160.05	7.17
Macro minerals							
Calcium (mg/kg)	72.31	63.44	58.64	60.25	63.66	6.10	9.58
Magnesium (mg/kg)	125.34	73.11	155.28	73.54	106.81	40.55	37.96
Potassium (mg/kg)	296.35	280.01	303.26	275.10	288.68	13.30	4.61
Sodium (mg/kg)	71.23	76.35	82.24	76.51	76.58	4.49	5.86
Phosphorus (mg/kg)	173.07	136.89	158.84	109.05	144.46	27.90	19.31
Micro minerals							

Manganese (mg/kg)	3.26	3.01	3.15	2.44	2.96	0.36	12.16
Iron (mg/kg)	14.91	12.35	16.32	14.23	14.45	1.64	11.35
Copper (mg/kg)	0.34	0.86	0.32	0.69	0.55	0.26	47.27
Zinc (mg/kg)	2.99	2.46	2.84	3.12	2.85	0.28	9.82
Mineral ratios							
Ca/P ratio	0.42	0.46	0.37	0.55	0.45	0.08	17.77
Na/K ratio	0.24	0.27	0.27	0.28	0.27	0.02	7.41

ME = Metabolizable energy, SD = Standard deviation, CV = Coefficient of variation

Performance Determination

The birds initial live weights were ascertained at day 0 and their final weights measured at day 28 of the experiment. Also measured were, feed intake, weight gain, and average daily weight gain and feed conversion ratio (FCR).

Data Analysis

Data obtained were subjected to analyses of variance using SPSS Users Guide, version 20.0 (SPSS, 2012) and the differences between the treatment means were compared using the Duncan Multiple Range Test.

Results and Discussion

The performance data of chicks subjected to 28 days feeding with the experimental diets are presented in table 2. It was observed that by the end of the 4 weeks starter period, T2 and T3 birds had averaged similar growth performance values with T1 especially in final body weight, weight gain, average daily weight gain and average daily feed intake. This is expected following the 7th day growth performance results earlier reported by Ohanaka *et al*. (2018). Specifically, the values generated from T1 – T3 were statistically similar ($p>0.05$) and significantly different from the T4 values ($p<0.05$) with FCR values following the same trend. The reduction in growth parameter values beyond T3 may have been due to the reduced feed intake observed in birds with the highest inclusion level of PKSA in their diet. Earlier studies have shown that feed intake and weight gain decreases with increasing levels of plant ash in the diets of rabbits (Iwu *et al*., 2013) and pullets (Nwogu *et al*., 2014). This may be due to some imbalance in the dietary electrolyte content of the T4 diet (Unamba-Opara *et al*., 2017). According to Mongin (1981) there is a critical effect of changes in the acid – base balance and imbalances in $Na^+ + K^+ - Cl^-$ of a diet on appetite, with reduction in weight gain, affecting FCR and mortality rate if not corrected. Dietary electrolyte balance (DEB) has a crucial role in broiler performance, and it is required for proper bone development and litter quality (Oliveira *et al.*, 2010). In the present study we did not calculate DEB of the experimental diets due to the fact that the Cl^- contents of the feeds could not be assayed (lack of laboratory facility). However, the increasing addition of PKSA to the diets probably altered the DEB of the diets leading to poor appetite, especially in the T4 birds.

Table 3: Performance of broiler chicks fed starter diets supplemented with PKSA

Parameters	T1	T2	T3	T4	SEM
Initial weight(g)	39.93	38.63	38.53	39.90	1.38

Final weight (g)	848.79[a]	834.31[a]	793.03[a]	693.12[b]	20.6
Weight gain(g)	808.86[a]	795.68[a]	754.50[a]	654.22[b]	19.95
Avg. daily weight gain(g)	28.89[a]	28.42[a]	26.94[a]	23.36[b]	0.71
Feed intake (g/bird/day)	49.34[a]	51.53[a]	48.19[ab]	44.66[b]	0.93
Feed conversion ratio (FCR)	1.71[b]	1.81[b]	1.79[b]	1.91[a]	0.09
Growth efficiency ratio (GER)	1.34	1.50	1.53	1.39	

Means with different superscript on the same horizontal row are significantly different @ ($p<0.05$)

Conclusion and Recommendation

All the performance characteristics evaluated were similar up to T3 beyond which a decline was recorded. Therefore, the inclusion of PKSA up to T3 in starter broiler diets is nutritionally safe and could therefore serve as an alternative source of mineral for house hold poultry producers.

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SHORT TIME CRYOPRESERVATION OF INDIGENOUS CHICKEN *Gallus gallus domesticus* SPERMATOZOA USING REFRIGERATOR

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Abstract

The cryopreservation technique of poultry sperm cells are still challenging. In this study, the cryopreservation of sperm cells of local chicken *Gallus gallus domesticus* was carried out using different cryoprotectants and extenders viz: Hank's Balance Salt Solution (HBSS), Phosphate Buffer Solution (PBS), Ginzburg Fish Ringer (GFR), Dimethyl Sulfoxide (DMSO), Glycerol, RPMI, Quail Egg Yolk (QEY) and Chicken Egg Yolk (EY). Sperm collection was obtained by massage method while the fresh and cryopreserved sperm cells (at 4^oC) were evaluated through motility and counting hours of 24, 48, 60, and 72. Results showed that the motility and sperm concentration of freshly collected sperm recorded 70% and 1.353×10^9 spermatozoa/ml respectively, while there were decrease in sperm motility and live sperm count as the preservation hours increased. However, cryoprotectants such as QEY+ GFR, HBSS+QEY, HBSS+EY, HBSS less Calcium + QEY serve as the best cryoprotectants. Hence, these cryoprotectants can be employed by the farmers in order to conserve genetic resources of male chicken for short term preservation.

Keywords: cryopreservation, sperm motility, sperm count

INTRODUCTION

Cryopreservation is the freezing of tissues or cells to preserve them indefinitely for future use. Presently, the cryopreservation of poultry sperm is still a challenge due to its low survival and motility. Blanco *et al*. (2000) reported that artificial insemination with frozen-thawed poultry sperm produces fewer fertile eggs than insemination with fresh semen. The essence of cryopreservation is to protect and preserve the biodiversity of species and genetic improvement. Therefore, successful cryopreservation of cock sperm will play an important role in the preservation of chicken biodiversity.

Cryoprotectants are chemicals that dissolve in water and lower the melting point of water. For applications outside cryobiology, such chemicals are sometimes called "antifreeze." They are also chemicals that protect living things from being injured by water freezing during exposure to cold. Cryoprotectants protect cells from damage caused by ice crystals, and some of the advances that have been made in the design of cryoprotectant solutions. Penetrating cryoprotectants are small molecules able to cross cell membranes. The role of penetrating cryoprotectants is to reduce ice growth and reduce cell dehydration during freezing. The common examples are glycerol, ethylene glycol, propylene glycol, and Dimethylsulfoxide (DMSO). Semen extender is a liquid diluent added mixed with semen to preserve its fertilizing ability. The extender allows the semen to be freighted to the female, rather than requiring the male and female to be near to each other. Special freezing extender use also allows cryogenic preservation of sperm ("frozen semen"), which may be transported for use, or used on-site at later date.

Domestic fowls *Gallus gallus domesticus* are the most important of all poultry birds. They have short generation interval when compared to most farm animals (Jennen *et al*., 2005) thereby making their

genetic improvement easier and faster. They have played an important role in economic development, poverty alleviation, malnutrition and hunger reduction among the resource poor rural households in developing countries, This is due to their low input requirements for production, short generation intervals, scavenging ability and adaptability to harsh environment conditions (Besbes 2009).

The conservation and use of indigenous animals under low level of input in the tropics are usually more productive and better than the exotic breeds. The locally adapted animals are also readily available to resource poor farmers and they can be productive without high disease-control inputs. The utilization and conservation of these indigenous genetic resources are of paramount (NRC, 1993). Lack of information about the management practices in the local chicken production has led to their underutilization.

The possibility of dilution and storage of local chicken sperm would make the work of poultry breeders much easier, enabling them to transport semen even to distant farms, to inseminate large groups of females, and to improve the utilization of sperm from superior Cock. The most common procedure for short term fowl semen storage (hours to days at refrigerator temperature) requires suspending sperm in an extender to retain their viability in vitro. Comparison of diluted and diluted stored sperm showed that applying extenders is necessary to sustain good quality sperm (Bilgili, Sexton and, Renden; 1987; Lukaszewics, 1988). Therefore, this study aimed at the protection of the biodiversity and improvement of indigenous or local chicken through cryopreservation of the sperm cell.

Materials and Methods

Location: The research was carried out at Biotechnology Laboratory, Department of Animal science, Obafemi Awolowo University, Ile-Ife.

Preparation of reagents: The following chemicals were used in preparation of the cryoprotectants and extenders:

i) Hank's Balance Salt Solution which contain g/100ml of the following components: 0.008 of Nacl, 0.403 of KCl, 0.0036 of Na_2HPO_4, 0.0060 of $KH2PO_4$, 0.0144 of $CaCl_2$, 0.0506 of $MgSO_4$ and 0.0353 of $NaHCO_3$; ii) Phosphate Buffer Saline containing g/100ml of the following components: 0.08 of Nacl, 0.0002 of KCl, 0.0023 of $NaHCO_3$, 0.015 of Na_2HPO_4 and 0.002 of KH_2PO_4; iii) Ginzburg fish Ringer (GFR) containing g/100ml of the following components: 0.07 of NaCl, 0.0028 of KCl and 0.0033 of CaCl; iv) Dimethyl sulphate (DMSO); Glycerol; RPMI; Quail and Chicken egg yolk: 100ml of saline water was added to only the yolk and were mixed vigorously, and the mixture was centrifuge for 10 minutes)

Sample collection: The animals used for this study were three matured local Cocks at the Department of Animal Science, Obafemi Awolowo University, Ile-Ife, Nigeria. The local chickens were fed with chicken feed and water. Semen was collected using the abdominal massage method described by Burrows & Quinn (1937). The testes located at the dorsum were stroked and massaged until there was protrusion of the cloacae. The semen was then milked and collected using a rubber tube. The sperm collected were added to each of the extenders and cryoprotectant in table 1 above at 9:1 that is 90*u*l of cryoprotecant by 10*u*l of semen and kept inside the refrigerator for the respective durations.

Sperm motility: Sperm motility in fresh and extended semen at various durations of the cryopreservation are assessed microscopically.

To calculate the motility, general formulae used is

$$\text{Motility} = \frac{\text{no of motile cell}}{\text{Total number of cell count}} \times 100$$

Results and Discussion

Semen evaluation: The motility and concentration of the fresh sperm were respectively recorded 70% and 1.353 × 10^9 spermatozoa/ml. Table 1 shows the motility count of the local chicken sperm cell using different cryoprotectants, while table 2 shows the effect of cryopreservation on sperm motility and count based on time duration inside the Refrigerator at 4^{o}C. The sperm motility reduced as the hours increased and the rated was dependent on the type of cryoprotective agent used for the preservation of the fresh semen and this agrees with the result obtained by Dumpala *et al*. (2006) that the motility of sperm reduces after one hour of semen collection if stored *in vitro*.

At 24 hrs, the motility showed that the CPA (DP, QEY+P, QEY+F, RPMI+QEY, RPMI+EY, HBSS+QEY, HBSS+EY, HBSS-Ca+QEY, HBSS-Ca+EY, DF, EY+F, EY+P,GP) have the highest motility rate between the range of 20 to 40 in comparison to the CPA(GF and RPMI+D) that revealed lowest motility of range between 10 to 15.

At the 48 hrs, some of the semen in the CPA maintain the same motility while some decreased, some of them that maintain their motility are: CPA (GF, QEY+P, RPMI+EY, HBSS+EY, HBSS-Ca+EY, EY+F), CPA(DP, QEY+F, HBSS+QEY, RPMI+D, HBSS-Ca+QEY,DF,EY+P,GP) and decreased respectively: 25, 30, 25, 30, 12, 30, 25, 30, 30 and 10.

At the 72 hrs, some of the semen in the CPA are inactive and immotile such as CPA (QEY+P, QEY+F, RPMI+QEY, RPMI+EY, HBSS+EY, HBSS+QEY, HBSS-Ca+QEY).

Table 1. Motility count of the local chicken sperm cell using different cryoprotectant.

CPA	12 hrs	24 hrs	48 hrs	72 hrs
DP	35	25	25	
GF	10	10	0	
QEY+P	30	30	20	12
QEY+F	40	30	25	15
RPMI+QEY	35	25	20	10
RPMI+EY	25	25	25	10
HBSS+QEY	35	30	30	15
HBSS+EY	35	35	25	15
RPMI+D	15	12	0	
HBSS-Ca+EY	25	25	20	0
HBSS-Ca+QEY	35	30	20	10
DF	30	25	15	
EY+F	35	35	15	
EY+P	35	30	15	1
GP	20	10	5	1

Table 2. Evaluation of sperm motility and sperm count based on hours of storage in Refrigeration (4^o C)

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	Motility per hours (%)				*Live Sperm count/hours (spermatozoa/ml)*		
CPA	12	24	48	72	24 hrs	48 hrs	72 hrs
DP	35	25	25		$2.53X10^8$	$1.31X10^8$	
GF	10	10	0		$3.12X10^8$	$1.31X10^8$	$1.22X10^8$
QEY+P	30	30	20	12	$6.231x10^8$	$2.59x10^8$	$1.01x10^8$

QEY+F	40	30	25	15	$2.71X10^8$	$1.91X10^8$	$1.31X10^8$
RPMI+QEY	35	25	20	10	$4.12x10^8$	$4.0X10^8$	$2.21X10^8$
RPMI+EY	25	25	25	10	$2.81X10^8$	$2.81X10^8$	$1.91X10^8$
HBSS+QEY	35	30	30	15	$3.02X10^8$	$4.92X10^8$	$1.75X10^8$
HBSS+EY	35	35	25	15	$3.72X10^8$	$1.81X10^8$	$1.16X10^8$
RPMI+D	15	12	0		$8.04X10^8$	$1.71X10^8$	$1.41X10^8$
HBSS-Ca+EY	25	25	20	0	$4.02X10^8$	$1.20X10^8$	
HBSS-Ca+QEY	35	30	20	10	$5.31X10^8$	$3.32X10^8$	$1.91X10^8$
DF	30	25	15		$8.24x10^8$	$4.02x10^8$	$1.508X10^8$
EY+F	35	35	15		$4.42x10^8$	$1.47x10^8$	
EY+P	35	30	15	1	$5.33x10^8$	$1.38x10^8$	
GP	20	10	5	1	$3.72x10^8$	$1.31x10^8$	

Conclusion

In conclusion, the study shows that CPA (QEY+F, HBSS+QEY, HBSS+EY, HBSS-Ca+QEY) serves as the best cryoprotectant because some sperm cells were still active and motile. Therefore, short term cryopreservation can be practised by the farmers in order to conserve genetic resources of male animals.

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PERFORMANCE AND HAEMATOLOGICAL INDICES OF *Clarias gariepinus* FED GRADED LEVEL OF CRUDE ETHANOLIC EXTRACT OF *Gmelina arborea* LEAF MEAL DIET.

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ABSTRAC T

A twelve week trial was conducted to investigate the performance and haematological indices of juvenile Clarias gariepinus fed graded level of crude ethanolic extract of Gmelina arborea leaf. The proximate analysis of the experimental diets were determined using A.O.A.C (2000) method and the data for each parameter were subjected to analysis of variance (ANOVA) while the means of various results were compared at 5% level of significance. The ethanolic extract of the leaf was added to the experimental diet at 0%, 5%, 10%, 15% and 20% ratio respectively and were labelled T_1, T_2, T_3, T_4 and T_5. The result shows that fishes fed 15% ethanolic extract of Gmelina arborea Leaf meal (GALM) had the highest Red Blood Cell (RBC) count, Packed Cell Volume (PCV),Haemoglobin Concentration(Hb),White Blood Cell (WBC) count, globulin concentration Albumin concentration, Total protein and Total lipid concentration. This result indicated that inclusion of 15% ethanolic extract of Gmelina arborea leaf in the diets of fish can improve the growth performance and haematological indices of Clarias gariepinus without any adverse effect on their physiological status.

INTRODUCTION

The major factor militating against fish farming in Nigeria has been the high cost of fish feed ingredients particularly fishmeal and this has resulted in the dependence of fish farmers in Nigeria on imported quality fish feeds which are usually expensive (Omitoyin, 2007). An estimated 4,000 tons of quality fish feed are imported into the country each year (AIFP, 2000) and utilization of commercially formulated feeds increase the cost of production thereby reducing the profit margin of fish farmers. This ultimately translates to high cost of fish production. For instance, feed represents a high proportion (50-80%) of variable cost of production (Helfrich and Craig, 2002). In order to reduce this high cost of fish production, there is therefore the need to search for cheap alternative feed stuffs from unconventional sources. *Gmelina arborea* is one of such novel feed stuffs. Analysis of the leaf showed that it contains 11.9% crude protein and some anti-nutritive factors such as Tannin, Saponin, Alkaloids and Terpenoids (Wikipedia, 2014). The objective of the current study therefore was to assess the bioactivity of the crude ethanolic extract of *Gmelina arborea* leaf on the growth performance and haematological parameters of Africa Cat-Fish (*Clarias gariepinus).*

MATERIALS AND METHODS

Experimental site and leaf ethanolic extract preparation.

Gmelina arborea leaves were collected from the estate of Federal College of Wildlife Management, New Bussa, Niger-State Nigeria and were taken to the herbarium of Forestry Research Institute of Nigeria for authentication. The collected leaves were washed in sterile distilled water and were air dried for ten days until constant weight was obtained. 100g of the powered dried leaves was added into a conical flask containing one litre (1litre) of 99.5% ethanol and the conical flask was covered and left for another seven days (7 days) at room temperature with daily agitation. After seven days, the supernatant was removed and the ethanol was evaporated using a rotary evaporator; the residue was then freeze – dried using an instrument manufactured by Labconco USA and then stored in a sterile bottle as described by Harikrishnan et al, 2009.

Experimental diet formulation and processing

Five different diets were prepared using Pearson's method of fish feed formulation to contain 40% crude protein. The ethanolic extract of *Gmelina arborea* leaf was incorporated into the experimental diet at 0% (control), 5%, 10%, 15% and 20% to replace equal weight of fish meal. The feed ingredients were

grounded individually to a fine powder by using hammer mill and were individually weighed before incorporation into the experimental diets. The pelleted feed were air dried for three days to remove moisture content and to maintain the proximate composition as described by Eyo. A.A. (1994). Samples of experimental diets were analyzed for their proximate composition as described by A.O.A.C (2000).

Experimental design and feeding trials.

Two hundred African Catfish Juveniles (*Clarias gariepinus*) of average weight 32.69 ± 0.91g were purchased from the hatchery unit of National Institute for Freshwater Fisheries Research, New-Bussa, Niger State, Nigeria and were fed on commercial diet for three days to allow for acclimatization (Okoye and Sule 2001). Prior to the commencement of the experiment all the fish were starved for 24hours, this in order to eliminate variation in weight due to residual food in the gut and also to prepare the Gastrointestinal tract for the experimental diets while at the same time to increase the appetite of the fish. The initial weight of the fish and the initial mean length were measured with graduated rule and recorded. The experimental fishes were randomly allocated into five treatment diets (T_1, T_2, T_3, T_4 and T_5) in quadruplicate in 20 concrete tank at a stocking density of 10 (ten) fingerlings per tank. Subsequently total weight and standard length measurement were taken fortnightly and all the water quality parameters were fortnightly monitored.

Blood collection and haematological analysis

Blood samples were collected in triplicate samples following the procedure of Klontz and Smith (1968) and Wedemeyer and Yasutake (1977) into sterile sample bottles containing Ethylene Diamine Tetra-Acetic acid (EDTA) as anticoagulants and the collected blood samples were taken to National Institute of Science Laboratory Technology (NISLT) Samonda, Ibadan, Oyo State, Nigeria for haematological analysis.

Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) and the means were separated by Duncan's Multiple Range Test at a significant level of 0.05. All computation were performed using SPSS 15.0 (SPSS Inc., Chicago II U.S.A)

RESULTS

TABLE 1: Percentage composition of the experimental diet

Ingredients	T_1(0%GALM)	T_2(5% GALM)	T_3(10% GALM)	T_4(15% GALM)	T_5(20% GALM)
Fish meal	30.00	25.00	20.00	15.00	10.00
Soya beans meal	19.00	19.00	19.00	19.00	19.00
Groundnut cake	20.00	20.00	20.00	20.00	20.00
Maize	29.00	29.00	29.00	29.00	29.00
GALM	0.00	5.00	10.00	15.00	20.00
D.C.P	1.00	1.00	1.00	1.00	1.00
Vitamins premix[1]	0.50	0.50	0.50	0.50	0.50
Lysine	0.3	0.30	0.30	0.30	0.30
Methionine	0.2	0.20	0.20	0.20	0.20
Moisture content (%)	9.85	8.06	8.12	7.97	7.31
Crude Lipid (%)	5.05	5.03	4.74	4.61	4.47
Crude protein (%)	40.85	39.71	38.76	37.63	37.085
Total Ash (%)	4.97	4.84	5.05	5.37	5.70

NFE	35.31	36.65	36.72	35.91	35.15
Crude fibre	3.97	5.36	6.25	6.97	7.21

[1]Content per Kg of premix :Dibasic Calcium Phosphate (DCP), 50g; Calcium Carbonate, 215g; Sodium Chloride, 40g; Potassium Chloride, 90g; Magnesium hydroxide, 124g; Iron Sulphate, 250g; Zinc Sulphate, 4g; Magnesium Sulphate, 3g; Cobalt Sulphate, 0.02g; Potassium Iodide, 0.04g Sodium Selenite, 0.03g and Sodium Fluoride 1g.

Table 1 above shows the percentage composition of the various ingredients used in the formulation of the experimental diets. T_1 contains 0% *Gmelina arborea* leaf meal (GALM), T_2, T_3, T_4 and T_5 contained 5%, 10%, 15% and 20% GALM respectively.

Table: 2 Growth response, Nutrient utilization and Survival rate parameters of Clarias *gariepinus* Juvenile fed crude Ethanolic extract of GALM.

Parameters	**T1(0% GALM)**	**T2(5% GALM)**	**T3(10% GALM)**	**T4(15% GALM)**	**T5(20% GALM)**
Initial mean weight (g)	$39.00^{a} \pm 0.53$	$39.36^{a} \pm 0.64$	$35.57^{b} \pm 0.07$	$24.17^{c} \pm 0.17$	$20.04^{d} \pm 0.54$
Mean final weight (g)	$60.69^{a} \pm 0.17$	$60.39^{a} \pm 0.34$	$60.10^{b} \pm 0.79$	$49.45^{c} \pm 2.18$	$29.40^{d} \pm 0.87$
Mean weight gained (g)	$21.69^{b} \pm 1.63$	$21.03^{b} \pm 0.03$	$24.53^{a} \pm 0.13$	$25.28^{a} \pm 0.39$	$9.36^{c} \pm 0.05$
Mean daily weight gain (g)	$0.26^{b} \pm 0.02$	$0.25^{b} \pm 0.02$	$0.29^{a} \pm 0.04$	$0.3^{a} \pm 0.05$	$0.11^{c} \pm 0.01$
Feed intake (g)/fish	$43.35^{c} \pm 1.30$	$43.20^{c} \pm 0.05$	$43.61^{b} \pm 1.02$	$45.33^{a} \pm 0.02$	$40.02^{d} \pm 0.05$
Specific growth rate (SGR)	$0.34^{a} \pm 0.02$	$0.29^{b} \pm 0.01$	$0.31^{b} \pm 0.02$	$0.33^{a} \pm 0.02$	$0.26^{c} \pm 0.02$
Food conversion ratio (FCR)	$2.00^{b} \pm 0.02$	$2.05^{b} \pm 0.25$	$1.78^{`c} \pm 0.05$	$1.79^{c} \pm 0.01$	$4.28^{a} \pm 0.07$
Protein efficiency ratio (PER)	$1.31^{c} \pm 0.04$	$1.28^{c} \pm 0.05$	$1.496^{b} \pm 0.06$	$1.68^{a} \pm 0.03$	$0.66^{d} \pm 0.02$
Protein Intake (PI)	$16.54^{a} \pm 1.04$	$16.48^{a} \pm 0.20$	$16.40^{b} \pm 0.44$	$15.05^{c} \pm 0.88$	$14.21^{d} \pm 0.33$
Standard length (SL)	$15.50^{c} \pm 1.00$	$15.00^{c} \pm 0.50$	$15.65^{b} \pm 0.75$	$15.90^{a} \pm 0.005$	$10.50^{d} \pm 0.33$
Condition Factor (K)	$1.63^{c} \pm 0.15$	$1.79^{b} \pm 0.13$	$1.57^{c} \pm 0.15$	$1.23^{d} \pm 0.10$	$2.54^{a} \pm 0.40$
Survival Rate (SR %)	96.67	93.33	90.02	94.09	92.18

***Means within the same row with different superscript are significantly different (P< 0.05)*

The results shown on Table 2 showed the growth performance of the experimental fishes The fishes fed 0% and 5% GALM diet did not show statistical significant in their weight gain. The results for Specific Growth Rate (SGR) showed that fishes fed 15% GALM diet had the highest value of 0.33 and lowest value of 0.26 was recorded in fishes fed with 20% GALM diet. The Specific Growth Rate (SGR), Mean Weight Gain (MWG) and Protein Efficiency Ratio (PER) showed a negative correlation with increase in GALM diet. The highest value of 1.68 recorded for protein efficiency ratio was observed in fishes fed 15% GALM diet and the lowest value of 0.66 was recorded in fishes fed diet containing 20% GALM. Fish growth exhibited significant inverse correlation with condition factor (K). The correlation coefficient (r) was recorded as -0.85.

Table 3: Haematological parameters of Clarias *gariepinus* juvenile fed graded level of GALM diet.

Blood parameter	**Initial Values**	**T1(0% GALM)**	**T2(5% GALM)**	**T3(10% GALM)**	**T4(15% GALM)**	**T5(20% GALM)**

PCV (%)	29.60^{d}±0.90	33.80^{a}±1.80	32.88^{a}±0.80	$31.96.^{b}$±1.63	30.59^{b}±2.00	26.80^{c}±2.43
WBC (10^3MM^3)	8.40^{c}±0.4	8.65^{b}c±0.2	8.70^{bc}±0.2	8.80^{b}±0.2	8.93^{b}±0.2	9.20^{a}±0.22
RBC (10^6MM^3)	3.80^{c}0.02	4.90^{a}±0.20	4.79^{a}±0.4	4.65^{b}±0.19	4.37^{b}±0.10	3.44^{d}±0.22
Hb (g/100ml)	8.50^{b}±0.40	9.32^{a}±0.3	9.50^{a}±0.10	9.69^{b}±0.24	10.50^{b}±1.21	7.50^{c}±0.4
Lymphocytes (%)	63.00^{c}±9.00	66.00^{b}±1.90	66.02^{b}±2.00	68.00^{ab}±1.9	72.00^{a}±1.9	73.51^{a}±2.00
MCHC (%)	32.78^{ab}±2.01	32.75^{ab}±1.00	34.00^{a}±2.00	34.00^{a}±0.47	34.77^{a}±0.99	33.17^{a}±0.5
MCH (pg)	32.57^{cd}±0.4	29.54^{d}±1.43	32.13^{cd}±0.29	44.40^{b}±2.6	46.17^{b}±0.42	40.84^{c}±0.4
MCV (fl)	98.96^{b}±1.93	86.74^{c}±2.10	91.62b^{c}±1.68	133.62^{a}±2.7	134.46^{a}±0.8	131.21^{ab}±0.3

Means within the same row with different superscript are significantly different (P< 0.05)

Table 3 revealed the haematological indices of fishes fed GALM based diet during the experiment. White Blood Cell (WBC) results showed that fishes fed 10% to 20% GALM diets had higher values than fishes fed 0% and 5% GALM diets. Haemoglobin concentration decreased in fishes fed diet containing 10% to 20% GALM. Lymphocyte count showed an increase as the level of GALM increases in the diet. The highest value of 73.51% was recorded in fish fed diet containing 20% GALM diet and the least value of 66.00% was recorded in fish fed the control diet (0% GALM). The results obtained for MCH and MCV showed that the fishes fed diets containing 15% GALM had the highest values of 46.17pg and 134.46fl for MCH and MCV respectively and the least values of 29.54pg and 86.74fl were recorded for MCH and MCV in fishes fed 0% GALM based diets. Conclusively, the PCV, RBC and Hb concentration showed a significant (P<0.01) inverse correlation with increase in GALM in the diets. The correlation coefficient (r) of -0.70, -0.92 and -0.65 were recorded for PCV, RBC and Hb concentration respectively.

DISCUSSION

Growth and nutrient utilization by the experimental fishes decreased as the level of GALM increases in the experimental diet. This observation may be as a result of persistence increase in the substitution level of fish meal with GALM in the diets which cause growth retardation. The decrease in the growth rate could also be due to reduction in the level of protein and essential amino acids in the diet having higher substitution level of fish meal with GALM (Russel., *et al* 1983). The result of the specific growth rate (SGR) could be due to differences in the GALM substitution level which decreased considerably from 15% to 20% substitution level in the diets. The consumption of anti-nutritional factors contained in GALM (Phenols, Tannin and Phytates) is probably responsible for the reduction in the palatability of the diets resulting in reduced feed intake leading to retarded growth response in the experimental fishes. Protein Efficiency Ratio (PER) was highest in fishes fed 15% GALM in their diet and it shows statistical significant difference (P<0.05) from fishes fed with other inclusion level of GALM. Haematological components of blood are valuable in monitoring feed toxicity especially with feed constituents that affects the formation of blood (Oyawoye and Ogunkunle 1988). All the haematological parameters measured in this study were within the recommended physiological ranges reported for *Clarias gariepinus.* However, a decrease in the haematological values of fishes at significant level (P<0.05) from fishes fed with 20% GALM diets could be as a result of the presence of higher concentration of anti-nutritional factors in the diets. Adeyemo (2005) reported that the reduction in values of |PCV, Hb and RBC count were due to the presence of toxic substances in the diets of the experimental fishes. An increase in the WBC and lymphocyte count is usually associated with microbial infection or the presence of foreign body or antigen in the circulatory system (Oyawoye and Ogunkunle 1998). Conclusively, the results obtained from this study showed that GALM could be substituted with fish meal up to 15% level in *Clarias gariepinus* diets without any negative effect on the growth, feed efficiency and Haematological status of the fishes.

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TITLE: INFERTILITY DUE TO MIXED BACTERIAL INFECTION IN RABBIT DOES

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ABSTRACT

Systemic and local infections and inflammations are known to cause infertility in humans and animals. However, the mechanisms by which infection/inflammation induces infertility are only partially known. A condition of infertility in a rabbit farm in Zaria, Kaduna State was investigated. The investigation involved disease history, clinical examination and microbiological analysis of vaginal discharge. History revealed that the rabbit does have been bred several time without conception and vaginal discharge. Clinically the does had slight pyrexia, mucoid vaginal discharge. Using a sterile swab stick vaginal swab was taken and submitted to microbiology laboratory. The laboratory result revealed the presence of pathogenic *Corynabacteria spp, Staphylococcus spp and Echerichia coli*. In vitro antimicrobial susceptibility test results indicated the *Corynabacteria spp, Staphylococcus spp and Echerichia coli* isolated were susceptible to Cyprofloxacin, Enrofloxacin, Gentamycin and Tetracyclin. The isolation of this bacterial organism comfirmed their pathogenic effect (infertility) in rabbit does reproduction and this investigation adds to the list of the diseases in Nigeria. The need to embrace good management practice and vaccination of sheep in the control of this disease in the country is emphasized.

Keywords: infertility, *staphylococcus spp, E.coli, Corynebacterium spp,* Rabbit does, Zaria, Nigeria.

INTRODUCTION

In rabbit farms, production efficiency is greatly condi-tioned by the fertility of does. Multiparous does generallyexhibit much lower fertility rates than nulliparous does, due to intensive reproductive rhythms, energy deficitfor the overlap between lactation and pregnancy, and poor health of the animals (Brecchia et al., 2006; Fortun-Lamothe, 2006). Infertility is lack of conception after constant sexual intercourse among matured animals (Pellati et al., 2008). The inability to reproduce by natural means is a disease of the reproductive system resulting in failure to achieve conception following mating. Infertility is usually reversible if it cause is removed and in if not treated could result to permanent infertility better regarded as sterility in aminals. Infertility in domestic animal could be due to infectious nd non-infectious agent such as nutrition, physiological disturbances and infectious causes, which may work separately or in combination (Cunningham and Beagley, 2008). Bacterial infection in reproductive organs is one of the most common causes of infertility in both male and female domestic animal. It is also associated with sexually transmitted infections and adverse pregnancy outcomes. Infection with different microorganisms, such as staphylococcus spp, Corynaebacteria spp, E. coli, Pasteurella, mycoplasma, etc. may lead to various clinical manifestations of animals reproductive function. *Staphylococcus* sp., E. coli although a commensal bacterium, more evidence is emerging to support their vaginal colonization and involvement in infertility (Resch and Nelson, 2016). E.coli is a gram negative, facultative anaerobe commonly found in the enteric system of domestic animals as normal flora but in overwhelming infection can mutate to elaborate virulent factors to become pathogenic (Singleton, 1999). Corynaebacteria and Staphyloocucs spp are Gram Positive bacteria which exist as commensal but produce toxigenic protein to cause diseases under some conditions of immunosuppression, mutation etc. (Madigan and Martinko, 2005)Bacterial has been implicated in various degree of infertility in domestic animal (Blood et al., 2007). Various bacteria such as Escherichia coli, *Corynaebacteria spp* and *Staphyloocucs spp* have been known to impede sperm motility in vitro, produce vaginititis, metritis, cervicitis in both human and domestic animals (Pauli, et al., 2014). In vitro studies have shown that bacteria attach to spermatozoa leading to morphological changes and decrease in the fertilization potential of sperm cell by eliciting spermagglutination (Tong et al., 2015).

Disease conditions have considerable effects on blood parameters in rabbits, it is important to analyse blood and urine in rabbits as well as in other animal species. The rabbits may mask the symptoms of the diseases or manifest some complex clinical signs. Hence, some important findings may be achieved using haematological and biochemical parameters (Lepitzki and Woolf, 1991; Melillo, 2007). When assessing rabbit diseases, knowledge of the reference values of haematologic and biochemical parameters is helpful in the evaluation of rabbit health situations and provides important information for clinicians (Archetti *et al.*, 2008). However, haematological and biochemical parameters analysed are influenced by many factors such as breed, age, gender, feeding, environmental conditions, disorders, stress, pregnancy and cardiac rhythm (Abdel-Azeem *et al*., 2010).Neutrophils represent the host's first line of defense against invasion by *bacteria* and a critical determinant in the outcome of bacterial infections. Following the uptake of bacteria, neutrophils typically undergo accelerated apoptosis and are cleared by macrophages through efferocytosis. This process results in eradication of the microbe and recovery of inflammation. Usually all the leucocyte levels in blood increases in bacterialinfection as first line of cell mediated immunity against the pathogen (Anosa, 1983)

RESULT

The result obtained from microbiological screening revealed the presence of haemolytic *E. coli*, pathogenic *Staphylococcus* and *Corynaebacterium spp*.

The vital parameters of the does are shown below;

Table 1: Vital Parameters of the rabbit does with infertility

Vital Parameters	Obtained Value	Normal Value
Average total rectal temperature (^{o}C)	41±0.05	38-40
Average total pulse rate (beat/min)	160±0.02	120-150
Average total respiratory rate (cycle/min)	70±0.06	30-60

However, the blood analysis of the samples rabbit does showed marked leucocytocisis as shown below;

Table 2: Haematological parameters of Bacterial infertility of rabbit does

Haematological parameters	Average Obtained value	Reference Value
PCV (%)	30 ±0.2	31
Hb (g/dl)	8.0 ±0.05	9.8
RBC (X106/mm3	4.5 ±0.4	5
MCV (fl)	50 ±0.8	53
MCH (pg)	15 ±0.42	17
MCHC (g/dl)	3.5±1.02	4
WBC (X103/mm3	7.0 ±0.05	5.3
Neutrophils (%)	40 ±0.06	37

Lymphocyte (%)	39 ± 0.1	32
Monocyte (%)	14 ± 0.9	4-13.5
Eosinophil (%)	5.0 ±0.65	0.5-5.5

DISCUSION

The vital parameters obtained were above normal range and could be attributed to septicemia which alters the thermoregulatory system due to the presence of endogenous pyrogene this is also reported by Blood *et al*. (2007). Septicemia caused by bacterial invasion of the bloodstream, lower respiratory tract, increase thermoregulation and cardiac activity due to elaboration of their virulent factors which are toxins this agrees with the report of Thammavongsa et al. (2013)There was leucocytosis particularly marked neutrophilia and other blood parameters this could be attributed to septicemia due to the presence of bacterial pathogen in the blood stream. neutrophils typically undergo accelerated apoptosis and are cleared by macrophages through efferocytosis resulting in accelerated and marked neutrophil synthesis consequent to increase toxin elaboration by the bacterial organisms. However the red blood cells parameters were lowere physiological range this could be due to increase haematological lysis due to septicemia caused by the bacterial parasite (Melillo, 2007).

The inferility observed in this case could be due to mixed bacterial infection of the reproductive system. E. coli, Staphylococcus and Corynaebacteria infertility could be due to bacterial colonization of ejaculate within the genital organs of the rabbit does, cervicitis, vaginitis and metritis (Pellati et l., 2008). Bacterial organisms seen in this case has be reported to to posses the ability to rapidly and irreversibly adhere to spermatozoa, resulting in agglutination, altered morphology, immobilization and impaired fertilization in animals (Kaur et al., 2015; Paulson and Polakoski, 1977), and in mice (Kazi et al., 2012)

CONCLUSION

It was concluded that the inversion of heamolytic E. coli. Pathogenic Staphylococcus spp and Corynabacteria spp in the reproductive system of rabbit does could cause infertily.

RECOMMENDATION

It was recommended that further study should be carried out to investigate the molecular mechanisms of infertility due to vaginal bacterial infection.

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CARCASS YIELD OF BROILER CHICKENS FED DIETS CONTAINING RED GRAPE (*Vitis vinifera*) SEED AND GARLIC (*Allium sativum*) POWDER

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ABSTRACT
This study was conducted to determine the carcass yield of 180 broiler Cobb chickens fed diets containing red grape seed and garlic powder. The birds were brooded for two weeks and then allotted to 6 dietary treatments with 3 replicates per treatment of 10 birds per replicate over a period of 6 weeks. The control diet was the basal diet without garlic or red grape seed supplementation. Treatments 2 and 3 contained garlic powder (GP) at 1.5 and 3.0g/kg feed respectively, treatments 4 and 5 contained red grape seed powder (RGSP) at 2.5 and 5.0 g/kg feed respectively, while treatment 6 contained the mixture of 1.5g/kg GP and 2.5g/kg RGSP. Data obtained on Carcass yield was subjected to analysis of variance (ANOVA) in a completely randomized design. Results shows that broilers on treatment 2 had higher ($p<0.05$) dressing percentage (70.55%) and eviscerated weight (1,594.87g) compared to other dietary treatments. However, the cut parts and organs of the carcass yield did not follow a definite pattern that could be attributed to treatment effect. Abdominal fat content (1.19%) was highest in broilers fed the control diet.

Keywords: **Grape (*Vitis vinifera*) seed and Garlic (*Allium sativum*) ,** carcass.

INTRODUCTION
In pursuit of improved chicken healthiness and in order to fulfill consumer's expectations in relation to food quality, poultry producers more and more commonly apply natural feeding supplements, mainly herbs (Gardzielewska *et al*., 2003; Onibi *et al*., 2009) and fruits (Zuo *et al*., 2002; Nunez de Gonzales *et al*., 2008). In recent years, consumers have become more conscious of the medicinal properties of garlic and garlic products (Ali *et al.*, 2000; Rivlin, 2001).

The key active ingredient in garlic is a plant chemical called allicin which rapidly decomposes to several volatile organosulphur compounds (Chang and Cheong, 2008). Substantial evidence suggests that the active component of garlic has some beneficial effects for livestock, having hypocholesterolemic effects, growth-promoting and antioxidant activities *(*Kim *et al*., 1997; Konjufca *et al*., 1997; Lewis *et al.*, 2003. Extracts of garlic enhanced host resistance in poultry due to its specific immune response (Dorhoi *et al.*, 2006).Also, fruits have gathered interest from the public and from the scientific community because of their health-promoting properties. The benefits of fruits have been attributed to their high phenolic compound content, which act as antioxidants (Zuo *et al.*, 2002). It is because of this high phenolic content that many fruits such as grapes are a good source of natural antioxidants in meat and poultry products (Karre, 2009). Recognition of such health benefits of catechins and procyanidins has facilitated the use of grape seed extract as a dietary supplement.

Garlic (*A. sativum*) and Grape (*Vitis vinifera*) seeds are one such potential feed supplements which have been reported as having a wide range of beneficial effects on the production performance, physiological biochemistry, growth, feed efficiency, egg production, as well as stimulation of immune system, increasing shelf-life and lowering blood and meat cholesterol levels in poultry birds (Khan *et al.*, 2012). Hence this study.

MATERIALS AND METHODS
The experiment was carried out at the Poultry Unit of Directorate of University Farms (DUFARMS), Federal University of Agriculture Abeokuta, Ogun State, Nigeria.

Fresh garlic bulbs were peeled and cut into smaller sizes using a knife. The thickness was about 2mm to facilitate drying under sunlight for 21days and further dried in the oven at 50^{o}C. The dried garlic

were then finely ground to powdered when constant weight was attained and stored immediately in Plastic containers at room temperature (25^{o}C) until used. Fresh Red Grapes were also purchased. They were peeled and squeezed using a juice extractor and the seeds were separated by handpicking. It was then dried under sunlight until constant weight was attained and then finely ground to a powdered form and stored at room temperature (25^{o}C). Stored test ingredients were then added to basal diet at appropriate levels of inclusion**.**

Experimental Animal Management

A total of 180, day-old broiler chicks (Cobb) were sourced from a reputable farm and were brooded together for the first two weeks in a deep litter pen using wood shavings. Feed and water were provided *ad libitum*, heat was supplied as required. Vaccinations and medications (without antibiotics) necessary for the birds were administered during brooding as the need arises. At the third week (after brooding), the experimental birds were randomly assigned to the six dietary treatments of 30 birds/treatment. Each treatment consists of three replicates of 10 birds per replicate. Birds were subjected to a 2-period feeding regime consisting of a starter phase (2 to 4 weeks) and finisher phase (5 to 8 weeks). The experimental diets were assigned to each of the 6 treatment groups and fed *ad libitum* while fresh and clean water was adequately provided daily. Garlic and red grape seed powder were added singly and in mixture to the basal experimental diets. All diets were formulated to meet nutrient requirements established by the NRC (1994).

Carcass Yield Evaluation: At the end of the 8th week, two birds per replicate whose weights are close to the average of the birds per replicate were selected, fasted for 16hrs and slaughtered via the neck severance and then allowed to bleed for two minutes followed by scalding in hot water at 65^{o}C. Feathers were plucked and weight was recorded. Head and shanks were removed, weighed and expressed as percentage of the live weight. After evisceration, the percentage dressed weight was recorded. The weight of the cut parts were also determined using a sensitive scale. Fat around the cloaca, bursa of fabricius, proventriculus, and muscles adjacent to the abdomen were considered as abdominal fat deposits.

RESULTS AND DISCUSSION

The effect of feed on carcass yield in Table 1 shows significant ($P< 0.05$) differences in the live weight, eviscerated weight and abdominal fat content of the birds. The highest live weight (2140.00g) and eviscerated weight (1594.87g) was recorded in birds supplemented with 1.5g/kg GP while dressing percentage shows no significant ($P>0.05$) differences across the treatments. Birds fed with 5.0g/kg RGSP had the lowest values of 1610.00g and 1155.10g for live weight and eviscerated weight respectively. This result is expected since the final live weight of birds in this treatment was comparatively higher than those in other dietary group. This result supports the report of Emiola *et al*. (2005) who stated that for broiler chickens with higher live weight, higher eviscerated carcass weight should be harvested. The results of cut-up parts and organ weights obtained did not follow a definite pattern that can be attributed to treatment effect. Though, there was significant differences ($P< 0.05$) in some of the carcass yield, however, the head, the neck and the offals (small and large intestines) were not significally different($P>0.05$) within the dietary groups. This is in agreement with Khan *et al*. (2012), who postulated that there was no difference in the small intestine, proventiculus and some percentage of carcass parts in broilers fed garlic powder as a supplement. Numerically, the highest percentage weight for breast muscle, back, heart and spleen was found in broiler chickens fed the control diet. This is in agreement with Ashayerizadeh *et al*. (2009) who reported that garlic powder added to broiler feed had effect on carcass yield except for breast weight and back weight. Also, Onu (2010), reported that the addition of ginger and garlic mixture of 0.25% did not affect the development of the organ weights. Abdominal fat of broiler chickens fed the control diet was significantly ($P> 0.05$) highest (1.19). This was equally observed by Zaboli *et al*. (2013) who reported that abdominal fat deposits increased in birds on the control diet and were significantly less in groups fed on diets with garlic and vitamin E supplements; with abdominal fat representing 2.35% of carcass weight in broiler chickens fed on the control diet and chickens fed on garlic and vitamin E diets had fat/carcass weight levels of 1.94 and 1.95%, respectively.

In conclusion supplementing with 1.5 g/kg garlic powder (GP) and 2.5 g/kg red grape seed (RGS) gave heavier live weight and eviscerated carcass weight and supplemrnting with both test ingredients at all levels helped reduce abdominal fat.

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Table 1: Effect of Feeding Dietary Garlic and Red Seed on Carcass yield of Broiler Chicken

Parameters	Control	1.5g GP	3.0g GP	2.5gRGSP	5.0g RGSP	1.5 GP + 2.5g

						RGSP
Live weight (g)	1835.00 ± 15.00^{c}	2140.00 ± 280.00^{a}	1770.00 ± 10.00^{d}	1980.00 ± 40.00^{b}	1610.00 ± 30.00^{e}	1870.00 ± 30.00^{c}
Eviscerated weight (g)	1400.90 ± 49.94^{ab}	1594.87 ± 51.47^{a}	1266.27 ± 14.23^{bc}	1434.03 ± 159.37^{ab}	1155.10 ± 14.09^{c}	1417.27 ± 25.89^{ab}
Dressed percentage (%)	66.65 ± 2.31^{b}	70.55 ± 2.93^{a}	65.58 ± 0.96^{b}	69.67 ± 0.02^{ab}	63.99 ± 2.02^{b}	68.75 ± 0.70^{ab}
Head (%)	2.55 ± 0.06	2.24 ± 0.19	2.25 ± 0.02	2.46 ± 0.23	2.65 ± 0.08	2.36 ± 0.05
Shank (%)	3.23 ± 0.01^{C}	4.06 ± 0.29^{b}	3.72 ± 0.09^{bc}	3.41 ± 0.29^{c}	5.14 ± 0.51^{a}	3.74 ± 0.06^{bc}
Thigh (%)	10.72 ± 0.78^{ab}	11.76 ± 0.61^{a}	9.75 ± 0.05^{b}	9.71 ± 0.18^{b}	10.12 ± 0.22^{ab}	10.45 ± 0.63^{ab}
Breast (%)	23.69 ± 0.91^{a}	19.68 ± 0.23^{ab}	21.21 ± 0.69^{a}	20.10 ± 1.72^{ab}	15.46 ± 3.32^{b}	22.77 ± 0.10^{a}
Neck (%)	4.70 ± 0.29	3.01 ± 1.50	4.25 ± 0.02	4.08 ± 0.27	3.63 ± 0.13	4.43 ± 0.13
Back (%)	12.83 ± 0.06^{a}	11.93 ± 0.54^{ab}	11.12 ± 0.12^{b}	12.33 ± 0.71^{ab}	11.51 ± 0.64^{ab}	12.15 ± 0.22^{ab}
Wings (%)	8.64 ± 0.11^{b}	9.09 ± 0.35^{ab}	8.57 ± 0.18^{b}	7.54 ± 0.07^{c}	8.84 ± 0.02^{ab}	9.24 ± 0.12^{a}
Drumstick (%)	9.66 ± 0.06^{ab}	10.30 ± 0.67^{a}	9.46 ± 0.24^{ab}	9.43 ± 0.08^{ab}	8.92 ± 0.02^{b}	9.24 ± 0.12^{ab}
Heart (%)	0.43 ± 0.02^{a}	0.41 ± 0.03^{a}	0.31 ± 0.01^{b}	0.37 ± 0.05^{ab}	0.42 ± 0.02^{a}	0.35 ± 0.02^{ab}
Kidneys (%)	0.33 ± 0.01^{abc}	0.22 ± 0.01^{c}	0.23 ± 0.03^{bc}	0.36 ± 0.01^{a}	0.35 ± 0.01^{ab}	0.30 ± 0.08^{abc}
Lungs (%)	0.54 ± 0.00^{ab}	0.52 ± 0.07^{ab}	0.42 ± 0.03^{b}	0.58 ± 0.06^{a}	0.51 ± 0.03^{ab}	0.51 ± 0.02^{ab}
Liver (%)	1.80 ± 0.04^{bc}	1.98 ± 0.08^{b}	1.77 ± 0.05^{bc}	2.02 ± 0.11^{b}	2.31 ± 0.13^{a}	1.64 ± 0.06^{c}
Gizzard (%)	1.44 ± 0.05^{b}	1.90 ± 0.10^{ab}	1.89 ± 0.00^{ab}	2.23 ± 0.36^{a}	1.86 ± 0.03^{ab}	1.74 ± 0.16^{ab}
Spleen (%)	0.09 ± 0.00^{a}	0.06 ± 0.01^{b}	0.11 ± 0.01	0.10 ± 0.00	0.10 ± 0.00	0.09 ± 0.01
Caecum (%)	0.52 ± 0.04^{c}	0.37 ± 0.02	0.52 ± 0.04^{c}	0.66 ± 0.02^{b}	0.79 ± 0.04^{a}	0.57 ± 0.04^{bc}
Small (%)intestine	2.76 ± 0.09	3.76 ± 0.35	3.23 ± 0.07	3.10 ± 0.35	3.67 ± 0.77	2.85 ± 0.31
Large intestine (%)	0.16 ± 0.00	0.13 ± 0.02	0.20 ± 0.02	0.12 ± 0.020.	0.19 ± 0.06	0.20 ± 0.01
Abdominal fat (%)	1.19 ± 0.00^{a}	0.30 ± 0.02^{b}	0.00 ± 0.00^{c}	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

a, b, c: Means in the same row with different superscripts differ significantly ($p<0.05$)

RUMINANT PRODUCTION

PERFORMANCE AND MORPHOSTRUCTURAL CHARACTERISTICS OF WEST AFRICAN DWARF GOATS FED DIET CONTAINING GRADED LEVELS OF ALKALINE TREATED MALTED SORGHUM SPROUT

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Abstract
A 90 day trial was conducted to determine the growth performance and morphostructural characteristics of West African Dwarf (WAD) goats fed diet containing graded levels of alkaline treated malted sorghum sprout (AMSP). A total of sixteen (16) WAD goats with an average weight of 5.8 ± 0.6 were randomly allotted into four dietary treatments in a completely randomized design. Four (4) diets were formulated to contain 0%, 20%, 40% and 60% of AMSP respectively. Data were collected on growth performance and morphostructural characteristics. Result showed that there were no significant differences (P>0.05) on all the growth parameters observed except the weight gain and feed conversion ratio. The weight gain values obtained in this study increased across the dietary treatment as the AMSP inclusion level increased but later decreased at 60% AMSP inclusion level. The highest value of final weight gain (18.6kg), weight gain (2.73kg) and average daily weight gain (32.54 g/d) were obtained in goats fed 40% AMSP. While the lowest final weight (7.14 kg), weight gain (1.55kg) and average daily weight gain (18.41g/d) was obtained in goats fed 60% AMSP. Goats placed on 40% AMSP had the best feed conversion ratio (8.60) and also recorded the highest body weight gain (2.93kg). Thus, it is concluded that 40% AMSP could be used in diets of growing West African Dwarf goats without any adverse effect on their performance and morphostructural characteristics.
Key words: Alkaline treatment, Malted sorghum sprout, morphostructural characteristics, West African dwarf goats and dry matter.

Introduction

In an attempt to mitigate the food production problem plaguing the goat industry in the country, there is need to necessitate the use of non-conventional feedstuffs (agro-industrial by-product) as alternative feedstuffs for the ruminant animal production. Malted Sorghum Sprout (MSP), a by-product of sorghum is a non conventional feedstuff used as livestock feed but had been reported with low nutritive value due to its anti-nutritional factors (Aning *et al.,* 1998). Detoxification by means of processing might be a good means of reducing the level of anti-nutritional factors and increase the nutritive value of MSP. Alkaline treatments on feedstuffs have been investigated extensively by numerous reviews to increase their feeding value for ruminants (Jakson 1978; Wanapat *et al.,* 1985). One economical source of alkaline is the use of wood ash. Body measurement in addition to live weight of ruminants has been used to evaluate animal performance (Salako, 2006). This study was therefore carried out to assess performance and morphostructural characteristics of West African Dwarf goats fed diet containing graded levels of alkaline treated malted sorghum sprout.

Materials and Methods

Experimental site and duration: The experiment was carried out at the Teaching and Research farm of Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan and it lasted for a period of twelve weeks.

Experimental animals, diet and design*:* A total of sixteen WAD goats were obtained from a reputable farm in Oyo State**.** The animals with a pre-trial body weight of 5.8 kg ± 0.6 were randomly allotted into four dietary treatments in a completely randomized design. The malted sorghum sprout (MSP) was purchased in dried form from Life care ventures limited, Sango Otta, Ogun State. The dried MSP was subjected to alkaline treatment such that 5kg of MSP was thoroughly mixed with 300g of wood ash. The entire mixture was then mixed with 20 litres of water and left in a container for 72 hours (3 days) but with frequent stirring. On the 3rd,

the mixture was brought out of the container, the water was allowed to seep out after which it was sundried on the concrete floor (Fanimo and Akinola, 2006). The sundried Alkaline treated MSP was then incorporated into the experimental diet at varying levels of 0%, 20%, 40% and 60% to formulate four dietary treatments as indicated in Table 1

Table 1: Chemical Composition (%) of the Experimental Diet

Parameters (%)	**Inclusion levels of AMSP**			
	0%	20%	40%	60%
Dry matter	87.32	81.63	68.58	60.11
Crude Protein	12.41	13.18	10.92	9.07
Ether extract	2.58	0.54	0.90	1.30
Ash	8.61	7.33	16.11	11.56
NFE	50.14	51.32	44.71	29.08
NDF	65.00	75.00	72.00	52.00
ADF	18.00	15.00	33.00	26.00
ADL	8.00	5.00	5.00	12.00
HM	47.00	60.00	39.00	26.00
CL	10.00	10.00	28.00	14.00

NFE: Nitrogen Free Extract, NDF: Neutral Detergent Fibre, ADF: Acid Detergent Fibre, ADL: Acid Detergent Lignin, HM: Hemicellulose, CL: Cellulose

***Management of experimental animals*:** The animals were housed in a well ventilated, washed and also fumigated using (DD force) prior to the arrival of the animals. On arrival, the animals were quarantined for a period of two weeks during which the goats were given prophylactic treatments; consisting of intra-muscular injection of Oxytetracycline LA at 1ml/10kg live body weight and Ivomectin at 1ml/25kg live weight. They were also administered vaccine against *Pestes des petit ruminant* (PPR). Guinea grass and cassava peels were fed to the animals during the adjustment period. Fresh cool clean water was also made available throughout the experiment. After the adaptation, the animals were balanced on weight equalization into four dietary treatments.

Data Collection

Feed Intake and Live Weight Gain**:** At the beginning of the experiment, the goats were weighed and subsequently on a weekly basis prior to feeding in the morning. The initial live weight was subtracted from the final live weight to determine the weight gained by the animals. Feeds offered and remnants were weighed daily to determine the feed intake of the animals. Both values were used to determine Feed Conversion Ratio (FCR).

Morphological parameters taken were: Body length, Life weight, Height at withers, Chest girth and Rump length. To achieve this, animals were put in an individual cage, allowed to balance in a particular position and restrained by a field assistant. The parameters were successfully measured using a tape rule.

***Chemical and Statistical analysis**:* The dried feed samples were milled separately through 2 mm screen and stored in polythene bags for chemical analysis. The proximate analysis and fibre fractions of the experimental diets were determined according to AOAC (2005) and Van Soest *et al.* (1991) respectively. Data obtained were subjected to one way analysis of variance (ANOVA) using SAS. (2004). Significant means were separated at 5% level of significant using the Duncan multiple range test of the same software.

Results and Discussion

Presented in Table 2 is the growth performance and linear body measurement of West African dwarf goats fed diet containing varying levels of alkaline treated malted sorghum sprout. There were no significant (P<0.05) difference in all the growth parameters and linear body measurement measured except the average daily weight gain (g/d) and feed conversion ratio. The weight gain values obtained in this study increased across the dietary treatments as the AMSP inclusion level increased but later decreased at 60% AMSP inclusion level. This could probably be due to the presence of some residual toxic components in Alkaline treated malted sorghum sprout that could have acted as anti-nutritional factors and then interfered with nutrient utilization reflecting in their respective final body weight values (Ogunsipe and Agbede, 1990). The highest value of final weight (8.61kg), and average daily weight (32.54g/d) was obtained in goats fed 40% AMSP while the lowest final weight (7.14kg) and average daily weight gain (18.49g/d) was obtained in goats fed 60% AMSP. The highest weight gain observed in goats on dietary treatments of 40%, 0% and 20% compared to 60% AMSP was an indication of nutrient intake from the diets that were well utilized consequently improved the total weight gain. This collaborates with the earlier reports of Badien (2002) that good level of diets supplementation will leads to better utilization of the diets by goats. Goats fed 40% AMSP had the best feed conversion ratio (8.60). The efficiency at which goats convert feeds for body weight in the present study compared unfavorably with the previous study of Yousuf and Adeoye, (2010) when West African Dwarf goats of similar body weight were fed shed leaves based diets. The highest values of body weight, chest girth, height at wither and height at rump obtained in goats fed 40% AMSP can be attributed to the fact that the nutrient was well utilized compared to other dietary treatments. This further buttressed the fact that the nutrition played a vital role in linear body dimension. This was in line with the findings of Otoikhian *et al.* (2008) who suggested that nutrition is the one of the major determinant of growth and physiological development of animals.

Table 2: Performance characteristics and Linear body measurement of West African Dwarf Goat fed diet containing graded level of Alkaline Malted Sorghum Sprout

Parameters	**Inclusion levels of AMSP**				
	0%	20%	40%	60%	SEM±
Initial Weight(kg)	5.84	5.63	5.87	6.19	0.14
Final Weight (kg)	7.89	7.74	8.61	7.14	0.23
Average Daily Weight Gain (g/d)	24.41^{ab}	25.12^{ab}	32.54^{a}	18.49^{b}	1.88
Average Daily Feed Intake	304.80	281.13	278.12	272.40	10.79
Water Intake (l/day)	0.48	0.57	0.49	0.58	0.03
Feed Conversion Ratio	12.79^{ab}	11.39^{ab}	8.60^{b}	15.29^{a}	1.02
Body length (cm)	35.89	35.11	35.67	31.89	0.82
Chest girth (cm)	43.44	41.33	44.33	43.00	0.69
Rump length (cm)	37.11	36.56	36.89	35.67	0.57
Rump at wither (cm)	18.11	18.89	18.44	17.44	0.45
Height at wither (cm)	36.89	35.33	37.22	34.11	0.68
Height at rump (cm)	37.89	38.56	40.22	36.78	0.79

Means along the same row with different superscripts are significantly different (P< 0.05).

Conclusion

It can be concluded that goats fed diet containing 40% AMSP had better performance in terms of body weight gain and feed conversion ratio. Although there was no significant difference but body measurement values were more pronounce in goats fed diet containing 40% AMSP

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EFFECT OF IRISH POTATO PEEL AND YAM PEAL MEALS ON THE PERFORMANCE AND NUTRIENT DIGESTIBILITY OF WEANER RABBITS

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Abstract

The study was conducted to evaluate the nutritive value of Irish potato peal meal (IPPM) and yam peel meal (YPM) on the performance of weaner rabbits. 25 weaner rabbits were assigned to five (5) dietary treatments of 5 rabbits each, and were individually caged in a completely randomized design. The rabbits were fed the dietary treatments, where treatment one (T1) is the control with no IPPM and YPM, treatment two (T2) and treatment three (T3) with 20% and 30% IPPM respectively while treatment four (T4) and five (T5) have 20% each and 30% each of the combination of IPPM and YPM respectively. The result showed that average daily feed intake was significantly higher ($P<0.05$) in the rabbits fed with the control diet (T1) compared to the other treatments. The feed to gain ratio were similar in all the treatments. The feed cost per kg gain was significantly different ($P<0.05$) across the treatments. Crude Protein, Crude Fibre and Ash digestibility were significantly higher in T1 (control) compared to T2, T3and T5, but was similar to T4. Ether Extract and NFE digestibility were significantly higher ($P<0.05$) in T1 compared to all other treatments.. It is concluded that, Irish potato peel and yam peel meals which is cheaper can be used to replace maize in the conventional rabbit feed without any adverse effect on their growth performance and nutrient digestibility.

Key words: potato peel, yam peel, rabbit, performance

Introduction

Primary feed ingredient such as grains, oil seed and their by products are used to feed monogastric animals. This puts monogastric animal in direct competition with man for basic food materials which in turn limits animal production (Aduku, 2004). This has led to the current rise in price in animal products and making them out of reach to the average Nigerian. This problem can be tackled by directing efforts at the production of animals that are highly prolific with short generation intervals and also has high feed to gain ratio (Akinmutumi and Onwukwe, 2002). One of the animals that has the above mentioned characteristics are the rabbits, they have high fecundity and short gestation time (Aduku and Olukosi, 1990; Fielding, 1991). They are fast growing and can convert forage and kitchen waste (e.g. cabbage, yam peels, potato peels, plantain peels etc.) into meat with high efficiency as they have high feed conversion efficiency (Nworgu and Ogbosuka, 2003).

The most important aspect of animal production is in the nutrition (Ewa *et.al*, 2001). Feed constitute about 70-75% of the total cost of animal production (Aduku, 2004). This has been attributed to the competition among humans industries and monogastric for conventional feed stuff. This therefore calls for the replacement of the expensive conventional feed stuff with cheaper available alternative feed stuffs.

A lot of agricultural by-products and kitchen waste have already been investigated such as use of yam peels (Ayoola and Akinbani, 2011); ripe plantain and yam peels (Akinmutimi et al, 2006) etc. However, there is no information on the utilization of combination of Yam peels and Irish Potato peels in rabbit nutrition, hence the aim of this study is to evaluate the effect of including yam peels and Irish potato peels on the performance of weaner rabbits.

Materials And Methods

Experimental Site

The study was carried out at the rabbitary unit of the Department of Animal Science farm Faculty of Agriculture, Ahmadu Bello University, Zaria, at 11^0 11' North and 7^0 38'East, altitude 686m above the sea level. The rabbits were housed in a long three tier wire cage consisting of 12 hutches, three hutches in the column and 4 across the row. Each row has collection tray under it for the collection of faeces and urine. Each hutch has a feeding and water trough. The floor of the rabbitary house was made of a hard concrete for easy and proper cleaning.

Sources of Experimental feed ingredients:

The Irish potato peels and yam peels of different varieties were collected from households and restaurants in Zaria, Kaduna state and were sundried for 5 days on a cemented floor. The peels were sun dried and milled before incorporation into the experimental diets. The dried peels were ground separately using a hammer milling machine. They were later packed in the sack and were stored at room temperature until required. Other feed ingredients were purchased from the market.

Experimental Diets

Five experimental diets were formulated and were designated as T1, T2, T3, T4, and T5. T1 was the control which has no Irish potato peels or yam peel meal, T2 and T3 contained Irish potato peels meal (IPPM) only at 20 and 30% inclusion rate respectively, T4 contains a combination of 20% Irish potato peel meal (IPPM) and 20% yam peel meal (YPM) and T5 contains a combination of 30% Irish potato peels meal (IPPM) and 30% yam peel meal (YPM). The diets were formulated to meet the requirement for rabbits (i.e. ME= 2884 and CP=18%). The composition of the diet is shown in Table 1.

Table 1: composition of experimental diets

	Treatments				
Ingredients	**T1**	**T2**	**T3**	**T4**	**T5**
Maize	35.75	24.56	18.97	14.81	4.36
Maize offal	35.75	24.56	18.97	14.81	4.36
IPPM	0.00	20.00	30.00	20.00	30.00
YPM	0.00	0.00	0.00	20.00	30.00
Full fat SBM	12.30	13.49	14.08	13.24	13.69
GNC	12.30	13.49	14.08	13.24	13.69
Bone meal	2.50	2.50	2.50	2.50	2.50
Lime stone	0.50	0.50	0.50	0.50	0.50
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.15	0.15	0.15	0.15	0.15
Common Salt	0.30	0.30	0.30	0.30	0.30
Vitamin premix	0.25	0.25	0.25	0.25	0.25
TOTAL	100.00	100.00	100.00	100.00	100.00
CALCULATED	**ANALYSIS**				
ME (Kcal/kg)	2890.58	2950.02	2979.76	2939.35	2963.79
Crude protein	17.65	17.65	17.65	17.65	17.65
Crud fibre	5.80	4.90	4,45	5.49	5.33

Ether extract	5.38	5.14	5.01	4.75	4.43
Ash	1.31	2.39	2.59	4.06	5.17
Lysine	1.60	1.62	1.37	1.65	1.58
Methionine	1.20	1.18	1.44	1.19	1.14
NFE	69.51	69.57	69.95	67.60	67,07
Feed cost/kg(N)	70.14	60.73	55.79	58.49	52.45

Biomix broilers supplied the following per kg diet. Vit A,1000I.U; vit D3, 2000I.U; vit. E,25 mg; vit K, 2mg; vit B6,1.8mg; vit B2,0.015mg; Niacin,27.5mg; pantothenic acid, 7.5mg; folic acid,0.075; biotin,0.06mg; choline chloride,300mg; cobalt,0.2mg; copper,3.0mg; iodine, 1 mg; iron,20mg; manganese,40mg; selenium,0.2mg; zinc,30mg; anti oxidant, 1.25mg.IPPM=irish potato peel meal, YPM= yam peel meal, NFE= nitrogen free extract, SBM= soya bean meal, GNC= groundnut cake, ME= Metabolizable Energy.

Experimental Animals

A total of twenty five (25) weaner rabbits of mixed sexes and breed were used. The rabbits were purchased from a credible source. The rabbit's house was cleaned and was disinfected prior to the arrival of the rabbits. On arrival, the rabbits were given prophylactic treatment. Anti-bacterial and Ivomec was administered and were fed with the control diet so as to condition them to the experimental diet for 48 hours before assigning them to their experimental treatment. Each treatment was replicated five times in a completely randomized design (CRD) with five rabbits per treatment.

Parameters Monitored

The parameter recorded includes the initial weight of the rabbits and they were subsequently weighed on weekly basis, the percentage mortality was calculated using Number of dead rabbits / overall number of rabbits x 100. At the end of each week, feed intake was measured by measuring the leftover and deducted from the total weight of feed supplied. Water intake was measured by measuring the volume of the left over water which is deducted from the amount of water supplied in the previous day. The same volume of water supplied was kept in an empty cage to determine the water loss through evaporation. The rabbits were weighed weekly to determine their weight gain. Feed conversion ratio and feed cost per kilogram weight gain (₦) were also calculated. The rabbits were weighed at the end of the experiment to get the final weight. The trial lasted for eight (8) weeks.

Digestibility

Nutrient digestibility studies were carried out on three rabbits from each treatment on the 7th week. The rabbit was caged individually for fecal and urine collection. A known weight of the experimental diet was supplied daily and water was given *ad libitum*. Daily fecal droppings and urine was collected for seven (7) days. The fecal samples were weighed and sundried over a period of seven days. The dried fecal samples were reweighed and analyzed for their nutrient content and the percent digestibility calculated using the formula below.

$$\% \text{ digestibility} = \frac{nutrient\,intake - nutrient\,in\,feaces}{nutrient\,intake} \times 100.$$

The nitrogen content of the urine was also determined for crude protein digestibility

Data Analysis

The data on growth performance, digestibility, and carcass parameters were subjected to analysis of variance using the general linear model of SAS software (SAS, 2004). Significant difference among treatment means were separated using the Duncan multiple range test in the SAS package

Results

Proximate composition of diet

The proximate composition of the experimental diets is presented in the Table 2. The results showed that diet 2, 3, 4, and 5 where numerically higher than diet 1, in terms of their Crude Protein, Crude Fibre, and Ash. The

diets however, were similar in terms of the Dry Matter and Ether Extract. The Nitrogen Free Extract of all the experimental diet are similar and ranged from 60.97% in T4 (I.e. 30% Irish potato and yam peel meal) to 63.84% in T1 (control)

Performances of the rabbits

The effect of a mixture of Irish potato peel and yam peel meal is presented in Table 3. The result showed that average daily feed intake was significantly higher (P<0.05) in the rabbits fed with the control diet (T1) compared to the other treatments. The rabbits fed with Irish potato peel meal alone or in combination with yam peel meal had similar feed intake. The feed to gain ratio were also similar in all the treatments.

The feed cost per kg gain was significantly higher (P<0.05) in the control diet (T1) compared to the other treatments. The lowest values of ₦45.54 and ₦61.26 where observed in treatment T3 and T5 respectively.

There were no significant differences in the final weight gain, the average weight gain and water intake across the treatments.

Nutrient Digestibility

The effect of Irish potato peel and yam peel meal on the nutrient digestibility by weaner rabbits is presented in the Table 4. There were significant differences (P<0.05) in the Crude Protein, Crude Fibre, Ether Extract and Ash digestibility across the treatments. Crude Protein, Crude Fibre and Ash digestibility were significantly higher in T1 (control) compared to T2, T3and T5, but was similar to T4. Ether Extract and NFE digestibility were significantly higher (P<0.05) in T1 compared to all other treatments.

Table 2: **Proximate composition of the experimental diets (%)**

	Treatments				
Parameters	T 1	T 2	T 3	T 4	T 5
Dry matter	94.78	93.79	94.66	94.38	94.17
Crude protein	16.88	17.50	17.50	17.56	17.75
Crude fibre	8.13	9.09	8.91	9.00	9.67
Ether extract	4.76	4.39	4.56	4.91	4.38
Ash	6.39	7.66	7.23	7.56	6.91
NFE	63.84	61.36	61.57	60.97	61.29

NFE= Nitrogen Free Extract

Table 3: Performance of Weaner Rabbits fed a mixture of Irish potato peel and yam peel meal.

Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**SEM**	**LOS**
Initial wt (kg)	0.70	0.73	0.65	0.70	0.66	0.08	NS
Final wt	0.93	1.17	1.00	1.07	0.96	0.09	NS
AFI.(g)	80^{a}	70^{ab}	50^{b}	70^{ab}	60^{ab}	0.008	*
AWG (g)	10	10	10	10	20	0.002	NS
Feed to gain ratio	1.90^{a}	1.74^{b}	0.89^{c}	1.28^{ab}	1.17^{ab}	0.33	*
Water intake ml/kg	149.77	266.37	199.55	259.75	204.00	51.92	NS
FC/kg gain(₦)	133.03^{a}	105.82^{b}	49.54^{c}	74.87^{abc}	61.26^{bc}	19.17	*
Mortality (%)	40.00	40.00	0.00	20.00	0.00	-	-

a b c = mean within the same row with different superscripts differ significantly (P<0.05), LOS = levels of significance, SEM= standard error mean, NS = Not significant, *= significantly different (p<0.05). T1 = Treatment one, T2 = Treatment two, T3 = Treatment three, T4 = Treatment four, T5 = Treatment five, AFI=average feed intake, AWG= average weight gain, FC=feed cost

Table 4: Effect of Irish Potato Peels and Yam Peel Meal on nutrient digestibility in Weaner Rabbits

Parameters	T 1	T 2	T 3	T 4	T 5	SEM	LOS
Crude protein	91.52[a]	75.93[b]	77.17[bc]	86.53[ab]	72.87[c]	3.37	*
Crude fibre	92.94[a]	86.12[b]	86.78[b]	88.63[b]	88.65[b]	1.39	*
Ether extract	97.05	92.17	92.03	93.81	92.89	6.99	NS
Ash	92.05[a]	80.82[b]	80.77[b]	88.31[a]	84.27[b]	2.22	*
NFE	94.16[a]	85.82[b]	85.08[b]	88.54[b]	87.37[b]	1.69	*

a b c = mean within the same row with different superscripts differ significantly (P<0.05). SEM = Standard error of the mean. LOS = levels of significance, NFE= Nitrogen Free Extract. T1 = Treatment one, T2 = Treatment two, T3 = Treatment three, T4 = Treatment four, T5 = Treatment five.

Discussions

The effect of including Irish potato peel alone or in combination with yam peel meal on the carcass characteristics presented in Table 5 showed significant difference (P<0.05) which is not in agreement with the result obtained by Ayoola and Akinbani (2011) for rabbits fed with graded level of yam peel. This may be attributed to the combination with irish potato peal meal, the variety of yam and the method of processing used.

In Table 3, T1 had a higher feed in take than the other treatments. This is in agreement with Ayoola et at. (2011) who said it may be due to the high crude protein content in yam peel meal.

The feed cost per kilogram weight gain was reduced with increase in Irish potato peels and yam peels. T3 (30% Irish potato peel meal) showed the best cost per kilogram gain.

The feed to gain ratio was higher in T3 and T5 compared to the other treatments

Conclusion

In conclusion, the result of this study indicates that Irish potato peel and yam peel meals which is cheaper and available can be used to replace maize in the conventional rabbit feed without any adverse effect on their growth performance and carcass characteristics.

It is economical to feed rabbits with Irish potato alone or in combination with yam peel at 30% level of inclusion each for optimum performance.

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RESPONSE OF WEANER RABBITS FED SUGARCANE PEELS MEAL-BASED DIETS SUPPLEMENTED WITH EXOGENOUS ENZYME

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Abstract
Fifty four weaner rabbits weighing between 750-970g liveweight were utilized in an experiment that lasted for 49days to investigate the effect of sugarcane peels meal-based diets (SCPM) on growth performance supplemented with or without Quantum blue® enzyme. Six diets were compounded to be isonitrogenous (18% crude protein) and isocaloric (2700kcal/kg, ME). Treatments T1,T2 and T3 contained 15.5%of SCPM supplemented Quantum blue® at 0,100PPM and 200PPM while treatments T4, T5and T6 contained 32.85% SCPM and supplemented with the enzyme as in T1,T2,and T3 respectively giving a 2x3 factorial. The rabbits were randomly allotted to the 6 treatments and each treatment was replicated 3 times. The results of the effect of enzyme supplementation or SCPM and that of their interactive effects on the growth performance of weaner rabbits shows that there was a significant variation ($P<0.05$) in all the parameters evaluated.

Keywords: Dietary fibre, enzyme supplementation, growth performance, sugarcane peels meal, weaner rabbits

INTRODUCTION
There is a resultant increase in the demand for animal proteins due to the rapid growth of human population in developing countries like Nigeria. The demand for livestock products is expanding due to growing populations and incomes along with changing preferences (FAO, 2009). (Obeidat *et al*., 2009),states that the main purpose of using alternative feed sources which are not competed for by human is to reduce total cost of production and still get a better result.

Rabbits possess various attributes that are advantageous in comparison to other livestock. Rao *et al.* (1979) and Taylor *et al*. (1989) noted that rabbit meat is of excellent protein quality, low in total as well as saturated fat, cholesterol and sodium which make it safe for cardiac patients. Rabbit production is considered as a good source of meat in tropical developing countries because of the abundance of by-product feedstuffs. Therefore, the objective of this study was to investigate the response of weaner rabbits fed sugarcane peels meal-based diets supplemented with exogenous enzyme.

Materials and Methods

Experimental site
The study was carried out at the University of Abuja Teaching and Research Farm, Animal Science section, along airport road, Federal Capital Territory Abuja, Nigeria. The project site lies between latitude 8'55°N and 90°N and longitude 700°N and 750°E. Annual rainfall ranges from1, 145-1,631mm. The temperature in the dry season is between 30.4-35.1°C and 25.8°-30.2°C during the dry season.

Source and processing of test ingredient (SCP)
Sugarcane peels was collected from retail sugarcane sellers, wash and sundried to almost zero moisture level and crushed into crumps, before it was added to the diet.

Chemical analysis
The crushed sample of sugarcane peels and experimental diets were analyzed for proximate constituents while the energy values of the feed, faeces, and sugarcane peels were determine using bomb calorimeter.

Experimental animals and management

Fifty four (54) weaner rabbits (New Zealand white and Chinchilla) breeds of same sex purchase from a reputable vendor were used for the study that lasted for 7 weeks. The rabbits on arrival were given anti-stress for the period of 4-5 days. They were housed in disinfected metal cages with wire mesh at the base for easy collection of faeces and urine. The composition of the experimental diets is presented in Table 1. The rabbits were randomly allocated to six (6) dietary treatments and each treatment replicated three (3) times with three (3) rabbits per replicate. The cages were cleaned on daily basis throughout the period of the experiment. Feeders and drinkers were made available as they were housed and fed differently. The feeders and drinkers were also washed daily before new feed and fresh water were served.

Data collection

The growth performance parameters evaluated included initial weight, final weight, weight gain, feed intake, FCR, PER, feed cost per weight gain.

Statistical analysis

Data obtained were subjected to Two Way Analysis of Variance and where significant differences ($P<0.05$) were observed, means were separated using Duncan's Multiple Range Test as described by Steel and Torrie (1980).

Table 1. Gross composition and calculated energy of experimental diets for weaner rabbits

Feed ingredients	**Diets**					
	T1	**T2**	**T3**	**T4**	**T5**	**T6**
*Premix	0.45	0.45	0.45	0.10	0.10	0.10
Salt	0.30	0.30	0.30	0.10	0.10	0.10
Soya bean (full fat)	19.00	19.00	19.00	30.45	30.45	30.45
Ground nut cake	11.00	11.00	11.00	4.00	4.00	4.00
Maize bran	26.25	26.25	26.25	10.00	10.00	10.00
Enzyme (ppm)	0.00	100.00	200.00	0.00	100.00	200.00
Maize	25.50	25.50	25.50	21.00	21.00	21.00
Bone meal	1.00	1.00	1.00	1.00	1.00	1.00
Methionine	0.50	0.50	0.50	0.25	0.25	0.25
Lysine	0.50	0.50	0.50	0.25	0.25	0.25
Sugar cane peels	15.50	15.50	15.50	32.85	32.85	32.85
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
**ME (kcal/kg)	2716.27	2716.27	2716.27	2669.26	2669.26	2669.26
Crude protein (%)	18.08	18.08	18.08	17.52	17.52	17.52
Crude fibre (%)	10.08	10.08	10.08	14.45	14.45	14.45
Ether Extract (%)	6.06	6.06	6.06	7.20	7.20	7.20
Ash (%)	2.75	2.75	2.75	3.51	3.51	3.51
Calcium (%)	0.46	0.46	0.46	0.50	0.50	0.50
Phosphorus (%)	0.45	0.45	0.45	0.50	0.50	0.50

Lysine (%)	1.21	1.21	1.21	1.11	1.11	1.11
Methionine (%)	0.72	0.72	0.72	0.48	0.48	0.48

*The vitamin – mineral premix supplied the following per 100kg of diet: Vitamin A 15,000 I.U, Vitamin D_3 300,000 I.U., Vitamin E 3,000 I.U., Vitamin K 2.50mg, Thiamine, (B_1) 200mg, Riboflavin (B_2) 600mg, Pyridoxine (B_6) 600mg, Niacin 40.0mg, Vitamin B_{12} 2mg, Pantothenic acid 10.0mg, Folic acid, 100mg, Biotin 8mg, Choline chloride 50g, Anti-oxidant 12.5g, Manganese 96g, Zinc 6g, Iron 24g, Copper 0.6g, Iodine 0.14g, Selenium 24mg, Cobalt 214mg. ** Calculated from (Pauzenga (1985).

Results and discussion

The results of the effect of enzymes supplementation on growth performance of weaner rabbits fed sugarcane peels meal is summarised on Table 2. Enzyme supplementation significantly (P<0.05) improved daily weigh gain ant total weight gain. Rabbits fed 200ppm gave the best result of 10.40g/rabbit/day and 511.67g/rabbit for the DWG and TWG respectively.

Table 3 summarises the effect of low or high fibre on growth performance of weaner rabbit. Rabbits fed the high fibre diets produced better (P<0.05) DWG (9.82g/rabbit/day) and TWG (484.44g/rabbit) as compared to those fed the low fibre diets.

The interactive effects of the enzymes supplementation and sugarcane peels meals significantly (P<0.05) improved the final weight, daily weight gain and total weight gain of the animals.

The result obtained in this present study is in agreement with (Alu *et al.,* 2009; Alu *et al.,* 2011), stating that, the effect of enzymes is noticed mostly in high fibre diet; even above the normal fibre level the animal can digest.

Conclusion and recommendation

From the above findings rabbit can be reared and strive very well with high fibre and addition of enzymes in their diet. The high cost of production which has always been the major challenge in animal production is reduced drastically, and a better result achieved.

Table 2. Effect of enzyme supplementation on growth performance of weaner rabbits fed low or high fibre diets

Parameters	0PPM Enzyme	100PPM enzyme	200PPM Enzyme	SEM	LOS	Low fibre	High Fibre	SEM	LOS
Av. IW (g/rabbit)	885.00	890.00	853.33	29.56	NS	882.22	870.00	24.14	NS
Av. FW (g/rabbit)	1071.67	1300.83	1365.50	122.04	NS	1137.56	1354.44	99.64	NS
Av. DWG (g/rabbit)	7.07^{b}	8.32^{ab}	10.40^{a}	0.86	**	7.37^{b}	9.82^{a}	0.70	**
Av. FI (g/rabbit)	38.00	37.00	40.17	1.19	NS	37.67	39.11	0.97	NS
FCR	3.92	4.53	3.93	0.65	NS	4.26	4.00	0.53	NS
Av. TW (g/rabbit)	348.33^{b}	410.83^{ab}	511.67^{a}	42.25	**	362.78^{b}	484.44^{a}	34.50	**
FC/WG (₦/kg)	466.13	560.10	500.13	84.63	NS	569.19	448.39	69.10	NS

ab= means on the same row having different superscript differs significantly(P<0.05); **SEM**= standard error of means; **LOS**= level of significance; **NS**= not significantly different (P>0.05)

Table 3. Interactive effects of dietary fibre and enzyme supplementation on growth parameters of weaner rabbits

Parameters	T1	T2	T3	T4	T5	T6	SEM	LOS
Av. IW (g/rabbit)	936.67	873.33	836.67	833.33	906.67	870.00	41.81	NS
Av. FW (g/rabbit)	840.00^{b}	1258.33^{ab}	1314.33^{ab}	1303.33^{ab}	1343.33^{ab}	1416.67^{a}	172.58	**
Av. DWG (g/rabbit)	4.60^{b}	7.80^{ab}	9.70^{a}	9.53^{a}	8.83^{a}	11.10^{a}	1.22	**
Av. FI (g/rabbit)	37.33	35.67	40.00	38.67	38.33	40.33	1.68	NS
FCR	3.77	4.80	4.20	4.07	4.27	3.67	0.91	NS
Av. TW (g/rabbit)	226.67^{b}	385.00^{ab}	476.67^{a}	470.00^{a}	436.67^{a}	546.67^{a}	59.75	**
FC/WG (₦/kg)	490.17	641.43	575.97	442.10	478.77	424.30	119.69	NS

ab= means on the same row having different superscript differs significantly(P<0.05); **SEM**= standard error of means; **LOS**= level of significance; **NS**= not significantly different (P>0.05)

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NUTRIGENETIC EFFECT OF PHYTASE INCLUSION IN DIETS ON EGG QUALITY PARAMETERS IN LOHMAN BROWN BREED OF LAYERS

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Abstract

The study was conducted to determine the effect of phytase inclusion in diets for Lohman Brown breed of layers. For this purpose, a total of sixteen laying Lohman Brown birds under battery cage system at the poultry section of the Teaching and Research farm of the Department of Animal Science, Bayero University Kano were used. Four diets were formulated with varying levels of phytase inclusion and fed to the birds for eight weeks. Phytase inclusion levels were T1 (control), T2 (0.11g), T3 (0.17g) and T4 (0.22g). Egg samples were collected weekly to assess the effect of experimental diets on internal and external quality parameters. These parameters include; egg weight (EW), egg shape index (ESI), egg diameter (ED), egg length (EL), shell surface area (SSA), haugh unit (HU), egg specific gravity (ESG), shell thickness (ST), yolk weight (YW), albumen weight (AW) and shell weight (SW). The results showed a significant effect of phytase inclusion ($p<0.01$) in all the parameters except shell weight (SW) with T4 and T3 having a better output than T2 and T1. The study concludes that microbial phytase in layer diets improves nutrient utilization and subsequently egg quality traits. Therefore, it is recommended that phytase inclusion in layer diets should be used at either 0.17g per kg or 0.22g per kg of feed offered.

Key words: Nutri-genetics, microbial phytase, feed utilization, egg quality traits.

Introduction

Poultry occupies a unique position in Nigerian livestock production. The significant growth of poultry production and consumption in a developing country like Nigeria has important implication for global trading of meat products as well as feeds and other related inputs (Landes *et al.*, 2004). However, cost of feeds make up to 70% of the total production cost, hence the need to better utilization of feed in the poultry industry. Better utilization of nutrients in feed and avoiding wastage could be leading factors in minimizing total cost of production with appreciable outputs in the industry (El-Wardany *et al.*, 1998). Feed utilization is a variable phenomenon and it is influenced by several factors such as strains of the bird, energy content of the feed, ambient temperature, density of the birds in the shed, hygienic conditions and rearing environment (Moorthy *et al.*, 2000). The phytate-bound nutrients are largely unavailable to Monogastric animals as they do not have natural phytase enzyme which is required to release nutrients from dietary phytate. In other words, the presence of phytate in poultry feed ingredients restricts the effective utilization of organic P and other nutrients such as Calcium, energy and amino acids in the alimentary tract (Ravindran *et al.*, 1995). The use of exogenous phytase in the poultry diet will not only release P from phytate but also forms complexes of phytase together with other essential nutrients leading to higher nutritional value of the diet (Boling *et al.*, 2000; Panda et al., 2005). Supplementing poultry feeds with microbial phytase have shown to increase P availability giving rise to increase feed conversion efficiency, egg production, egg weight and shell quality (Jalal and Scheideler, 2001). Thus, the objective of this study was to evaluate the effect of phytase inclusion in diets on egg quality parameters from Lohman Brown Layers.

Materials and Methods

The study was conducted in the Poultry unit, Teaching and Research Farm, Bayero University Kano, Kano State, Nigeria. Kano state is located in the semi-arid area of North-West Nigeria within the latitude

$10^0$33" and $12^0$27" north of the equator and, longitude $7^0$34" and $9^0$29" east of the Greenwich meridian (KNARDA, 2006). A total of sixteen Lohman Brown layers at second phase of lay were used. They were in four treatments with two replicates and four birds per treatment with two per replicate. They were housed in a battery cage with automatic nipple drinkers in a study that lasted for eight weeks. Feeds and water were given ad-libitum. Four eggs were collected from each treatment making a total of sixteen eggs every week for quality assessment within twenty-four hours of collection. The parameters measured were: Egg weight (EW): Individual egg was measured with a sensitive weighing scale, Egg shape index (ESI): The expression given by Anderson *et al.*, (2004) was used to estimate ESI which is

$$ESI = \frac{Egg\ width}{Egg\ length} X\ 100$$

The broad and narrow ends gave the egg length while the widest cross-section region was the width using Vernier Caliper. Egg circumference (EC): This was take at the widest cross-section region. Egg diameter (ED): This was calculated as EC/2. Haugh unit (HU): This was estimated with following expression. HU = 100log (h + 7.6 – 1.7 $W^{0.37}$), Where h = observed height of albumen in millimeters and W is the weight of egg in grams. Egg specific gravity (ESG): This was estimated with the following expression

$$ESG = \frac{0.968\ X\ EW}{EW-SW} + 0.4921\ X\ SW$$

Where SW = shell weight and EW = egg weight. Yolk weight (YW): The yolk was separated from the albumen and placed on a weighed petri-dish on a sensitive scale and the yolk weight was determined by the difference between the weight of petri-dish with yolk and the weight of petri-dish. The same procedure was used to determine the weight of the albumen (AW). Shell weight (SW): Shells were allowed to air dry for twenty-four hours and were measured using sensitive scale. Shell thickness (ST): Vernier Caliper was used to determine the thickness of the shell when they were dry.Shell surface area (SSA): This was determined with the following expression: SSA (cm^2) = 3.9782 x EW x 0.7056. Where EW is the weight of the egg. Data collected were subjected to GLM procedures of SAS® (SAS, 2004). Pearson correlation procedure of SAS was used to access the relationship among variables.

Result and Discussion

Table 1 shows the summary statistics for egg quality parameters measured. The coefficient of variation for egg attributed taken ranged from 3.97 for egg length to 22.39 for shell thickness. This showed a low to moderate variability among the Lohman Brown layers which indicate that the birds were purely of the same strain with little or no variation among them. The result are in congruent with the report of Li and Bryden, (2006) on The Use of Phytase in Layer Diets for Australian Egg Corporation Limited.

In poultry industry, phytase is commonly added to poultry diets to improve P utilization, which leads to a decrease in feed cost and P excretion in the environment. Moreover, it is well-documented that dietary phytase has positive effects on productive performances of poultry. The benefits result from the fact that phytase increases utilization of P and other nutrients such as Ca and amino acids. Table 2 shows the effect of phytase inclusion in layer diets on egg quality attributes measured. The four treatments (T1, T2, T3 and T4) had good results but there were significant difference ($p<0.01$) among the treatments with T3 and T4 performing better in all the variables measured. The results indicate that higher phytase inclusion at 0.17g and 0.22g per kg gave better egg quality attributes. Reports from studies indicate that increasing egg production and quality as a result of phytase supplementation were due to phytate presented in most of the ingredients of poultry diets which are capable of forming complexes with essential nutrients such as proteins and some inorganic cations. These results are in agreement with reports of studies from Jong Hyuk *et al.* (2017) who reported the effect of super-dosing phytase on production performance and egg quality in laying hens; also in harmony with the study from Geraldo *et al.* (2014) who reported on carbohydrase and phytase supplementation in diets for semi-heavy laying

hens. These result also confirmed the report of Lim *et al.* (2003) as phyatse inclusion improved egg production and reduced percentages of broken and soft-shelled eggs and P excretion.

Table 1. Summary statistics for egg quality parameters from Lohman Brown layers.

Parameters	N	Mean	CV (%)	Min	Max
EW	128	61.40	9.58	46.00	72.00
EL	127	57.44	3.97	51.72	65.62
AW	128	37.78	11.81	27.00	46.00
YW	128	16.33	15.37	12.00	22.00
SW	126	5.66	13.60	3.83	7.24
ST	128	0.67	22.39	0.40	0.99
ESI	127	76.93	4.63	64.07	9.64
SSA	127	172.31	9.49	129.12	202.11
ED	127	22.07	4.12	19.92	23.90
ESG	126	3.84	10.16	2.93	4.65
HU	127	71.38	10.82	60.74	84.45

Table 2: Effect of phytase inclusion in diets on egg quality parameters in Lohman Brown Layers

Parameters/TRT	T1 (0.00g)	T2 (0.11g)	T3 (0.17g)	T4 (0.22g)	SEM
EW (g)	62.50^{b}	63.00^{b}	66.38^{a}	67.75^{a}	0.49
AW (g)	37.88^{b}	37.91^{b}	40.17^{a}	40.63^{a}	0.39
YW (g)	15.00^{b}	16.00^{b}	18.55^{a}	17.96^{a}	0.18
SW (g)	5.61	5.97	6.01	6.11	0.05
ST (mm)	0.63^{b}	0.65^{b}	0.68^{b}	0.83^{a}	0.01
SSA (cm^2)	175.44^{b}	176.84^{b}	179.56^{a}	180.88^{a}	1.35
ED (mm)	22.17	22.19	22.19	22.73	0.08
ESG	3.85^{b}	3.91^{b}	4.24^{a}	4.88^{a}	0.02
HU	73.06^{b}	73.49^{b}	73.99^{b}	76.46^{a}	0.69
EL (mm)	56.22^{c}	56.98^{c}	57.99^{bc}	58.48^{a}	0.19
ESI	75.92^{b}	77.72^{ab}	78.43^{a}	78.51^{a}	0.20

Means on the same row with different superscript differ significantly ($p<0.01$). TRT = Treatments

EW = egg weight, EL = egg length, AW = albumen weight, YW = yolk weight, SW = shell weight, ST = shell thickness, ESI = egg shape index, SSA = shell surface area, ED = egg diameter, ESG = egg specific gravity, HU = haugh unit.

Table 3 shows the Pearson correlation coefficients among the egg quality parameters measured. The relationships were very significant and showed moderate to very strong relationships. The coefficients ranged from 0.20 for EW/ESI, ESI/SSA to 0.99 for EW/SSA, ST/ESG. These indicates that egg weight could be a factor in determining other quality attributes and could be used for selection procedures and genetic improvement for egg qualities in poultry. The result agrees with the study of Suleiman *et al.* (2017) who reported on the comparative evaluation of egg quality traits from chickens and guinea fowls.

Recommendation: Laying birds can tolerate up to 17g to 22g per 100kg of feed for effective egg production and good egg quality attributes, and therefore recommended. Also, there is a need to research into super-dosing microbial phytase for laying hen in tropical environment to evaluate growth performance and egg qualities.

Table 3. Pearson correlation matrix for egg quality parameters measured

	EW	EL	AW	YW	SW	ST	ESI	SSA	ED	ESG	HU
EW	-	0.60**	0.87**	0.38**	0.60**	0.00	0.20*	0.99**	0.84**	0.59**	0.92**
EL		-	0.43**	0.46**	0.24*	0.03	0.46**	0.60**	0.41**	0.24*	0.54**

AW	-	0.04	0.51**	0.08	0.29*	0.87**	0.78**	0.51**	0.81**
YW		-	0.26*	0.23*	0.10	0.38**	0.27**	0.26*	0.32*
SW			-	0.09	0.26*	0.61**	0.55**	0.99**	0.56**
ST				-	0.04	0.01	0.04	0.09	0.03
ESI					-	0.20*	0.52**	0.26**	0.21**
SSA						-	0.85**	0.61**	0.91**
ED							-	0.55**	0.80**
ESG								-	0.55**

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ADULTERATION OF LIVESTOCK FEEDSTUFFS AND ITS ECONOMIC IMPLICATIONS

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ABSTRACT
Adulteration can be described as the act of adding foreign substances deliberately or accidentally into the original ingredient for financial gain or due to carelessness and lack of proper hygienic condition during processing, storing, transportation and marketing. There are two types of adulteration, deliberate adulteration and in-deliberate adulteration. Ingredients commonly adulterated includes Maize, Fish meal, Groundnut cake (GNC), Maize offal's and other micro ingredients. The effects of adulteration have deleterious effect on livestock which leads to poor performance. Economically, it is detrimental to revenue generation drive of the government. Feed Adulteration can be curbed through: effective pest control regime should be implemented, periodic testing, feed ingredient should be obtained from a safe source.
Keywords: Feed; livestock; Adulteration; Economy.

INTRODUCTION
Food and drink products are often a target of adulteration (intentional or unintentional) while supply chains usually deal with perishable products that could be harmful to consumers if they are not managed properly (SGS, 2013). Adulteration is the act of either by adding extraneous substances (adulterants) into food items or products or reducing essential nutrients partly or wholly for financial gain or due to carelessness and lack of proper hygienic condition during processing, storing, transportation and marketing. This ultimately results that the consumer is either cheated or often become victim of diseases. Because of that it is important for the consumer to know the common adulterants and their effect, since the increasing number of feed producer and the outstanding amount of feedstuffs import enables the producers to mislead and cheat consumers (Anita and Neetu, 2013). Economically motivated adulteration, however, involves purposeful and intentional replacement of the expected feed substance with a cheaper one.

TYPES OF ADULTERATION
Either because of high demand or seasonality in supply, various feed ingredients can be adulterated in diverse situations. According to different authors like El-loly et al., (2013), Asrat and Yilma (2014) and Nayaran (2014)..

Intentional/deliberate Adulteration
This is the fraudulent addition of extraneous, improper or cheaper ingredients to products or dilution or removal of some valuable ingredients in order to increase profits.

Incidental/unknown adulteration
This type of adulteration is brought due to lack of proper hygienic conditions of feed ingredients throughout production site to consumption table. Here the producers or traders/retailers are not in position to add different adulterants but the ways the products are produced, handled, passed, processed, stored, transported and marketed may be the places where they were contaminated or adulterated since any substance Without its original is

extraneous to the product; include: residual pesticides from cans, rodent droppings, preservatives, (Narayan, 2014) and Asrat and Yilma (2014).

Some common adulterants in feedstuffs

Full fat soya mixed with ground yellow maize added, Lysine mixed with Brown yam flour, Methionine mixed with Cassava flour, Ground bone meal mixed with Charcoal, Ground Oster shell mixed with Bar beach sand, Maize mixed with chopped cobs and chaff.

CAUSES OF INTENTIONAL/UNINTENTIONAL ADULTERATION

Intentional adulteration

The main reason that attracts adulteration is for boosting their cash income by increasing its volume. Even though increasing their profit margins initiated adulteration done by some selfish producers, processors and retailers.

Similarly, any break in steady supply of original product or service could induce the introduction of fake and adulterated ones in order to meet the demand by users. Here, the new sources may not be immediately differentiated or identified and therefore the stringent measures which original producers are subjected to would have been avoided.

Unintentional adulteration/contamination

Rat and lizard are reservoirs for zoonotic disease such as Salmonellosis and Bubonic plague and are vectors of livestock and poultry disease such as Bird flu and many other Bacteria and Fungi disease.

Mold due to moisture from leaking roofs or poor covering during transportation in bad weather. Some grains come from the farm with infestation and are usually not treated.

Effect of adulteration

The problems of adulteration makes the feedstuffs used in finished feed unsafe and unhygienic for use due to poor handling (Asrat et al., 2012). Consumption of adulterated feed causes serious diseases and poor performance in livestock.

Effect of feedstuff adulteration on livestock industry

Contamination of feeds arising from naturally occurring toxicants, microbiological contaminants, and chemical contaminants, such additives used above the permitted levels, pesticides and veterinary residues in feed or as toxic component from feed processing could have deleterious effect in animals.

Effect of feedstuff adulteration on economy

Livestock output depends on the quality feed which is archive through quality feedstuffs, adulterated feed ingredient affect the output performance of livestock, economically, it is detrimental to revenue generation drive of the government, Nigeria suffered huge loss to product adulteration. About N15 billion is said to be annually lost to fake and substandard product in Nigeria (Leadership 4 December, 2017).

How to cubed/reduce ingredients adulteration

Personnel should be trained to understand the ingredient, knowledge of ingredient authenticity, their identity, quality and purity should be fundamental.

Periodic testing: An essential supplement to quality and safety that anchors them together in reality is periodic testing to verify the authenticity of feed ingredients-proof that feed ingredients are what they say they are.

The feed manufacturers should follow the applicable guidelines established by NIAS in purchasing feed ingredients.

The ingredients store should be designed so that it can be adequately cleaned, and ingredients should be stored in a manner that will not encourage microbial growth of contaminants.

Conclusion and Recommendations

Food adulteration has negative impacts on public health. The causes for feedstuff adulteration are; profit margin by increasing volume of the products and dishonesty of producers, retailers and processors. This ultimately results that the consumer is either cheated or often become victim of diseases on his animals. Consumption of adulterated feed causes serious diseases like chronic respiratory disease, diarrhea, and poor performances of livestock. Therefore, the following recommendations were forwarded; adequate laws, funding and staffing should be appeared to control above discussed causes of adulteration. NIAS, NAFDAC and SON should liaise with each other to regulate the feedstuff quality.

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ADOPTION OF IMRPOVED FEEDING TECHNOLOGIES AMONG FARMERS IN IWO LOCAL GOVERNMENT AREA OF OSUN STATE, NIGERIA

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ABSTRACT

The study was carried out to examine the adoption of improved feeding technologies among livestock farmers in Iwo Local Government Area of Osun state. A purposive sampling method was used to select 100 livestock farmers for the study. Primary data were collected from the livestock farmers with the aid of structured questionnaire. The data were analyzed using descriptive statistics such as means, frequency and percentages. Findings revealed that the mean age of the farmers was 48.44 years and most were married male with a mean family size of 6 persons. Most (83%) of the farmers were literate with majority (69.8%). The major source of awareness for the improved feeding technologies was agricultural extension agents. Soybean wastes had the highest level of awareness (85%) and adoption (55%) among the farmers. There was an increase in the cost feeding of the animals from ₦516.00 before the adoption of the innovation to ₦4146.00 after adoption. There was also an increase in the average income per production cycle from ₦54600.55 before adoption to ₦135500.50 after adoption. High cost of raw materials was ranked the first constraint to adoption of innovation. It was recommended that farmers should be encouraged to adopt innovation through the provision of financial assistance by relevant institutions while increasing awareness on benefits of adopting feeding technologies through extension.
Keywords: **Adoption, Improved feeding technologies, Livestock farmers, Awareness**

INTRODUCTION

Background of the study

Authors have emphasized the need for utilizing alternative feed ingredients which are wastes from human and industrial uses (Nsa *et al.,* 2007). There is, therefore need for animal nutritionists to seek for alternatives to the inadequate and expensive conventional feed stuffs to forestall an impending serious food crisis. Some authors (Kwari *et al.,* 2004) have stressed the need for utilization of alternative feed ingredient.

In Africa and other developing countries, feed and feeding comprises 60-70% of total production costs (Madubuike, 1993), with the present trend of rising feedstuffs prices and global inflation, livestock production is increasingly constrained by feed scarcity and the high cost of feeds (Ayantunde *et al.*, 2005). Shortages of feeds and forages are usually acute during the dry season. The situation is even made worse by the climate change phenomenon resulting to erratic weather. In an attempt to solve these problems, scientists have considered the use of agricultural by-products or wastes in the feed of livestock thereby giving rise to various feeding technologies to reduce cost and improve productivity of livestock.

In Iwo Local Government Area of Osun State, three specific feeding technologies have been introduced to farmers for adoption. These include the use of dried plantain peels, cassava peels and soybean wastes in the feed of livestock. Studies (Fanimo *et al.,* 2006; Adesehinwa *et al*., 2011) have been carried out on the effectiveness of including these materials in the feeds of livestock.

Though, there are numerous feeding technologies developed by scientists a lot more needs to be done to ascertain the adoption of these feeding technologies by farmers who are the end users. DFID (2006) maintained that the issue of the level and determinants of adoption of technologies which is lacking among agrarian communities has been as important as their impact on livelihood. Thus the adoption of these technologies by the farmers as well as constraints to the adoption should be of great importance. It is based on this background that this study was conducted to assess the adoption of the introduced

improved feeding technologies among farmers in Iwo LGA of Osun state. The specific objectives were to determine the awareness and use of the technologies, ascertain the sources of awareness, determine the impact of the adopting technologies and constraints to adopting the technologies.

Materials and methods

The study was carried out in Iwo Local Government Area of Osun State. It has an area of 245km^2 and a population of 191,348 as most populous Local Government in Osun State by the 2006 National census figures. The town is located on latitudes 7^0 39^1N and on the longitudes 4^0 9^1E. The primary economic activity of the area is agriculture with the major crops grown being cocoa, yams, maize, cassava, and oil palm. Livestock commonly reared in the area are poultry, goat and sheep. The population of the study included all the poultry, pig and rabbit farmers in Iwo Local Government Area. Ten wards were randomly selected from the fifteen wards in the Local Government Area. Ten livestock farmers were randomly selected in each of the selected wards to give 100 livestock farmers as the sample size of the study. Data collected from the livestock farmers with the aid of interview schedule were analyzed using descriptive statistics such as percentage, frequency and means.

Results and discussion

Socio-economic characteristics of respondents

Table 1 shows that majority (88.0%) of the respondents were male while 12.0% were female. This indicates a greater involvement of the males in livestock in the study area. It further shows that 52.0% of the respondents were within the age range of 40-50 years while 16.0% fell in the range 40 years and below. The mean age was of 48 years implying that livestock production in the area was dominated by adults in their productive and active years. The table also reveals the mean of the household size to be 6 persons with majority (55.0%) of the respondents within the family size of 5-7 persons. A greater percentage (97.0%) of the respondents were married indicating that married people are more involved in livestock farming which may be due to household needs. Most (86.0%) of the respondents had formal education from ranging from the primary to the tertiary level while only 12.0% did not have formal education. This high level of education could positively affect adoption of innovation by farmers. Imoh and Essien (2005) reported that education enhances farmers' ability to understand, evaluate and adopt new production techniques. The table also shows that majority (60.0%) had their major occupation as farming thereby confirming that the study area is a typical agrarian locality. 51.0% were members of the farmers association while 39.0% were not members of farmers association. Farmers association serves as a medium where farmers meet for the purpose of sharing vital information. Adams (1982) in Idio and Okoro (2017) observed that the rate of adoption could be affected by social affiliation

Table1: Socio-economic characteristics of respondents (n=100)

Variable	Frequency	Percentage (%)	Mean
Age (years)			
40 and below	16	16.0	48.44
41-50	52	52.0	
50-60	29	29.0	
Above 60	3	3.0	
Household size (persons)			
2-4	24	24.0	8.00
5-7	55	55.0	

Above 7	17	17.0
No response	4	4.0
Marital status		
Single	1	1.0
Married	97	97.0
No response	2	2.0
Educational level		
No formal education	14	14.0
Primary education	38	38.0
Secondary education	30	30.0
Tertiary education	18	18.0
Major occupation		
Farming	60	60.0
Civil service	14	14.0
Trading	9	9.0
Artisan	2	2.0
Student	1	1.0
No response	14	14.0
Membership of farmers association		
Yes	51	51.0
No	39	39.0
No response	10	10.0

Source: Field survey, 2013

Awareness and use of feeding technologies among the livestock farmers

Table 2 shows that 62.0% of the respondents were aware of the cassava wastes inclusion, 56% were aware of the inclusion of ripe plantain peels while 85% had become aware of soybeans waste inclusion in livestock feeds. Only 20.0% adopted the cassava peel technology, 17% had adopted ripe plantain peel while 55% of the respondents had adopted the use of soybean waste. The result indicates that that soybean waste has the highest level of awareness, and the highest level of adoption among the livestock farmers followed by cassava waste. The least adopted technology was ripe plantain. A larger proportion of the farmers adopted the soybeans waste probably because it is a good source of high quality protein.

Table 2: Awareness and use of feeding technologies (n=100)

Feeding technologies*	Aware	Not aware	Adopted	Not adopted
Cassava peels	62(62)	38(38)	20(20)	80(80)
Ripe plantain peels	56(56)	44(44)	17(17)	83(83)
Soybeans waste	85(85)	15(15)	55(55.0)	45(45.0)

Source: Field survey, 2013 Percentage in parenthesis * Multiple responses provided

Sources of awareness of feeding technologies

As shown in Table 3, majority (73.0%) of the respondents were aware of the technology through the agricultural extension agents, 7.0% were aware through the means of television, 8.0% had no response, and 11.0% became aware through the Poultry Farmers Association while 1.0% got informed through other farmers. The result indicates that extension officer/agents were playing a vital role in creating awareness on improved livestock practices in the area of study. This result is similar to that of Adeokun *et al.,* 2008 where extension agents were found to be the major sources of information on improved goat packages to women farmers.

Table 3: Sources of awareness of feed technologies (n=100)

Sources of awareness	Frequency	Percentage (%)
Agricultural extension officers/agents	73	73.0
Other farmers	1	1.0
Television and Radio	7	7.0
Farmers association	11	11.0
No response	8	8.0

Source: Field survey, 2013

Impact of technology adoption among livestock farmers

Table 4 shows that the average monthly cost of feeding the animals increased from ₦516.00 before the adoption of the innovation to ₦4146.00 after adoption. This indicates an increase in cost of feeding after adoption of the innovation. Adoption of technology may lead to increased production cost caused by additional money used in purchasing feed materials. The table also reveals increase in the average income per production cycle from ₦54600.55 before adoption to ₦135500.50 after adoption. This implies that the adoption of the feeding technologies by the farmers had increased significantly their income per production cycle. This will also lead to an increase in the profitability of the farmers thereby improving their living standards. Farmers should be encouraged to adopt feeding technologies since these technologies are able to increase farmers' income. These same is expected for all innovations that are disseminated to farmers. One of the characteristics of every innovation is its economic viability.

Table 4: Impact of technology adoption among the livestock farmers

Variable	Before adoption	After adoption
Average monthly cost of feeding(Naira)	516.00	4146.00
Income per production cycle (Naira)	54600.55	135500.50

Source: Field survey, 2013

Problems faced in using the new feeding technologies

Table 5 shows that majority (78.8%) of the respondents faced the problem of high cost of feed raw materials followed by scarcity of raw materials (62.5%). 52.5% were of the opinion that the technology was of time consuming while 13.8% had the problem of difficulty in processing the feeds. These were ranked 1st, 2nd, 3rd and 4th respectively. The result reveals that high cost of feed raw materials was the most serious problem to the use of the technology.

Table 5: Problems faced in using the new feeding technologies (n=80)

Problems *	Frequency	Percentage	Rank
High cost of feed raw materials	63	78.8	1st
Scarcity of raw materials	50	62.5	2nd
Difficulty in processing	11	13.8	4th
Time consuming	42	52.5	3rd

Source: Field survey, 2013 ***Multiple responses provided.**

Conclusion and recommendations

Awareness of feeding technologies among livestock farmers was relatively high but with a low level of adoption except in the use of soybean wastes. The adoption of these technologies had increased the average monthly cost of feeding the livestock while also increasing the income per cycle of the farmers. The highly ranked constraints to using these technologies were high cost and scarcity of feed materials. It is therefore recommended that:

There should be increased awareness through extension on the benefits of adopting feeding technologies among livestock farmers.

Farmers should be encouraged to adopt innovation through the provision of financial assistance by relevant institutions and agencies.

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Nutrient characterization of cassava plant meal

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Abstract
The study assessed the nutrient profile in composite Cassava Plant Meal (CPM) with a view to enhancing its efficiency through bio-fortification. Three CPM products were developed from Tropical *Manihot* Species (TMS) 30572 harvested at 24 months. The sun-dried unpeeled cassava root meal, cassava leaf meal and tender cassava stem meal were mixed at ratios 2:1, 2.5:1 and 3:1 while the ratio of the leaves to tender stems was 5:1 across the three cassava plant meal products. The proximate composition, minerals, amino acids, vitamins and fatty acids contents of CPM and maize were determined. Results of proximate contents showed that CPM products had comparable crude protein and nitrogen free extract as maize. CPM products showed superiority (p <0.05) in calcium content over maize meal though maize meal was significantly higher (p <0.05) in phosphorus content compared to the three CPM products. There was significant difference (p <0.05) in the lysine, methionine, arginine, alanine, cysteine, serine and leucine contents of all CPM products and maize. Also, there was no significant difference (p >0.05) between CPM product 1 and maize meal for tryptophan, valine, proline and isoleucine. CPM products had significantly (p <0.05) higher values than maize in cholecalciferol, thiamine, niacin and riboflavin contents. In all analysed fatty acids contents, CPM products had significantly (p <0.05) higher values than maize with CPM product 1 showing superiority over other CPM products and maize. Based on the findings of this study, it can be concluded that CPM products had comparable nutrient profile as maize with CPM product 1 comparatively better in all evaluated nutrient profile.
Key words: Cassava plant meal products, maize, nutrients.

Introduction

Improving livestock productivity especially poultry and swine production require adequate supply of low-cost feeding ingredients. The cost of feeding has been reported to be 65 – 80 % of the total cost of production (Longe, 2006) with maize constituting 40 – 60 % of a balanced maize-soy based diet for poultry and swine. However, the seasonal feed deficit, ever rising cost of feeding ingredients and competition with human food consumption (Halimani *et al.,* 2007) have consistently driven efforts towards the use of alternative dietary energy feed resources for monogastrics (Morgan and Choct, 2016; Akinfala, 1997). One of such alternative dietary energy feedstuff is cassava. Cassava and its components have enjoyed widespread patronage as potential energy source for animal production in Nigeria. It is cheap, widely grown with a yearly tuber production of 59.5 million tons and grows at an annual rate of + 4.0 %; the largest in the world (FAOSTAT, 2017). However, after harvesting the value-giving component, substantial proportion of the co-products (leaves and tender stems) are allowed to rot on farms and homesteads (Akinfala and Tewe, 2004). The incorporation of these cassava fractions to form composite cassava plant meal (unpeeled cassava tuber meal + cassava leaves and tender cassava stem meal) had been shown by previous studies to enhance performance of pigs (Akinfala *et al.,* 2013; Adeyemi and Akinfala, 2018) and poultry (Akinfala *et al.,* 2002; Akinfala *et al.,* 2011). Similarly, studies have reported detailed information on the efficiency and nutrient profile of cassava flour (Ngiki *et al.,* 2014; Nagib and Sousa, 2007) or leaves (Iyayi and Losel, 2001) or peels (Ngiki *et al.,* 2014; Iyayi and Losel, 2005) and its acceptability as energy source for livestock. Nevertheless, the detailed nutrient profile of CPM has not been widely documented. Detailed information on feed resource could support sustainable livestock production and offer wider feed options in livestock production system (FAO,

2018). The research was carried out to characterise the nutrients in cassava plant meal with a view to enhancing its efficiency through bio-fortification.

Materials and methods

Experimental location and preparation of test ingredients

The experiment was carried out at the Poultry Meat Laboratory of the Department of Animal Sciences Obafemi Awolowo University, Ile-Ife and the Laboratory of Animal Science, University of Ibadan, Ibadan. The cassava variety of Tropical *Manihot* Species (TMS) 30572 aged 24 months were purchased from a commercial farm at Ile-Ife. The roots were lifted and soil was shaken off the roots while the cassava leaves were harvested from the plant stem and the tender stems were harvested at 5 cm, usually 6 to 7 nodes from the top of the plant. All the cassava components were harvested between April and June 2017. The fresh roots (unpeeled cassava root) were washed and chopped into small pieces, sun-dried on a concrete floor for an average of 5 – 6 days depending on the intensity of the sunlight, milled with 3 mm sieve mesh and packed into sacks. Also, the fresh cassava leaves and tender stems were sun-dried for about 5-6 days and 9-10 days respectively after harvesting, milled and packed into separate sacks. The composite cassava plant meal products were mixed in line with the procedure of Akinfala *et al.* (2002) at three different ratios of 2:1, 2.5:1 and 3:1 represented as products 1, 2 and 3 respectively. The mixing ratio was in attempt to have comparable minimum crude protein content of 10 % as maize.

Nutrient determination

The nutrients determined in the cassava plant meal products include amino acids (essential and non-essential amino acids), vitamins (fat and water soluble vitamins), minerals (calcium, phosphorus, sodium, chlorine, zinc, manganese and copper) and essential fatty acids (linoleic acid 18:2, linolenic acid 18:3 and arachidonic acid 20:4). The fat soluble vitamins were determined following the procedure outlined by Adams and Moss (1995). The amino acid profile was carried out using the spectrophotometric determination of Ninhydrin chemical reaction. Minerals (Ca, P, Na, Zn, Mg, Mn, Cu, K and Cl) and fatty acids were determined following the methods of AOAC (2005). Also, proximate composition was determined in line with the procedure outlined by AOAC (2005).

Results and discussion

The three cassava plant meal (CPM) products had comparable values with maize in the crude protein, ether and nitrogen free extracts (Table 1). Although, significant difference (p <0.05) exists in the values obtained for the crude fibre and ash with maize having the lowest values while CPM product 1 had the highest. The ash content of the CPM products decreases with increased inclusion of unpeeled cassava root meal in the mix.

Table 1: Proximate composition of maize and cassava plant meal products

		Cassava Plant Meal Products				
Proximate Composition (%)	**Maize**	**1**	**2**	**3**	**SEM**	***P***
Dry Matter (DM)	88.05	90.18	90.17	90.06	0.36	0.15
Crude Protein (CP)	10.38	12.62	12.25	12.51	0.56	0.24
Crude Fibre (CF)	2.57^{d}	8.05^{a}	4.69^{c}	6.81^{b}	0.79	0.01
Ash	2.82^{c}	6.69^{a}	6.53^{a}	6.15^{b}	0.60	0.01
Ether Extract (EE)	4.53	5.38	3.12	3.33	0.37	0.30
Nitrogen Free Extract	67.75	57.44	63.58	61.26	0.07	0.28

^{a,b,c,d} means in the same row having different superscripts differ at p <0.05; SEM: Standard Error of Means
ND = Not Determined

Product 1 contained sun dried unpeeled cassava tuber meal + cassava leaf meal + tender cassava stem meal mixed at a ratio of 2:1 while the ratio of the leaves to tender cassava stems was 5:1 while Products 2 and 3 contained the same components but mixed at ratios 2.5:1 and 3:1 respectively.

The mineral contents of maize and cassava plant meal is shown in Table 2. The CPM products have significantly (p <0.05) higher values than maize for calcium, magnesium, potassium, manganese and sodium. The values obtained for phosphorus content of CPM were lower than maize. The calcium and phosphorus contents of CPM increased significantly (p <0.05) across products 1 through 3. Lower calcium values (1.93 ppm and 0.28 ppm) were reported by Akinfala *et al.* (2011) who determined the mineral contents of CPM product 2 and maize. The minerals (zinc and copper) composition of CPM was comparable with maize. The variations observed in the mineral composition of CPM and maize may be due to variations in their ash and fibre contents.

Table 2: Mineral composition of cassava plant meal products

	Cassava plant meal products					
Minerals	**Maize**	**I**	**II**	**III**	**±SEM**	***P***
Calcium (%)	0.021[b]	0.269[a]	0.389[a]	0.417[a]	0.06	0.03
Magnesium (%)	0.115[c]	0.189[a]	0.182[a]	0.173[b]	0.02	0.032
Potassium (%)	0.316[b]	0.744[a]	0.781[a]	0.768[a]	0.76	0.01
Copper (g/Kg)	0.003	0.005	0.004	0.005	0.001	1.00
Manganese (g/Kg)	0.011[b]	0.060[a]	0.056[a]	0.058[a]	0.008	0.004
Sodium (g/Kg)	0.265[b]	0.371[a]	0.395[a]	0.386[a]	0.021	0.023
Phosphorus (%)	0. 237[a]	0.076[b]	0.089[b]	0.091[b]	0.033	0.029
Zinc (g/Kg)	0.063	0.061	0.059	0.061	0.001	0.81
Chlorine (%)	3.626[b]	2.376[b]	1.530[c]	5.125[a]	1.08	0.006

means having different superscript in a row differ significantly (p <0.05)

Significant difference (p <0.05) exists in the amino acid contents (Tryptophan, Valine, Proline and Isoleucine) of maize and CPM (Table 3). The valine and isoleucine contents of CPM decrease across products 1 through 3 while proline content of the three CPM products increased with increasing levels of unpeeled cassava root meal. For other analysed amino acids (lysine, methionine, arginine, alanine, cysteine, serine, phenylalanine and leucine) contents, there were similarities in the values obtained for maize and CPM products. The increasing values obtained for arginine, cysteine and phenylalanine may be due to the increased proportions of these amino acids in the unpeeled cassava root meal.

Table 3: Amino acid composition of cassava plant meal products

	Cassava plant meal products					
Amino acids (%)	**Maize**	**I**	**II**	**III**	**±SEM**	**p value**
Lysine	0.63	0.61	0.47	0.55	0.03	0.35
Methionine	0.35	0.29	0.23	0.29	0.03	0.58
Arginine	0.87	0.79	0.89	0.92	0.03	0.32

Alanine	1.29	1.31	1.28	1.42	0.03	0.32
Tryptophan	2.16[a]	2.09[ab]	1.92[c]	2.12[a]	0.37	0.02
Cysteine	1.93	1.81	1.82	2.06	0.05	0.25
Valine	3.20[a]	3.10[a]	2.96[ab]	2.72[b]	0.08	0.04
Serine	1.66	1.51	1.61	1.55	0.03	0.15
Phenylalanine	2.53	2.42	2.42	2.49	0.03	0.55
Proline	1.42[a]	1.25[a]	1.30[bc]	1.39[b]	0.03	0.03
Isoleucine	4.09[a]	4.09[a]	3.80[b]	3.71[b]	0.07	0.01
Leucine	4.88	5.22	5.05	5.01	0.06	0.23

means having different superscript in a row differ significantly (p <0.05)

The vitamin contents of CPM products decrease across products 1 through 3 with increased inclusion of unpeeled cassava root meal except for vitamin E (tocopherol). The maize meal showed superiority over CPM in vitamins A (retinol), E (tocopherol) and C (ascorbic acid). CPM products have significantly higher values of vitamins D (cholecalciferol), thiamine, niacin and riboflavin. The vitamin D contents of the three CPM product were 31.80 %, 27.32 % and 26.11 % better than maize. The decreasing trend observed in the vitamin (A, D, C, thiamine, niacin and riboflavin) contents of CPM products 1 through 3 may be due to the low contents of these vitamins in the unpeeled cassava root meal as compared to the leaves and tender stem meals. Similarly reports were found by Salvador *et al.* (2014) and Montaldo (1977) who evaluated the niacin and thiamine as well as riboflavin contents of cassava root meal and unpeeled cassava root meal respectively and obtained lower values.

Table 4: Vitamins composition of cassava plant meal products

	Cassava plant meal products					
Vitamins	**Maize**	**I**	**II**	**III**	**±SEM**	**p value**
A (g/g)	911.67[a]	577.50[b]	355.83[c]	324.17[c]	50.24	<0.001
D (g/g)	443.33[c]	650.00[a]	610.00[b]	600.00[b]	23.88	<0.001
E (g/g)	350.00[a]	275.00[c]	283.33[bc]	295.00[b]	9.15	<0.001
C (g/ml)	3.06[a]	1.73[ab]	1.49[b]	1.69[ab]	0.29	0.012
Thiamin (mg/100g)	0.157[c]	0.270[a]	0.243[ab]	0.213[b]	0.13	0.002
Niacin (mg/100g)	1.467[b]	1.833[a]	1.700[a]	1.667[ab]	0.05	0.024
Riboflavin (mg/100g)	0.077[c]	0.130[a]	0.103[b]	0.093[bc]	0.01	0.024

means having different superscript in a row differ significantly (p <0.05)

Cassava plant meal products were superior to maize in all the measured essential fatty acids contents. CPM product 1 had significantly (p <0.05) higher values than products 2 and 3. The difference in the values may be due to variations in crude fibre and ether extract contents of the three products and maize.

Table 5: Essential fatty acid composition of cassava plant meal products

	Cassava plant meal products					
Fatty acid (%)	**Maize**	**I**	**II**	**III**	**±SEM**	**p value**
Linoleic acid	1.04[c]	5.61[a]	3.92[b]	4.48[b]	0.59	0.004
Linolenic acid	0.07[c]	0.28[a]	0.20[b]	0.22[b]	0.03	0.001
Arachidonic acid	1.52[d]	6.09[a]	4.26[c]	4.87[b]	0.63	0.001

means having different superscript in a row differ significantly (p <0.05)

Conclusion and Recommendation

Based on the findings of this study, it can be concluded that cassava plant meal products had comparable nutrient profile as maize with CPM product 1 comparatively better in all evaluated nutrient profile. It is therefore recommended that CPM be supplemented with ample quantity of phosphorus to enhance desirable performance of livestock.

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SERUM BIOCHEMICAL ESTIMATES OF BROILER STARTER CHICKS FED TIGERNUT (*CYPERUS ESCULENTUS*) MEAL TREATED WITH BAKERY YEAST.

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ABSTRACT

A 28-day feeding trial was carried out to determine the serum biochemical parameters of broilers starter chicks fed toasted Tiger nut treated with bakery yeast. A total of one hundred and twenty unsexed day-old broiler chicks obtained from a commercial hatchery at Ibadan were randomly assigned to four dietary treatments replicated three times with 10 birds per replicate in a General linear Model Procedure using SPSS (Statistical Package for Social Scientist) Design. The results of the study revealed that total protein, albumin and globulin concentration increased as the dietary levels of tigernut increased in the diets. The findings of this experiment suggested that tiger nut meal should be included in the ration of broiler starter chicks as partial replacement for maize at 50% level for optimum performance, production efficiency and stable physiology and normal cellular metabolism in the body of broiler chicks.

Keywords: Serum biochemical estimates**,** Broiler chicks, Tiger nut, Bakery yeast

Introduction

Poultry production globally plays vital role in supplying the population with animal protein and boosting income generation in the rural populace. In Nigeria, the industry is fast gaining ground and achieving optimum nutritional standard and food security (Nkwocha *et al*., 2014). According to World Food Programme (WFP), (2015), poultry production is a reliable antidote to malnutrition and hence a sine quo non for Sub-Saharan Africans to fast track food security.

Tigernut "*Cyperus esculentus*" is an underutilized tuber belonging to the family *Cyperaceae*, which produces rhizomes from the base of the tuber that is somewhat spherical (Gambo and Da'u, 2014).

Tiger nut and its products are rich in carbohydrate, mono-di and polysaccharides (TTSL 2005, Moore, 2004). They contain relatively high levels of protein, Oleic acid (Monounsaturated) fatty acid which has a bigger resistance to chemical decomposition) and fat (TTSL, 2005). Tiger nuts have excellent nutritional quality with a fat composition similar to olive oil and rich mineral content, especially phosphorous and potassium (FAO, 2008; Moore, 2004). Tiger nut oil has a mild, pleasant flavor and is considered as food oil similar but superior in quality to olive oil.

The study is therefore aimed at determining the serum biochemistry of broiler starter birds fed toasted tigernut meal treated with bakery yeast.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the poultry section of Imo State Polytechnic Teaching and Research Farm, Umuagwo-Ohaji, Imo State in South Eastern Nigeria. The climatic data of the area showed that annual rainfall ranges between 2000-2500mm. The institution is situated on latitude 6^0N and longitude 7^0E of the equator with the temperature ranging from (26.5-32^0c) and humidity of (70-80%)(Nimet, 2015).

Experimental Birds and Design

One hundred and twenty (120), day old Agrited broiler chicks were bought from a commercial hatchery at Ibadan, Oyo State, Nigeria, certified to be of good health and physical stability. The chicks were acclimatized for 3 days and fed control diet. Kerosene stoves and lanterns were used to provide the heat needed to keep the temperature within optimum range/between 33^{o}c to 35^{0}c).The birds were raised in a deep litter system measuring 4.8 x 3.0m whose floor was covered with wood shavings and feed was provided throughout the experimental period *adlibitum*. Standard management practices were strictly observed. The broiler chicks were randomly allocated to 4 (four) dietary treatments and replicated three times with each replicate having ten (10) birds in a General Linear Model Procedure using SPSS version 20 (SPSS, 2014). The routine management and prophylactic measures were observed accordingly.

Feed preparation and feeding

Tiger nut seeds (*Cyperus esculentus*) was purchased from the local market in Owerri, Imo State. The tiger nut was toasted, passed through hammer mill which crushed the nuts into tiger nut meal. Proximate analysis was carried out to determine the proximate composition of the tiger nut seed meal (AOAC, 2005) as shown in Table 1. The tiger nut was then treated with bakery yeast few days before use in feed formulation to enhance digestibility and biotransformation of organic synthesis. Four isonitrogenous (24±0.24 CP) diets were formulated such that tiger nut replacing maize at 0%, 25%, 50% and 75% dietary levels respectively, the control diet (0%) contained no tiger nut meal (table 2).

Table 1: Proximate composition of tiger nut seed meal (% dry matter)

Parameters	Composition (%)
Dry matter	**89.40**
Crude protein	**7.46**

Ether extracts	**8.61**
Crude Fibre	**25.33**
Ash	**8.27**
NFE	**39.73**
Metabolizable Energy	**2390.985kcal/kg**

Metabolizable energy calculated; ME (Kcal/kg) =37 x %CP +81 x %EE +35.5 x %NFE (Pauzenga, 1985)

Table 2: Ingredient composition of experimental diets fed to starter broilers

	Dietary levels of tigernut meal			
Ingredient	**0%**	**25%**	**50%**	**75%**
Maize/ meal	**50**	**12.5**	**25.00**	**12.50**
Tigernut meal	**-**	**37.5**	**15%**	**37.00**
Soya bean meal	**15**	**15**	**20**	**15**
Groundnut cake	**20**	**20**	**5**	**20**
Wheat offal	**5**	**5**	**5**	**5**
Fish meal	**5.5**	**5.5**	**5.5**	**5.5**
Palm kernel cake	**5**	**-**	**-**	**-**
Salt	**0.25**	**0.25**	**0.25**	**0.25**
Bone meal	**3.00**	**3.00**	**3.00**	**3.00**
Bakery yeast	**0.50**	**0.50**	**0.50**	**0.50**
Lysine	**0.25**	**0.25**	**0.25**	**0.25**
Methionine	**0.25**	**0.25**	**0.25**	**0.25**
Total	**100**	**100**	**100**	**100**
CP	**24.88**	**24.37**	**24.37**	**24.37**
ME	**2839.20**	**3119.325**	**3025.95**	**3119.33**

500g of bakery yeast contains 100mg of ascorbic acid; 100mg of sorbitan monostereate (E-44), and natural yeast

Blood Sample Collection

At the end of the 4 weeks feeding trials, three birds were randomly selected from each replicate, and 5ml blood sample was collected through the wing vein with a 5ml sterile syringe. The blood collected was used for the analysis of serum parameters (albumen, total protein, glucose, cholesterol, urea, etc).

Data analysis

All data obtained were statistically analyzed using the General linear Model (GLM) procedure of SPSS version 20 (SPSS, 2014) while differences in treatment means were separated using Duncan's Multiple Range Test from the same software package.

Results and Discussion

The proximate composition of tiger nut is shown in Table 1, while the ingredient composition of experiment diets fed to starter broilers are on Table 2, while the serum biochemical estimates are summarized on Table 3 respectively.

Table 3: Serum biochemistry of broiler starter chicks fed graded levels of tiger nut treated with bakery yeast.

Parameters	T_1	T_2	T_3	T_4	SEM
	0%	25%	50%	75%	
Urea mg/dl	6.60	6.70	6.90	7.20	0.15
Creatinine Mg/dl	5.30	5.50	5.65	5.70	0.13
Glucose Mg/dl	37.60^a	42.30^b	46.00^c	51.00^d	4.66
Cholesterol Mg/dl	52.20^a	55.00^b	58.60^c	62.00^d	3.27
Total protein g/dl	54.00^a	57.50^b	59.70^b	64.50^c	3.50
Albumin g/dl	20.30^a	22.10^b	22.70^b	24.25^c	1.98
Globulin g/dl	33.70	35.40	36.80	42.25	2.85
SGOT iu/l	9.40^a	9.80^a	10.30^b	10.50^b	0.45
SGPT iu/l	12.40^a	12.70^a	13.10^b	13.40^b	0.33

^{abcd} **Mean along the row having different letters differ significantly P<0.05**

The serum biochemistry of the starter birds revealed that total protein, albumin, serum glutamate pyruvate transferase (SGPT), Serum glutamine oxaloacetic transferase (SGOT), glucose, cholesterol and globulin concentrations increased as the dietary levels of tigernut increased in the diets. High level of blood serum globulin is an indent of growth since new protoplasm is added to the cell.

Normally glucose level in the blood is necessary for the metabolic activities of the body and it appears that the tigernut meal builds or promotes blood by supplying the necessary blood forming metabolites like Magnesium, Iron, Copper, etc which enhances effective transportation of oxygen, glucose and other feed nutrients in the animal body.

The implication of the above result is that tigernut meals are richly utilized by broilers at relatively higher dietary inclusions. Moreover, the effect of feeding high dosage of tigernut which contained relatively high fibre compared with maize perhaps, was the reflection of high creatinine values but not significantly different (P>0.05) between the control group. The high creatinine values in the serum indicated poor utilization of nutrient due to muscles wastage (Udoyong *et al*., 2010).

CONCLUSION AND RECOMMENDATIONS

From all indications, tigernut based diets promoted highest values in virtually all the serum biochemical estimates notably Urea, Glucose, Total protein, Albumin, Globulin, SGOT and SGPT.

In view of the above experimental results, Tigernut meal should be included in the ration of broiler starter chicks as partial replacement for maize at 50% level for optimum performance and production efficiency.

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DEVELOPMENTS IN MARKETING CHANNELS AND SYSTEMS FOR SMALLHOLDER CHICKEN PRODUCTION IN NIGERIA

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ABSTRACT
There are a number of marketing opportunities that can benefit stakeholders in the smallholder chicken value chain. For sustainability, the smallholder chicken farmers depend on the constant availability of inputs like foundation chicks, simple housing and equipment. This paper presents observations from some activities carried out by Bdellium Consult Ltd on smallholder poultry developments in the past three years, and discusses the advances, challenges and opportunities in the development of marketing channels for the smallholder poultry production in Nigeria. Traditionally the cocks are allowed to run along with the hens to produce fertile eggs that the hens will sit on to incubate in order to produce chicks. However, in the recent times, a class of farmers popularly called "Brood and Sell Farmers" that serve as mothering units for smallholder farmers have emerged. Complementary enterprises, vendors and artisans have also emerged within the value chain, with a number of marketing systems developing to support the different smallholder production systems. There are sellers of live birds who have organized themselves into virile Fowl Sellers Association (FSA) within majority of the live bird markets in urban and rural centers. The niche market for village chickens is now throwing up a number of companies that are investing in the setting up modern facilities for slaughtering and processing village chickens. There is therefore the need for more coordinated interphase in the smallholder chicken production value chain in order for stakeholders to maximize and benefit from existing opportunities.

Keywords: Smallholder chicken farmers, input supply, marketing outlets

INTRODUCTION
The poultry sector of the agricultural industry is one of the most accessible farming operations to both the rural and urban farmers in Nigeria. The smallholder farmers form the bulk of poultry producers in Nigeria with an estimate of about 90 million people involved in rural family poultry, managing total assets of about N320 billion ($2,400 million) **(**(F.M.A& R.D. 2008**).** The characteristics of the smallholder chicken farmers have been described by various authors, Sonaiya and Swan (2004); Adene and Oguntade (2006); Akinwunmi, Okike and Rich, (2010); and F.A.O. (2012).

The principal actors in the value chain are the farmers (especially rural dwellers), live-bird traders, transporters and consumers. Marketing opportunities that can benefit these stakeholders who are active players in the smallholder chicken production have existed over the years. This write up discusses the advances, challenges and opportunities in the development of marketing channels for the smallholder poultry production in Nigeria from the field experience of our company, Bdellium Consult Ltd work with smallholder chicken farmers in the last three years.

RESULTS AND DISCUSSION
Market developments
Market development for the smallholder poultry value chain covers two key areas of input supplies and products distribution:

The supply of chicks

In the conventional village poultry production, the chicken owners usually allow the cocks to run along with their hens to produce fertile eggs that the hens will sit on to incubate in order to produce chicks that will run with the hens on free range. Occasionally, too, some farmers procure post brooded chicks produced in this manner within their precinct to carry out their own chicken farming. This has been the mode for continuous chicks' supply that has largely sustained the village chicken production system particularly in the rural communities. However, the emerging scenarios in some rural and peri-urban communities is to have hatchery distributors and retailers sell day old chicks (DOCs) to farmers in open market on market days.

Report by I.A.R.& T. (2015) revealed that the breeder farms and hatcheries supplying DOCs are still concentrated in the South-West (especially in Ibadan, Oyo state) with a few scattered across the southern parts of the country. But these hatcheries are more focused on producing chicks for the medium and large commercial poultry farmers with the smallholder farmers getting the remnants and are often faced with irregular supply with serious seasonal fluctuations in prices of DOCs. Therefore, huge opportunities exist for breeder farms and hatcheries that produce good quality day-old-chicks to serve the interest of the smallholder farmers.

The recent efforts of the African Chicken Genetic Gain (A.C.G.G.) project in Nigeria in the facilitation of the establishment of breeding companies that will multiply farmers' preferred breeds of dual-purpose chickens will go a long way in promoting the smallholder chicken production business.

Distribution of post brooded chicks

Most of the smallholder chicken farmers have poor infrastructure limited technical know-how on the basic of brooding chicks, hence, some of them prefer the post-brooded chicks that are fully feathered and have some immunity against diseases as foundation stocks. This trend has led to the emergence of a class of farmers now popularly called "Brood and Sell Farmers" (BSF) that serve as mothering units for smallholder farmers. The BSFs are specialized farmers that invest in raising chicks from day old for an average of four to five weeks and offer the fully feathered chicks for sale to farmers though a network of chicks' hawkers. They also sell directly to farmers in the open market.

The BSFs, though not officially recognized have carved a niche for themselves and a number of them are thriving on the sales of these chicks. They are mostly found in the villages and peri-urban communities where they have developed process and network for the distribution chicks to their various customers. They offer mainly post-brood cockerels which are cheaper to raise and sell. A few of them also raise and sell post-brooded pullets and dual-purpose chicks. The prices of these chicks vary greatly from location to location across Nigeria.

Inputs supply

The smallholder chicken farmers have also provided opportunities for other complementary enterprises, vendors and artisans within the value chain. These include carpenters or wood-work experts who are engaged to build simple and cheap housing units, merchants of brooding materials like coal pots, charcoal, polythene sheet, feed merchants and agro shops that sell poultry equipment like feeders, drinkers, vaccines and medicaments. It is now common within some communities to find agro-service enterprises that combine the distribution or sale of poultry house equipment, feed milling, veterinary and medicament together as a business. A number of communities where development agencies like Global Alliance for Veterinary Medicine (GALVmed), Propcom Mai-karfi etc. are operating across Nigeria now have people that have been trained to offer simple community health services like vaccination against prevalent Newcastle disease and de-worming.

Opportunities for chicken haulage business

Until recently, the mode of transporting chickens were very unkind to the chickens and the human population. But after the outbreak of Highly Pathogenic Avian Inlueza (HPAI), the Federal Ministry Agriculture and Rural Development (F.M.A.R.D.) intervened to built the capasity of the stakeholders in

transporting the chickens appropriately in chicken transport cages. Opportunities therefore exist for interested parties to invest in chicken haulage enterprises that will service the smallholder farmers

The Live bird markets

The main product of the smallholder chicken farmers is the meat but a few of them also sell eggs from their chickens. Majority of these farmers sell their birds live with little or no value addition. A number of marketing systems have emerged to support the different production systems. In some communities, the smallholder chicken farmers sell directly to the customers whether at home, town hall meetings and in local market at the prevailing market prices. These prices are determined by the weight of the chicken and sex. Often times, there could be a long negotiation (haggling) before sale price is agreed. Farmers are sometimes at the mercy of the buyer especially at the market place when it seems that the market day is almost closing.

The sellers of live birds have organized themselves into virile Fowl Sellers Association (FSA) and they have branches spread across Nigeria operating like a cartel. Interaction among producers, collectors and middlemen takes place early in the morning in the south and late in the afternoon in the north. This timing allows for the transport of birds in the coolest hours of the day. The Federal Ministry of Agriculture and Rural Development (F.M.A.R.D.) has been training the live birds sellers and organizing the way they ply their trade by assisting the fowl seller association to build acceptable sales outlet across Nigeria

Market opportunities for chicken processing

The village chicken meat is considered to be tastier due to gradual growth and selective feeding, it is very popular among consumers and used as a delicacy for chicken barbeque (*chicken suya).* There is a definite popular demand and trade in village chickens. There are few smallholder chicken processing plants that have set-up operations around the commercial broilers out-growers' farms, some of these also serve as off-takers to the smallholder farmers' chickens. But majority of the live bird markets in urban and rural centers have young men and women around them that assist patrons of the live bird markets in slaughtering and dressing their chickens for token fees that is usually a tiny fraction of the cost of purchase. But these slaughter slabs are usually very unhygienic. The F.M.A.R.D. and health officials have also stepped up in ensuring food safety by regulating handling and processing of chickens and also facilitating the incorporation of hygienic slaughtering facilities into the live bird markets.

The niche market for village chicken is now throwing up a number of companies that are investing in the setting up modern chicken facilities that slaughter and process village chickens. They are presented to customers well packaged and frozen. These companies have their own network of aggregators spread across the rural communities and are also working with the fowl seller's association to collect chickens in the numbers required.

They have also embraced the new trends of marketing through the web and social media. They set up network markets and undertake delivery logistics for their customers

Their targets are usually in the urban centers and these include individuals, families, hotels, restaurants, caterers, super markets and chain stores

Marketing of eggs

In the markets, eggs come largely from the commercial poultry sector. Generally, it is possible to find only a few eggs of local chickens and sometimes a couple of eggs of guinea fowl or duck. The marketing of eggs by the smallholder chicken farmers is not all that common, sales of eggs are within family and friends where farmers sell directly to consumers. In the northern parts of Nigeria, the presence of local eggs is a little higher. The producers collect the eggs which are usually fertile because male and female chickens scavenge together and mate regularly. The eggs may then be set under a brooding chicken (to replace some of her own eggs) or taken to a hatchery.

CONCLUSION AND RECOMMENDATION

The different types of smallholder chicken production systems have their peculiar channels and systems for the distribution of their products. Therefore, price of the products, the product itself, the type of market place and packaging of the products are factors that influence the exchange of money for poultry products. With the existing structure and status of the smallholder chicken farmers, there is need for more coordinated effort from all stakeholders to support these farmers in Nigeria in order for them to reach their full potentials. To fully benefit from all the opportunities available for the marketing of the product of the smallholder chicken farmers in Nigeria, there is need for awareness creation on the benefits of consuming these more organic products. Also, off-takers or processors can set up structures that will develop a financing model to facilitate linkages that will benefit the players in the smallholder chicken value chain. A more coordinated interface with the smallholder chicken production value chain is required for all the stakeholders to maximize and benefit from the existing potential.

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NUTRITIONAL EFFECTS OF GROUNDNUT HAULMS ON TESTICULAR FUNCTIONS AND ONSET OF PUBERTY OF KANO BROWN BUCK KIDS

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ABSTRACT

This study was carried out to investigate the effects of feeding groundnut haulms on onset of puberty and testicular functions of Kano Brown buck (KBB) kids. A total of 30 KBB, aged 3 months old with average initial body weight of 6.05 ±1.57kg were used for the study. Animals were kept in an individual pens under one shed to eliminate any variations attributed to environmental and management changes. A concentrate diet (control) was formulated to contain 13% crude protein and groundnut haulms were supplemented at 0, 100, 200, 300 and 400 g/head/day designated as T_1, T_2, T_3 T_4 and T_5, respectively. Animals on treatment 1 were fed on the control diet (*ad libitum*) for the whole period of the experiment. Animals on treatments 2, 3, 4 and 5 were also offered the control diet and supplemented with 100, 200, 300 and 400 g/head/day of sun-dried groundnut haulms, respectively. Result showed that age at puberty decreased significantly ($P < 0.05$) with increased groundnut haulms supplementation, with animals on T_5 (400 g) attained puberty earlier followed by those on T_4 (300 g) supplementation. Animals on the control (0 g) attained puberty at a later age. Semen volume, semen colour, normal sperm cells, concentration, motility and scrotal circumference were significantly ($P < 0.05$) higher in animals on T_5 (400 g) supplementation at the onset of puberty. Sperm morphological abnormalities (detached head, narrow head, coil tail and bent tail) decreased significantly ($P < 0.05$) with increased groundnut haulms supplementation. It is concluded that feeding groundnut haulms hastened attainment of age at onset of puberty with significant increased in testicular functions of KBB.

Key words: Nutrition, onset of puberty, groundnut haulms, testicular functions, Kano Brown buck kids.

Introduction

Goats are kept primarily for meat and contribute substantially to the household income and food security in most rural areas (Raji *et al*., 2008). The reproductive efficiency in goat production is aimed at bringing both young male and female animals into optimum sperm cell production and conception at an early age. The interaction between nutrition and reproduction has been known to have important implications for the reproductive performance of farm animals (Bindari *et al*., 2013). Nutrition is central to reproductive performance with sub-optimal nutrition associated with delayed onset of puberty, reduced expression of reproductive behaviours, reduced reproductive rates and poor growth of young. However, reproductive behaviour is inhibited as nutrition becomes progressively more limiting and also, optimal levels of nutrition are required if animals are to express their full genetic potential for reproduction. Puberty in bovine bulls has been defined as the age at which ejaculated semen contained at least 50 x 10^6 spermatozoa with a minimum of 10% motility (Oyedipe *et al*., 1981; Rekwot *et al*., 1987). It is also defined as the age at which sexual development is attained and the animals become capable of reproduction (first ovulation in the female and first spermatozoa in the ejaculate of the male) (Bielli *et al*., 2001). Early puberty is an important index to achieve optimum reproductive performance in goats. Puberty can also be achieved at an earlier age with improved feeding and, thus, reduction in the generation interval and then increase the rate of genetic gain of our local livestock. Animals that are gaining more rapid weight due to increased feed intake have greater weight of internal organs as a proportion of body weight, higher rate of metabolism, higher circulating concentration of insulin-like growth factor-I (IGF-I), and they attain puberty earlier (Wester, 1994). The age at which puberty is attained is more dependent upon body weight than influenced by animal's plane of nutrition. Puberty is achieved when sexual maturation has progressed to the point where insemination and fertilization can be accomplished. Effective male reproduction requires both the production of sufficient and viable spermatozoa and adequate libido to ensure deposition of the sperm cells in the female genital tract. Full development of the sex organs is required to physically accomplish a successful mating and development, if libido is needed to initiate copulation. Failure to achieve maturity in any aspect will result in reproductive incapability (Wester, 1994). The current study was

designed to investigate the nutritional effects of groundnut haulms on onset of puberty and testicular functions of KBB.

Materials and methods

Study Area

The study was conducted at the Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture and Agricultural Technology, Kano University of Science and Technology, Wudil. Wudil lies between longitude $8^0 58'$ East and latitude 11^0 35' North at an altitude of 403m above sea level. The average annual rainfall ranges from 850 to 870mm, minimum and maximum temperature is 26^0C and 33^0C, respectively (Olofin et al., 2008).

Experimental Animals

Thirty (30), three months (3) old male Kano Brown bucks with average body weight of 6.05 ±1.572kg were used for the study. Animals were treated against ecto-and-endo parasites using Ivotek super® (Ivermectin + Clorsulon) at dose of 200 µg/kg body weight. They were also vaccinated against pnuemo-enteritis complex [peste-des-petits ruminants (PPR)] at a dose of 1 ml/animal subcutaneously. Animals were quarantine for two (2) weeks and water and mineral lick were provided *ad libitum*. All animals were kept in individual pens under one shed so as to eliminate any variations attributed to environmental and management changes Mukherjee, 1992).

Experimental procedure

The thirty (30) animals were randomly divided into five (5) treatments of six (6) animals per treatment. Each animal within a group was housed individually. Animals in treatment 1 were fed on the basal diet (*ad libitum*) for the whole period of the experiment. Animals in treatments 2, 3, 4 and 5 were offered 100, 200, 300 and 400 g/head/day of sun-dried groundnut haulms supplement. A completely randomized design was used and data was taken for 24 weeks.

Pubertal study

Age at onset of puberty was determined as the age at which sexual development is attained and the animals become capable of reproduction (first spermatozoa in the ejaculate of the male) (Bielli *et al*., 2001).

Semen collection and evaluation

Semen was collected and evaluated biweekly using Lane pulsator electro-ejaculator (Lane Manufacturing Co., Denver, Colorado). The following parameters were determined:- volume, motility, semen pH, coluor, sperm concentration, live and dead ratio and sperm morphological abnormalities.

Statistical analysis

Data generated were coded and then subjected to analysis of variance (ANOVA) using General Linear Model of (SAS, 2002), where significant difference exist, means were separated using Duncans Multiple Range Test (DMRT).

Results and discussion

The results of the effect of groundnut haulms supplementation on pubertal characteristics is presented in Table 1. Although there was no significant ($P > 0.05$) difference in body weight for age at onset of puberty, animals on 400 g supplementation had numerically higher body weight. This confirmed earlier by report [4] that bulls on high protein diet have higher growth rate, compared to low-protein diet. Age at onset of puberty was significantly ($P < 0.05$) influenced by groundnut haulms supplementation. Animals on treatment 5 (400 g) supplementation attained puberty at earlier age than the other groups. This result may be attributed to higher protein consumed by these animals. This report was in agreement with the finding of Alabi, 2005) who showed that Bunaji bulls on low energy diets attained puberty later than those on high energy diets, apparently attributed to low nutrient intake. Similarly, Rekwot *et al*. (1987) reported that low concentration of protein in the diet of Bunaji bulls and their Friesian crosses delays onset of puberty and that Bunaji bulls attain puberty later than their Friesian crosses, when placed on low protein diets, but earlier when placed on high protein diet. Additionally, Reid and Looli (1964) reported that feeding 100% total digestible nutrient levels to heifers enable them to attain puberty at 49 weeks, compared to 88 weeks when the level is reduced to 68% total digestible nutrients.

Scrotal circumference, semen volume, semen colour, normal sperm cells, concentration and motility (Table 1) increased significantly ($P < 0.05$) with increase groundnut haulms supplementation at onset of puberty. This result confirmed the report of Hassa (2010) that yearling Kano Brown bucks fed graded levels of groundnut haulms have significantly ($P < 0.05$) higher scrotal circumference, semen volume, colour, motility, concentration and normal spermatozoa. Rekwot *et al*. (1987) also reported similar observation in Bunaji bulls and their Friesian crosses on low and high protein diets, where bulls on high protein diets attained puberty at a younger age with better pubertal traits than those placed on low protein diets. A significant ($P < 0.05$) high percentage of sperm morphological abnormalities (Table 2) for animals on lower groundnut haulms (100 g) and the controls (0 g) in the present study showed that animals on higher levels of supplementation (300 g and 400 g) had better semen traits and attained puberty at an earlier age. This agreed with the report of Rekwot *et al*. (1988) that bulls fed low protein diets have poorer semen quality than those fed high protein diets.

Conclusions

The following conclusions could be drawn from the present study:-

Groundnut haulms enhanced attainment of onset of puberty in KBB kids, indicating that supplementation up to 400 g reduce age at puberty and improved reproduction in buck kids.

Testicular functions were significantly improved with increased groundnut haulms supplementation

Sperm morphological abnormalities were reduced with increased groundnut haulms supplementation.

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Table 1: Pubertal characteristic of Kano Brown bucks fed groundnut haulms supplements at onset of puberty

	Treatments (g)					
Parameter	0	100	200	300	400	SEM
Body weight (kg)	6.78	7.17	7.57	7.77	7.92	0.58
Scrotal circumference (cm)	8.92^{b}	15.00^{a}	15.58^{a}	13.43^{a}	15.30^{a}	1.06
Semen volume (ml)	0.13^{b}	0.15^{b}	0.14^{b}	0.23^{ab}	0.42^{a}	0.07
Semen colour	2.17^{b}	2.17^{b}	2.67^{ab}	3.00^{a}	3.17^{a}	0.20
Semen Ph	8.00^{a}	7.83^{a}	7.83^{a}	7.5^{a}	6.67^{b}	0.21
Live spermatozoa (%)	26.17^{c}	51.67^{ab}	31.67^{c}	66.00^{a}	40.00^{bc}	6.05
Normal sperm cells (%)	23.45^{b}	50.58^{a}	50.29^{a}	50.46^{a}	53.12^{a}	4.37
Sperm concentration (x10^{6}/ml)	240.00^{c}	436.50^{bc}	525.00^{abc}	798.00^{a}	716.80^{ab}	101.09
Motility (%)	37.50^{b}	37.33^{b}	48.14^{ab}	63.09^{a}	45.33^{ab}	5.79
Age at puberty (months)	5.70^{e}	5.50^{d}	5.23^{c}	5.05^{b}	5.00^{a}	0.00

^{abcde}Means within the same row with different superscript are significantly different ($p < 0.05$) SEM = Standard Error of the Mean, n = 6 animals per group.

Table 2: Nutritional effects of groundnut haulms on sperm morphological abnormalities of KBB

	Treatments (g)					
Parameter	0	100	200	300	400	SEM
Detached head (%)	4.14^{b}	24.88^{a}	13.25^{ab}	7.67^{b}	10.74^{ab}	5.07
Narrow head (%)	42.58^{a}	15.06^{b}	10.91^{b}	20.48^{b}	16.20^{b}	3.32
Coil tail (%)	10.17^{a}	8.77^{ab}	7.69^{ab}	4.54^{b}	3.58^{b}	1.74
Bent tail (%)	19.67	14.27	16.09	16.54	15.83	1.86

^{ab}Means within the same row with different superscript are significantly different ($p < 0.05$) SEM = Standard Error of the Mean, n = 6 animals per group.

Cadmium, lead and chromium traces in liver, intestine and kidney of Scavenging swine and dogs slaughtered in Wukari metropolis of Taraba state, Nigeria

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Abstract

The aim of this study was to determine the concentrations of cadmium, chromium and lead) traces in the intestine, kidney and liver of scavenging swine and dogs slaughtered in Wukari metropolis of Taraba State. Samples of liver, intestine and kidney of swine and dogs were collected in slaughtered spots in Wukari metropolis. The collected samples of liver, intestine and kidney were digested and analyzed for cadmium, chromium and lead using flame atomic absorption spectrophotometer (AAS). The concentrations of these metals in the liver, kidney and intestine of pigs and dogs ranged from 0.03 to 0.03mg/kg for cadmium; 0.05 to 0.11 mg/kg for chromium and 0.14 to 0.23 mg/kg for lead. The highest concentration of lead was observed in the intestine of swine. The organs of dogs were less accumulated with heavy metals compared to swine. The results indicated that there was no significant (P>0.05) effect of heavy metal residues in organ of swine and dogs to heath risk for residents of Wukari metropolis.

.**Keywords:** Heavy metals, organs, swine, dogs.

Introduction

Heavy metals are ever present and the enter the environment by natural means or human activities through sources like natural weathering, mining, soil erosion, industrial effluents, agro chemicals and many other means (Morais *et al.,*2012). Exposure to heavy metal is very dangerous to both animal and human health. Toxic effects usually associated with chronic exposure are mutagenecity, carcinogenicity, Immune-suppression; poor body condition and impaired reproduction (Bayersmann.and Hartwig, 2008; Garcia-Leston *et al.,* 2010). By nature animals' liver, lungs and intestine are sources of metals like iron, copper, magnesium and zinc. However liver might contain higher amount of heavy metals and other contaminants which tend to accumulate in tissues (Adei and Forson-daboh., 2008), and affects performance and meat quality of these animals. Also some of these metals bio-accumulate in the food chain causing environmental and human health concerns (Sedki *et al*., 2003). As a result, human exposure to toxic metals has become a major health risk. Monitoring levels of trace elements and heavy metals in the different organs of animals meant for human consumption, allows assessing the quality and nutritive value for this purpose. Hence, this study was

therefore designed to investigate contamination of some heavy metal residues in liver, intestine and kidney of slaughtered free ranged swine and dogs.

MATERIALS AND METHODS

Study Area

The study was conducted in Wukari metropolis of Wukari Local Government Area, Taraba State. Wukari is located between latitude 7°5N to 7°85'N and longitude 9°46'E to 9°78'E of the Greenwich meridian (TSD, 2008)

Collection of Samples

A total of 48 visceral organs (kidney, liver and intestine) from scavenging slaughtered swine (n=24) and dogs (n=24) were collected from various slaughter locations in Wukari metropolis. The organs were cleaned of dirt, oven-dried at 60^0C for 24 hr and packed in airtight containers before analysis.

Sample digestion and analysis

The samples (liver, kidney and intestine) of swine and dogs were digested in HNO_3 (16 mol/L) and H_2O_2 (30%) as described by Jeffrey (2003) at the Department of Animal Science Biochemistry Laboratory, ABU, Zaria. The concentrations of lead, cadmium, mercury and chromium was determined using flame atomic absorption spectrophotometer (AAS, Model 3030, Perkin-Elmer, USA) at the Department of Soil Science Laboratory, ABU, Zaria .

Data Analysis

Data generated from the laboratory analysis were subjected to student t-test to test for significant differences of heavy metal concentrations between the visceral organs of scavenging swine and dogs using JMP® SAS (2012).

RESULTS

The results in Table 1 show the concentration of cadmium, chromium and lead in the intestine of swine and dogs. The results revealed that cadmium and chromium concentrations are similar (P>0.05) in swine and dogs. The concentration of lead in swine is higher (0.23 mg/kg) compared with value of 0.10mg/kg in dog intestine.

Table 1: Concentrations (mg/kg, dry weight) of Cadmium, chromium and lead in intestine of swine and dogs.

Parameters	pigs	Dogs	p-value
Cadmium	0.02	0.02	0.01
Chromium	0.11	0.05	0.01

Lead	0.23	0.10	0.01

p-value for t-test comparing the heavy metal residues in swine and dog

The results in Table 2 present the concentrations of cadmium, lead and chromium in the liver of swine and dogs. The result shows higher numerical concentration of chromium (0.11mg/kg) and lead (0.19mg/kg in swine compared with those obtained in dogs.

Table 2: Concentration (mg/kg, dry weight) of cadmium, chromium, lead and mercury in liver of swine and dog.

Parameters	**Swine**	**Dog**	**p-value**
Cadmium	0.03	0.01	0.03
Chromium	0.11	0.09	0.01
Lead	0.19	0.05	0.01

p-value for t-test comparing the heavy metal residues in swine and dog

The results in Table 3 revealed that chromium (0.13mg/kg) and lead (0.14mg/kg) in swine were higher (P>0.05) compared with those in dog with exception of Cadmium.

Table 3: Concentration (mg/kg, dry weight) of cadmium, chromium and lead in kidney of swine and dogs.

Parameters	**swine**	**Dog**	**p-value**
Cadmium	0.02	0.02	0.01
Chromium	0.13	0.10	0.02
Lead	0.14	0.10	0.01

P-value for t-test comparing the heavy metal residues in swine and dog

Discussion

The low Pb concentrations in the liver, intestine and kidney in this study for dogs compared with higher values (0.09-0.23mg/kg) in swine could be due to high scavenging activities in contaminated feed, water source and the environment. Pb values range of 0.09-0.23mg/kg in this study is less than the maximum level of 0.5 mg/kg in offal for human consumption (EC, 2001). The Pb values obtained in this study is less than reported value of 0.46ug/g for swine in Canada as reported by Prior (1976). The Cadmium values range (0.01-0.03mg/kg) concentration in this study is less than value of 0.26ug/g reported for slaughtered swine in Canada by Korsrud *et al*.(1985) and other scholars in Casablanca city

in morocco by Chafik *et al.* (2014) for cattle, sheep, equine and goats. The cadmium concentrations in this study is less than the maximum level of 1.0 mg/kg for human tolerance (EC, 2001).

Conclusion

These findings imply that consumers of these organs in Wukari metropolis are not exposed to hazard of high concentrations of these toxic metals in free range swine and dogs, , an indication of low pollution in the study environment

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EFFECT OF DIETARY SUPPLEMENTATION WITH *Monodora myristica* ON THE PERFORMANCE AND ECONOMICS OF PRODUCTION OF STARTER BROILERS

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Abstract

This study was conducted to evaluate the effect of dietary supplementation with *Monodora myristica* (African nutmeg) on the growth performance and economics of production of starter broilers. 120 one week old CHI broilers chicks were randomly allotted to five treatment groups in a completely randomized design. Each group was replicated three times with 8 birds per replicate. Five experimental broiler starter diets were formulated such that T_1, T_2, T_3, T_4 and T_5 contained 0g, 5g, 10g, 15g and 20g of *Monodora myristica* respectively. Feed and water was provided *ad libitum.* Parameters evaluated were weight gain, feed intake, feed conversion ratio and cost-benefit analysis. There was no significant ($p>0.05$) difference in feed intake of the birds among the groups. The final body weight, body weight gain, daily weight gain and feed conversion ratio were significantly ($p<0.05$) influenced by *Monodora myristica*. *Monodora myristica* significantly ($p<0.05$) improved the weight gain and feed conversion ratio of the birds. T_2 (5g) recorded significantly ($p<0.05$) the best growth performance. Results also showed the cost of feed consumed and cost of production were comparable across the treatments. Supplementation of African nutmeg reduced the cost of feed/kg weight gain, increased the revenue generated and the net return from the treated birds. It could be concluded that dietary supplementation of *Monodora myristica* at up to 20g/kg feed has the potential to improve body weight gain, efficiency feed, economically viable and could be used as growth promoter.

Keywords: broilers, *Monodora myristica*, performance, supplementation

Introduction

The non-prescriptive use of antibiotics in poultry production to improve poultry performance and health has been banned due to concerns about their residues in animal tissues and subsequent induction of bacterial resistance. This situations has resulted in search for natural and safe alternatives in form of prebiotic, probiotic, enzymes, herbal products, spices, immune modulators, organic acid etc. to maintain optimum growth rates (Kral *et al*., 2011)

Monodora myristica commonly called African nutmeg is a perennial edible plant of the family Annonaceae that grows wild in evergreen forests of Africa (Burubai *et al*., 2008). *Monodora myristica* has its common names as African nutmeg, calabash nutmeg, and in Nigeria, it is called "Ehuru" in Igbo, "Abolakoshe" in Yoruba and "Ebenoyoba" in Benin (Okafor, 2003, Burabei, *et al.*, 2008). Its seeds usually embedded in a white sweet smelling pulp, were reported to possess valuable economic and medicinal value (Okafor, 2003). In Nigeria and other African countries, the kernel obtained from the seeds of African nutmeg (*Monodora myristica*) is a popular spicing agent as well as an aromatic stimulating addition to medicine and snuff (Ekeanyanwu and Etienajirhevwe, 2012). The seeds are composed of moisture (14.7 %), protein (9.1 %), oil (29.1 %), food energy (458 kcal / 100 g), fibre (25.9 %) and ash (2.3 %) (Burubai *et al*., 2008). The seeds are also rich in potassium, phosphorus, calcium and magnesium. Ukoha (2011) reported a proximate composition of toasted *Monodora myristica* to include 25.38% crude protein, 21.54% Ether extract, 6.24% crude fibre, 9.40% ash and 37.44% nitrogen free extract. *Monodora myristica* seed extract contains important pharmacological compounds like alkaloids, flavonoids, and vitamins A and E as well as many important lipids (Eze-Steven *et al.*, 2013). Previous studies have reported the antioxidant properties of *M. myristica* seeds (Moukette *et al*., 2015). This minty smelling seed has also been investigated to possess cholesterol lowering activity (Nwozo *et al*., 2015), antimicrobial activity (Esekhiagbe *et al*., 2009) as well as anthelmintic activity (Ekeanyanwu and

Etienajirhevwe, 2012). In view of the potentials of this plant, and the fact that much work has not been done to evaluate its benefits in poultry nutrition, this study was designed to determine the effect of dietary supplementation with African nutmeg (*Monodora myristica*) on growth performance and economics of production of starter broilers.

Materials and methods

The experiment was conducted at Poultry Research Unit, Department of Animal Science, Ebonyi State University, Abakaliki.

Experimental Diets

Five experimental broiler starter diets were formulated and used for the experiment. *Monodora myristica* powder gotten by grinding/milling the African nutmeg seed to a fine powder was incorporated into the diet such that birds in T_2, T_3, T_4 and T_5 were served feed that contained 5g, 10g, 15g and 20g of African nutmeg/kg of feed respectively. Birds in treatment 1 (T_1) were served 0g African nutmeg per kilogram feed. The ingredient and chemical composition of the experimental broiler starter diets is shown in Tables 1

Table 1: Ingredients and chemical composition of the experimental diets

Ingredients	T_1(5g)	T_1(5g)	T_2(10g)	T_3(15g)	T_4(20g)
Maize	52.00	52.00	52.00	52.00	52.00
Soyabean meal	24.00	24.00	24.00	24.00	24.00
Wheat offal	10.00	10.00	10.00	10.00	10.00
Palm kernel cake	7.00	7.00	7.00	7.00	7.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Monodora myristica	-	+	+	+	+
Total	100.00	100.00	100.00	100.00	100.00
Chemical Composition					
Crude protein	21.40	21.40	21.40	21.40	21.40
Ether extract	3.83	3.83	3.83	3.83	3.83
Crude fibre	6.45	6.45	6.45	6.45	6.45
ME (Kcal/kg)	2858.7	2858.7	2858.7	2858.7	2858.7

* Premix supplied (Univit 15 Roche) contained: 15001.U, Vit.A;15001.U, Vit.D;30001.U, Vit.E;3.0g, Vit.K;2.5g, Vit,B2;0.3g, Vit.B6; 8.0mg, Vit.B12;8.0g, Nicotinic acid; 3.0, Ca-Panthothenate;5.0mg, Fe;10.0g, Al;0.2g, Cu;3.5mg, Zn;0.15mg, I;0.02g, Cu;0.01g,Sc.

Experimental birds and management

One hundred twenty healthy eight day old CHI broiler chicks were divided and distributed randomly into four groups having three replicates of 8 birds each in a completely randomized design. Feed and water were provided *ad-libitum* throughout the experimental period. The birds were weighed to obtain their initial body weight before the commencement of the experiment. Each experimental unit of the chicks was reared in a separate pen. The birds were kept under similar management conditions like space, light, temperature, ventilation and relative humidity. The pen was provided with electric heaters to adjust the environmental temperature according to the age of the birds. Parameters evaluated were body weight gain, feed intake, feed conversion and economics of production. The trial lasted 28 days Data were analyzed by using General

Linear Model procedure of SAS (2004). Duncan s multiple range test was used to detect the differences ($p \leq 0.o5$) among different group means.

Results and Discussion

Results on the growth performance of broiler starter fed *Monodora myristica* are presented in Table 2.

Table 2: Growth performance of starter broilers fed graded levels of *Monodora myristica*

Parameters	T_1(0g)	T_2(5g)	T_3(10g)	T_4(15g)	T_5(20g)	SEM
Initial body weight (g)	175.00	170.80	179.20	170.80	170.80	6.72
Final body weight (g)	1166.67^b	1358.33^a	1316.67^a	1341.67^a	1325.00^a	38.91
Body weight gain (g)	991.70^b	1187.50^a	1137.50^a	1170.80^a	1154.20^a	34.91
Daily weight gain (g)	35.42^b	42.41^a	40.63^a	41.82^a	41.22^a	1.24
Total feed intake (g)	2691.67	2675.00	2729.17	2695.83	2691.67	38.37
Daily feed intake (g)	96.12	95.54	97.47	96.28	96.13	1.37
Feed conversion ratio	2.72^a	2.26^b	2.40^b	2.31^b	2.33^b	0.08

a, b, Means with different superscripts along the same row are significantly (P<0.05) different; SEM

Table 2 showed *Monodora myristica* had significant (P<0.05) effect in the final body weight, body weight gain, daily weight gain and feed conversion ratio of the birds among the treatments. Birds fed African nutmeg supplemented (T_2, T_3, T_4 and T_5) diets had significantly (p<0.05) higher weight gain than birds fed unsupplemented T_1 diet. There was no significant difference (P>0.05) in body weight gain and feed conversion ratio of the groups (T_2, T_3, T_4 and T_5) fed *Monodora myristica* supplemented diets. *Monodora myristica* significantly enhanced the weight gain and feed conversion ratio of the birds fed the treated diets. The improvement of body weight gain and feed conversion are due to the active materials (phenols and flavonoids) found in *Monodora myristica*, causing greater efficiency in the utilization of feed, resulting in enhanced growth (Ogunmoyole *et al.*2013). The increase in weight gain of broilers fed *M. myristica* diets over the control is in line with the report by Ukoha (2011), who reported an increase in body weight gain of broilers fed African nutmeg. There was no significant (P>0.05) difference in the feed intakes of the birds fed the supplemented diets and the control. The similarity in feed intakes of the birds are in line with the finding of Bozkurt *et al.* (2012) who observed that inclusion of the natural herbal growth promoters in broiler ration did not improve feed consumption.

Economics of Production for Starter

The Economics of production of starter broilers fed African nutmeg (*Monodora myristica*) is shown in Table 3

Table 3: Cost Effectiveness of feeding *Monodora myristica* supplemented diets to starter broilers

Parameters	T_1	T_2	T_3	T_4	T_5
Cost of bird procurement (₦)	240.00	240.00	240.00	240.00	240.00
Cost of feed/kg (₦)	150.00	150.00	150.00	150.00	150.00
Total feed consumed/bird (g)	2691.67	2675.00	2729.17	2695.83	2691.67
Medication and miscellaneous (₦)	60.00	60.00	60.00	60.00	60.00
Body weight gain (g)	991.70^b	1187.50^a	1137.50^a	1170.80^a	1154.20^a
Cost of feed consumed/bird (₦)	403.75	401.25	409.38	404.37	403.75
Feed cost (₦)/kg weight gain/bird	407.12	337.90	359.89	345.38	349.81
Total cost of production (₦)	703.75	701.25	709.38	704.37	703.75
Cost of bird (meat)/kg (₦)	1000.00	1000.00	1000.00	1000.00	1000.00
Revenue generated /bird (₦)	1166.67	1358.33	1316.67	1341.67	1325.00
Net return/bird (₦)	462.92	657.08	607.29	637.30	631.25
Cost benefit ratio	1.52	1.07	1.17	1.11	1.11

The result of the economic effectiveness of feeding African nutmeg supplemented diets to starter broilers showed that the cost of feed consumed and cost of production were comparable across the treatments. Supplementation of African nutmeg reduced the cost of feed/kg weight gain, increased the revenue generated and the net return from the treated birds. Birds in T_1 recorded the highest cost of feed/kg weight gain, least revenue generated and net return. The decrease in the cost of the feed/kg gain of birds fed supplemented diets is attributed to enhanced weight gain of birds fed supplemented diets which resulted to high sales of the product and thus net returns from the supplemented groups. The results of the present study are in line with the findings of Ahmad (2005), who reported that dietary inclusion of polyherbal in the rations was more beneficial in broiler production. Increase in the profit margin of the birds fed rations supplemented with *Monodora myristica* may be attributed to the better efficiency of feed utilization, which resulted in more growth and better feed conversion ratio, ultimately leading to higher profit margin in the broiler reared on *Monodora myristica* supplemented diets.

Conclusion

From the findings of the present study it can be concluded that supplementation of broiler starter diets with *Monodora myristica* at up to 20g per kg of feed significantly increased body weight gain and feed conversion ratio as compared to that of control group of broiler. Thus, *Monodora myristica* supplementation in the broiler rations may be useful for the safe, economical and efficient production of broiler. The findings of this study indicated that inclusion of *Monodora myristica* in broilers diets should be encouraged since it does not have any adverse effect on the birds performance and is economically viable.

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EFFECT OF AQUEOUS TURMERIC EXTRACTS ON THE PERFORMANCE AND ECONOMICS OF PRODUCTION OF FINISHER BROILERS

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ABSTRACT

The effect of aqueous turmeric extracts on growth performance and economics of production of finisher broilers was investigated using 150 CHI strain broilers in a 28- day feeding trial. Five levels of aqueous turmeric extracts measuring either 0ml, 20ml, 40ml, 60ml or 80ml per litre of water and designated as T_1, T_2, T_3, T_4 and T_5, respectively were used in the trial. The birds were randomly assigned to the five groups at 30 chicks each in a completely randomized design. Each group was replicated 3 times with feed and water offered *ad libitum*. Results showed that turmeric extracts had significant ($p<0.05$) effect on final body weight, body weight gain, daily weight gain and feed conversion ratio of the birds. Birds fed turmeric extracts recorded significantly ($p<0.05$) higher body weight gain and superior feed conversion ratio than the control. There was no significant ($p>0.05$) difference in feed intake and water intake of birds fed the treated and untreated water. Data on economics of production showed that aqueous turmeric extract numerically reduced the cost of feed/kg weight gain, increased the revenue generated and the net return from the birds fed treated water. It could be concluded that feeding of turmeric extract at up to 80ml/litre is beneficial to broiler chicken production since it resulted in improved weight gain, feed conversion ratio and showed evidence of improving economics of production.

Keywords: aqueous extracts broilers, performance and turmeric

Introduction

Turmeric rhizome (*Curcuma longa*) is an extensively used spice, as food preservative and coloring material that has biological actions and medicinal applications (Chattopadhyay *et al*. 2004). Turmeric contains 6.3% protein, 5.1% fat, 3.5% minerals, 69.4% carbohydrates, and 13.1% moisture (Chattopadhyay *et al*. 2004). The active ingredients of turmeric rhizomes consist of volatiles and non-volatiles constituents (Dono, 2012). Curcumin is the main important bioactive ingredient responsible for biological activity of *curcuma longa* (Nouzarian *et al*. 2011). Curcumin has been shown to have several biological effects, exhibiting antifammatory (Holt *et al*. 2005), antibacterial (Araújo and Leon 2001), immunomodulatory (Kumari *et al*. 2007 and antioxidative (Hosseini_Vashan *et al*. 2012) properties. It is used in gastrointestinal and respiratory disorders (Anwarul *et al*. 2006). When compared with the synthetic antibiotics, phytochemicals in turmeric are known to be natural, less toxic, residue free, and are thought to be ideal as feed additives in animal diets (Wang *et al*. 2015). A number of studies have been conducted to evaluate its effect on the performance of broiler chickens, laying hens and rabbits (Nouzarian *et al*. 2011and Hosseini_Vashan *et al*. 2012). Studies on broiler chickens showed increased weight gain and improved FCR (Wuthi-udomler *et al*., 2000) with dietary supplementation of turmeric. In contrast, Kumari *et al*. (2007) found no effect of turmeric on FCR. It has been found that the feeding of turmeric rhizome powder in the poultry diet helped to improve the morbidity and mortality of broiler chickens (Al-Kassie *et al*., 2011). It has also been proven that the use of turmeric in poultry feed is of public health benefit with no side effects (Dono, 2014). Yet, the beneficial effects of aqueous turmeric extract on poultry have not been extensively investigated. Therefore, there is need to determine the effect of aqueous turmeric extracts on growth performance and economics of production of broiler finisher.

Materials and Methods

Study location: The experiment was carried out at the Poultry Unit of the Teaching and Research Farm

of the Department of Animal Science, Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki,

Source and processing of turmeric: Turmeric rhizomes used for the experiment were sundried and milled before extraction. The extracts were prepared by soaking 100g dried turmeric in one litre of water for 24 hours. The next morning, the extract was obtained by filtering the infusion using a filter paper

Experimental treatments: Five levels of aqueous turmeric extracts measuring either 0ml, 20ml, 40ml, 60ml or 80ml per litre of water and designated as T_1, T_2, T_3, T_4 and T_5, respectively were used in the trial.

Birds and management: One hundred and fifty, five week-old CHI strain broiler were randomly allotted to five treatment groups in a completely randomized design (CRD) at 30 birds per treatment and designated as T_1, T_2, T_3, T_4 and T_5 respectively. Each treatment groups was further divided into three replicate of 10 birds each. The birds were fed commercial broiler finisher diets. The aqueous extract, water and feed were made available to the birds *ad libitum*. The birds were kept under standard management conditions with adequate provisions for space, light, temperature, ventilation and relative humidity. Vaccination and other routine poultry management practices were maintained.

Data collection and analysis: Chicks were weighed at the beginning of the experiment to obtain their initial body weight and on weekly basis thereafter. Body Weight change was calculated as the difference between the final and initial body weight. Feed intake was taken daily as the difference between the feed offered and left over. Feed conversion ratio (FCR) was computed as the ratio of feed consumption to weight gain. Performance index (PI): was calculated during studied growth periods according to the equation of Kassu *et al*. (2016) *PI* = (live body weight (kg) / feed conversion ratio) x 100. At the end of experiment economics of production of each group was calculated. The feed cost per unit gain was calculated in order to evaluate the profitability of feeding turmeric extracts on the net profit of bird sales At the end of the study, data thus collected was subjected to analysis of variance (ANOVA) as described by Steel and Torrie (1996). The differences between means were compared by least significance difference test (Steel and Torrie, 1996).

Results and Discussion

Performance Characteristics

Results on the growth performance of finisher broilers fed aqueous turmeric extracts are presented in Table 1.

Table 1: The Effect of aqueous turmeric extracts on the Performance of finisher broilers

Parameters	T_1(0ml)	T_2(20ml)	T_3(40ml)	T_4(60ml)	T_5(80ml)	SEM(±)
Initial body weight (g)	1300.94	1336.95	1307.05	1314.18	1315.13	13.27
Final body weight (g)	2907.04[b]	3190.54[a]	3217.19[a]	3250.75[a]	3294.14[a]	110.32
Body weight gain (g)	1606.10[b]	1853.59[a]	1910.14[a]	1936.57[a]	1979.01[a]	102.51
Daily weight gain (g)	57.36[b]	66.20[a]	68.22[a]	69.16[a]	70.68[a]	8.56
Total feed intake (g)	5048.60	5148.22	5157.67	5275.68	5069.97	101.85
Daily feed intake (g)	180.31	183.86	184.20	188.42	181.07	3.64
Feed conversion ratio	3.14[b]	2.78[a]	2.70[a]	2.72[a]	2.66[a]	0.24
Total water intake(ml)	8166,2	8116.08	8018.08	7822.16	7742.28	225
Daily water intake(ml)	291.65	289.86	286.36	279.36	276.51	9.12
Performance Index	92.58 [c]	114.77[ab]	119.16[ab]	119.51 [ab]	123.84[a]	4.87

a, b, Means with different superscripts along the same row are significantly (P<0.05) different.

Table 1 revealed significant (P<0.05) differences in the final body weight, body weight gain, daily weight gain and feed conversion ratio of the birds among the treatments. Birds fed aqueous turmeric extracts (T_2, T_3, T_4 and T_5) had significantly (p<0.05) higher weight gain and better feed conversion ratio than birds on the control (T_1). There was no significant difference (P>0.05) in final body weight, body weight gain and daily weight gain of the birds (T_2, T_3, T_4 and T_5) fed aqueous turmeric extracts. Aqueous turmeric extracts significantly improved the weight gain of the treated birds. The improvement in protein utilization, absorption and suppression of gram negative bacteria and Chlostridium that cause growth depression might be the reason for the improvement in body weight gain and feed conversion ratios (cite a reference). There were some reports which show that turmeric had the ability to stimulate the digestive system, such as stimulate the intestinal lipase, sucrase and maltase activities (Platel and Srinivasan, 1996) as well as the secretion of pancreatic lipase, amylase, trypsin and chymotrypsin enzymes (Platel and Srinivasan, 2000). Therefore, there is a possibility to suggest that improvement on the growth performance due to dietary turmeric meal in broiler chickens is attributed to the improved digestive system in the body. Better feed conversion ratio of the broilers on turmeric extract may be attributed to the antibacterial properties of turmeric, which resulted in better absorption of the nutrients present in the gut and ultimately leading to improvement in feed conversion ratio. Results of this present are in line with Rajput *et al*. (2013) who reported that curcumin enhanced weight gain and feed conversion ratio of broiler chickens. Our finding disagrees with reports by Hosseini-Vashan *et al.* (2012) and Wang *et al* .(2015) who reported non- significant effect of turmeric on weight gain and feed conversion ratio.

Turmeric extracts did not significantly influence feed and water intakes of the birds. However, birds fed aqueous turmeric extracts had numerically higher feed intake compared to the control birds. This finding was in accordance with Sadeghi *et al*. (2012) showing the non- significant effect of turmeric on feed intake.

Results on Performance index indicated that there were significant differences among treatments in PI. Birds on 80ml (T_5) had significantly (p<0.05) higher PI followed by birds fed 60ml, 40ml and 20ml. Birds on 0ml had the lowest PL

Economic of production

The cost effectiveness of feeding aqueous turmeric extracts to finisher broilers are presented in Table 2

Table 2: Economic efficiency of feeding aqueous turmeric to finisher broilers

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Cost of bird (₦)	1200.00	1200.00	1200.00	1200.00	1200.00	NA
Cost of feed/kg (₦)	158.00	158.00	158.00	158.00	158.00	NA
Total feed consumed/bird (g)	5048.60	5148.22	5157.67	5275.68	5069.97	101.85
Medication and miscellaneous (₦)	68.00	68.00	68.00	68.00	68.00	NA
Body weight gain (g)	1606.10^{b}	1853.59^{a}	1910.14^{a}	1936.57^{a}	1979.01^{a}	102.51
Cost of feed consumed/bird (₦)	797.68^{c}	813.42^{b}	814.91^{b}	833.56^{a}	801.06^{c}	81.06
Feed cost /kg weight gain/bird(₦)	496.66^{a}	438.83^{b}	426.62^{b}	430.43^{b}	404.78^{c}	7.75
Total cost of production (₦)	2065.68	2081.42	2082.91	2101.56	2069.06	60.43
Cost of meat/kg (₦)	1000.00	1000.00	1000.00	1000.00	1000.00	NA
Revenue generated /bird (₦)	$2,907.04^{b}$	$3,190.54^{ab}$	$3,217.19^{a}$	$3,250.75^{a}$	$3,294.14^{a}$	20.58
Net return/bird (₦)	841.36^{b}	1109.12^{a}	1134.28^{a}	1149.19^{a}	1225.08^{a}	12.08
Economic efficiency	1.05^{c}	1.36^{b}	1.39^{ab}	1.37^{b}	1.53^{a}	0.03
Relative economic efficiency	100.00^{b}	129.52^{b}	132.38^{b}	130.48^{b}	145.71^{a}	5.71

a, b, Means with different superscripts along the same row are significantly (P<0.05) different. NA= Not available

The results of economics of production of feeding turmeric extract is presented in Table 2. Results revealed that the cost of feed consumed were significantly ($p<0.05$) higher for 20ml, 40ml and 60ml aqueous turmeric extract treated birds. Birds fed 0ml and 80mltrmeric extracts had significantly ($p<0.05$) reduced the cost of feed consumed. Feeding of aqueous turmeric extract significantly ($p<0.05$) reduced the cost of feed/kg weight gain, increased the revenue generated and the net return from the treated birds. Feeding of aqueous turmeric extract also significantly ($p<0.05$) improved the economic efficiency. The input-output analysis showed that significantly ($p<0.05$) the highest REE was recorded by the chicks fed 80ml (T_5) followed by birds fed 60ml, 40ml and 20ml. Birds in T_1 recorded the least revenue generated, net return and EE while cost of feed/kg weight gain was the highest. These results indicated that feeding turmeric extracts were more economical than the control. This improvement could be due to the improvement in feed conversion ratio or reduction in amount of feed required to produce one unit of meat. These findings are in agreement with observations of Mahmood *et al.* (2014) who reported that increase in the profit margin from the birds fed ration containing commercial herbal growth promoters might be attributed to the better efficiency of feed utilization, which resulted in more growth and better feed conversion ratio, ultimately leading to a higher profit margin of the broilers reared on ration supplemented with commercial herbal products.

Conclusion

Spices have been reported to be natural feed additives due to their suitability, preference, lower cost of production, and environmentally friendly. The feeding of turmeric extracts to finisher broilers at levels up to 80mls per litre of water is beneficial to broiler chicken since it resulted to improved weight gain, feed conversion ratio and showed higher indication of economic gain.

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HEAMATOLOGICAL AND SERUM BIOCHEMICAL INDICES OF BROILERS FED INORGANIC AND CHELATED TRACE MINERALS

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Abstract

This study was carried out to evaluate the effect of supplemental inorganic and chelated Cu, Zn and Mn on haematology and serum biochemistry of broiler chickens. A 42-day feeding trial was conducted using a total of three hundred Arbor Acre broiler chickens. The birds were allocated to five dietary groups. Each group had six replicates with ten birds each. The treatments were control (basal diet), 100% inorganic trace minerals (ITMs) supplemental level (15, 100, 100 mg/kg for Cu, Zn, Mn respectively), 50% ITMs supplemental level (7.5, 50, 50 mg/kg of Cu, Zn, Mn), 50% Chelated trace minerals (CTMs) supplemental level (7.5, 50, 50 mg/kg of Cu, Zn, Mn) and 25% CTM supplemental level (3.75, 25, 25 mg/kg of Cu, Zn, Mn, in that order). Data collected were subjected to one–way Analysis of Variance using a Completely Randomised Design. A lower ($p<0.05$) white blood cell count ($11.07x10^6/mm^3$) and an improved ($p<0.05$) red blood cell count ($13x10^6/mm^3$) was observed for the group fed 50% CTM supplemental level. The group fed 50% supplemental level of CTM had the highest ($p<0.05$) total protein (73.2 g/L), albumin (41.20 g/L) and globulin (32 g/L) in serum as compared to the other groups. The serum Cu, Zn and Mn were significantly higher ($p<0.05$) for the group fed 25% supplemental diet of CTM. The study concluded that trace minerals supplementation increased serum trace minerals of broiler chicken.

Key words: chelates, inorganic salts, haematology, serum biochemistry, broilers

Introduction

Evaluating haematological and serum biochemical parameters is a means of assessing the health status of animals and effect of treatments can be deduced from these analyses. Trace minerals are essential nutrients in broiler chicken's diets and they play very important roles in birds and these include cell proliferation and growth, tissue and bone development and integrity, immune development and response, reproduction, enzymes formation, gene regulation, and protection against oxidative stress and damage (Richards *et al*., 2010). Inorganic trace minerals (ITM) of Cu, Zn and Mn are often used in broiler chicken diets at the higher inclusion level than the recommended quantity by NRC (1994), but the absorption is limited because of the antagonistic effect in diet and gastrointestinal tract (Manangi *et al*., 2012). This results to increasing concerns over the excretion of minerals as pollutant in the environment (Manangi *et al*., 2012). A chelated mineral means the bonding or combination of metal ions with organic ligand or ligand complex such as amino acids, proteinate, polysaccharides or organic yeast (Bao, *et al*., 2006). Therefore, this study was carried out to investigate the effect of supplemental inorganic and chelated Cu, Zn and Mn on haematology and serum biochemistry of broiler chickens.

Materials and Methods

This study was carried out according to the research ethics and guidelines of the College of Animal Science and Livestock Production of the Federal University of Agriculture, Abeokuta, Nigeria. It was carried out at the broiler section (unit) of the Directorate of University Farm (DUFARM), Federal University of Agriculture, Abeokuta, Ogun State. A total of 300 unsexed day old Arbor Acre (AA) broiler chicks used for the study. The broilers were allocated to five (5) treatments; each treatment was divided into six (6) replicates with ten (10) birds each, making a total of sixty (60) birds in a treatment. The treatments were control (basal diet), 100% inorganic trace minerals (ITMs) supplemental level (15, 100, 100 mg/kg for Cu, Zn, Mn respectively), 50% ITMs supplemental level (7.5, 50, 50

mg/kg of Cu, Zn, Mn), 50% Chelated trace minerals (CTMs) supplemental level (7.5, 50, 50 mg/kg of Cu, Zn, Mn) and 25% CTM supplemental level (3.75, 25, 25 mg/kg of Cu, Zn, Mn, respectively). Feed and water were given *ad libitum* throughout the experimental period. Chelated trace minerals of Cu, Zn and Mn (Mintrex®) containing 15% Cu from Cu (2-hydroxyl- 4-methylthiobutanoic acid as $HMTBa)_2$, 16% Zn from $Zn(HMTBa)_2$ and 13% Mn from $Mn(HMTBa)_2$ were obtained from Novus Inc., USA. The inorganic sources of Cu, Zn and Mn were purchased from an inorganic manufacturer in Lagos. The composition of the inorganic sources used are described as follow; copper sulphate pentahydrate ($CuSO_4.7H_2O$: containing 25% Cu), zinc oxide (ZnO: containing 72% Zn) and manganese dioxide (MnO_2: containing 64% Mn) were used as inorganic supplemental Cu, Zn and Mn respectively. The five (5) treatments diets with varying supplemental level of inorganic trace minerals (ITM) and chelated trace minerals (CTM) is shown in Table 1.

Table 1: Gross Composition of Experimental Basal diets

Ingredients (Kg)	(0 – 3 weeks)	(4 – 6 weeks)
Maize	54.00	65.00
Soya meal	40.00	30.70
Wheat Bran	2.00	1.00
Lime stone	1.50	1.00
Bone meal	1.20	1.00
Fish meal (72% CP)	0.50	0.50
Methionine Hydroxyl Analog	0.25	0.20
Lysine	0.20	0.20
Salt	0.15	0.15
Vitamin-Mineral Premix (Cu, Zn & Mn free)[1]	0.25	0.00
Vitamin-Mineral Premix (Cu, Zn & Mn free)[2]	0.00	0.25
Determined analysis		
Dry matter (%)	88.90	94.00
Crude protein (%)	23.70	19.20
ME (KCal/kg)	2946.23	3054.90
Nitrogen free extract (%)	47.02	55.6
Crude Fibres (%)	4.11	4.48
Ether extract (%)	5.23	4.92
Ash content (%)	8.84	9.80

Blood Sample Collection

At day 42, 30 birds (a bird from each replicate) were bled via wing vein puncture. 2 mL of blood was collected from each bird using sterile syringe and needle and deposited into tubes containing ethylenediamine-tetra-acetate (EDTA) and another 2 mL was collected into plain sterile bottles. The blood in the EDTA bottles were used to determine haematological parameters while that in the plain bottles were used to determine serum parameters The PCV was determined by microhaematocrit method and Hb and RBC were determined using colorimetry cyanomethaemoglobin and improved Neubauer haemocytometer methods respectively. The serum total protein, albumin and globulin were analysed colorimetricaly using a diagnostic reagent kit.

Statistical Analysis

Data collected were subjected to a Completely Randomized Design using SAS (2007). Comparisons among means were done using Tukey's test of the software.

Results and Discussion

The effect of supplemental trace minerals on haematology are presented in Table 2. Groups fed 50% and 25% supplemental level of CTM had higher ($p<0.05$) packed cell volumes (34.67% and 33.67%) and haemoglobin (11.33 g/dL and 11.20 g/dL respectively) relative to other dietary groups. Higher haemoglobin and PCV concentration in blood of broiler birds fed diets supplemented with chelated

trace minerals compared to BD reflects the importance of Cu in haemoglobin synthesis. This indicates that Cu was more bioavailable in the CTM groups since Cu and Fe are known to play vital roles in the synthesis of haemoglobin and for the synthesis of enzyme needed for normal metabolism (Close, 1999). The white blood cell of the group fed 50% CTM level was significantly lower ($p<0.05$) compared to the other groups and it also had a significantly higher ($p<0.05$) red blood cell while the groups fed 100% ITM, 50% ITM level and BD had lower RBC. The increased WBC of birds given BD relative to those receiving CTM suggests a stimulation of the immune system by the control diet. This showed that the birds fed CTM supplemented diets with the lower WBC had immune stability and the birds were not challenged. This is in line with the report of Jegede *et al*., (2011) who reported higher haemoglobin and PCV with lower WBC in broilers fed Cu-proteinates.

Table 2: Effect of inorganic and chelated trace mineral on the haematological parameters of the experimental broiler chickens (42 days)

PARAMETERS	Control	ITM		CTM			
	(BD)	100%	50%	50%	25%	SEM	P-Value
PCV (%)	28.50^{b}	31.00^{ab}	32.33^{ab}	34.67^{a}	33.67^{a}	0.66	0.00
Hb (g/dL)	9.57^{b}	10.33^{ab}	10.67^{ab}	11.33^{a}	11.20^{a}	0.21	0.02
WBC (10^6/mm^3)	17.97^{a}	17.43^{a}	18.67^{a}	11.07^{b}	13.90^{ab}	0.92	0.01
RBC (10^6/mm^3)	2.42^{c}	2.80^{b}	2.89^{ab}	3.12^{a}	2.98^{ab}	0.07	0.00
Neutrophil (%)	51.00^{a}	26.00^{b}	27.33^{b}	15.67^{b}	14.00^{b}	3.73	0.00
Lymphocyte(%)	46.00^{b}	70.67^{a}	69.00^{a}	80.00^{a}	81.33^{a}	3.71	0.00
Basophil (%)	0.00	0.33	0.00	0.33	0.67	0.15	0.68

[abc] Means in the same row having different superscripts are significantly different at ($P<0.05$)

The effect of supplemental trace minerals on serum biochemistry of the experimental birds is shown in Table 3. Birds fed 50% CTM recorded the highest ($p<0.05$) total protein value (73.2g/L), albumin (41.20 g/L) and globulin (32 g/L) in serum as compared to other groups with the group fed 100% ITM level having the lowest ($p<0.05$) serum protein of 62.53g/L. Also, the group fed BD had a significantly lower ($p<0.05$) albumin (35.77g/L) compared with 41.2g/L of the group fed 50% supplemental diet of CTM. The serum Cu (16.5ug/dL), Zn (14.13ug/dL) and Mn (1.88ug/dL) were significantly higher ($p<0.05$) for the group fed 25% CTM compared to the group fed 100% supplemental ITM level with 15.08, 11.03, and 1.61ug/dL of serum Cu, Zn and Mn respectively while the group fed BD had the lowest ($p<0.05$) Cu, Zn and Mn in the serum. The improvement in total protein, serum albumin and globulin in groups fed diet supplemented with CTM as a result of the supplemented methionine hydroxyl analog (MHA) chelated with trace minerals compared to the groups fed diet supplemented with ITM. The higher serum protein, albumin and globulin show that the MHA or 2- hydroxyl -4- methyl thiobutanoic acid (HMTBa) which is regarded as precursor of DL-methionine (first limiting amino acid) (Richards *et al*., 2007) were released from the ligand. Copper is also involved in blood proteins and has capacity to influence serum protein (Uany., *et al*, 1998) This study is supported by Corzo *et al*., (2009) who reported that supplemental amino acid (valine and isoleucine) in broiler chicken diet increased the serum protein, albumin and globulin. The increased serum Cu, Zn and Mn of the groups fed supplemental diet of CTM compared with the groups fed ITM level and BD with lower serum minerals indicates that the CTM were more bioavailable to the broiler chickens and this also shows that there is less antagonism with other dietary minerals and among themselves. This study agrees with the report of Salami *et al.,* (2016) who reported higher bioavailability of trace mineral from mineral chelates and less antagonistic interaction of chelates with other dietary constituents in the digestive tract compared with inorganic salts.

Table 3: Effect of inorganic and chelated trace minerals of serum biochemistry of the experimental broiler chickens (42 days)

PARAMETERS	Control	ITM		CTM			
	(BD)	100%	50%	50%	25%	SEM	P-Value
TP (g/L)	65.90^{c}	62.53^{d}	67.00^{bc}	73.20^{a}	69.87^{b}	0.99	0.00
Albumin (g/L)	35.77^{c}	36.67^{bc}	38.30^{bc}	41.20^{a}	39.73^{ab}	0.60	0.00
Globulin (g/L)	30.27^{ab}	25.87^{c}	28.70^{b}	32.00^{a}	30.13^{ab}	0.58	0.00
Creatinine (mg/dL)	0.77	1.40	1.27	0.87	1.43	0.11	0.17
Uric (mg/dL)	5.80	8.57	8.33	7.93	7.60	0.41	0.21
Serum Cu (ug/dL)	6.77^{c}	15.08^{b}	15.53^{b}	16.17^{a}	16.50^{a}	0.97	0.00
Serum Zn (ug/dL)	4.05^{e}	11.03^{d}	12.80^{c}	13.53^{b}	14.13^{a}	0.98	0.00

^{abc} Means in the same row having different superscripts are significantly different at (P<0.05)

Conclusion

Trace mineral supplementation increased serum trace mineral concentration. Supplementation of CTM (Cu, Zn and Mn) at 50 % improved haemoglobin and packed cell volume of broiler chickens.

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The Effect of aqueous extract of *Lagenaria breviflora* (Robert) whole fruit on Egg Lipoprotein profile of Laying Birds

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Abstract
The continuous demand of the ever-growing Nigerian populace to meet their daily protein requirement resulted in the positive shift in the consumption of table eggs but with many opting for alternatives because of the perceived cholesterol content. The study was therefore carried out to investigate the effect of *Lagenaria breviflora* R. (LB) whole fruit on egg lipoproteins of laying birds on two management systems. A total of 126 Yaffa brown layers aged 36 weeks were administered aqueous extract of *L. breviflora* R. at three levels (0, 50, and 75 g fresh weight per L of water). Data obtained on egg lipid profiles were arranged in one way analysis of variance. The percentage change (reduction) in total cholesterol, LDL and VLDL were higher in 50 g-dosed birds likewise with a higher HDL-cholesterol. Therefore, commercial layers administered LB at 50 g/L as an alternative medication in cholesterol reduction in table egg production.
Keywords: Phytobiotics, *Lagenaria breviflora*, lipoproteins, egg-type chickens, cardiovascular.

Introduction
Poultry products are considered a good and low-priced source of animal protein because of its good and high biological value. There has been a growing interest in recent years over the concentration of cholesterol in human diet since eggs are concentrated source of cholesterol in the diet and limited egg consumption has often been recommended to reduce total serum cholesterol concentrations (Ekunseitan, 2016). Chicken eggs have been recognized as an excellent source of all essential nutrition and complete food for people of all ages (Salma *et al.,* 2007). Many reviews have postulated a relationship between yolk cholesterol and cardiovascular diseases in humans but with no clear association between egg consumption and cardiovascular diseases, egg can be part of an overall heart- healthy diet (Eckel, 2008; Wang *et al.,* 2009). The culprit responsible for this oxidized form that narrows or "hardens" the arteries is the LDL cholesterol and low level of the HDL fraction (Kasprzak and Hetmañski, 2004). Therefore, it is imperative to counteract this process by eating foods rich in natural antioxidants (Ponte et al., 2004).
Researches have focused on the beneficial effects of phytogenic substances in poultry production. These phytogenic substances contains Phenolic compounds that have been documented to have hypo-cholesterolemic effects: cholesterol and lipoprotein decreasing effects of alfalfa (Ponte et al., 2004), thyme (Bolukbasi *et al.,* 2006), garlic (Habibian Dehkordi *et al.,* 2010) and lately *Lagenaria breviflora* R. (Ekunseitan *et al.,* 2016). There is an urgent need to increase organic livestock production to meet the animal protein needs of the world's increasing population with attentive interest in reducing its cholesterol component. This study can be considered as a pilot study showing the influence of oral administration of L. breviflora whole fruit on the egg cholesterol in the laying hens.

Materials and Methods
The experiment was carried out at the poultry unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Ogun State, Nigeria located 7° 15' N, 3° 26' E and 76 m above sea level.

A total of 126 Yaffa brown layers aged 36 weeks were used for the study. *Lagenaria breviflora* whole fruit was administered : 0(Control), 50, and 75 g fresh weight per Litre of water): control (where L. breviflora was not given to the birds, but other conventional vaccinations and medication given).The birds were randomly allotted to the treatment groups, each treatment was assigned 42 birds and further divided into three replicates of 14 birds each. The experiment was carried out for a period of 10 wks. Birds were fed ME layers mash (17.10% CP and 2708.80 Kcal/Kg) while housing unit was provided with nest boxes.

Egg samples were collected from the birds randomly from each replicate and taken to the laboratory to determine total cholesterol, High-Density Lipoprotein (HDL), Low-Density Lipoprotein (LDL) and very low-density lipoprotein VLDL. The egg samples were collected very early in the morning three periods over the duration of the experiment. The collection period: start (beginning of the study), mid (5weeks) and Final (10 weeks) of the experiment. The yolk was analysed for Cholesterol and lipoprotein content.

Data obtained were arranged in a One-way analysis of variance. Significant differences among treatment means were separated using Turkeys test at 5% level of significance.

Results and Discussion

The effect of *Lagenaria breviflora* administration on yolk cholesterol is presented in Figure 1. There was an upward increase ($p<0.05$) in Total cholesterol in 0 g and 75 g LB administered treatment group while a decreasing trend was observed in 50 g treatment group. This can be ascribed to its sulphur containing compounds which are capable of reacting with –SH group systems (Prasad *et al*., 2009) since *L. breviflora* R. has been established to comprise compounds like higher hydrocarbons (higher alkanes, alkenes, benzenes) and sulphur-containing ones amongst them is 2-methyl-Benzothiazole (Ekunseitan, 2016). This may be possible by the mechanism of hypo-cholesterolaemic and hypolipidemic action of S-group which is known to be proficient in altering the hepatic activities of lipogenic and cholesterogenic enzymes thereby significantly reducing cholesterol content in blood of birds and subsequently amount shed into egg laid. As consumption of egg yolk with higher Cholesterol content could be disastrous to the health of an individual with predisposition to cardiovascular diseases.

Figure 1: Effect of *Lagenaria breviflora* administration on Yolk Cholesterol

The effect of *Lagenaria breviflora* administration on yolk HDL is presented in Figure 2. There was an increase in HDL in all treatment groups with 95.25, 85.25 and 68 % increase observed in Control, 50 and 75 g groups respectively. *L. breviflora* R. (LB) has been affirmed to contain phytochemicals notably phenols, carotenoids, flavonoids which have been reported to have wide orbit of biological activities (Ekunseitan *et al.*, 2016). Since this study could be considered as a first pilot study showing the influence of different doses of oral administration of *L. breviflora* on the egg cholesterol in the laying hens.

Figure 2: Effect of *Lagenaria breviflora* administration on Yolk HDL

A reduction in LDL-component of egg was observed as the level of administration of *L. breviflora* increased from 0 – 50 g while an increase noticed in 75 g-dosed treatment group (Figure 3). The percentage change in VLDL component of egg was negative in all treatment group indicating a decrease with the highest reduction observed in 50 g-dosed birds but a 15% increase in the 75 g group (Figure 4). The perceive ability of LB in influencing lipid profiles (VLDL) at 50 g maybe as an increase in esterified cholesterol leading to increase or reduction in excretion by bile and antioxidant action of LB (Onasanwo *et al*., 2011), resulting in decrease in hepatic production of VLDL which serves as precursor of LDL-cholesterol in blood circulation (Prasad *et al*., 2009). Since the bulk of cholesterol is majorly transported to yolk with very low density lipid via the intestine (Wang *et al.,* 2009), the reduction or positive activity of LB on VLDL can be used as a useful factor to regulate the degree of deposition.

Figure 3: Effect of *Lagenaria breviflora* administration on Yolk LDL

Figure 4: Effect of *Lagenaria breviflora* administration on Yolk VLDL

Conclusion and Recommendations

The yolk Total Cholesterol, LDL, and VLDL of eggs were lowered, but with a higher HDL deposition in the 50 g group compared to the control and 75 g. Therefore, commercial layers can be administered LB up to 50 g as a cholesterol-lowering agent in the egg.

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CARCASS CHARACTERISTICS OF RABBITS FED DIFFERENT FORAGES AS SUPPLEMENT

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Abstract

The experiment was carried out to determine the carcass characteristics of weaned rabbits fed selected forages as feed supplement. A total number of thirty-six weaned mixed breed of rabbits were allotted randomly to four treatments with nine rabbits and each treatment was replicated three times with three rabbit per replicate and designated as Control (T1) concentrate plus (+) amaranthus, (T2) concentrate plus (+) tridax, (T3) concentrate plus (+) fig leaves, (T4) concentrate plus (+) water melon waste. The experiment lasted for eight weeks. Data were obtained on carcass characteristics, internal organs, by-products. Results revealed that the value of carcass traits, internal organs and by-products were not significantly ($P>0.05$) different except in liver and lungs (internal organs) and pelts (skin) and hind legs (by-products) were not significantly different ($P>0.05$) for all the parameters obtained. Based on the findings, it can be recommended that T1 (Amaranthus), can be used as supplement to concentrate feed, because it was consumed more than other treatment groups.

Keywords: Rabbits, supplements, carcass, characteristics, forages

Introduction

Over the years, the world population has witnessed a drastic increase in human population especially in developing countries like Nigeria. This has led to an increased demand for food and protein of animal origin which is in short supply. FAO (2006) estimated the average protein consumption in Nigeria to stand at 8g/capita/day which is in sharp contrast to 38g/capita/day recommended for an individual per day (FAO, 2006). Feeding account for about 70 % total cost of production (Aduku and Olokoji, 2009). Hence the use of unconventional feedstuff is gaining ground in many developing countries and Nigeria in particular. The reduction of cost of using cheap and unconventional feed materials is an important aspect of commercial rabbit production (Muriu *et al*. 2002). This research work was aimed at evaluating the effects of different forage wastes as supplement on the carcass characteristics of rabbit meat.

Materials and methods

Location of the Experiment: The research work was carried out at the Rabbit Section of the Teaching and Research Farm of Ibrahim Badamasi Babangida University Lapai, Niger state.

Source of rabbits, test ingredient and management of rabbits

Thirty-six weaned rabbits of mixed sexes and breeds were obtained from Sultan Veterinary Consult Farm No 2, Samaru Street Hayindogo Samaru Zaria, Kaduna state**.** Four different forage wastes namely tridax procumbens, ammaranthus waste, fig leaves, and water melon wastes were collected from the

surrounding environment in Lapai town, Lapai Local Government Area of Niger state, Nigeria. The rabbits were between 5-6 weeks and randomly allocated to four treatment groups with nine rabbits per treatment. Each treatment had three replicates of three rabbits per replicate. The same experimental diet was formulated with crude protein set at 23% for each. T1 was designated as concentrate with Amarathus, T2 concentrate and Tridax procumbens waste, T3 concentrate with fig leaves waste and T4 concentrate and water melon peels/wastes. The rabbits were giving Ivermectin injection against both endo and ecto-parasite. Vitacox-plus and Neo-furaseryl-plus were adequately given as well. The cages were well clean and disinfected with Dettol and equipped with drinkers and feeders. Prior to the experiment, the animals were allowed adjustment period of one week to enable them get used to their various cages and diets. Fresh clean water was provided *ad-libitum*. The experiment lasted for 8 weeks. Data generated were subjected to analysis of variance (ANOVA) using statistical package for social sciences (SPSS, 1998). Means were separated using Duncan Multiple Range Test (DMRT) as described by Duncan, (1955).

Table 1: Composition of Experimental Diets

Ingredients	$T_{1:}$	$T_{2:}$	$T_{3:}$	$T_{4:}$
Maize	76.00	76.00	76.00	76.00
Fish meal	1.50	1.50	1.50	1.50
Groundnut cake	20.00	20.00	20.00	20.00
Limestone	1.00	1.00	1.00	1.00
Bone meal	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Total	100	100	100	100

Results and Discussion

The mean value of the carcass traits of rabbit fed different forages as supplement are shown in Table 2. There were no significant ($P<0.05$) differences in the parameters measured except for the dressing weight expressed as percentage live weight. The result appeared not to be in agreement with the observation by Taiwo *et al.* (2014) and *Naandam et al.* (2012) when rabbits were fed *stylothensis* and *sida acuta* as sole feed.

The result of internal organs (liver, kidney, lungs, intestine, heart and caecum) of rabbits fed different forages as supplements are presented in Table 3. There were no significant ($p>0.05$) differences in all the parameters considered. The result coincides with the finding of Esiegwu *et al.* (2013) who observed non-significant effects on internal organs weight when rabbits were fed with *Garcina kola* seed meal, but disagree with the findings of (*Naandam et al.*, 2012), where gut characteristics were affected by types of forages used.

The result of by-products (blood weight, pelt/skin, head weight, tail weight, fore leg and hind leg) of rabbits fed different forages as supplements are presented in Table 4. There were no significant

(p>0.05) differences in the parameters determined except for pelt/skin and hind leg weight. This probably suggests that the dietary treatments result in negative metabolic reactions or disorders that could affect muscles growth, lipogenesis / lipolysis or osteolastic activity. (Taylor *et al*., 2003). Moreover, Aduku *et al.* (1986) reported that, skin, feet and some offals are not consumed in Europe and U.S.A; they only increased the dressing percentages of rabbit from 60-62 % and 50 % respectively and that head, skin and feet contributed about 18, 11 and 3 % respectively to the skinned carcass

Table 2: Carcass characteristics of rabbits fed different forages as supplements

Parameters	T1	T2	T3	T4	SED	LSD
Thoraxic (% LW)	46.20	47.13	49.93	38.63	6.98	NS
Fore limb	42.93	43.53	42.30	41.10	6.41	NS
Hind limb	86.97	91.57	76.60	62.66	13.12	NS
Dressing wt (% LW)	533.33	501.67^{b}	533.33^{b}	500.00^{b}	84.16	*
Slaughter wt (g)	1066.67	1156.67	1050.00	1033.33	128.6	NS
Lumber sacral (% LW)	102.47	110.60	106.13	94.07	18.62	NS
Neck weight(%Lw)	13.40	15.27	15.47	13.00	3.51	NS

abc= means within the same row bearing different superscript differ significantly (p<0.05) ±= standard error of means (SEM) least significant difference (LSD)

T_1 = Concentrate plus Ammarathus (100 g), T_2 = Concentrate plus *Tridax procumbens* (100 g), T_3 = Concentrate plus Fig leaves (*Ficus carpensis*) (100 g), T_4 = Concentrate plus water melon waste (100g)

Table 3: Internal organs of rabbits fed different forages as supplements

Parameters	T1	T2	T3	T4	SED	LSD
Liver	15.87	17.23	15.13	13.20	1.04	NS
Kidney	4.70	5.47	4.70	4.33	0.29	NS
Lungs	3.53	3.97	4.70	2.80	0.240	NS
Intestine	79.80	82.07	71.60	80.87	5.69	NS
Heart	1.73	1.90	1.43	1.27	0.10	NS
Ceacum	26.53	32.07	29.87	34.30	2.11	NS

abc = means within the same row bearing different superscript differ significantly (p<0.05)NS= not significant difference (P>0.05) *=significant (P<0.05) SEM= standard error of means. least significant difference (LSD)

Key:T_1 = Concentrate plusAmaranthus(100g T_2 = Concentrate plus Tridaxprocumbeans(100g) T_3 = Concentrate plus Fig leaves (ficuscarpensis) T_4 = Concentrate plus Water Melon Waste

Table4: Table 4: By-products of rabbits fed different forages as supplements

Parameters			**Treatments**			
% live weight	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**	**LSD**
Blood weight	16.47	15.33	16.20	14.33	1.44	NS
Pelt/skin	75.33[a]	73.03[a]	52.60[b]	48.77[c]	4.48	*
Head weight	53.87	58.50	56.93	56.97	2.18	NS
Tail weight	2.63	2.83	2.17	2.20	0.12	NS
Fore leg	4.00	4.73	3.87	3.80	0.24	NS
Hind leg	9.13[a]	8.73[b]	8.13[c]	7.73[c]	0.65	*

abc = means within the same row bearing different superscript differ significantly ($p<0.05$)NS= not significant difference ($P>0.05$) *=significant ($P<0.05$) SEM= standard error of means. least significant difference (LSD)

Key: T_1 = Concentrate plus Ammarathus (100g) T_2 = Concentrate plustridaxprocumbens (100g)

T_3 = Concentrate plus Fig leave (fiscus carpensis) (100g) T_4 = Concentrate plus Water Melon Waste (100g)

Conclusion: The result of experiment showed that forages which are cheaply available in all parts of the country can be successfully used to supplement rabbits diet up to 100g without any side effect on carcass characteristics of growing rabbits.

Recommendation: Based on the findings, it can be recommended that T2 (Tridax), can be used as supplement to concentrate feed, because it was consumed more than other treatment groups.

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Abstract

The aim of this study was to investigate performance indices of rabbits fed different protein sources. Fifteen, grower mixed breed rabbits were randomly allotted to three dietary treatments in a completely randomized design. The experimental diets contained soyabean meal, groundnut cake and sesame seed meal, respectively as protein sources. The study lasted for eight weeks. Parameters recorded were; initial weight, final weight, feed served and feed refusal, while weight changes, average weight change/week, total feed intake, average feed intake/week and feed conversion ratio were calculated. Proximate analysis was carried out using standard procedures. Data were analysed using descriptive statistics and ANOVA at $\alpha_{0.05.}$ Dietary reatments had significant effect ($P<0.05$) on; final weight, weight change, average weight change/week and total feed intake. Rabbits fed diet containing soybean cake had the highest values for final weight, average weight change/week and total feed intake when compared to values obtained for rabbits fed groundnut cake and sesame seed-based diets, respectively. Better feed conversion ratio was observed for rabbits on soybean meal-based diet than those on groundnut cake and sesame seed meal. The proximate analysis is presented in Table 3, parameters analysed were not significantly different ($P>0.05$). In conclusion, soybean cake can be effectively used as source of protein in rabbit's diet when compared with both sesame seed and groundnut cakes.

Keywords: Sesame seed cake, soybean cake, groundnut cake, growth indices

Introduction

With increasing population, the rate at which humans depend on animals for protein is increasing (Biobaku *et al.,* 2003). Rabbits possess attributes that make them advantageous over other livestock species. Rabbits can be produced on forage alone, although production can be improved on by addition of other feed supplements. Rabbits are highly prolific and have a short gestation period (28-32 days). They are also good converters of feed, easy to care for and they require low capital investment

in rearing (Biobaku *et al.*, 2003). There is dearth of information on performance of grower mixed breed rabbits fed diets containing different sources of protein. The aim of this study therefore was to evaluate performance of grower rabbits fed different protein sources.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at Rabbit Unit Division of National Veterinary Research Institute, Vom, Plateau State, Nigeria.

Experimental animals and management

Fifteen grower rabbits of mixed breed were used for this study. The rabbits were weighed individually, randomly allotted to three dietary treatments with five replicates per treatment and rabbits were housed in individual metal cages. The experimental diets are presented in Table 1 with soybean meal, groundnut cake and sesame seed meal as the dominant protein sources.. The rabbits were fed twice daily (morning and evening). The study lasted for eight weeks.

Table 1. Composition of experimental diets (g/100g diet)

Ingredients	T1	T2	T3
Maize	45.00	44.00	44.00
Soybean cake	18.00	0.00	0.00
Groundnut cake	0.00	18.00	0.00
Sesame seed cake	0.00	0.00	18.00
Wheat offals	15.00	15.00	15.00
Rice offals	17.00	17.00	17.00
Fish meal	1.00	1.00	1.00
Bone meal	2.25	2.25	2.25
Limestone	1.00	1.00	1.00
Common salt	0.30	0.30	0.30
Premise	0.25	0.25	0.25
Methionine	0.10	0.10	0.10
Lysine	0.10	0.10	0.10
Total	100.00	100.00	100.00
Calculated Anaysis (%)			

Crude protein	15.85	15.98	15.75
Metabolizable energy	2524.10	2546.10	2553.48
Crude fibre	8.55	8.54	8.69

T1= Soybean cake , T2= Groundnut cake, T3= Sesame seed cake

Parameters measured

Parameters recorded were; feed served, feed refusal, initial weight and final weight, while weight changes, average body weight change/week, total feed intake, average feed intake/week and feed conversion ratio were calculated.

Proximate analysis was done using the methods described by AOAC (1990).

Experimental design and statistical analysis

Experimental design was a completely randomized design and data obtained were subjected to analysis of variance using SAS (2010). Means were separated using least significant difference.

Results and Discussion

Presented in Table 2 are the selected performance indices of rabbits fed different protein sources. Dietary treatment had significant effect (P<0.05) on; final weight, weight changes, average weight change/week and total feed intake. Rabbits on soybean cake based-diet had the highest values for; final weight, weight change, average body weight change/week and total feed intake when compared to rabbits fed groundnut cake and sesame seed meal. This result is similar to that obtained by Biobaku *et al.* (2003), who used soybean cake, groundnut bean cake and fish meal. The feed conversion ratio values of the rabbits in all the treatments were not significantly different. The proximate analysis is presented in Table 3. All parameters analysed were not significantly (P>0.05). The results obtained in this result are in agreement with the results obtained by Mbanya *et al.* (2005) and Biobaku *et al.* (2003). This could be due to fact that the protein sources used were all plant protein sources with almost similar chemical profile.

Table 2. Growth indices of rabbits fed different protein source

Parameters	T1	T2	T3	SEM
Final weight, (g)	1460.00^{a}	1370.00^{b}	1210.00^{c}	36.56
Weight gained (g)	710.00^{a}	570.00^{b}	460.00^{c}	36. 17
Weight gained/week	88.00^{a}	71.25^{b}	57.50^{c}	4.56
Feed intake (g)	62.50^{a}	58.20^{b}	56.30^{b}	1.08
Feed Conversion Ratio	0.08	0.10	0.12	0.01

^{a,b,c} Means across rows with different superscripts differ significantly at P<0.05

Table 3. Proximate analysis of diets fed to rabbits using different protein source

Parameters (%)	T1	T2	T3	SEM
Ash	7.50	4.87	6.50	1.80
Moisture content	6.72	7.50	6.40	1.76
Ether extract	2.82	2.20	2.82	0.59
Crude fibre	4.50	4.52	4.60	0.58
Crude protein	17.20	17.39	17.10	0.58
Carbohydrate	45.10	45.10	46.20	0.61

[a,b,c] Means across rows with different superscripts differ significantly at P<0.05

Conclusion

In conclusion, soybean cake can be effectively used as source of protein in rabbit's diet when compared with both sesame seed and groundnut cakes.

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SERUM BIOCHEMICAL ESTIMATES OF BROILER STARTER CHICKS FED TIGERNUT (*Cyperus esculentus*) MEAL TREATED WITH BAKERY YEAST

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ABSTRACT

A 28-day feeding trial was carried out to determine the serum biochemical parameters of broilers starter chicks fed toasted Tiger nut treated with bakery yeast. A total of one hundred and twenty unsexed day-old broiler chicks obtained from a commercial hatchery at Ibadan were randomly assigned to four dietary treatments replicated three times with 10 birds per replicate in a General linear Model Procedure using SPSS (Statistical Package for Social Scientist) Design. The results of the study revealed that total protein, albumin and globulin concentration increased as the dietary levels of tigernut increased in the diets. The findings of this experiment suggested that tiger nut meal should be included in the ration of broiler starter chicks as partial replacement for maize at 50% level for optimum performance, production efficiency and stable physiology and normal cellular metabolism in the body of broiler chicks.

Keywords: Serum biochemical estimates**,** Broiler chicks, Tiger nut, Bakery yeast

Introduction

Poultry production globally plays vital role in supplying the population with animal protein and boosting income generation in the rural populace. In Nigeria, the industry is fast gaining ground and achieving optimum nutritional standard and food security (Nkwocha *et al*., 2014). According to World Food Programme (WFP), (2015), poultry production is a reliable antidote to malnutrition and hence a sine quo non for Sub-Saharan Africans to fast track food security.

Tigernut "*Cyperus esculentus*" is an underutilized tuber belonging to the family *Cyperaceae*, which produces rhizomes from the base of the tuber that is somewhat spherical (Gambo and Da'u, 2014).

Tiger nut and its products are rich in carbohydrate, mono-di and polysaccharides (TTSL 2005, Moore, 2004). They contain relatively high levels of protein, Oleic acid (Monounsaturated) fatty acid which has a bigger resistance to chemical decomposition) and fat (TTSL, 2005). Tiger nuts have excellent nutritional quality with a fat composition similar to olive oil and rich mineral content, especially phosphorous and potassium (FAO, 2008; Moore, 2004). Tiger nut oil has a mild, pleasant flavor and is considered as food oil similar but superior in quality to olive oil. The study is therefore aimed at determining the serum biochemistry of broiler starter birds fed toasted tigernut meal treated with bakery yeast.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the poultry section of Imo State Polytechnic Teaching and Research Farm, Umuagwo-Ohaji, Imo State in South Eastern Nigeria. The climatic data of the area showed that annual rainfall ranges between 2000-2500mm. The institution is situated on latitude 6^0N and longitude 7^0E of the equator with the temperature ranging from (26.5-32^{0}c) and humidity of (70-80%) (Nimet, 2015).

Experimental Birds and Design

One hundred and twenty (120), day old Agrited broiler chicks were bought from a commercial hatchery at Ibadan, Oyo State, Nigeria, certified to be of good health and physical stability. The chicks were acclimatized for 3 days and fed control diet. Kerosene stoves and lanterns were used to provide the heat needed to keep the temperature within optimum range/between 33^{o}c to 35^{0}c).The birds were raised in a deep litter system measuring 4.8 x 3.0m whose floor was covered with wood shavings and feed was provided throughout the experimental period *adlibitum*. Standard management practices were strictly observed. The broiler chicks were randomly allocated to 4 (four) dietary treatments and replicated three times with each replicate having ten (10) birds in a General Linear Model Procedure using SPSS version 20 (SPSS, 2014). The routine management and prophylactic measures were observed accordingly.

Feed preparation and feeding

Tiger nut seeds (*Cyperus esculentus*) was purchased from the local market in Owerri, Imo State. The tiger nut was toasted, passed through hammer mill which crushed the nuts into tiger nut meal. Proximate analysis was carried out to determine the proximate composition of the tiger nut seed meal (AOAC, 2005) as shown in Table 1. The tiger nut was then treated with bakery yeast few days before use in feed formulation to enhance digestibility and biotransformation of organic synthesis. Four isonitrogenous (24±0.24 CP) diets were formulated such that tiger nut replacing maize at 0%, 25%, 50% and 75% dietary levels respectively, the control diet (0%) contained no tiger nut meal (table 2).

Table 1: Proximate composition of tiger nut seed meal (% dry matter)

Parameters	Composition (%)
Dry matter	89.40
Crude protein	7.46
Ether extracts	8.61
Crude Fibre	25.33
Ash	8.27

NFE	39.73
Metabolizable Energy	2390.985kcal/kg

Metabolizable energy calculated; ME (Kcal/kg) =37 x %CP +81 x %EE +35.5 x %NFE (Pauzenga, 1985)

Table 2: Ingredient composition of experimental diets fed to starter broilers

	Dietary levels of tigernut meal			
Ingredient	0%	25%	50%	75%
Maize/ meal	50	12.5	25.00	12.50
Tigernut meal	-	37.5	15%	37.00
Soya bean meal	15	15	20	15
Groundnut cake	20	20	5	20
Wheat offal	5	5	5	5
Fish meal	5.5	5.5	5.5	5.5
Palm kernel cake	5	-	-	-
Salt	0.25	0.25	0.25	0.25
Bone meal	3.00	3.00	3.00	3.00
Bakery yeast	0.50	0.50	0.50	0.50
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total	100	100	100	100
CP	24.88	24.37	24.37	24.37
ME	2839.20	3119.325	3025.95	3119.33

500g of bakery yeast contains 100mg of ascorbic acid; 100mg of sorbitan monostereate (E-44), and natural yeast

Blood Sample Collection

At the end of the 4 weeks feeding trials, three birds were randomly selected from each replicate, and 5ml blood sample was collected through the wing vein with a 5ml sterile syringe. The blood collected was used for the analysis of serum parameters (albumen, total protein, glucose, cholesterol, urea, etc).

Data analysis

All data obtained were statistically analyzed using the General linear Model (GLM) procedure of SPSS version 20 (SPSS, 2014) while differences in treatment means were separated using Duncan's Multiple Range Test from the same software package.

Results and Discussion

The proximate composition of tiger nut is shown in Table 1, while the ingredient composition of experiment diets fed to starter broilers are on Table 2, while the serum biochemical estimates are summarized on Table 3 respectively.

Table 3: Serum biochemistry of broiler starter chicks fed graded levels of tiger nut treated with bakery yeast.

Parameters	T_1 0%	T_2 25%	T_3 50%	T_4 75%	SEM
Urea mg/dl	6.60	6.70	6.90	7.20	0.15
Creatinine Mg/dl	5.30	5.50	5.65	5.70	0.13
Glucose Mg/dl	37.60^a	42.30^b	46.00^c	51.00^d	4.66
Cholesterol Mg/dl	52.20^a	55.00^b	58.60^c	62.00^d	3.27
Total protein g/dl	54.00^a	57.50^b	59.70^b	64.50^c	3.50
Albumin g/dl	20.30^a	22.10^b	22.70^b	24.25^c	1.98
Globulin g/dl	33.70	35.40	36.80	42.25	2.85
SGOT iu/l	9.40^a	9.80^a	10.30^b	10.50^b	0.45
SGPT iu/l	12.40^a	12.70^a	13.10^b	13.40^b	0.33

^{abcd} Mean along the row having different letters differ significantly $P<0.05$

The serum biochemistry of the starter birds revealed that total protein, albumin, serum glutamate pyruvate transferase (SGPT), Serum glutamine oxaloacetic transferase (SGOT), glucose, cholesterol and globulin concentrations increased as the dietary levels of tigernut increased in the diets. High level of blood serum globulin is an indent of growth since new protoplasm is added to the cell.

Normally glucose level in the blood is necessary for the metabolic activities of the body and it appears that the tigernut meal builds or promotes blood by supplying the necessary blood forming metabolites like Magnesium, Iron, Copper, etc which enhances effective transportation of oxygen, glucose and other feed nutrients in the animal body.

The implication of the above result is that tigernut meals are richly utilized by broilers at relatively higher dietary inclusions. Moreover, the effect of feeding high dosage of tigernut which contained relatively high fibre compared with maize perhaps, was the reflection of high creatinine values but not significantly different ($P>0.05$) between the control group. The high creatinine values in the serum indicated poor utilization of nutrient due to muscles wastage (Udoyong *et al*., 2010).

CONCLUSION AND RECOMMENDATIONS

From all indications, tigernut based diets promoted highest values in virtually all the serum biochemical estimates notably Urea, Glucose, Total protein, Albumin, Globulin, SGOT and SGPT.

In view of the above experimental results, Tigernut meal should be included in the ration of broiler starter chicks as partial replacement for maize at 50% level for optimum performance and production efficiency.

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EFFECTS OF REPLACING MAIZE WITH THRESHED RICE HEAD SUPPLEMENTED WITH AND WITHOUT ENZYME ON THE NUTRIENT DIGESTIBILITY OF WEANER RABBITS

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ABSTRACT

A feeding trial was conducted to investigate the effect of replacing maize with threshed rice head (TRH) supplemented with and without enzyme on the nutrient digestibility of weaner rabbits. Fifty four rabbits were randomly allotted to six dietary treatments of three replicates. There were three rabbits per replicate in a 2 x 3 factorial experimental design. There were three inclusion levels (0, 7.5 and 15%) supplemented with and without enzyme in the diets. The response on TRH without enzyme inclusion showed that all the parameters measured (dry matter, crude protein, crude fibre, ether extract and ash) were significantly ($P<0.05$) affected by the test diets except nitrogen-free extract digestibility. The results of TRH levels (0, 7.5 and 15%) with enzyme supplementation had significant ($P<0.05$) effect on the coefficient of crude protein and crude fibre digestibility. The study indicated that TRH can be included in the diet of rabbit up to 15% with enzyme supplementation.

Key words: Rabbits, digestibility, Rice threshed head, maize

INTRODUCTION

There is a resultant increase in the demand for animal protein due to the rapid growth of human population in developing countries like Nigeria. Biobaku and Dosumu (2013) reported that this observed low animal protein consumption may be attributed to the declining animal protein production in the country. Rabbit, as a micro-livestock, is an economic animal that can bridge the wide gap between dietary protein production and consumption in Nigeria. This is because rabbit has peculiar digestive physiology which permits the use of forages and agro-industrial by-products thus making it non competitive specie with man for cereal and legume grains. According to Obeidat *et al*. (2009), sourcing for alternatives to the inadequate and expensive energy and protein feed stuffs like maize and soybean has become imperative since reducing production cost in order to maximize profit is the main objectives of farmers. Researches have shown over the years that different rice parts during and after harvesting contain various nutrients that favours their use as animal feed. Proximate analysis of threshed rice head revealed relatively good values of crude protein (8.06%), crude fibre (13.15%), ash (4.18%), ether extract (2.68%), nitrogen free extract (66.41%) and metabolizable energy (2259.70kcal/kg) at 92.48% dry matter content.

MATERIALS AND METHODS

Experimental Animals, Design and Management

A total of fifty fourhealthy five weeks old weaner rabbits were used in this study. They were randomly selected and allotted to six experimental diets in a 2 x 3 factorial design. There were three replicates per treatment and each replicate had threerabbits, comprising of nineanimals per treatment. The rabbits were housed in a cage with wire meshed hutches. The cage was raised above the ground in a well-ventilated pen. Feed and water were supplied *ad-libitum.*

Sources and Processing of Threshed Rice Head (TRH)

The threshed rice head was collected from rice farms in Gwagwalada, Abuja. After drying, the threshed rice head were thencrushed in a feed mill and sample was taken for proximate analysis before inclusion into diets.

Experimental Diets

Six experimental diets were formulated with the threshed rice head (TRH) with and without enzyme supplementation at different levels of replacement.Diets 1, 3 and 5 contained 0, 7.5 and 15% TRH without enzyme while diets 2, 4 and 6 contained 0, 7.5 and 15% TRH with enzyme supplementation. Maxi grain enzyme was used in this study.

Digestibility Study

At the end of the 8th week feeding trial, nutrient digestibility study was conducted. Rabbits closest to the average mean weight in each replicate were selected for the study. The rabbit were housed in a metabolic cage. Wire mesh was used to separate the faeces and the urine was collected from the tray beneath the cage. Faecal samples were collected for a period of seven days. The faeces were separated from feeds and other extraneous materials, sundried and bulked. The dried samples were then weighed,grinded and taken to the laboratory along with samples of feed for proximate analyses.Samples were analyzed for crude protein, crude fibre, ether extract, ash and nitrogen free extract. Nutrient retention was calculated with the formlula: Nutrient intake-Nutrient output divided by nutrient intake multiplied by 100.

Data Analysis

Data collected were subjected to statistical analysis using general linear model according to SAS (2001). Significant differences were separated using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The data for nutrient digestibility of rabbits fed diets containing Threshed Rice Head (TRH) with and without enzyme supplementation as partial replacement for maize are presented in Table 1.

Rabbits fed 15% TRH level had higher coefficient of crude protein, crude fibre, ether and ash digestibility than those fed 0 and 7.5% TRH levels. Rabbits fed 0 and 15% levels of TRH had similar dry matter digestibility which were significantly ($P<0.05$) higher than that of 7.5% TRH level. However, there was no significant ($P<0.05$) difference in the Nitrogen free extract digestibility across all TRH levels. Results on CP digestibility contradicts the reports of Adeniji (2008) who fed bovine rumen

content to rabbits and attributed the low CP digestibility to the high fibre content of the feed.The increased digestibility of ether extract and total ash absorption with increased levels of TRH in the diets of the rabbits also disagrees with the result of Igwebuike*et al*. (1998) who reported that increased crude fibre levels in rabbit diets depresses ether extract digestibility and total ash absorption. Nitrogen free extract digestibility was not significantly affected by the test material in the diets, thus, suggesting efficient utilization of soluble carbohydrates in all the diets. The result of this study is in line with the findings of Onifade *et al.,* (1999) who reported high digestibility of readily available carbohydrates by rabbits in a feeding trial involving alternative tropical energy feed resources in rabbit diets.Generally, the results of this study disagree with the submission of Alawa and Amadi (1991) who reported that nutrient digestibility significantly decreases with increasing levels of dietary crude fibre. The results obtained in this study might be due to the fact that gut micro organisms in the digestive tract of the rabbits helped to properly degrade the fibrous content of the feed thereby making the nutrients available to the experimental animals.

The observed improvement in crude protein and crude fibre digestibility due to enzyme supplementation in this study is in line with the results of Gidenne and Jehl (2000) who reported that enzyme supplementation reduces intestinal viscosity thereby improving contact between nutrients and digestive enzymes, thus, leading to improved digestibility coefficients. The enzyme supplementation result of this study is probably due to the enhanced effect of the exogenous enzymes on gut micro-flora and volatile fatty acids production thus resulting in improved nutrient digestibility**.** Even though Biobaku and Dosumu (2013) earlier reported that enzyme supplementation had no effect on fibre digestion in rabbits, the higher crude protein and crude fibre digestibility in this study is in agreement with the report of Abaza and Omara (2011) who observed similar results in fibre digestibility when corn cobs were supplemented with enzyme in the diet of growing rabbits. Adeyemo *et al*. (2014) also recently reported improved crude protein and crude fibre digestibility in rabbits fed enzyme supplemented diets.

Conclusion

It can be concluded that weaner rabbits can efficiently utilize TRH up to 15% in their diets especially when supplemented with enzyme.

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Table 1 Apparent nutrient digestibility of rabbits fed diets containing graded levels of threshed rice head with and without enzyme supplementation as partial replacement for maize

	Dry matter (%)	Crude protein (%)	Crude fibre (%)	Ether extract (%)	Ash (%)	NFE (%)
TRH Levels						
0%	75.75[a]	84.90[b]	75.30[b]	80.70[b]	82.70[c]	69.80[a]
7.5%	74.70[b]	82.10[c]	75.00[b]	78.60[c]	84.50[b]	69.40[a]
15%	75.50[a]	86.55[a]	79.00[a]	87.00[a]	85.65[a]	69.90[a]
SEM	0.25	0.23	0.19	0.19	0.20	1.27
LOS	S	S	S	S	S	NS
Enzyme Level						
No enzyme	75.36[a]	83.60[b]	76.10[b]	82.03[a]	83.46[b]	64.90[a]
Enzyme	75.26[a]	85.43[a]	76.76[a]	82.16[a]	85.10[a]	63.83[a]
SEM	0.13	0.19	0.15	0.15	0.16	1.22
LOS	NS	S	S	NS	S	S
Interaction	S	S	S	S	S	S

[a, b, c]: means with different superscripts within the same row differ significantly (P < 0.05); NFE-Nitrogen free extract; TRH-Threshed rice head; SEM-Standard error of means; LOS-Level of significance; NS-Not significant; S-Significant

GROWTH PERFORMANCE AND HAEMATOLOGICAL PROFILE OF BROILER BIRDS SERVED DIETARY INCLUSION OF PROBIOTICS (*SACCHAROMYCES CEREVIASAE*) AND ENZYME (BIO-ENZYME)

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Abstracts

This study was conducted to evaluate the growth performance and haematological profiles of broiler birds served dietary inclusion of probiotics (*Saccharomyces cereviasae*) and enzyme (Bio-enzyme). One hundred and twenty day-old broiler chicks of Agrited strain were used for the study. The birds were randomly allotted to four dietary treatments. Each treatment contained 30 birds replicated three times to contain 10 birds per replicate in a completely randomized design experiment. The four dietary treatments wereT1 Control (no probiotics and enzyme), T2 (had both probiotics and enzyme), T3 (probiotics only) and T4 (Enzyme only). The birds were given fed and water *ad-libitum* and the quantity of feed consumed each day was determine through weigh back techniques. The birds were weighed weekly throughout the experimental period and the experiment lasted for eight weeks. At the end of the experimental period, two birds were randomly chosen from each replicate for haematological profiling. Blood samples were collected into EDTA containers with the aid of sterile syringes and needles and taken to the laboratory for analysis. The results showed significant ($p<0.05$) differences in the final body weight, total weight gain, average daily weight gain, total feed intake, average daily feed intake and feed conversion ratio. Birds on treatment 2 had the highest final body weight of 3011.57g and seemed to have performed better than other dietary treatments. Similar trend was observed in the haematological profile as treatment two were highest in value across the treatments and parameters measured except in packed cell volume where the highest value (36.33 %) was recorded in treatment 4. It was concluded from the study that treatment two which contained both probiotics and enzyme performed better and thus, recommended to farmers for broiler production.

Keywords: Broilers,growth performance, haematology, probiotics and enzyme.

Introduction

Poultry production plays an important role in animal protein supply most effectively within the shortest possible time (Hossinzadeh and Jahanian, 2010), this is because of their short generation intervals, high prolificacy and fast growth rate. According to Nworgu (2004), high cost of feed is the major problem of poultry farmers in Nigeria. Adene (2004) reported that feed accounts for 65-80 % of the total cost of production. Due to the high cost of poultry feed ingredients; farmers have alternatively chosen agro by-products of poor quality and less nutritive value in rearing their birds. Nutritive feed stuffs are either not available or not cost effective, and sometimes, the nutrients are not readily accessible to the birds.

From series of research results over the past decades, poultry nutritionists have come up with different types and levels of growth promotants aimed at improving efficiency of chicken production by increasing growth rate and feed conversion ability (Miranda *et al*., 2014). Some of these promotants of growth ever in use included hormones (natural and synthetic) that are specific receptors in their target tissues. They also included antimicrobial compounds that change the population of micro-organisms in the gastrointestinal tract of healthy animals, resulting in improved animal performance. Probiotics present a potential alternative to the prophylactic use of antibiotics in feed animals. Also known as direct-fed microbials, probiotics are classified as live nonpathogenic microorganisms that are capable of maintaining a normal gastrointestinal microbiota (Ohimain and Ofongo, 2012). Probiotic, meaning "for life" in Greek, has been defined as "a live microbial feed supplement, which beneficially affects the host animal by improving intestinal balance". Probiotics can be composed of one or many strains of microbial species, with the more common ones belonging to the genera *Lactobacillus*, *Bifidobacterium*, *Enterococcus*, *Bacillus*, and *Pediococcus* (Gaggia *et al*., 2010). Enzymes are now being routinely used in poultry feeds to improve digestibility of feed ingredients. In general, feed enzymes are available which act on carbohydrates, plant bound materials and proteins. Commercial and academic studies have shown that the judicious use of enzymes can ameliorate inconsistency in nutritional value of maize, thereby improving body weight in birds (Cowieson, 2005). Therefore, this study was aimed at evaluating the growth performance and haematological profiles of broiler birds served dietary inclusion of probiotics (*Saccharomyces cereviasae*) and enzyme (Bio-enzyme).

Materials and Methods

Study location

The experiment was conducted at the Poultry Unit, Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. Nsukka is in Enugu State, Nigeria.

Experimental design, animals and management

The study was conducted to evaluate the growth performance and haematological profiles of broiler birds served dietary inclusion of probiotics (*Saccharomyces cereviasae*) and enzyme (Bio-enzyme). One hundred and twenty day-old broiler chicks of Agrited strain were used for the study. The birds were randomly divided into four groups and assigned to the four dietary treatments. Each treatment contained 30 birds replicated three times to contain 10 birds per replicate in a completely randomized design. The four dietary treatments were T1 Control (no probiotics and enzyme), T2 (had both probiotics and enzyme), T3 (probiotics only) and T4 (Enzyme only). The birds were given fed and water *ad-libitum* and the quantity of feed consumed each day was determined through weigh back techniques. The birds were weighed weekly throughout the experimental period and the experiment lasted for eight weeks. Vaccination and medications were provided as when due and other routine management practices were provided accordingly. At the end of the experimental period, two birds were randomly chosen from each replicate for haematological profiling. Blood samples were collected into EDTA containers with the aid of sterile syringes and needles and taken to the laboratory for analysis.

Table 1: The percentage composition of the experimental diets of the broiler chickens

Parameters	Treatments

	T1 (Control)	T2 (Probiotics and Enzyme)	T3 (Enzyme only)	T4 (Probiotics only)
Maize	53.00	53.00	53.00	53.00
Wheat offal	10.00	10.00	10.00	11.00
Palm kernel cake	5.50	5.50	5.50	5.50
Groundnut cake	15.00	15.00	15.00	15.00
Soya bean meal	10.00	10.00	10.00	10.00
Fish meal	1.50	1.50	1.50	1.50
Bone meal	4.00	4.00	4.00	4.00
Salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Vit-Premix	0.25	0.25	0.25	0.25
Probiotics	-	0.80	-	0.80
Enzyme	-	0.02	0.02	-
Total	100.00	100.00	100.00	100.00
Calculated composition				
CP%	20.12	20.01	20.11	20.04
Energy (MJME/kg)	3.68	3.81	3.75	3.71

Proximate and Statistical analysis

Proximate analysis of feeds was done according to AOAC (1990). Data collected were subjected to analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS, 2013) version 19.00. Significant different means were separate using Duncan's new multiple range test (Duncan, 1955).

Results and Discussion

Table 2 shows the effect of probiotics and enzyme inclusion on the growth performance of broiler birds.

Table 2: Effect of probiotics and enzymeinclusion on the growth performance of broiler birds

Parameters	Treatments			
	T1 (Control)	T2 (Probiotics and Enzyme)	T3 (Enzyme only)	T4 (Probiotics only)
IBW (g)	40.62±1.24	40.17±0.17	45.33±3.03	42.02±3.33
FBW (g)	2138.87±3.17^{d}	3011.57±2.89^{a}	2923.67±3.59^{b}	2696.58±2.86^{c}
TWG (g)	2098.37±2.20^{d}	2971.41±3.02^{a}	2881.67±37.47^{b}	2654.57±25.71^{c}
ADWG (g)	38.19±0.06^{d}	53.78±0.05^{a}	52.27±0.64^{b}	48.15±0.51^{c}
TFI (g)	4598.73±82.42^{c}	4426.40±12.92^{d}	5025.65±15.09^{a}	4808.78±24.47^{b}
ADFI (g)	82.69±1.02^{c}	79.01±0.21^{d}	89.74±0.27^{a}	85.87±0.44^{b}
FCR	1.16±0.02^{a}	1.47±0.03^{d}	1.72±0.03^{c}	1.78±0.02^{b}

IBW = Initial body weight, FBW = Final body weight, TWG = Total weight gain, ADWG = Average daily weight gain, TFI = Total feed intake, ADFI = Average daily feed intake, FCR = Feed conversion ratio.

The results indicated no significant difference ($p>0.05$) in the initial body weight across the treatments and the values ranged from 40.17 to 45.33 g. However, there were significant differences in the final body weight, total weight gain, average daily weight gain, total feed intake and feed conversion ratio across the treatments. Treatment 2 had the highest final body weight value while treatment 1 (Control) had the lowest values of 3011.57g and 2138.87g, respectively. Total weight gain and average daily weight gain followed similar trend but in total feed intake and average daily feed intake, treatment 3 had the highest value whereas treatment 2 had the least values. Birds in treatment 2 were best in feed conversion ratio (1.47) and recording the highest final body weight (3011.57g). The significant ($p<0.05$) increase in final body weight recorded in treatment 2 may be attributed to the activities of the probiotics which may have elaborated the digestive enzymes such as sucrose and phytase that helped in nutrient digestion thereby promoting growth. This was supported by Cowieson *et al*. (2004) who reported that hydrolysis of phytate by phytase is essential to liberate the bound nutrients in the GIT for absorption. Selle and Ravindran (2007) in agreement with that opinion stated that adding microbial phytase to diets enhances the bird's growth performance and mineral digestibility, and reduces nutrient excretion to the environment. The beneficial effect of probiotic supplementation to broiler diet in terms of increased body weight and body weight gain is well documented in a study by Bandy and Risam (2001).

Table 3: Effect of probiotics and enzymes inclusion on the haematological profile of the broiler chickens

Parameters	T1 (Control)	T2 (Probiotics and Enzyme)	T3 (Enzyme only)	T4 (Probiotics only)
PCV (%)	29.67±0.33^{d}	32.33±0.32^{c}	34.00±0.58^{b}	36.33±0.33^{a}
Hb (g/dl)	6.90±0.06^{c}	10.70±0.12^{a}	10.07±0.03^{a}	8.70±0.06^{b}
RBC (x10^{9}/mm^{3})	180.00±2.89^{c}	261.67±1.67^{a}	251.67±4.41^{a}	210.00±5.77^{b}

WBC ($x10^3mm^3$)	1840.00±13.80[c]	4800.00±0.00[a]	3513.33±15.11[b]	4783.33±16.67[a]

a,bc,d = Significant means, PCV = Packed cell volume, Hb = Haemoglobin concentration, RBC = Red blood cell, WBC = White blood cell.

The results of the effect of the inclusion of probiotics and enzymes on the haematological profile of the broiler chickens are presented in table 3. The result showed that there were significant ($p<0.05$) differences in the PCV, Hb, RBC and WBC across the treatments. Birds on treatment 4 had the highest value of PCV (36.33%), followed by bird in treatment 3, but the least value of PCV (29.67 %) was obtained from the birds in the control (T1). Treatment 2 had the highest value of haemoglobin concentration, red blood cell count and white blood cell count (20.70g/dl, $261.67x10^9/mm^3$ and $4800x10^3/mm^3$ respectively), whereas the control had the least values s (14.90g/dl, $180.00x10^9/mm^3$ and $1840x10^3/mm^3$ respectively). The percentage PCV (32.33 %) obtained in treatment 2, combination of probiotics and enzyme, was the same with the result (32.50%) recorded by Rahman *et al*. (2013) who also included probiotics and enzyme in broiler's diets. On the contrary, Rahman *et al*. (2013) recorded (8.70g/dl) in haemoglobin concentration which was significantly $p<0.05$) lower than 10.70g/dl obtained in this study, on similar bioactive ingredient treatment. Ogunwole *et al*. (2017) who fed broilers with acidified blood meal diets obtained Hb values ranging from 9.85g/dl to 10.66g/dl which are similar to some values obtained in this study. The results in RBC are also in agreement with the results of Ogunwole *et al*. (2017). There were significant differences ($p<0.05$) across the treatments in WBC.

Conclusion and Recommendation

It was concluded from the study that treatment 2 which contained both probiotics and enzyme performed better and thus, recommended to farmers for broiler production.

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DETERGENT FIBRE ANALYSIS AND PROXIMATE COMPOSITION OF 12 IMPROVED TROPICAL FORAGE LEGUME SPECIES IN THE SOUTHERN GUINEA SAVANNA OF NIGERIA.

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ABSTRACT
This study was conducted to assess the detergent fibre fractions and proximate composition at maturity of 12 tropical improved forage legumes. *The results showed significant (P<0.05) differences among the 12 forage legume species for detergent fibre analysis. The lignin content ranged from 10.66% for Cajanus cajan to 14.70 for Lablab purpureus. ADF content ranged from 26.13% to 32.04% for Gliricidia sepium and Desmodium intortum respectively. The NDF for the legume species ranged from 42.88% to 54.70% for Gliricidia sepium and Centrosema pascuorum, respectively. The percent dry matter ranged from 95.70% in Lablab purpureus to 98.83% in Cajanus cajan. Percent crude protein (CP) recorded ranged from 9% in Cajanus cajan to 17.75% in Aeschynomene americanum. Ash percent of the forage legume species ranged from 5.32% in Stylosanthes hamata to 8.52% in Leucaena leucocephala. The percent dry matter ranged from 95.70% in Lablab purpureus to 98.83% in Cajanus cajan. The results obtained in this study revealed that most of the forage legumes species have the potential to supply adequate nutrients for ruminant production.*
Keywords: Agro-ecology, Detergent fibre, Forage legumes,, Proximate, Nutrients.

INTRODUCTION

The low level of animal production from the savanna ecology of Nigeria is generally associated with the inadequacy of good quality forages. Apart from crop residues, the major feed resource is the natural range which limits animal productivity due to its poor quality. Nutritive value of forages depends in part upon the availability of nutrients in the plant for the animal. This availability is controlled by the chemical composition of the forage in respect to factors limiting the utilization of cellulose and hemicelluloses which includes lignin, and total amount of plant cell wall substances. With these points in mind the objective of this study was to assess the detergent fibre fractions and proximate composition at maturity of 12 improved forage legumes grown in the southern guinea savanna of Nigeria for establishment.

MATERIALS AND METHODS

The study was conducted from May to November, in 2015 to 2016 Cropping Seasons at the Pasture field of the Livestock Teaching and Research Farm, College of Animal Science of the University of Agriculture, Makurdi, Nigeria. Makurdi is located on latitude 07^{o} 41' N, longitude 08^{o} 37'E and altitude 106.4 m (NIMET, 2016). Twelve (12) forage legume species: (*Cajanus cajan* (L) Millsp, *Stylosanthes hamata* (Verano), *Gliricidia sepium* (Gliricidia), *Centrosema pubescens* (Centro), *Mucuna pruriens-white seeded, Alysicarpus vaginalis, Leucaena leucocephala, Desmodium intortum, Lablab purpureus* (Rongai), *Mucuna pruriens-black seeded, Aeschynomene americanum and Centrosema pascuorum* (Centro) were used for the study. The twelve line plots were arranged in a Randomized Complete Block Design (RCBD) with three replicates for the field experiment, while a Completely Randomized Design (CRD) was adopted for the pot experiment and replicated three (3) times. The total plot size was 36m^2 with each Unit plot having a size of 0.75m^2. The fibre fractions (NDF, ADF and

ADL) were estimated by the method of Van Soest *et al*., (1991). According to AOAC (2012), leaf samples were analyzed to determine dry matter, crude protein (Kjeldahl process), ether extract, crude fiber and nitrogen free extract at maturity. Dry matter was estimated by oven drying the forage species of known weight at 70ºC until constant weight was attained and moisture content was determined by difference.

RESULTS AND DISCUSSION

Table: Detergent Fibre Fractions (%) at Maturity for Field and Pot Experiments.

Specie	Lignin	ADF	NDF
Cajanus cajan	10.66^{e}	27.48^{cd}	46.98^{f}
Stylosanthes hamata	12.36^{cd}	28.44^{bcd}	46.38^{f}
Gliricidia sepium	11.80^{de}	26.13^{d}	42.88^{g}
Centrosema pubescens	14.20^{ab}	29.99^{ab}	50.01^{cde}
Mucuna pruriens (white)	14.17^{ab}	29.60^{abc}	49.85^{de}
Alysicarpus vaginalis	13.01^{bcd}	29.91^{abc}	51.30^{bcd}
Leucaena leucocephala	12.86^{bcd}	27.50^{cd}	48.28^{ef}
Desmodium intortum	14.09^{ab}	32.04^{a}	52.12^{bc}
Lablab purpureus	14.70^{a}	30.91^{ab}	50.19^{cde}
Mucuna pruriens (black)	13.88^{ab}	31.15^{a}	53.28^{ab}
Aeschynomena americanum	11.66^{de}	29.98^{ab}	51.47^{bcd}
Centrosema pascuorum	13.97^{ab}	31.60^{a}	54.70^{a}
SEM	**0.920**	**1.469**	**1.345**

a, b, c = Means on the same column with different superscripts are significantly ($P<0.05$) different.

SEM: Standard Error of Mean, ADF: Acid Detergent Fibre, NDF: Neutral Detergent Fibre

Proximate Composition of the Forage Legume Species at Maturity

Species	DM %	ASH %	EE %	CF %	CP %

Cajanus cajan	98.83[a]	6.08[e]	18.11[c]	14.11[f]	9.00[g]
Stylosanthes hamata	96.29[cd]	5.32[f]	13.29[g]	29.83[b]	10.29[f]
Gliricidia sepium	97.40[b]	7.42[c]	14.41[f]	16.06[e]	13.54[d]
Centrosema pubescens	97.90[ab]	6.32[de]	16.91[d]	18.90[d]	12.96[de]
Mucuna pruriens (White)	96.42[c]	5.47[f]	17.32[d]	36.91[a]	15.56[b]
Alysicarpus vaginalis	96.58[c]	7.25[c]	15.72[e]	15.41[e]	12.36[e]
Leucaena leucocephala	97.47[b]	8.52[a]	19.42[b]	11.67[h]	15.53[b]
Desmodium intortum	96.80[bc]	7.34[c]	21.22[a]	13.95[fg]	14.52[c]
Lablab purpureus	95.70[d]	8.32[a]	18.20[c]	13.23[g]	17.50[a]
Aeschynomena americanum	96.50[c]	6.52[d]	16.90[d]	21.10[c]	17.75[a]
Centrosema pascuorum	97.60[ab]	7.93[b]	12.87[g]	16.12[e]	15.50[b]
Mucuna pruriens (Black)	96.50[c]	5.34[f]	17.48[d]	19.33[d]	13.37[d]
SEM	**1.29**	**0.22**	**0.35**	**0.47**	**0.36**

a, b, c = Means on the same column with different superscripts are significantly (P<0.05) different

SEM: Standard Error of Mean; DM: Dry matter; EE: Ether extract; CF: Crude fibre and CP: Crude protein.

The mean ADF and NDF fractions obtained in the present study compare favorably with those reported by Oji and Isilebo (2000) for selected browses of southern Nigerian. Meissner *et al*. (1991) observed that NDF level of forage above 65% can limit feed intake. However, note that there are no forage legume species of the present study that is up to that threshold level. This is suggesting that the intake of the tested forage legumes will not be hindered in this agro-ecological zone. The dry matter content of the forage plants obtained in the present study compared favourably with the findings of Oduozo and Adegbola (1992) (90.50 - 92.70%). A mean ash content of 6.82% was obtained which compares favourably with Mecha and Adegbola (1980) who reported mean ash values of 6.92, 6.10, 8.93 and 7.96% for trees, shrubs, herbs and grasses, respectively. Crude protein (CP) contents of all the species of this study were higher than 10% except for *Cajanus cajan*, which is sufficient for ruminants (Subba, 1999).

CONCLUSION AND RECOMMENDATION

The results obtained in this study revealed that most of the forage legumes species have the potential to supply adequate nutrients for ruminant production. The foliage of the plants contained moderate to high levels of crude protein at maturity. It is recommended that *Cajanus cajan*, *Lablab purpureus*, *Centrosema pascuorum*, *Centrosema pubescens* and *Mucuna pruriens* (White and black seeded) be adopted by livestock farmers and pasture agronomists in this location to establish ranches and fodder banks based on their ability to adapt, establish well and meet nutrient requirements for ruminants.

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EFFECT OF MEAT TYPE AND PACKAGING MATERIALS ON THE MICROBIAL PROPERTY OF STORED DRIED MEAT STRIPS

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ABSTRACT
The objective of this study was to investigate the effect of meat type (Pork and beef) packaging materials (polythene bags, sealed plastic container, brown envelopes) on the microbial quality of dried meat stripes. The experiment which was conducted using a 2 x 3 factorial arrangement in a completely randomized design. The dried beef and pork in different packaging materials were kept under room temperature and examined on day 0, 14, 28, 42. Data collected were the initial dry weight, final weight, Bacteria and Fungi count, fortnightly (2weeeks). These were used to analyzed for moisture content and microbial activities. Packaging material has no effect on the bacteria load, amount of deactivated bacteria, fungi load and amount of deactivate fungi. Pork had higher bacterial load than beef and brown Paper absorbed more moisture than the other packaging materials. Dried beef strips can be stored for 42 days without harmful effect before consumption and that the use of sealed plastic container and polyethylene bags for packaging of dried beef and pork.
Key words: Dried meat strips, Pork, Beef, Packaging materials, Bacteria, Fungi

INTRODUCTION
Meat, traditionally preserved by drying, is made available sometimes in packaged linen bags, baskets or pottery to facilitate storage and transport and to provide some kind of protection against dirt, insects, etc. With teeming population of consumers, however, this traditional system now becomes outmoded because more time is needed between slaughtering and ultimate consumption, giving room for deterioration in quality and spoilage.
Over the years, a number of traditional Nigerian/African meat products have gained universal acceptability. These products included barbecued meats such as *'tsire' (suya)* and *balangu;* sun-dried or dehydrated meat products such as *kilishi*, and smoke-dried meat products like *banda, kundi* and *unam inung*. These traditional meat products are popular, convenient and leisure food items whose consumption has become invariant with socioeconomic class. However, poor packaging or absence of same restricts their usage and stability. They are still packaged with newspaper, clay pot and sometimes inappropriate single film polyethylene which are possible source of contamination (Uzeh *et al.*, 2006). This constrains the marketing and distribution of large amounts of meat products to distant consumption centre. Some of the causes of these poor packaging are finance and technology. There is need to seek ways to extending the shelf stability of these meat products through packaging to augment the impact of processing for longer shelf-life. Packaging films such as polyethylene, sealed plastic container and brown paper offers likely advantage; it will guarantee low cost while incorporating the barrier properties of polypropylene. Since cost and technology are major constraints to improved packaging of these meat products, attempt was proposed in this work to exploit available technology and cheaper raw material.

MATERIALS AND METHODS
The experiment was carried out at the Meat Quality Laboratory of the Department of Animal Production and Health of the Federal University of Agriculture, Abeokuta which is at longitude 7°9'39" N and latitude 3°20'54" E and 74m. The area is in the derived savannah vegetation zone of south west Nigeria, it is characterized by a binomial rainfall pattern which peaks in July and September. The meat from the thigh muscle of beef was source from an Abbatoir in Abeokuta town, while pork was source from the University farms and packaging materials were sourced from Kuto market in Abeokuta metropolis. This is the packaging experiment which was conducted using a 2x3 factorial arrangement in a completely

randomized design. The factors are dried meat from two sources i.e. Beef and Pork, and packaged in three materials i.e. brown envelopes, Polyethylene bags and sealed plastic containers. The dried beef and pork in the different materials were kept under room temperature and examined on days 0, 14, 28, 42. Change in Strip Weight, was taken by subtracting the initial strip weight from the final strip weight. This was use to determine the moisture gain. Microbial Analysis (Bacterial load, Fungi load) was also determine from each collected samples from each treatment and analyzed for microbial activity as described by Adeyeye, 2016.

All data collected were subjected to ANOVA in a completely randomized design using a 2x3 factorial arrangement and significant means (P>0.05) was compared using Duncan multiple range test.

RESULTS

The main effect of meat types, packaging materials and storage conditions on dried meat strips is displayed in Table 1. On day 0, the total bacterial count was higher (P<0/05) in pork than in beef. On day 14, % moisture gain were not significantly (p>0.05) affected by meat types. Total bacterial count and total fungi count were significantly (p<0.05) higher in pork. The deactivated bacterial was also significantly (p=0.03) higher in beef having a higher deactivation ($0.76cfu\times10^5$) than pork ($0.24cfu\times10^5$).

Meat strips packed in brown paper bags were significantly (P<0.05) higher (3.70%) than values obtained for those packed in Polyethylene bags and sealed plastic containers.

On the twenty-eighth day of storage, meat type significantly affected the total bacterial count (p=0.00) and total fungi count (p=0.02) with pork recording higher values than beef in both parameters. The moisture gain (%), deactivated bacteria ($cfu\times10^5$) and deactivated fungi ($cfu\times10^5$) were not significantly influenced (P>0.05) by meat type. The packaging materials had significant effect (p=0.00) on percentage moisture gain with meat strips packed in brown paper having higher value than those packed in polyethylene bag and sealed plastic container. Total bacterial count, total fungi count, deactivated bacterial and deactivated fungi were not significantly (p>0.05) influenced by the packaging materials used. Influence of meat type on dried meat strips at the 42nd day of storage revealed that only total fungi count was significant (p<0.05) affected pork ($2.49\ cfu\times10^5$) had a higher total fungi value than beef ($1.53\ cfu\times10^5$). Packaging materials significantly (p<0.05) affected the amount of moisture gained from the atmosphere. Brown paper gained the highest moisture (6.17%) while sealed plastic container gained the lowest (1.67%) moisture. Total bacterial count, total fungi count, deactivated bacterial and deactivated fungi were however not significantly (p>0.05) influenced by the different packaging materials. Trends observed in days 0, 14, 28 and 42 revealed that total fungi count was higher than total bacterial count and in all the days considered. Moisture gain did not differ significantly for both meat types, pork had higher values for total bacterial count and total fungi count on all days observed. Moisture gain for all packaging materials used showed that moisture gained in meat strips packed in Brown Paper was greater than Polyethylene bags and sealed Plastic Containers that had similar values. The interactive effect of meat types and packing materials did not have significant effect on all the parameters measured, as a result were not presented in this report.

DISCUSSION

Generally, the shelf life of products is defined as the period between the packaging of a product and its end use when the product properties remain acceptable to the product users (Lorenzo and Gomez, 2012). Changes such as microbial growth, lipid oxidationand colour changes in meat with storage affect the shelf life and acceptance of meat (Esmer *et al*., 2011). The

Table 1: Main Effect of Meat Type, Packaging Materials and Storage Conditions on Dried Meat Strips

		Meat Type			Packaging Material				
	Parameters	**Beef**	**Pork**	**P-value**	**BP**	**SPC**	**PB**	**P-value**	**SEM**
Day 0	Total Bacterial Count	1.97[b]	2.589[a]	0.00	2.28	2.28	2.28	1.00	0.08
	Total Fungal Count	3.62	4.144	0.05	3.88	3.88	3.88	1.00	0.12
Day 14	Moisture Gain (%)	1.36	1.94	0.41	3.70[a]	0.22[b]	1.00[b]	0.00	0.39
	Total Bacterial Count	1.21[b]	2.35[a]	0.00	1.66	1.85	1.83	0.54	0.14
	Total Fungal Count	3.03[b]	4.18[a]	0.02	3.46	4.08	3.28	0.35	0.32
	Deactivated Bacteria	0.76[a]	0.24[b]	0.03	0.62	0.43	0.44	0.74	0.13
	Deactivated Fungi	0.59	-0.04	0.24	0.43	-0.20	0.60	0.43	0.32
Day 28	Moisture Gain (%)	4.59	3.82	0.32	8.24[a]	1.61[b]	2.78[b]	0.00	0.61
	Total Bacterial Count	0.79[b]	1.72[a]	0.00	1.07	1.39	1.31	0.28	0.12
	Total Fungal Count	1.17[b]	1.68[a]	0.00	1.30	1.48	1.49	0.49	0.08
	Deactivated Bacteria	1.17	0.87	0.22	1.21	0.89	0.97	0.53	0.12
	Deactivated Fungi	2.45	2.47	0.96	2.58	2.40	2.39	0.87	0.14
Day 42	Moisture Gain (%)	3.75	3.53	0.80	6.17[a]	1.48[b]	3.26[b]	0.00	0.55
	Total Bacterial Count	1.17	1.71	0.05	1.36	1.49	1.40	0.91	0.12
	Total Fungal Count	1.53[b]	2.49[a]	0.00	2.09	1.93	2.00	0.90	0.15
	Deactivated Bacteria	0.79	0.88	0.82	0.92	0.79	0.81	0.95	0.16
	Deactivated Fungi	2.09	1.66	0.39	1.79	1.95	1.88	0.97	0.21

[a, b,]; Means in the same row with different superscripts differ significantly (P<0.05)

Notes: BP- Brown Paper; SPC- Sealed Plastic Containers; PB- Polyethylene Bags; OS- Opened Shelf; CS Closed Shelf

differences in the total bacterial count for both meat types may be due to the sources of the meat types from and the contamination may be as a result of the environmental conditions and handling (Borch *et al.*, 1996). The application of high temperature during the process of drying of the meat was expected to have deactivated the microbial load of the meat product. However, the presence of bacterial counts after drying implicates the presence of thermophilic bacteria which have the ability to thrive under heat levels equal to or higher than the 70^{o}C drying temperature utilized in the present study. Such microbes could also arise from the environment (because the environment may not be void of microbes, which can get into products from the air). This corroborate the reports by Saad *et al*., (2011) that processed meats can be contaminated from different sources such as processing, cooking and even the environment.

The role of food packaging in the food industry is being increasingly recognized as it has multiple factors and is very important in terms of increasing product shelf life by retarding food quality degradation and ensuring food safety (Olayemi and Omojola, 2017). The higher moisture gain recorded for meat stored in brown paper bags might be due to the greater oxygen permeability of the medium which might have resulted in a greater introduction of air from the atmosphere with consequent increased oxygen and moisture content in the meat. The paper medium has been reported to have a poor barrier to air and is moisture sensitive than the other packaging materials (Marsh and Bugusu, 2007), this however did not result in a higher bacterial count when compared with the other storage mediums utilized. However, it can be concluded dried beef strips can be store for 42 days without harmful microbial growth and that the sealed plastic containers and polyethylene bags might serve as better

storage mediums for dried beef and pork strips, owing to the fact that the moisture gain by the meat strips were lower.

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HAEMATOLOGICAL AND SERUM PARAMETERS OF WEST AFRICAN DWARF SHEEP FED CROP RESIDUE BASED CONCENTRATE AND UNRIPE PLANTAIN PEEL

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Abstract

This study was conducted to determine the effect of feeding unripe plantain peel supplemented with mixed rations of crop residues on the haematological and serum biochemical parameters of West African dwarf (WAD) sheep. Sixteen growing female WAD sheep with average live weight of 8.10 ± 0.16 kg were randomly allotted to four dietary treatments in a complete randomised design with four animals per treatment. Dietary treatments include; diet 1 (Dried corn cob), diet 2 (Dried cassava peel), diet 3 (Groundnut haulm) and diet 4 (Cowpea husk), each mixed with soya bean hull,palm kernel sludge and *Gliricidia sepium* (w/w). The results showed that packed cell volume (PCV), haemoglobin (Hb) and red blood cell (RBC) values of sheep fed diets 4 (52.00 %, 16.95 g/dL and 14.25 ($x10^6$ µL)) were higher ($p<0.05$) than the range of values of PVC (33.00-45.00%), Hb (10.65-14.65 g/dL) and RBC (11.79-13.29 ($x10^6$ µL) obtained for sheep fed diets 1, 2 and 3, respectively. Serum protein, albumin and glucose differed ($p<0.05$) across the treatments while other serum parameters were not ($p>0.05$) different. The results obtained in this study implied that unripe plantain peel supplemented with mixed rations of crop residues had no deleterious effects on the health status of the WAD sheep.

Keywords: Blood parameters, crop residues ration, unripe plantain peel, sheep.

Introduction

Crop residues and agro-industrial by-products are major alternative feed resources of small ruminant often utilized to salvage dry season feed challenges. However, arbitrary combination of crop residues as ration for ruminants in confinement by smallholder farmers without due consideration to the proportions and nutritive values results in poor performance. About 18% of annual dry matter intake of ruminants is from crop residues (Olayiwola and Olorunju, 1987). Prominent among these crop residues are cassava peel, cowpea husk, groundnut haulm, corncob and plantain peels whose abundance depends on the agro-ecological zones where they are cultivated. The nutritional quality of crop residues when incorporated into ruminant diets is well documented (Aregheore, 2000). The plane of nutrition interferes with the blood metabolites, other constituents in the blood and health status of an animal. Hence, haematological and serum biochemistry assays are necessary to diagnosing nutrient deficiency, physiology and health status of farm animals, especially those kept under native husbandry system (Daramola *et al*., 2005). Considering the nutritional limitations of crop residues as rations for small ruminant particularly in the dry season, this study was designed to determine the effect of feeding unripe plantain peel supplemented with mixed ration of crop residues on the haematological and serum biochemical parameters of West African dwarf (WAD) sheep.

Materials and methods

The experiment was conducted at the sheep and goat unit of the Institute of Agricultural Research and Training, Moor Plantation, Ibadan. Prior to commencement of the experiment, animals were given prophylactic treatments against ecto and endo-parasites. The animals were adjusted to their treatments diets over a 2-week preliminary period, which was followed by 84-day feeding trial. Sixteen WAD female sheep with the average live weight of 8.10 ± 0.16 kg were randomly allotted to individual pens and to one of four treatment diets in a complete randomized design with four animals per replicate.

Feeding and collection of blood

Crop residues as indicated in Table 1 (Diet 1 to Diet 4) were offered separately to individual animals at 3% body weight at 08:00 h. Unripe plantain peel was offered to all the sheep at 2% body weight at 16:00 h. Provision was made for a daily feed allowance of 10% above the previous week's consumption. Clean water was served *ad libitum*. At the end of the feeding trial, two sets of blood samples (approximately 10 ml) were collected from each sheep through jugular vein puncture using a 10 mL syringe fitted with a needle before feeding. Blood, 5 mL, was drawn into labelled heparinized tubes to prevent coagulation for determination of haematological parameters. The remaining 5 mL blood sample for serum analysis was drawn into EDTA free bottles, allowed to coagulate at room temperature and centrifuged for 5 min at 3000 rpm. The supernatant sera were then stored in a freezer for subsequent biochemical analysis.

Table 1: Ingredient composition of the experimental diets

Ingredients (kg)	Diet 1	Diet 2	Diet 3	Diet 4
Dried corn cob	53.0	-----	------	-----
Palm kernel sludge	30.0	30.0	30.0	30.0
Soya bean hull	12.0	12.0	12.0	12.0
Dried cassava peel	----	53.0	-----	-----
Groundnut haulm	----	---	53.0	------
Cowpea husk	----	---	------	53.0
Gliricidia sepium	4.5	4.5	4.5	4.5
Salt	0.5	0.5	0.5	0.5
Total	**100**	**100**	**100**	**100**

Chemical and statistical analyses

Dried samples of the experimental diets (crop residues) and unripe plantain peel were analyzed according to the standard proximate procedures (AOAC, 2000). The packed cell volume (PCV) was estimated by the method of Jain (1993) and hemoglobin (Hb) concentration according to the method of Schalm *et al*. (1975). Red blood cell (RBC), total white blood cell count (WBC) and differential WBC counts were determined using the Neubauer hemocytometer counting chamber. Serum total protein and albumin were determined by the method of Peters *et al*. (1984) and globulin according to Coles (1986). Blood urea nitrogen (BUN) and glucose were determined by an enzymatic colorimetric method (Helmut and Yvette, 1959). Creatinine was determined by the method of Bonsnes and Taussky (1945), while cholesterol was determined by the method of Allain *et al*. (1974). Data were subjected to analysis of variance (ANOVA) for completely randomized design. Least significant difference (LSD) statistics were used to detect significant differences among means at $p< 0.05$.

Table 2: Proximate composition (g/100g DM) of experimental diets and unripe plantain peel

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	Plantain peel	SEM
Dry matter	86.11^{e}	88.50^{b}	88.35^{c}	89.43^{a}	87.17^{d}	0.30
Crude protein	5.20^{e}	15.34^{b}	14.82^{c}	17.33^{a}	5.42^{d}	1.39
Crude fibre	31.66^{a}	27.88^{c}	21.86^{d}	29.13^{b}	16.88^{e}	1.43

Ash	5.78[b]	4.71[c]	4.30[e]	5.90[a]	4.37[d]	0.18
Ether extract	1.06[e]	2.94[c]	2.85[d]	3.66[a]	3.20[b]	0.23
Nitrogen free extract	56.30[b]	49.13[d]	56.17[c]	43.98[e]	70.13[a]	2.88

[abcd]= Means on the same row with different superscripts are significantly different (p<0.05)

Table 3: Haematological parameters of West African dwarf sheep fed mixed ration of crop residues and unripe plantain peel

Parameter	T1	T2	T3	T4	SEM	P-value
PCV (%)	33.00[b]	43.50[ab]	45.00[ab]	52.00[a]	3.00	0.1517
Hb (g/dL)	10.65[b]	14.20[ab]	14.65[ab]	16.95[a]	1.00	0.1550
RBC (x10^6 µL)	11.79[b]	12.84[ab]	13.29[ab]	14.25[a]	0.39	0.1369
WBC (x 10^3 µL)	7.40	8.43	6.65	6.55	0.04	0.4049
Lymphocyte (%)	63.50	62.00	59.50	61.00	1.29	0.7937
Neutrophils (%)	32.50	33.50	34.00	35.00	1.14	0.9206
Platelets (10^3/µL)	156.0[bc]	184.0[ab]	122.0[c]	216.5[a]	12.04	0.0071

[abc]= Means on the same row with different superscripts are significantly different (p<0.05)
PCV= Packed cell volume; Hb= Haemoglobin; RBC= Red blood cell; WBC= White blood cell.

Results and Discussion

The results of haematological and serum parameters of WAD sheep fed unripe plantain peel supplemented with crop residue mixtures is presented in Table 3. The packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC) and platelets differed (p<0.05), while the WBC, lymphocyte and neutrophils were similar (p>0.05) across the treatments. Unlike the range of values of PVC (33.00-45.00%) and Hb (10.65-14.65 g/dL) for sheep fed diets 1, 2 and 3, respectively, the PCV and Hb values of sheep fed diets 4 (52.00 % and 16.95 g/dL) were above the normal reference values (27-45% and 9-15 g/dL) for sheep (Radosti *et al*., 2006). However, the values of RBC, WBC, lymphocyte, neutrophils and platelets across the treatments fell within the normal reference values reported (Radosti *et al*., 2006) for sheep. Except for the higher values of PCV and Hb of sheep fed diet 4, other haematological parameters agree with the findings of Ogundipe and Akinlade (2016) for WAD sheep fed a basal diet of cassava peel supplemented with fresh *Gliricidia sepium* leaves.

Table 4: Serum biochemical parameters of West African dwarf sheep fed mixed ration of crop residues and unripe plantain peel

Parameter	T1	T2	T3	T4	SEM	P-value
Total protein (g/dL)	9.61[a]	9.06[ab]	8.68[b]	9.78[a]	0.17	0.0644
Albumin (g/dL)	2.69[b]	2.42[b]	2.49[b]	4.36[a]	0.28	0.0132
Globulin (g/dL)	6.92	6.64	6.19	5.42	0.28	0.2665
Cholesterol (mg/dL)	22.39	15.50	22.16	16.14	1.35	0.0988
Glucose (mg/dL)	32.68[c]	94.83[a]	41.38[c]	61.21[b]	7.32	<.0001
Creatinine (mg/dL)	1.55	1.80	2.00	1.45	0.12	0.3934
BUN (mg/dL)	23.49	20.62	21.48	20.89	0.53	0.2191

[abc]= Means on the same row with different superscripts are significantly different (p<0.05)
BUN= Blood urea nitrogen

Serum protein, albumin, and glucose differed ($p<0.05$) across the treatments, while the cholesterol, creatinine and BUN levels were not ($p>0.05$) different (Table 4). Total serum protein was above the normal range (6.0–7.9 g/dL), ditto the albumin (4.36 g/dL) of sheep fed diet 4, as reported by Mitruka and Rawnsley (1977) for healthy sheep. Serum glucose values of sheep fed diets 2 and 4 fell within the normal range (55.0-131.00 mg/dL) reported by Mitruka and Rawnsley (1977). However, the values of cholesterol were below the normal range (50.00-140.00 mg/dL) (Mitruka and Rawnsley, 1977). The low level of cholesterol is an indication that crop residues based diets are low in water soluble carbohydrate and energy, which could lead to deposition of fats in tissues. Although the values of BUN in this study differed from serum urea values (12.68-17.02 mg/dL) reported by Jiwuba *et al*. (2017), the range of creatinine (1.45-2.00 mg/dL) fell within the creatinine levels (1.61-1.89 mg/dL) for WAD sheep (Jiwuba *et al*., 2017). All the results obtained implied that the experimental diets had no deleterious effect on the health status of WAD sheep.

Conclusion

The haematological and serum biochemical parameters of WAD sheep fed unripe plantain peel supplemented with crop residues fell within the normal reference values for apparently healthy sheep. Therefore, unripe plantain peel supplemented with crop residue based concentrate can be fed to WAD sheep to reduce dry season feed crisis without any detrimental effect on nutritional and health status of the animal.

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Influence of Ficus Leaf Meal Based Diet on Some Blood and Rumen Metabolites of Growing Bunaji Bulls

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Abstract
A study was conducted to evaluate the influence of inclusion of *Ficus thonningii* leaf meal (FTLM) in a CSC based diet for growing Bunaji bulls on some rumen metabolites. FTLM was included at 0 and 10, 20 and 30 % in the diets. The pH values observed in the rumen fluid was similar (P>0.05) across dietary treatments. Rumen ammonia nitrogen and total volatile fatty acid (TVFA) were higher (P<0.05) at 0 and 10 % inclusion levels as compared to 20 and 30 % inclusion levels. Blood urea nitrogen (BUN) was highest (P<0.05) at 30 % inclusion level (3.87 mmol/L) compared to 0% inclusion level (1.83 mmol/L). Creatinine level was also highest (P<0.05) in 30 % FTLM (55.00 µmol/L), while glucose level was highest (P<0.05) at 10 % inclusion level (7.13 mmol/L). Inclusion of FTLM in the diet of growing Bunaji bulls up to 10% has no any detrimental effect on some of rumen and blood metabolites.

Keywords: Bunaji bull, blood profile, *Ficus thonningii*, rumen indices, cotton seed cake.

Introduction

Leaf meal of browse trees and shrubs, when used as supplement, offers a good source of easily digestible and extractable protein (Iyayi, 1991). Apart from the protein, they contain 2-8 per cent fatty acids, which play an important role in ruminant nutrition. Browse fodder trees or shrub form an integral part of tropical and sub tropical farming system (Smith, 1993). Ficus species belong to the family Moraceae. The characteristic of this family have been described by Keay *et al.* (1964) but the main features include possession of latex, alternate leaves, paired stipules, minute flowers crowded in highly specialized inflorescences. The proximate analysis of the leaves of some Ficus species in northern Guinea Savannah of Nigeria to range from 8.9 to 25.9% (Abdu *et al.,* 2012). Abdu *et al.* (2012) reported significant effect of *F. sycomorus* leaf meal supplementation on voluntary feed intake, nutrient digestibility and nitrogen balance in Yankasa bucks. Majority of work reported on Ficus has been on (Bamikole *et al.,* 2001), goats (Abdu *et al,.* 2012) and (Bamikole *et al.,* 2001) on WAD goat and rabbit (Jokthan *et al.,* 2003). These works have revealed the potentials of Ficus as dry season feed but there is scanty information on the use of Ficus foliage for feeding cattle in literature. The aim of this work was to evaluate some blood and rumen metabolites in Bunaji bulls fed *F. thonningii* leaf meal.

Materials and Methods

The study was conducted at the National Animal Production Research Institute, Ahmadu Bello University, Zaria. It is located within the northern Guinea Savannah zone of Nigeria at latitude 11^0 09' 06'' N, longitude 7^0 38' 55" and altitude of 706m above sea level (E-trex legent GPS instrument, 2016). Twelve growing Bunaji bulls, between the age of 12 and15 months and with an average body weight of 150kg,were randomly grouped into four groups of three animals per group, and each group were assigned randomly to one of four dietary treatments. The dietary treatments consisted of inclusion levels of FTLM at 0, 10, 20, and 30 percent in a concentrate diet and fed at 1.5% of their body weight in addition, they were fed basal diet of D. Smutsii hay adlibitum at two instalment. The experiment lasted for 90 days. The ingredient and chemical composition of the feeds is shown in (Table 1).Rumen fluid samples were collected, strained through double layers of cheese cloth and stored in plastic bottles containing equal quantity of 0.1N H_2SO_4 to trap the ammonia. Immediately after collection, temperature and pH were recorded using digital hand thermometer and Henna Digital Hand pH meter (model 9409). The rumen ammonia concentrations were determined by simple micro-Kjeldahl distillation (AOAC, 2005). Total volatile fatty acids were determined by gas chromatography (Cottyn *et al.,* 1968).

Table 1: Gross and Chemical composition of supplementary concentrate diets, *D. smutsii* and *F. Thonningii*

Ingredients	Inclusion levels of *FTLM (%)*				*D. smutsii*	*F. thonningii*
	0	**10**	**20**	**30**		
Maize offal	76.53	67.37	58.23	48.93		
Cotton seed cake	2.47	1.63	0.77	0.07		
FTLM	0	10	20	30		
Wheat bran	10	10	10	10		
Rice bran	5	5	5	5		
Poultry litter	5	5	5	5		
Salt	1	1	1	1		
Total	100	100	100	100		
Dry matter	93.86	93.81	93.40	93.83	94.42	89.29
Crude protein	15.25	16.63	15.13	15.00	7.88	13.69
Ether extract	9.60	4.42	8.43	6.74	3.61	16.11
Ash	6.62	5.61	7.15	6.74	4.56	12.52
Neutral detergent fibre	41.72	43.63	45.75	46.66	68.43	38.05
Acid detergent fibre	16.69	22.64	25.58	28.28	47.32	37.95
Cellulose	13.56	18.74	17.88	22.16	41.82	11.75
Hemicellulose	25.03	20.99	20.17	18.38	21.11	0.10
Lignin	3.13	3.90	7.70	6.12	5.50	26.20

FTLM=*Ficus thoningii leaf meal*

Blood samples were collected from three animals in each of the treatment groups using Hyperdemic Syringe for the determination of serum biochemical indices (blood glucose GL, total protein TP, urea nitrogen BUN and creatinine). TP were determined using refractometer (Cole, 1974) BUN by Diacetylmonoxime method with the use of a commercial kit (Stanbio-urea nitrogen kit, procedure number 580, Stanbio Laboratories) as reported by Kiran and Mutsvangwa (2007). Creatinine was determined using the modifying method of (Valley *et al.*, 1980), GL concentration is the difference between Albumin and TP All data obtained from the study were subjected to analysis of variance (ANOVA) using SAS (2008). Duncan Multiple Range Test of SAS was used to separate treatment means. The statistical model for the experiments was as follows: $Y_{ijk} = \mu + B_i + e_{ijk}$

Results and Discussion

The results of some blood metabolites of growing Bunaji bulls are presented in Table 2. The Blood urea nitrogen (BUN) was highest (P< 0.05) in 30 % inclusion level (3.87 mmol/L), followed by the 10 and 20% FTLM (2.97 and 2.77mmol/L, respectively), which were similar and the least was in 0% inclusion level (1.83mmol/L). This can be attributed to slow solubilisation of cotton seed cake. The values reported are within the normal range for healthy animals. This indicates that there was generally optimum BUN concentration for all the diets, which implies that there were efficient nitrogen metabolic transaction in the rumen. Animals fed diet with 30 % inclusion level of FTLM had significantly (P< 0.05) lower total blood protein (5.27 g/dL) compared to those fed 0, 10 and 20 % inclusion levels (5.60, 5.73 and 5.73 g/ dL, respectively). The low value observed in animals fed higher inclusion level of FTLM can be attributed to inefficiency of nutrient (protein) utilization by the animals. Fasae *et al*.(2011) reported similar result in West African Dwarf goats, which was attributed to the tannin content. Animals fed diet with 10 % inclusion level of FTLM had significantly (P < 0.05) higher blood glucose level (7.13 mmol/ L) compared to those

Table 2: Effects of inclusion levels of *F. thoningii leaf meal* on some blood metabolites of growing Bunaji bulls

Parameters	Inclusion levels of FTLM				SEM /LOS
	0	10	20	30	
Total protein (g/ dL)	5.60[a]	5.73[a]	5.73[a]	5.27[b]	0.16*
Blood urea N (mmol/ L)	1.83[c]	2.97[b]	2.77[b]	3.87[a]	0.35*
Creatinine (umol/ L)	31.67[b]	36.33[b]	38.33[b]	55.00[a]	3.70*
Glucose (mmol/ L)	3.17[b]	7.13[a]	2.90[b]	4.27[b]	0.79*

[a,b,c]Means with different superscripts in each row differed significantly (*P*< 0.05) , LOS= Level of significant

fed higher inclusion levels of FTLM. The glucose in the blood of animal is an important source of energy and metabolic intermediates (Galliot,1995). The glucose value was high at 10% inclusion level while the inclusion levels at 0%, 20% and 30% were similar which supports the observation by Russel and Wright (1983) that blood glucose level is a poor indicator of nutritional status due to its sensitivity to stress and insensitivity to nutritional change. The creatinine level of the bulls was significantly (P < 0.05) higher (55.00 umol/ l) at the highest inclusion level (30 %) compared to 0, 10 and 20 % inclusion levels, (31.67, 36.33 and 38.33 µmol/L, respectively). The higher creatinine concentration observed at 30 % inclusion level suggests increased muscle mass catabolism and level of physical activity in the animals. Previous study documented that creatinine levels may indicate proper physiological status of kidneys in goat (Ismartoyo *et al*., 1993).Table 3 presents the effects of varied inclusion levels of FTLM on some rumen induces of growing Bunaji bulls. There was no significant (P>0.05) difference in rumen pH across the treatment groups. The concentration of ammonia nitrogen was significantly (P<0.05) reduced in animals fed 20 and 30 % levels of FTLM as compared to those fed 0 and 10 % levels of inclusion which might be due to reduced proteolytic activity in the rumen of bulls fed 20 and 30 % levels of *Ficus* inclusion. Min *et al*. (2002) reported a similar result in *L. corniculatus*, a plant rich in condensed tannin, that it markedly reduced rumen proteolytic activity and rumen ammonia concentration in sheep. Bermingham *et al*. (2001) found a decreased ammonia nitrogen concentration in sheep rumen fed Sainfoin leaves which contained 38 g CT/ kg DM. The total volatile fatty acids concentration followed the same trend. The variation observed in TVFA in this study might be due to variations in the type and concentration of tannins present in the test materials. Similar observation has been reported by (Makkar *et al*., 1995) in animal fed quabracho tannins, but Getachew *et al*. (2008), however, reported lower VFA production by adding condensed tannin in batch culture of mixed rumen microorganisms.

Table 3: Effect of inclusion levels of *F. thonningii* leaf meal on some rumen indices of growing Bunaji bulls

Parameters	Inclusion levels of FTLM				SEM/LOS
	0	10	20	30	

pH	6.77	6.82	6.86	6.84	0.04^{NS}
Temperature ^{o}C	25.16^{b}	25.84^{a}	25.08^{c}	25.16^{b}	0.20*
NH_3 – N (mg /L)	6.67^{a}	6.56^{a}	6.04^{b}	5.92^{b}	0.18*
TVFA (mmol /L)	26.67^{a}	26.25^{a}	24.17^{b}	23.67^{b}	0.74*

^{a,b,c}Means with different superscripts in each row differed significantly ($P< 0.05$) TVFA=Total volatile fatty acid NH_3-N=Ammonia nitrogen NS=Not significant, LOS=level of significant

Conclusion

From the result of this study, it can be concluded that inclusion of FTLM in the diet of growing Bunaji bulls up to 10% has no any detrimental effect on some of rumen and blood metabolites studied. Therefore, 10% FTLM can be included in the diet of growing Bunaji bulls.

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PERFORMANCE EVALUATION AND COST IMPLICATION OF WEST AFRICAN DWARF BUCKS ON FIVE HOUSING PATTERNS

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Abstract

An experiment was conducted to evaluate the effect of five novel housing patterns on growth performance, carcass characteristics of WAD goats and the cost of building these structures. Five housing patterns designated T_1CH, T_2ZH, T_3MH, T_4BH and T_5TH were erected and served as treatments (T_1 - T_5). Twenty West African dwarf bucks were divided into five (5) groups of four animals each. Each group was assigned to one of the five treatments (housing pattern) in a completely randomized design. The experiment lasted 56 days. Data on growth parameters and cost was collected. Investigations revealed that housing patterns significantly ($P < 0.05$) affected weight gain (1.06, 1.58, 0.99, 1.38 and 1.40kg for T_1CH – T_5TH respectively).Feed intake (1945.00, 1957.00, 1934.00, 1934.00 and 1954.00g for T_1 – T_5 respectively). Feed conversion ratio (1.83, 1.24, 1.95, 1.47 and 1.59 for T_1CH, T_2ZH, T_3MH, T_4BH and T_5TH respectively). There were significant ($P < 0.05$) differences among treatments for the parameters on cost analysis except cost of feed consumed and output/unit cost of housing. On the average, bamboo housing pattern (T_4BH) comparatively yielded lower cost in all the parameters and also had the best output/unit cost. It can be concluded that goats on bamboo housing pattern (T_4BH) performed better and can easily be adopted by small holder farmers.

Key words: WAD bucks, cost, hosing patterns, performance,

INTRODUCTION

Animal protein consumption in Nigeria and other developing countries has been reported to be comparatively low (Ayorinde and Aromolaran, 1998). The average Nigerian consumes about 54 grams of protein per day, with 6.5 grams coming from animal sources. This is a far copy from the recommended daily protein intake of 80 grams with 28 grams derivable from animal protein (FAO, 1985). The West African dwarf goat is most prevalent in the hot humid forest zone of southern Nigeria. Its relative tolerance to excessive humidity and trypanosomiasis which are important factors in animal production in the forest zone, singled it out as a breed of choice (Odoemelam, 2012). Akusu and Ajala (2000) noted that West African dwarf is early maturing, prolific and a non - seasonal breeder.

In most parts of the tropics, goats lack a proper housing pattern and this may invariably contribute to the reduced performance of West Africa dwarf goats together with poor feeding leads to a staircase growth pattern (Davies and Onwuka, 1993). However, there is dearth of information on some novel housing patterns which are affordable besides providing comfort to the animals. This research therefore evaluates the effects of five housing patterns on growth performance and carcass characteristics together with cost implication of the housing patterns.

MATERIAL AND METHODS

The study was carried out at the Akwa Ibom State University, Obio Akpa Campus. Obio Akpa is located between latitude 5^0 17^1N and 5^0 27^0N between longitude 7^0 27^1N and 7^0 58^1E with an annual rainfall ranging from 3500mm - 5000mm and average monthly temperature of 25^0C. Akwa Ibom is a coastal state, lying between latitude 4^0 28^1N and 5^0 3^1N and between longitudes 7^0 27^1E and 8^0 20^1E with a

relative humidity between 60 - 90%. It is in the tropical rainforest zone of Nigeria. Five different housing systems were built to accommodate the experimental animals. Housing unit 1 was made up of concrete block walls, cemented floor and zinc roof. Housing unit 2 was constructed with zinc roof, zinc walls and earthen floor. A building with thatch roof, mud walls and earthen floor was housing unit 3. Housing unit 4 was built with bamboo walls, tarpaulin roof and earthen floor while the last unit had thatch walls, thatch roof and earthen floor. All these housing units measured 3m x 4m each. The five housing systems were used as treatments as follows; T_1CH – Concrete house, T_2ZH - Zinc house, T_3MH – Mud house, T_4BH – Bamboo house, T_5TH – Thatch house.

Twenty (20), five months (20 weeks) old weaner goats (10 bucks and 10 does) of average initial body weight of 8.62kg and 10.25kg respectively of the West African Dwarf (WAD) type commonly reared by small-holder livestock owners were used for the experiment. These animals were dewormed and treated against ectoparasites. The goats were randomly assigned to each of the five housing units, designated as T_1 – Concrete house (CH), T_2 – Zinc house (ZH), T_3 – Mud house (MH), T_4 – Bamboo house (BH) and T_5 – Thatch house (TH) respectively in a Randomized complete block design (RCBD). The animals were allowed to come out on daily basis to exercise themselves in a paddock (25m x 25m) from 7.30 – 9.00a.m. Four forages were combined in the ratio 1:1:1:1 and offered to the animals in their respective housing units. These forages included *Andropogon tectorum, Aspilia africana, Panicum maximum,* and *Gmelina arborea*. Clean fresh water and salt licks (TANLICK®) were provided *ad libitum.* Feed offered and refused were recorded on daily basis. Average weekly weight gains were computed

Statistical Analysis

The data collected were subjected to analysis of variance procedures. Significant means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Table 1 shows the performance of WAD goats raised under five different housing systems. The results from this study showed significant ($P<0.05$) differences for performance parameters such as final weight, feed intake and daily weight gain. There were significant ($P<0.05$) differences in final weights of goats in all the housing patterns with the highest weight (11.63kg) recorded in bamboo housing pattern. Values for daily feed intake were similar across all the housing patterns. For feed conversion ratio, zinc house recorded the least followed by bamboo housing pattern (1.41).

TABLE 1: Growth Performance of West African dwarf goats under five housing patterns

Parameters	T_1 (CH)	T_2(ZH)	T_3(MH)	T_4(BH)	T_5(TH)	SEM
Initial weight(kg)	8.62	10.00	10.13	10.25	9.75	630.81
Final weight (kg)	9.68^{c}	11.58^{a}	11.12^{b}	11.63^{a}	11.15^{b}	566.86
Weight gain (kg)	1.06^{c}	1.58^{b}	0.99^{d}	1.38^{a}	1.40^{a}	316.36
Daily feed intake (g)	34.73	34.95	34.53	34.69	34.73	62.78
Feed intake (g)	1945.00^{b}	1957.00^{a}	1934.00^{c}	1934.00^{c}	1954.00^{a}	351.67
Daily weight gain (g)	18.93^{c}	28.21^{a}	17.68^{c}	24.648^{b}	25.00^{b}	0.00
F C R	1.83	1.24	1.95	1.41	1.59	0.57

$^{a-d}$ means in same row with different superscripts are significantly different ($P<0.05$). SEM: Standard error of mean, T_1 (CH) – Concrete house, T_2 (ZH) – Zinc house, T_3 (MH) – Mud house T_4 (BH) – Bamboo house, T_5 (TH) – Thatch house

Table 2 shows the cost implication of West African dwarf goats reared under five housing patterns. Based on cost analysis result, bamboo housing pattern (BH,T_4) recorded a comparable cost/kg weight gain to T_2 (Zinc house), T_3 (Mud house) and T_5 (thatch house).

The observations on cost/ housing unit revealed a significant ($P<0.05$) variation in the values obtained in each of the housing patterns. Bamboo house (T_4), had the least value (₦2025.00) while T_2 (Zinc house) recorded the highest value. The high cost of production obtained in zinc house may be due to high cost/kg weight gain and high cost / housing pattern (Odunsi and Iji, 2009).

However, the output/unit cost of housing indicates numerically that bamboo house (BHT_4) recorded a lower value when compared to other housing patterns signifying that it is cheaper to raise goats .

TABLE 2: Cost implication of West African dwarf goats in five housing patterns

Parameters (₦)	T_1 (CH)	T_2 (ZH)	T_3 (MH)	T_4 (BH)	T_5 (TH)	SEM
Cost/kg of feed	3.85	3.85	3.85	3.85	3.85	0.00.
Cost of feed consumed	7.47	7.55	7.43	7.47	7.51	1.58
Cost/ kg weight gain	7.05^b	4.78^d	7.51^a	5.41^c	5.36^c	2.24
Cost / housing unit	14300.00^a	15175.00^a	2662.50^b	2025.00^d	2312.50^c	0.00
Cost of production	7.47^b	7.55^a	7.43^c	7.46^b	7.31^c	2.20
Output/unit of cost (kg/₦)	13490.57	9604.43	2689.39	1467.39	1651.79	0.04

$^{a-d}$ means on the same row with different superscripts are significantly ($P<0.05$) different. SEM: Standard error of mean, T_1 (CH) – Concrete house, T_2 (ZH) – Zinc house, T_3 (MH) – Mud house, T_4 (BH) – Bamboo house, T_5 (TH) – Thatch house

CONCLUSION

From the findings of this research, it can be concluded that bamboo housing pattern had the highest weight gain and the least cost of production. Therefore, it should be adopted as the most productive and affordable housing for West African Dwarf goats.

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CHEMICAL COMPOSITION AND DEGRADABILITY CHARACTERISTICS OF SIGNAL GRASS *(Brachiaria decumbens)HAY*

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ABSTRACT

Three ruminally fistulated Balami rams were used to evaluate the nutritive value of signa (*Brachiaria decumbens)* grass harvested in the 1st 3 months from northern Guinea Savannan using the *In Sacco* degradability method. The grass was incubated for periods of 6, 12, 18, 24, 36, 48, 72 and 96 hrs and the result of the proximate analysis varied with highest 11.24% in the 1st month and lower 9.54% in the 3rd month. The highest potential degradability (a + b) was in the 1st month which was significantly ($p<0.05$) higher than the 2nd and 3rd months, respectively. The rate of degradation constant (c) was significantly ($p<0.05$) lower in the 1st month (0.03) followed by the 3rd month (0.05) and the highest (0.06) was in the 2nd month. Effective dry matter degradation significantly ($p<0.05$) decreased with increase in outflow rate across the months' time of cutting (harvest) with the 1st month having the highest, followed by the 2nd and the third month. From the result of this study the 1st month had the highest degradation characterizes over the last two months. Signal grass has crude protein content up to 9.54% at 3 months of age which is an indication that it met the minimum requirement of 8% CP for maintenance of ruminant.

INTRODUCTION

The de facto reference method to determine rumen degradability of feed components is the *in situ* nylon bag technique (NBT). Therefore, the use of the *in situ* nylon bags feed evaluation technique developed by Qrskov and McDonald (1979) is an important tool in the measurement of quality of ruminant feeds. The objective of this study was to evaluate the degradation characteristics of signal grass *Brachiaria decumbens* grass for the first three (3) months of growth.

Materials and Methods

The research was done at the pasture land of Livestock Teaching and Research of the Federal Polytechnic, Bauchi. The average rain fall is between 700mm to 1300mm with temperature range of 25^0 to35^0C.

Samples Collection: The *Brachiaria decumbens* grass (leaves) harvested for the 1st three (3) months were used in this study. It was then oven diet at 105^0C per 24h to constant weight and ground to pass through a 1.0mm sieve.

In Sacco Procedure

Three cannulated Balami Rams were used for degradability of Signal grass. Nylon bags were numbered with indelible ink for easy identification.

Management and feeding of animals

Three ruminally annulated Balami rams were used for the study. The rams were housed in individual pens with concrete flour bedded with wood shavings. The rams were fed maize offal, cowpea husk and salt lick as supplements on daily basis. Similarly, water was offered *ad libitum* the diets offered increase rumen microbial population to meet their requirement for essential nutrients and also to provide optimum rumen environment for degradability (Njidda *et al*, 2015). Also the area around the cannula was cleaned regularly with warm water and detergent to prevent infection by pathogens.

In sacco DM degradability study

The rate of nutrient disappearance of *Brachiaria decumbens* grass (leaves) was determined with the use of nylon bag technique.

Milled (1.0mm) samples (5g) from each month were placed in the nylon bag tied at the neck with undergradable string and arranged serially. The samples were then inserted into the cannula and incubated in triplicates. A bag was removed from each of the three animals at 6, 12, 18, 24, 32, 48, 72 and 96 hours for the *Brachiaria decumbens* nutrients disappearance. After each withdrawal, the samples were washed under tap water until clear water was obtained and allowed to drip. The bags plus samples were then oven dried at 65^0c for 48hrs and the weight of the bags plus residues measured and recorded. Soluble portion of the feed was determined by weighing 5g of the feed samples into nylon bags in triplicates, it was soaked in warm tap water at 40% for one hour. It was removed and washed under a running tap for 15 minutes in two circles till clear water was obtained. The bags were tied in the Thermofisher oven at 60^0 for 48hrs to constant weight (Orskor *et al*, 1980). The computation of degradability was done using exponential equation as described by (Orskov *et al*, (1980): $P = a+b\ (1 - e^{-ct})$., where p = potential degradability after time 't', a = water soluble fraction (zero hour), b = insoluble but degradable fraction after time, c= rate of degradation of slowly degradable fraction b, t = incubation length ie 6, 12, 18, 24, 32, 48, 72 and 96 hours; e = exponential. The effective ruminal degradability of DM (EDDM) was calculated according to Orskov and McDonald (1979): $EDD = a+bx\ (^{c}/_{c} +K)$ where $k=0.12h^{-1}$

CHEMICAL ANALYSIS

The samples were analyzed in triplicates for dry matter (DM) and crude protein (CP), Ash, E.E. according to AOAC (2002) procedures, Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) according to Vansoest *et al* (1994).

STATISTICAL ANALYSIS

For rumen degradability the NEWAY EXCEL package for processing data from feed degradability and *in-vitro* gas production was used to compute the data obtained (Chen and Gomes, 1992). The dry matter degradability of each sample for the disappearance of dry matter from the bag after incubation and washing loss according to the equation by Orskor and McDonald (1979).

RESULTS AND DISCUSSION

Chemical Composition

The result of the proximate composition is presented in Table 1. The dry matter content of *Brachiaria decumbens* ranged between 92.63% for the third month to 95.64% in the first month which is higher than 90.5% and 91.05% reported by Ibrahim (2014). The range of CP content of 9.54% for the 90 days post-emergence to 11.24% for 30 days post emergency falls within the range of different cut of 10.9 to 13.32% reported by Maja *et al.* (2014). The NDF content (54.25%) in the second month and 56.23% in the 1st month is lower than the range of 68.35 to 69.14% reported by Maja *et al* (2014). The ADF range of 43.63 to 46.39% in the second and first months respectively slightly agrees with 36.32 to 44.99% revealed by Maja *et al* (2014). The variation might be due to variations in species and maturity of the grasses at harvest. Table 3 shows the washing loss fraction which significantly ($p<0.05$) decreases with increased in age with the lowest in the third month (18.42%) while the highest was recorded in the first month (40.01%). This could be attributed to increase in fibre content as the plant grows. The **c** value of *Brachiaria decumbens* grass (0.05) slightly agrees with 0.039 revealed by Bagoro (1997) for sorghum stover. The potential degradability, significantly ($p<0.05$) followed the same sequence with 60.0% as the lowest value in the third month and the highest value of 96.20% in the 1st month . This is not in line with 83 to 87% reported by Andell *et al,* (2012) who compared the degradability characteristics of different forages. The variations also occurred in the actual dry matter disappearance due to differences of age at harvest. This findings agree with Deschamps (1999) that reduction in DM degradability with advanced maturity as the main factor restricting grass utilization in diets of high producing animals. The actual dry matter disappearance (Table 2) of 40.76% to 52.00% at 24hrs incubation 55.12 to 62.2% at 48hrs and 58.8 to 67.33% at 72hrs incubation periods is in agreement with values reported by Luis *et al* (2008) as 42.9 to 52.7% at 24hrs 54.8 to 63.6% at 48hrs and 58.9 to 68.9% at 72hrs incubation period when the authors evaluated the degradability characteristics of Elephant grass at four harvest stages of maturity. Effective DM degradability decreased with increase with age of harvesting in this study.

CONCLUSION

It was observed that *Brachiaria decumbens* grass has CP context of 9.5% at 3 months of age which is an indication that it met the minimum requirement of 8% CP required for maintenance of ruminant animals. The actual dry matter disappearance of 55.12% of incubation period of 48hrs is an indication of good digestible grass.

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Table 1: Proximate analysis of *Brachiaria decumbens* signal grass (2kg IDM)

Months	DM	CP	ASH	EE	ADF	NDF
1	95.64	11.24	8.16	1.12	46.39	56.23
2	93.84	10.16	10.37	1.35	43.63	54.29
3	92.63	9.54	9.28	1.20	44.51	55.39

Table 2: Actual Dry Matter Disappearance (%) of signal grass (*Brachiaria decumbens*) Incubation periods (hrs)

Months	0	6	12	18	24	32	48	72	96	SEM
1	26.04[a]	22.22[b]	34.11[c]	37.00[d]	52.00[e]	57.24[f]	62.23[f]	67.33[g]	73.5[h]	± 6.22
2	20.76[a]	30.12[b]	31.32[c]	36.00[d]	40.76[e]	52.21[f]	58.76[f]	61.11[g]	62.65[h]	± 5.11
3	18.42[a]	29.82[b]	32.62[c]	36.11[d]	43.50[e]	48.33[f]	55.12[f]	58.90[g]	60.00[h]	± 4.78

a,b,c means different superscripts with the same column differ significantly ($p<0.05$)

Table 3: Degradation characteristics and effective degradation of signal grass (*Brachiaria decumbens*) incubated in the rumen of rams.

Months	a	b	a+b	C	SEM
1	46.01[a]	50.19[a]	96.20[a]	0.03[a]	19.65
2	34.30[b]	39.95[b]	74.25[b]	0.06[b]	15.18
3	18.42[c]	41.58[c]	60.00[c]	0.05[c]	13.19

a,b,c means different superscripts with the same column differ significantly ($p<0.05$)

Table 4: Effective degradability (Dry Matter) of Signal grass (*Brachiaria decumbens)* hay calculated at three months different outflow rates.

Months	0.02	0.05	0.08	RSD	SEM
1	43.63[a]	34.26[a]	29.97[a]	3.12[a]	19.65
2	65.17[b]	57.33[b]	52.16[b]	2.23[b]	15.18
3	82.39[c]	71.76[c]	65.94[c]	3.87[c]	13.12

a,b,c means different superscripts with the same column differ significantly ($p<0.05$)

Influence of Chicken and Rabbit manure on the Nutritive quality of *Lablab pupureus, Mucuna pruriens* and *Centrosema pascuorum*

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Abstract

This study was conducted to evaluate the effects of manure type on the proximate composition and fibre fractions of *Lablab pupureus, Mucuna pruriens* and *Centrosema pascuorum* during the rainy season of 2018. A total of 27 experimental plots (3×3 m each) were used for the study. The plots were laid out in a 3 x 3 factorial arrangement such that each unit had one of the 3 leguminous forage planted with one of the manure (control, rabbit, poultry) applied. Each plot was replicated thrice in a completely randomized design. Plant samples were harvested 12 weeks after planting for the determination of their chemical composition. In comparison with other legume studied, *C. pascuorum* had higher ($p<0.05$) Ash, Neutral detergent fibre (NDF) and Acid Detergent Lignin (ADL) content while *L. purpureus* showed higher ($p<0.05$ values for Crude Protein (CP), Nitrogen Free Extract (NFE) and Acid Detergent Fibre (ADF). Dry matter content of *M. pruriens* (86.64%) was also higher ($p<0.05$). Higher ($p<0.05$) values of CP, CF, NDF, ADF and ADL were found in legumes fertilized with either rabbit or poultry manure compared to the control. Application of rabbit manure led to a significant improvement in the DM, CF and fat and CP, and ash content of *M. pruriens* and fat and NDF contents in *L. purpureus*. Therefore application of rabbit manure to legumes understudied is recommended for improved nutritive quality.

Introduction

Ruminant animals rely more essentially on pasture for their nutrient requirement than on any other feed resources (McDonald *et al*., 1995). Legumes such as *Lablab pupureus, Mucuna pruriens* and *Centrosema pascuorum* have been used as feed resources for bovines, sheep and goats due to their high CP content and their highly digestible fibre compared to grasses They are rich in nutrients needed to supplement ruminant livestock in critical period (Ayala Burgos *et al.*, 2003). However, factors such as seasonal variations, poor quality soil have been shown to influence the nutritional quality as well as chemical compositions of forage species, (Sleugh *et al*., 2000). Thus the application of fertilizers and manures have been practised over the years to boost the DM content of the soil and consequently improve the nutritive quality of the legumes planted on them. However inorganic fertilizers are often associated with reduced crop yield, soil acidity and nutrients imbalance (Ojeniyi,2000), thus use of organic manure have been strongly advocated for (Gambara et al., 2002), Hence this study was designed to study the impact of rabbit and poultry manure on the nutritive quality of *Lablab pupureus, Mucuna pruriens* and *Centrosema pascuorum*

Materials and methods

The experiment was carried out at National Biotechnolgy Development agency, Abuja, Nigeria which lies within the latitude 4^0 4^1 and North and longitude 8^0 16^1 East, during the rainy season (August-November) 2018.The experimental land area following conventional tillage operations was cleared and harrowed after it was mapped out. Soil samples were randomly collected at the depth of 0-15 cm using

soil auger. The samples were bulked per replicate, mixed thoroughly and sub samples were taken for analysis to determine their nutrient status.

Experimental design

A total of 27 experimental plots (3×3 m each) were used for the study. The plots were laid out in a 3 x 3 factorial arrangement such that each unit had one of the 3 leguminous forage planted with one of the manure (control, rabbit, poultry) applied. The experimental arrangement was done as follows

L. purpureus + control manure, *L. purpureus* + rabbit manure *L. purpureus* + poultry manure

C. pascuorum + control manure *C. pascuorum* + rabbit manure *C. pascuorum* + poultry manure

M. Pruriens + control manure *M. Pruriens* + rabbit manure *M. Pruriens* + poultry manure

Seeds of *Lablab purpureus, Centrosema pascuorum* and *Mucuna pruriens* were sourced from the National Animal Production Research Institute, Zaria. Prior to seed sowing, there was germinating test to determine the level of the seeds viability. The experimental land area was divided into three equal block each with space of 2 m between them. Each block was divided into individual plot size of 3m × 3m with 1 m between the plots. The manure was applied by broadcasting on the bottom of the seed bed mixed with soil and distributed equally to the entire plot using hand hoe .Two seeds each of the legumes were sown at 0.5 m (inter-row) × 0.5 m (intra-row) with an established planting density of 49 plants/9m^2

At week 12 of planting, legume samples (stem and leaf) were collected from each experimental plots and replicates. The dried forage samples were milled and allowed to pass through a 1mm sieve screen and subjected to proximate analysis (AOAC, 2010) and fibre fraction analysis. Neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) was determined according to Van Soest *et al*. (1991) procedure. Cellulose was calculated as the difference between ADF and ADL while hemicellulose was calculated as the difference between NDF and ADF. Data collected were subjected to Analysis of Variance using SAS (1999) package and the treatment means separated using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

The effect of manure application on the proximate and fibre composition of *M puriens*, *L. purpureus* and *C. pascuorum* is shown on table 1. Compared to other legumes used in the present study, *C. pascuorum* had higher ($p<0.05$) CF, Ash, NDF, ADL contents, *L. purpureus* had higher ($p<0.05$) CP, NFE and ADF contents, while *M puriens*, had higher ($p<0.05$) DM contents. However, there were no differences in the fat content of the legumes considered. This trend observed are in sync with the observations of Agbogidi and Ofuko (2005) who reported that plants respond differently to environmental factors based on their genetic makeup and their adaptation capability. Higher CP content in *L. purpureus* compared to *M. pruriens* in the present study is at variance with the report of Nyambati (2002) who reported that *M. pruriens* had a higher CP content than *L. purpureus* when both legumes were subjected to the same defoliation mode. These variations in observations may be probably attributed to differences in the precipitation received during the year of planting Badr et al. (2005)

Legumes fertilized with either rabbit or poultry manure had higher ($p<0.05$) CP, CF, NDF, ADF and ADL content compared to the control while fat content was not affected ($p>0.05$) by manure application.

Furthermore, application of Rabbit manure led to a significant improvement ($p<0.05$) in the CP, CF, Ash, Fat, NDF, ADF and ADL contents of *L. purpureus;* DM, fat, and ADF content of *M. pruriens*; DM,NFE and NDF content of *C. pascuorum.* The ash content of *M. pruriens* and fat content of *C. pascuorum* were also improved by application of poultry manure. Ash content recorded for the legumes

in the present study is higher than the values of 66.6 and 71.8 g/kg DM reported by Nworgu and Ajayi (2005) which might be because of the manure application. The plants also had CP content higher than the minimum protein requirement of 100 – 120 g/kg DM recommended by ARC (1985) for ruminants

Legume	Manure type	DM	MC	CP	CF	ASH	FAT	NFE	NDF	ADF	ADL

The NDF contents was however higher than the value of 410.9 g/kg DM reported by Mahala *et al*. (2012) which might be due to the higher age at harvest considered in this study as Minson (1990) as earlier reported that fibre constituents of a plant is dependent on its maturity.

In conclusion, the study seem to suggest that rabbit manure is superior to poultry manure with respect to boosting the nutritive quality of the legumes understudied particularly *L. purpureus.*

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Table 1:Effects of manure application on the proximate and fibre compositions (%) of *Lablab pupureus, Mucuna pruriens* and *Centrosema molle*

Main effects											
C. molle		84.92^{b}	15.27^{a}	22.96^{c}	31.44^{a}	10.75^{a}	1.58	18.44^{c}	53.48^{a}	36.50^{c}	5.50^{a}
L.Purpureus		84.76^{b}	15.40^{a}	27.36^{a}	19.72^{c}	8.72^{c}	1.55	27.63^{a}	51.68^{b}	41.93^{a}	4.83^{b}
M. pruriens		86.64^{a}	13.57^{b}	25.34^{b}	26.60^{b}	10.26^{b}	1.55	23.19^{b}	50.98^{c}	39.05^{b}	4.36^{c}
	control	85.50^{b}	14.67^{b}	24.93^{b}	22.92^{c}	10.77^{a}	1.47^{b}	25.77^{a}	51.06^{c}	36.05^{c}	4.17^{c}
	Poultry	84.47^{c}	15.76^{a}	25.31^{a}	24.77^{b}	8.23^{c}	1.54^{ab}	24.84^{b}	51.21^{b}	40.84^{b}	5.05^{b}
	Rabbit	86.34^{a}	13.82^{c}	25.42^{a}	30.07^{a}	10.74^{a}	1.68^{a}	18.65^{c}	53.87^{a}	40.58^{a}	5.47^{a}
Interaction											
C. molle	Control	83.02^{f}	17.16^{a}	24.94^{d}	28.60^{d}	17.61^{a}	1.69^{b}	10.51^{i}	52.98^{c}	33.08^{f}	4.21^{d}
	Poultry	84.75^{e}	15.51^{b}	22.43^{f}	34.61^{b}	6.05^{h}	2.09^{a}	19.75^{f}	50.33^{e}	40.09^{d}	5.31^{b}
	Rabbit	87.00^{b}	13.13^{e}	21.52^{g}	31.11^{c}	8.59^{f}	0.94^{c}	25.06^{e}	57.14^{a}	36.32^{e}	6.99^{a}
L. purpureus	Control	87.02^{b}	13.13^{e}	24.54^{e}	19.56^{g}	5.58^{i}	1.57^{b}	36.08^{a}	50.69^{d}	42.35^{b}	4.75^{c}
	Poultry	82.75^{f}	17.46^{a}	28.06^{b}	18.61^{h}	6.55^{g}	1.03^{c}	28.69^{c}	50.15^{e}	41.12^{c}	4.34^{d}
	Rabbit	84.50^{e}	15.63^{b}	29.48^{a}	20.99^{e}	14.04^{b}	2.07^{a}	18.12^{g}	54.19^{b}	42.32^{b}	5.39^{b}
M. pruriens	Control	86.46^{c}	13.72^{d}	25.30^{c}	20.60^{f}	9.13^{e}	1.14^{c}	30.71^{b}	49.50^{f}	32.71^{g}	3.54^{e}
	Poultry	85.93^{d}	14.30^{c}	25.45^{c}	21.10^{e}	12.08^{c}	1.49^{b}	26.07^{d}	53.16^{c}	41.32^{c}	5.50^{b}
	Rabbit	87.52^{a}	12.70^{f}	25.26^{c}	38.10^{a}	9.58^{d}	2.02^{a}	12.78^{h}	50.28^{e}	43.10^{a}	4.04^{d}
SEM											
Legume type		0.48	0.49	0.44	1.37	1.18	0.16	2.47	0.73	0.94	0.29
Manure applied		0.52	0.52	0.69	2.13	1.2	0.15	2.33	0.67	0.95	0.27
Legume type × manure applied		0.12	0.11	0.1	0.08	0.09	0.11	0.08	0.08	0.09	0.11
P-value											
Legume type		*	*	*	ns	*	*	*	*	*	*
Manure applied		*	*	*	ns	*	*	*	*	*	*
Legume type × manure applied		*	*	*	*	*	*	*	*	*	*

[a-i] Means along the same row with different superscripts are significantly ($p<0.05$) different ;SEM=Standard Error of Mean; ;NDF= Neutral detergent fibre; ADF=Acid detergent fibre; ADL=Acid detergent lignin; DM= Dry matter content; CP= Crude protein; EE= Ether extract, CF=Crude fibre, MC=Moisture content, ns=not significant, * signuficant

GROWTH PERFORMANCE OF RED SOKOTO BUCKS FED DIETS CONTAINING VARYING RATIOS OF COWPEA (*Vigna unguiculata*) SHELL AND GMELINA (*Gmelina arborea*) LEAVES

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Abstract
Twenty-five (25) male Red Sokoto goats weighing 10.10±1.65 kg were used to study the effect of replacing cowpea shell (CS) with dried *Gmelina arborea* leaf meal (GL) at 0, 25, 50, 75 and 100 % levels on dry matter intake and live weight changes. The goats were balanced for weight and randomly assigned to five (5) dietary treatments with 5 bucks per treatment in a Complete Randomized Design (CRD). The experimental diets consisted of *Digitaria smutsii* hay and concentrate diet fed at 3 % and 2 % of body weight (BWT), respectively. The feeding trial lasted for 120 days. Results from the feeding trial revealed that *Gmelina arborea* leaf meal had no significant ($P > 0.05$) effect on total dry matter intake. However, the 50 % inclusion level had the best result in numerical terms with dry matter intake 534.19 g/d which translated into higher weight gain of 1.90 kg and ADG of 21.11 g/d. The study showed that dried *Gmelina arborea* leaf meal can be included in the diet of male Red Sokoto goats up to 50 % for best results and that cowpea shells can be completely replaced during critical period of feed scarcity without adverse effects on growth.

Key words: Growth Performance, *Gmelina arborea,* Cowpea shell, Red Sokoto Bucks

Introduction

The adequacy of feeding livestock with the right quality and quantity of forage materials during the long dry season period which could last for 5 to 7 months has always been a source of great concern to livestock farmers, researchers and extension workers in northern Nigeria. In trying to circumvent the constraints of lack of forage materials for livestock during the dry season, a vast array of browse plants have been examined and suitable ones identified for livestock during the critical period of food shortage in the zone (Omokanye *et al*., 2014). Browse plants have great potential as source of high quality nutrient for ruminants, being high in protein, minerals and vitamins (Aye, 2016). In the dry season and to some extent during the raining season, livestock farmers mostly cut and carry *Gmelina arborea* (Roxb) leaf and tender stem/twig for their animals. Earlier studies identified *G. arborea (Gmelina)* as one of the most preferred browse species by small ruminants during the dry season (Abdu *et al*., 2012).

In semi-arid West Africa, crop residues such as cowpea (*Vigna unguiculata*) shell are an important component in the diets of ruminants. In this region, cowpea shells are available especially during the dry season after the seed harvest when feed shortage is at its most acute stage (Solaiman, 2007). The availability of cowpea shell makes it a good source of feed for goats. These residues are however low in nutritional value. Efforts to improve their nutritive value had been through physical and chemical treatment which are costly and hazardous (Doma, 1998). Supplementation with legume residues may therefore be cheaper and less harmful (Akinfemi *et al*., 2009). Solaiman (2007) reported that cowpea residues are considered low in quality nutrient and should be fed to goats along with other forages (such as Gmelina leaves) and concentrate. If used as a sole source of roughage it may limit intake due to its high fibre contents and decreasing protein, minerals and vitamins. *Gmelina arborea* leaves is a good source of plant protein and can be used to supplement cowpea shell protein shortage. Therefore, the

objective of this study was to evaluate the effect of replacing cowpea shell with dried *Gmelina arborea* leaf meal on the growth performance of Red Sokoto Bucks during the dry season in northern Nigeria.

Materials and Methods

The experiment was conducted at the Experimental Unit of the Small Ruminant Research Programme (SRRP) of the National Animal Production Research Institute (NAPRI), Shika, Zaria, Kaduna State. Shika is located in the Northern Guinea savannah zone of Nigeria.

Fresh *Gmelina arborea* leaves were harvested within the premises of Ahmadu Bello Unviersity, main Campus and NAPRI between the months of March and April, 2015. Small branches of *Gmelina arborea* trees were cut, the leaves were manually removed and sun-dried for fifteen (15) days. The dried leaves were ground to about 2 mm in size, bagged and kept in a ventilated room until required for feed formulation. Cowpea shells were obtained as a post harvest waste from the Institute of Agricultural Research (IAR), Ahmadu Bello University, Samaru, Zaria in August 2015. This was further processed by beating the plant materials to smaller particles size for easy handling. The diets were formulated to contain five (5) different replacement levels of cowpea shell with dried *Gmelina arborea* leaves at 0, 25, 50, 75 and 100 %, respectively. Other ingredients in the diet include: maize offal , dried broiler litter, bone meal and table salt (Table 1). The diets were formulated to contain a minimum of 12.00 % CP. *Digitaria smutsii* hay which was used as the basal diet was obtained from the Small Ruminant Research Programme of NAPRI.

Table 1: Ingredient Composition of Diets Containing Varying Levels of Cowpea Shell and *Gmelina arborea* Leaves fed to Red Sokoto Bucks

Ingredients (%)	**T1(0)**	**T2(25)**	**T3(50)**	**T4(75)**	**T5(100)**
Maize Offal	41.30	38.28	38.18	38.28	41.30
Dried Broiler Litter	16.14	16.14	16.14	16.14	16.14
Gmelina Leaf Meal	0.00	10.90	21.84	32.68	40.56
Cowpea Shell	40.56	32.68	21.84	10.90	0.00
Bone Meal	1.50	1.50	1.50	1.50	1.50
Table Salt	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Calculated Nutrient Analysis					
Crude Protein (%)	12.00	12.02	12.09	12.15	12.30
ME (Kcal/ Kg)	2249.00	2247.00	2266.00	2256.00	2256.00

Twenty-five (25) male Red Sokoto goats aged 7 months and weighing 10.10 ± 1.65 kg were used for the experiment. The bucks were allocated to the five (5) dietary treatments (0, 25, 50, 75 and 100 %) replacement levels of cowpea shell with dried *Gmelina arborea* leaves with each treatment replicated 5 times in a Completely Randomized Design (CRD). The animals were individually pen-housed and fed throughout the 120 days experimental periods with concentrate diet at 2 % of body weight once per day at 09:00 hours following cleaning of the pens. The basal diet (*Digitaria smutsii* hay) was offered at 3 % of body weight. Water and mineral salt lick were made available to all the bucks *ad libitum*. The bucks were given prophylactic treatment, consisting of Ivermectin at 200 mg/kg body weight (BWT) against endo - and ectoparasites and Terramycin Long Acting (LA) at 20 mg/kg BWT against bacterial diseases 7 days before the commencement of the experiment. Ivermectin was administered orally into the side of the mouth with a needleless syringe and Terramycin LA was administered intramuscular. The 25 male goats were weighed at the beginning of the experiment and fortnightly thereafter. The fortnightly weights were used to adjust the quantity of feed offered while maintaining the levels of feeding the concentrate and forage, respectively. Left-over feeds (concentrate and forage) were weighed and

recorded to determine the voluntary feed intake. Five (5) litres of water was made available for each buck and refusal was recorded to determine the voluntary water intake.

Results and Discussion

The result of the growth performance of the Red Sokoto bucks (Table 2) showed no significant difference (P> 0.05) in feed and water intake. Also, there was no significant difference (P> 0.05) in concentrate mixture and hay intakes across the treatments. Total dry matter intake ranged from 489.00 g/d in T4 to 534.19 g/d in T3.

Dry matter intake is an important factor in the utilization of feeds and a critical determinant of energy and performance in small ruminant (Abdu *et al*., 2015). The inclusion of *G. arborea* leaves showed no significant difference on DMI. This is in agreement with Goska *et al*. (2008) who reported that forage dry matter intaked not differ due to CP source in supplements when Red Sokoto bucks were fed cottonseed cake, blood meal or their mixtures. The DMI obtained in this study was slightly similar to the 460-673 g/d reported by Osakwe and Udeogu (2007) who fed *Pennisetum purpureum* supplemented with *Gmelina aborea* leaves to West Africa Dwarf (WAD) goats. It appears that the mixture of cowpea shell and Gmelina leaves at 50:50 (T3) was probably more palatable and acceptable to the bucks. The variations observed in feed intake could be as a result of improvement in the protein status of the feed which enhances rumen micro-organism profile and encourage a more rapid and thorough digestion of ingesta leading to assimilation. Okafor *et al*. (2012) reported that inclusion of Gmelina leaves in the diet can help to increase the efficiency of utilization of crop residue (groundnut haulms) by the rumen microbes which resulted in improved weight gain. Lanyasunya *et al*. (2007) in a study in China, reported that increase in intake is attributed to increase in nitrogen in the diet and available fermentable fibre.

Table 2: Feed Intake, Live Weight Changes and Feed Utilization by Red Sokoto Bucks Fed Diets Containing Varying Levels of Cowpea Shell and *Gmelina arborea* Leaves

	Replacement Levels (%)						
Parameters	**T1(0)**	**T2(25)**	**T3(50)**	**T4(75)**	**T5(100)**	**SEM**	**LOS**
Intake (g/d) Dry Matter Basis							
Concentrate Mixture	262.04	265.18	270.33	259.05	219.48	29.253	NS
D.smutsii Hay	244.87	232.29	263.86	229.95	269.70	27.809	NS
Total Dry Matter Intake	506.91	497.47	534.19	489.00	489.18	37.965	NS
Total DMI/$W^{0.75}$ (g/kg $W^{0.75}$)	79.83	83.47	91.63	86.24	80.99	7.823	NS
Live Weight Changes							
Initial Weight (kg)	11.75^{a}	10.80^{a}	10.50^{a}	10.10^{ab}	11.00^{a}	0.789	*
Final Weight (kg)	13.13^{a}	12.50^{a}	12.40^{a}	11.20^{b}	12.25^{a}	0.793	*
Total Weight Gain (kg)	1.38^{b}	1.70^{a}	1.90^{a}	1.10^{d}	1.25^{c}	0.357	*
Average Daily Gain (g)	15.28^{b}	18.89^{a}	21.11^{a}	12.22^{d}	13.89^{c}	1.190	*
Average Water Intake (Litre)	2.30	2.50	2.70	2.10	2.20	0.635	NS
Feed Conversion Ratio	33.17^{b}	26.34^{a}	25.31^{a}	40.02^{d}	35.22^{c}	1.780	*

SEM = Standard Error of the Mean; g = Gram; kg = kilogram; $W^{0.75}$ = Metabolic Weight; NS = Not significant (P > 0.05); LOS = Level of significance; * = Significantly (P < 0.05) different

The concentrate intake increased from T1 – T3 and declined from T4 to T5. This decrease in concentrate intake may be due to the low palatability of the diets containing high inclusion levels of gmelina leaves. This is supported by the report of Okafor *et al*. (2012) who stated that feed intake in goat decreases with increasing inclusion levels of browse plants. The average daily water intake was similar (P> 0.05) across the treatments and it ranged from 2.10 L/d (T4) to 2.70 L/d in T3. There was significant (P < 0.05) difference in all the other parameters measured. The best FCR was obtained at 50 % (T3) inclusion level of *G. arborea* leaves and cowpea shell followed by T2, T5, T1 while the worst value was recorded for T4. The final weights were similar and ranged from 11.20 kg in T4 to 13.13 kg in T1. The ADG were similar across the treatments. The value of ADG was highest in bucks fed T3 diet (21.11 g/d) followed by bucks on T2, T1, T5 (18.89 g/d, 15.28 g/d, 13.89 g/d), respectively while the worst value

was recorded for T4 with ADG of 12.22 g/d. The best FCR was obtained at 50 % inclusion level of *G. arborea* leaves and cowpea shell. This could be attributed to better nutrient utilization of feeds at moderate levels of tannins and crude fibre in the diet. The daily weight gain of bucks on 50 % inclusion level of CS and GL (T3) tended to be higher in numerical terms with DMI of 534.14 g/d which translated into higher weight gain of 1.90 kg and 21.11 g/d.

This might be as a result of slightly higher but not significant DMI, lower ADF and NDF content of the treatment diet. The average daily water intake was similar across the treatments and it ranged from 2.10 L/d (T4) to 2.70 L/d in T3. This was slightly lower than the 3.0 L/d reported by Osuhor *et al*. (2004) for *Yankasa* rams fed a basal diet of maize stover-lablab mixture. The difference may be due to species and live weight differences. The *Yankasa* rams used by Osuhor *et al*. (2004) were heavier than the Red Sokoto bucks in this study. The difference might also be as a result of the lower environmental temperature during this study. This is supported by the report of Schoenian (2003) who stated that water requirement of small ruminants decreased with decreased environmental temperature.

Conclusion

Based on the study, it was concluded that the inclusion of dried *Gmelina arborea* leaf meal as replacement for cowpea shell had a positive effect on dry matter intake and live weight changes.

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PERFORMANCE AND BIOECONOMICS OF FEEDING GROWING WEST AFRICAN DWARF (WAD) GOATS WITH DIFFERENT COPPER SALTS BASED DIETS

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Abstract

Performance and bioeconomics of feeding 20 growing West African Dwarf (WAD) goats with varying levels of different copper salts was studied. The goats were randomly allotted to five dietary treatments, comprising of four goats each, with T_1 (control), T_2 (15 mg Cu/Kg DM of Copper Sulphate), T_3 (20 mg Cu/Kg DM of Copper Sulphate), T_4 (15 mg Cu/Kg DM of Copper Nitrate) and T_5 (20 mg Cu/Kg DM of Copper Nitrate). Performance and bioeconomics parameters of the experimental goats were determined. The results obtained indicates that copper salts had no significant effect ($P>0.05$) on the performance and bioeconomic of the goats. The general poor performance of goats including those on the control diet could be due to unfavourable environmental condition which led to low feed intake and low weight gain of the goats. Poor weight gain could also be due to the fact that, WAD Goats are not used to confinement. The season (rainy season) the research was carried out is associated with several ailments of goats. The weight loss experienced by goats in T_5 could be due to the inability of those goats to withstand the earlier mentioned conditions when compared to those on other treatments (the place of individual difference). Weight loss in T_5 could also be due to unknown reasons. It is recommended that WAD goats should not be totally confined, when carrying out research and that the addition of copper salts to the diets of WAD goats have no economical value.

Key words: WAD Goats, Copper Sulphate, Copper Nitrate, Performance and Bioeconomics

Introduction

The major constraint to ruminant livestock production in the tropics is the unavailability of cheap and quality feedstuffs, especially in periods of drought or dry season. For a greater part of the year, grassland does not supply sufficient minerals and other nutrient to stock for greater productivity. Minerals likely to be highly involved are Magnesium and Copper (McDowell *et al.*, 1977). Research has shown that significant differences exist in mineral metabolism between species (Arnold *et al.*, 1993), even between ruminants (Haenlein, 2004). Copper (Cu) is an essential element required by goats and other animals for a number of biochemical functions (Davis and Mertz, 1987). Dietary Cu, when fed at pharmacological concentrations has been shown to alter lipid metabolism in goats (Solaiman *et al.*, 2006). In the past ruminant's Cu deficiencies have usually been corrected by supplementation with inorganic mineral supplements. Some deficiency symptoms have been identified; however excessive amounts have also been associated with deleterious effects. In view of this, scientists have recognized the need for the inclusion of certain recommended levels of either organic or inorganic Cu salts in animal diets to improve performances. During the last several years, free choice and chelated minerals have become popular for use in free choice mineral supplements.NRC (1980) indicated that sheep are more sensitive

to high Cu supplementation than cattle and goats. Limited research had been done on Cu supplementation in sheep. A lot of work has been done on the use of copper salt, but few reports are available on the comparison of different copper salt. This study is aimed at comparing the effect of different copper salts on the performance of West African Dwarf goats.

Materials and Methods

The Study was conducted at the Sheep and Goat Unit of the Teaching and Research Farm of Kogi State University, Anyigba. The copper salts ($CuSo_4$, and $CuNo_3$) were included at two levels ($CuSo_4$ 0.15%) in T_2, ($CuSo_4$ 0.20%) and T_3, and ($CuNo_3$ 0.15%) in T_4, ($CuNo_3$ 0.20%) in T_5 respectively, while T_1 with no copper salt inclusion serves as the control diet. A total of 20 growing male West African Dwarf goats of about 5-6months, having an average initial weight of 5.85kg were used for this experiment. The goats were randomly allotted in a completely randomized design to five (5) groups of four (4) goats each, having a goat as a replicate. An adjustment period was allowed for the goats before data collection commenced. It addition to feeding the copper-based diets, Northern Gamba grass (*Andropogon gayanus kunth*) was fed to the goats based on cut and carry basis. Data were subjected to one-way analysis of variance (ANOVA) and means that were significantly different were separated by Least Significant Difference (LSD) using SPSS window Version 16 package.

Results and Discussions

From Table 1, all the performance parameters obtained were not significantly (P>0.05) affected by treatments. In agreement with the present findings, Cu supplementation at 10 to 40mg Cu/kg DM did not affect daily weight gain, daily concentrate intake compared with controls in steers (Engle and Spears, 2000a, 2000b; 2001). Mullis *et al.* (2003) found out that Cu supplementation at 7 to 14mg Cu/kg DM did not have significant (P>0.05) affect on the animals. According to Engle and spears (2000b), Cu supplementation to finishing steers at 20 or 40mg Cu/kg DM decreased average daily gain and average daily feed intake as compared to the control diet. Asare-Bediko and Aina (2013) reported that Cu supplementation at 20mg Cu/kg DM to fattening goats did not affect average initial body weights (AIBW) and final body weight (FBW) of the animals. Furthermore, Aina *et al.* (2011) found that Cu supplementation at 20mg Cu/kg DM to West African Dwarf Sheep were not significantly (P>0.05) different, but values obtained for feed intake in the control was higher than those obtained in the other treatments. There are many factors that could affect an animal response to Cu supplementation, such as differences in breed (Mullis *et al.* 2003). Mondal and Biswas (2007)) found out that concentration of Cu supplementation, Cu concentration of the basal diet, the duration and form of Cu supplementation (organic or inorganic), the absence and presence of dietary Cu antagonists (S, Mo, Zn, Fe), initial Cu status of the animal, environmental and health factors affects the utilization of Cu. Arthington and Pate (2002) also reported that Cu supplemental level and the composition of the experimented diet can also affect the animal's performance.

Table 1: Performance Characteristics of Experimental Goats Fed Copper Salts-Based Diet

Parameters	T1	T2	T3	T4	T5	LOS
AIBW (g)	5375±225.00	5600±350.00	6550±50.00	5150±350.00	5550±500.00	NS
FBW (g)	5725±25.00	5900±250.00	6775±25.00	5340±440.00	5395±605.00	NS
TWG (g)	350±250.00	300±100.00	225±25.00	190±90.00	-155±105.00	NS
DWG (g)	16.67±11.91	14.29±4.77	10.71±1.19	9.05±4.29	-7.38±5.00	NS
TCI (g)	2945±195.00	2508±468.00	2815±225.00	1664±696.00	1824±584.00	NS
DCI (g)	140±9.29	119±22.27	134±10.72	79.24±33.14	86.84±27.79	NS
TFI (g)	8393±298.00	7250±1530.0	8265±325.00	7525±885.00	8103±417.00	NS

DFI (g)	399.64±14.17	345.24±72.86	393.58±15.48	358.34±42.15	385.86±19.86	NS
TWI (ml)	4500±500	3340±50.00	3235±1195	3480±1030	2050±1000	NS
DWI (ml)	214.29±23.81	159.05±2.38	154.04±56.91	165.72±49.05	97.62±47.62	NS
TFI (g)	11338±102.50	9758±1062.50	11080±550.00	9189±1581	9927±166.50	NS
FCR	65.71±46.64	37.92±16.18	50.14±8.02	67.44±40.27	-117±78.19	NS

LOS- Level of Significant; NS- Non Significant; AIBW= Average Initial Body Weight; FBW= Final Body Weight; TWG= Total Weight Gain; DWG= Daily Weight Gain; TCI= Total Concentrate Intake; DCI= Daily Concentrate Intake; TFI= Total Forage Intake; DFI= Daily Forage Intake; TWI= Total Water Intake; DWI= Daily Water Intake; TFI= Total Feed Intake; FCR= Feed Conversion Ratio; T1(control, no supplemental Cu); T2(15 mg Cu/Kg DM from Copper Sulphate); T3(20 mg Cu/Kg DM from Copper Sulphate); T4(15 mg Cu/Kg DM from Copper Nitrate) and T5(20 mg Cu/Kg DM from Copper Nitrate).

From Table 2, it can be deduced that, all the bioeconomics parameters were not significantly (P>0.05) affected by the treatments. The highest total feed cost recorded by T_3 is due to the cost of copper salt inclusion, and total concentrate consumed, which is higher than T_2, T_4 and T_5 but lower than that consumed by T_1. The highest Benefit cost ratio recorded by T_4 could mean that, the farmer had a better chance to make more profit. The higher the Benefit cost ratio, the better the investment. The feed conversion ratio was lowest in T_5 (-117±78.19) and highest in T_4. The negative value in T_5 is as a result of weight loss of the experimental goats. Values obtained for gross margin was lowest in T_3 and highest in T_4. The lowest protein and energy efficiency ratio obtained in T_5 and highest in T_2 could mean that the goats in T_2 were more efficient in protein and energy utilization. The higher the protein and energy efficiency, the more efficient the animal and vice versa. This negative value in T_5 is attributed to weight loss of the goats.

Table 2: Economics of Feeding Copper Salts-Based Diet to West African Dwarf Goats

Parameters	T1	T2	T3	T4	T5	LS
FC/Kg (₦)	49.42±0.00	59.10±0.00	63.13±0.00	59.99±0.00	63.33±0.00	NA
FC/Kg G (₦)	3247±2305	2241±956	3115±498	4045±2416	-7410±4952	NS
TVCP (₦)	3192±9.64	3194±27.19	3221±13.98	3146±41.75	3162±37.05	NS
BCR	1.13±0.01	1.13±0.01	1.12±0.01	1.15±0.02	1.14±0.01	NS
TFC (₦)	146±9.64	148±27.63	175±13.98	99.83±41.76	115±36.96	NS
FCR	65.71±46.64	37.92±16.18	50.14±8.02	67.44±40.27	-117±78.19	NS
R (₦)	3600±0.00	3600±0.00	3600±0.00	3600±0.00	3600±0.00	NS
GM (₦)	408±9.64	406±27.19	379±13.98	454±41.75	438±37.05	NS
PER	0.045±0.003	0.157±0.067	0.105±0.017	0.098±0.059	-0.059±0.040	NS
EER	0.000568±0.00	0.000590±0.00	0.000359±0.00	0.000428±0.00	-0.000279±0.00	NS

LS - Level of significantly; NA - Not Analyzed; NS - Non significant; FC/Kg= Feed cost per Kg; FC/Kg G= Feed cost per Kg gain; TVCP= Total Variable Cost of Production; BCR= Benefit Cost Ratio; TFC= Total Feed Cost; FCR= Feed Conversion Ratio; R= Revenue GM= Gross Margin; PER= Protein Efficiency Ratio; EER= Energy Efficiency Ratio; T1(control, no supplemental Cu); T2(15 mg Cu/Kg DM from Copper Sulphate); T3(20 mg Cu/Kg DM from Copper Sulphate); T4(15 mg Cu/Kg DM from Copper Nitrate) and T5(20 mg Cu/Kg DM from Copper Nitrate).

Conclusion

From this study, it was found out that both the performance and bioeconomics parameters of the goats were not significantly affected by Cu inclusion in the diets.

Recommendations

Micro mineral analysis to show the total copper present in the experimental diets should be carried out to prevent copper toxicity. When carrying out research with WAD goats, goats should not be totally confined. Further research is needed to determine the possible roles of copper salts on performance and other physiological parameters of West Africa Dwarf goats. More research should be carried out using different breeds and species of ruminants, fed the experimental based diets, using other levels of inclusions.

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A REVIEW OF DIFFERENT METHODS FOR MITIGATING METHANE GAS EMISSION BY LIVESTOCK

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ABSTRACT

In the atmosphere exists trace gases whose contributions to the blanketing effect are considered significant. They include Nitrous Oxide (N2O), Methane (CH4) and Carbondioxide etc of which methane has the highest potential in warming up of the atmosphere (GWP) than others. wellsprings of methane gas in the atmosphere could be anthropogenic or natural or a combination of both. In nature they occur from decompositions that are anaerobic.The animal agriculture is said to account for nearly 18% of emissions from greenhouse gases induced by humans. There is the existence of many favourable opportunities for methane (CH4) reduction emission from animal agriculture and other gases with greenhouse effect. In a quest to meeting the ever rising animal protein need of both animals and humans globally, there is tremendous rise in the amount of livestock being farmed so is their GHG emissions. Carbon dioxide (CO2) produced by Cattle farming is said to generate more GHGs equated in Carbon dioxide equivalent, than transportation sector. The quest to reduce emissions from greenhouse gas and the necessity of seeking alternative to synthetic antibiotics is of great importance to both the livestock farmer and the environmentalist. Finally this review suggests strategies used for ameliorating anthropogenic livestock methane emissions to the atmosphere.

Keywords: *Diet Modification, Genetic Selection, Feed Additive, Mitigation, and Methane Gas.*

INTRODUCTION

Some of the environmental threats our planet faces today is due to long term changes in climate and temperature patterns known as global climate change. Steinfeld et al., (2006) claims that about 18% of human induced emissions from greenhouse gas is been contributed by livestock production and contributes significantly to the world's environmental problems, although highly inconstant across the world. If man is to counteract climate change, people may have to eat more of vegetable based diets. Regarded as the second-most significant anthropogenic greenhouse gas, methane's global warming ability is more than 25-fold higher than that of CO2 (Thauer et al., 2010). Methane's production represents a significant loss of the total energy in feed 2-15% (Vannevel and Demeyer, 1996).There has been considerable increase in the average temperature and predictions given by the IPCC, (2007), reveals possible rise from 1.8-4°C by 2100. These temperature rises are much greater than those seen during the last century, when average temperature rose only by 0.06°C (0.12°F) per decade (NOAA, 2007). The negative impacts these rises in temperatures may leave could be irreversible and unceremonious.Therefore, ruminal methane reduction is beneficial to both the environmental protectionist and livestock farmer as it felt in long-term sustainable production.This review seeks to:

Revise the Methane emission and its sources,

Evaluate the contribution of livestock's to atmospheric methane, **proffer most efficient and environmental friendly mitigation strategies**.

Methanogenesis is the process by which microbes (methanogens) produces methane. Methane derived from rumen is due to the break down of fibrous feed materials in the digestive system of the animal (EPA, 2006).

Prior to Industrial Revolution, methane levels were kept in safe range by natural sinks. Humans are generating methane a lot faster than the earth can remove them. Through belching, a single sheep is said to emit about 0.7 cubic feet of methane /day, cows are much more of ecological nuisance as nearly 18 cubic feet of methane is expired during each belching into the air/day" (Vannevel and Demeyer, 1996). Thus the need to reduce or control the rate at which methane gas is been produced by livestocks via flatus and through the escape of methane gas from rumen which is associated with global warming. 95% of methane is produced through eructation whereas 5% is produced by flatus of (Nowak, 2004). But this review will concentrate production of methane by livestock and methods of reducing its production.

MITIGATION STRATEGIES.

Methane as one of the final products of ruminal fermentation, techniques for methane reduction would naturally include altering rumen fermentation patterns, since formate and H2 are utilized principally for rumen methanogenesis.There are different mitigation strategies for methane emission they include:

Modification of diet fed to the animals,
selection of animals on genetic basis with higher feed efficiency
Feed additive inhibitor.
Diet Modifications.

Mitigation of methane based on nutrition, rests on three main approaches: selection of ingredients to alter volatile fatty acid (VFA) pattern of production; increased passage rate which alters population of microbes and volatile fatty acid production thus shifting some digestion to the intestines; and feeding better-quality feed to boost milk production for each cow, which will weaken cost of methane required for maintenance energy requirements (Knapp et al., 2014). Less methane is produced in diets rich in carbohydrate as production of propionate will remove H2 from methane production(Mandi, 2014). According to Knapp et al., (2014), the faster feed materials pass out from the rumen, the lower the formation and possibly little to which CH4 emission is produced per quantity of feed. Thus, grinding and pelleting of forages increases passage rate and reduces methane emitted by the animal (Mandi, 2014). Patra 2013, reported that Fat supplementation is efficacious in decreasing production of methane.High rate of digestibility of energy diets results in reduced methane production (Mitsumori and Sun 2008).The quality of forage fed animals can be improved by harvesting or foraging on immature grasses, genetic strains selection or species with higher digestibility e.g [sorghum and midrib of corn] (Knapp et al., 2014).

Genetic selection of animals with higher feed efficiency

Improvement programmes at genetic levels are receiving attention and mitigating enteric methane's production is a potential breeding goal. Differences in choices of plants grazed upon during grazing exhibited by individual animals, rate of rumen digesta retention and host-microbes relationship could be inherited thereby amendable with genetic selection of animals with lower entheric CH4 production on daily basis or dry matter intake basis (Clark, 2013).

Feed Additive Inhibitors:

Organic feed additive

Some chemical additives do not incite long term anti methanogenic potential, has risk of resistance to antibiotics and residual effect. Consequently, the situation provoked an ardent interest in alternatives to chemical feed additives (Yang et al., 2015) which is found in secondary metabolites of plants.

Inorganic feed additives:

Nitrocompounds: Ni-trocompounds reduces rumen methanogenesis 90% in invtro studies (Saengkerdsub et al., 2006) and more than 69% in vivo (Brown et al., 2011).

3-Nitrooxypropanol (3NOP) : Report by Haisan et al., (2014), reveals that 2,500 mg/day of 3-nitrooxypropanol in the feeds of dairy cows that are lactating can lower methane production without any deleterious effect on milk production or dry matter intake.

Nitroethane: Methane was reduced by treatment with propynoic acid by 75.7%, with ethyl-2-butynote by 23.3%, with 2-nitroethanol by 99.3%, and with sodium nitrate by 70.1%. (Zhou et al., 2011)

CONCLUSION

It is no news that the climate of the earth and temperature pattern has, and is changing. The changes seen are said to be caused by some gasses that has the potentials of trapping thermal infrared radiations from escaping from the earth's atmosphere there by resulting in the increase in temperature. Out of the three most important greenhouse gasses (GHG) that is carbon dioxide, nitrous oxide and methane, methane is said to be of most import to both the livestock farmer and the environmentalist as it accounts for about 2-15% loss of total energy generated from feed fed to animals and it's blanketing effect of the atmosphere is about 25 times above that of carbon dioxide. Many of the approaches reviewed for their methane mitigation abilities, are only partially additive. Before an approach is been adopted for reducing enteric methane, considerations of the economic impacts on farm profitability and the existing relationship between enteric methane and other health parameters should be made. If farmers were to adopt changes, the strategies promoted should be neutral in cost and cost effective.

Currently, both organic and inorganic products are employed by farmers to limit CH4 emission. As a result of transient inhibition ability, relatively high cost and residual effects of chemical inhibitors, famers are encouraged to use organic inhibitors which are relatively less expensive, has longer inhibitory effect and no residual effect in animals. Alongside animals that genetically emit less methane proper feeding management plan should be employed.

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PROFITABILITY ANALYSIS OF TWO FORAGE COWPEA VARIETIES AS INFLUENCED BY IRRIGATION INTERVALS AND PHOSPHORUS APPLICATION RATES IN ZARIA-NIGERIA

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Abstract

An experiment was conducted to investigate the profitability of production of two forage cowpea varieties (Sampea 14 and 15) under varying irrigation intervals and phosphorus (P) application rates in Zaria-Nigeria. The experiment was laid out in a 2×3×3 factorial arrangement in a split plot design with three replicates. The treatments consist of combinations of two cowpea varieties, three irrigation intervals and three P levels, respectively. Results revealed that an operating profit margin analysis (OPMA) of 0.6% per 100kg bag of cowpea grains was realized for the two cowpea varieties across all the treatment combinations. An OPMA of 2.17% was realized for the forage of the two cowpea varieties across the treatment combinations except for Sampea 14 harvested from the use of irrigation interval of 5 and 10 days in combination with 20 and 40 kg P/h and Sampea 15 harvested from the use of irrigation interval of 15 days in combination with 40 kg P/ha. The highest OPMA (2.68%) was realized with Sampea 14 harvested from the use of irrigation interval of 5 days in combination with 20 kg P/ha, followed by Sampea 14 (1.30% OPMA) harvested from the use of irrigation interval of 10 days in combination with 40 kg P/ha while Sampea 15 harvested from the use of irrigation interval of 15 days in combination with 40 kg P/ha recorded the least OPMA (0.73%). Therefore, it was concluded that irrigation interval of 10 days in combination with 20 kg P/h could increase forage yield of Sampea 14 by more than 200% and grain yield of the two cowpea varieties by 60%. This will help to better the living standard of farmers under smallholder crop-livestock production system in Nigeria.

Keywords: Forage, irrigation, phosphorus, profitability, Sampea.

Introduction

Feeding of forage legumes has been found easily adoptable, but farmers do not pay particular attention to the planting of pure forage legume stands, rather greater emphasis is on the cultivation of other crops. In an integrated crop-livestock farming systems, planting of dual-purpose legumes is gaining popularity. Apart from its grains that yield immediate economic returns, its fodder is also a good dry season feed supplement to livestock. In the savannas of West Africa, cowpea is a valuable source of livestock fodder making the dual purpose cultivars very attractive to farmers (Kamara *et al.*, 2012). Profitability levels of cowpea grains or fodder vary depending on the quality of the agronomic practices employed. Among these, seed varieties, phosphorus (P) application rates and irrigation frequency are powerful management tools whereby a grower can strongly influence crop productivity and profitability during the dry season. Cowpea can produce good yields of high quality dry matter forage/haulm of up to 10t/ha under irrigation (Lemma *et al.*, 2009) compared to the world average yield of 0.5t/ha (Madamba *et al.*, 2006) and dry fodder yield of 0.23t/ha by Sampea 14 cowpea variety (Bala *et al.*, 2018) under rain fed conditions. Considering the good qualities of this legume crop in the tropical savanna, there is need to investigate the suitable irrigation interval and P fertilization levels that could meet up with profit demands of cowpea famers and offer better opportunity for grains and forage yields to support livestock production during the critical period of the year. The objective of this study was to investigate the

profitability analysis of two forage cowpea varieties as influenced by irrigation intervals and P application rates.

Materials and Methods

The experiment was conducted at the irrigation site of the Institute for Agricultural Research (IAR) Samaru-Zaria and laid out in a 2×3×3 factorial arrangement in a split plot design with three replicates. The treatments consist of combinations two cowpea varieties (SAMPEA 14 and 15), three irrigation intervals (5, 10 and 15 days) and three phosphorus application rates (0, 20 and 40 kg/ha), respectively. Variety and irrigation interval were assigned as the main plots, while the phosphorus application rates was placed in the sub-plots. There were a total of 54 net plots measuring $4m^2$ with 1m inter-row path and watering channels.Irrigation treatment commenced at 3 weeks after sowing. The dry forage yields (cowpea haulms) and grain yield were obtained using a standard procedure of Tarawali *et al*. (1995).The total expenditure used in the production was recorded as the variable cost. The costs for cowpea yields per kilogram were estimated based on the current prices at grains and fodder markets. The financial benefit derived from it was estimated using the farm budgeting tools as follows;

a. Operating profit margin analysis (OPMA) in % = Operating Income (OI) /Total Revenue (TR) × 100
b. Total revenue (TR) in ₦/ha = is the product of average price of cowpea grain and haulm yield.
c. Operating income (OI) = the potential yield (grain and forage/haulm).

Data collected were analyzed using the above farm budgeting tools.

Results and Discussion

The profitability of two forage cowpea varieties as influenced by irrigation intervals and phosphorus (P) application rates is shown in Table 1. The price/kg of cowpea grains (₦166, 00) and cowpea haulm (₦46, 00) was used in the analysis. Profitability analysis is a common tool used by many managers of different enterprises to make decisions on whether to participate in the enterprise or not. It gives an idea of how much a farmer makes on each naira of sales. Results revealed that an operating profit margin analysis (OPMA) of 0.6% for cowpea grains was realized for the two cowpea varieties across all the treatment combinations. The percentage OPMA implies that farmers will earn extra income of 0.6% per 100kg bag of cowpea grains irrespective of the variety, irrigation intervals and the level of P used. The low OPMA could be due to high costs of irrigation and inputs. In crop production most of the factors that affect profitability are the production costs, fertilizer usage, seed variety, labour and land rent (Ibro, 2008). Studies by Abubakar, (2006) and Haruna *et al.* (2009) conducted on profitability of different varieties of cowpea grains in Zamfara and Gombe reported a remarkable profit gain among farmers.

Similarly, an OPMA of 2.17% of cowpea forage/haulms was realized for the two cowpea varieties across all the treatment combinations except for Sampea 14 harvested from the use of irrigation interval of 5 and 10 days in combination with 20 and 40 kg P/ha and Sampea 15 harvested from the use of irrigation interval of 15 days in combination with 40 kg P/ha. These results showed that a corresponding gain of more than 200% (2.17% per 100kg bag of cowpea forage/ haulm) would be realized by the farmers from sales of cowpea forage/haulms irrespective of cowpea variety used, irrigation intervals and the level of P. This is an added bonus, aside the final grain yield at harvest; which, could more than compensate for the little grain yield gained (Igbala *et al*., 2018). This is in conformity with Singh *et al.* (1997) who reported that farmers who cut and store cowpea fodder, for subsequent sale at the peak of the dry season, have been found to obtain as much as 25% of their annual income by this means.

The highest OPMA (2.68%) was realized with Sampea 14 harvested from the use of irrigation interval of 5 days in combination with 20 kg P/ha which was followed by same cowpea variety (1.30% OPMA) harvested from the use of irrigation interval of 10 days in combination with 40 kg P/ha. The treatment combinations could increase forage yield of Sampea 14 by more than 200% and grain yield of the two cowpea varieties by 60 %. High or increasing operating margin is preferred because the farmer earned more per naira of sales. The lowest OPMA (0.73%) was generated by Sampea 15 when it was harvested

from the use of irrigation interval of 15 days in combination with 40 kg P/ha (Figure 1). The low OPMA might be due to reaction of cowpea to moisture stress at longer irrigation intervals, leading to reduction in yields and consequently the revenue generation. It was reported that shorter irrigation intervals favoured excessive yield (Etissa *et al.*, 2014). Therefore, production of forage cowpea varieties under varying irrigation and phosphorus rates was found to be profitable. The study has further shown that, substantial financial gains can be made by the smallholder crop-livestock farmers who are in dare need of funds to meet up with farms operational activities at the peak of the dry season.

Conclusion

Based on the results obtained in this study, it could be concluded that irrigation interval of 10 days in combination with 20 kg P/ha could increase forage yield of Sampea 14 by more than 200% and grain yield of the two cowpea varieties by 60%. Consequently, this will improve the living standard of farmers under smallholder crop-livestock production system in Nigeria.

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Table 1: Profitability analysis of two forage cowpea varieties (V) as influenced by irrigation intervals (I) and phosphorus application rates (P).

Treatments	Yield (kg/ha)		Gross revenue (₦/ha)		Operating profit margin analysis (%)	
combination	Grain	Haulm	Grain	Haulm	Grain	Haulm
$V_1I_1P_1$	3630	700	602,580	32,200	0.60	2.17
$V_1I_1P_2$	4550	1350	755,300	62,100	0.60	2.17
$V_1I_1P_3$	2930	0570	486,380	26,220	0.60	2.17
$V_2I_1P_1$	3790	1320	629,140	60,720	0.60	2.17
$V_2I_1P_2$	4590	2290	761,940	105,340	0.60	2.17
$V_2I_1P_3$	3890	960	645,740	44,160	0.60	2.17
$V_1I_2P_1$	3630	1320	602,580	60,720	0.60	2.17
$V_1I_2P_2$	1480	3700	245,680	138,000	0.60	**2.68**
$V_1I_2P_3$	3200	1230	531,200	56,580	0.60	2.17
$V_2I_2P_1$	4120	2600	683,920	119,600	0.60	**1.30**
$V_2I_2P_2$	3350	1000	556,100	46,000	0.60	2.17
$V_2I_2P_3$	5450	2300	904,700	105,800	0.60	2.17
$V_1I_3P_1$	1870	390	310,420	17,940	0.60	2.17
$V_1I_3P_2$	1960	800	325,360	36,800	0.60	2.17
$V_1I_3P_3$	2000	680	332,000	92,000	0.60	**0.73**
$V_2I_3P_1$	3380	2300	561,080	105,799	0.60	2.17
$V_2I_3P_2$	1800	700	298,800	32,200	0.60	2.17
$V_2I_3P_3$	1410	1000	234,060	46,000	0.60	2.17

V_1 = Sampea 14, V_2 = Sampea 15, I_1 = at 5 days I_2 = at 10 days I_3 = at 15 days, P_1 = at 0kg P/ha, P_2 = at 20kg P/ha, P_3 = at 40kg P/ha, Price/kg of cowpea grain = ₦166:00, Price/kg of cowpea haulm = ₦46:00,

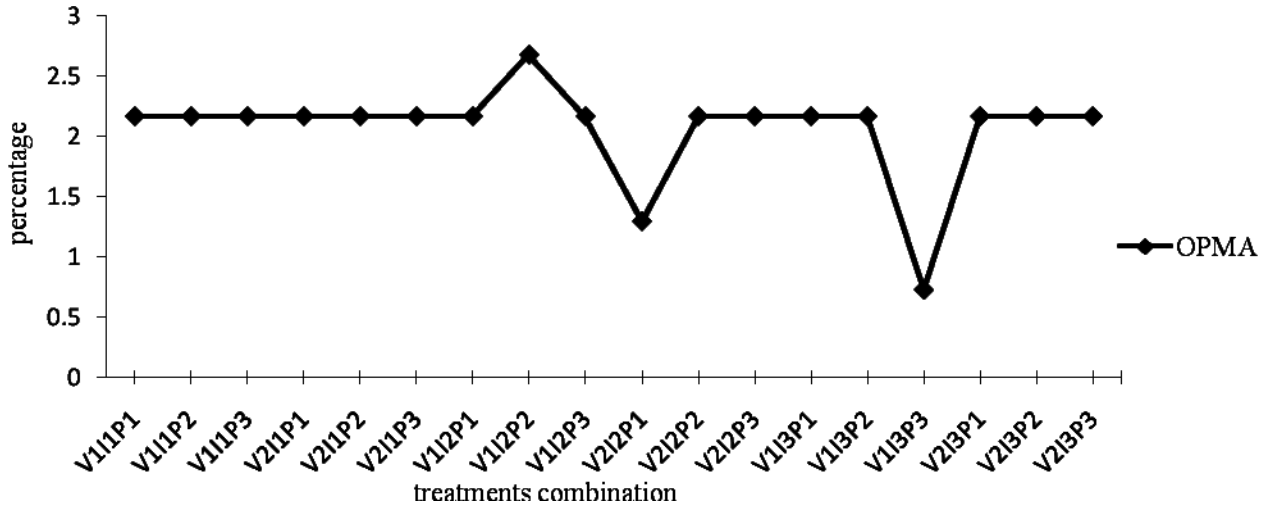

Figure 1: Trend of operating profit margin analysis of two varieties of cowpea as influenced by irrigation intervals and phosphorus application rates.

CHANGES IN MINERAL CONTENT OF *Panicum maximum* var Ntchisi AS INFLUENCED BY POULTRY MANURE RATE AND AGE AT HARVEST

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Abstract
The effects of poultry manure rate and age at harvest on the mineral content of *Panicum maximum* var Ntchisi was carried out at the Federal University of Agriculture, Abeokuta, Nigeria. The N rates were 0, 100, 200 and 300 kgN ha^{-1} and the age at harvest was at 4, 8 and 12 12 weeks after cutback. The experiment was a 4 x 3 factorial in a Randomized complete block design which amount to twelve (12) treatment combinations with four replicates. The results showed that the manure rate had significant ($P<0.05$) effect on the all the macro and micro mineral content of the grass, same was observed for the age at harvest except for the Cu content. The calcium content as affected by manure rate ranged between 2.76 to 4.35 gKg^{-1} DM The age at harvest ($P<0.05$) affected the calcium content, which ranged from 2.90 gKg^{-1} DM in the grass harvested at 12WAC and 3.74 gKg^{-1} DM in the grass harvested at 4WAC. Manure rate influenced the phosphorus content which ranged from 0.76 gKg^{-1} DM in the unfertilized grass to 1.78 gKg^{-1} DM in the grass to which 300 $kgNha^{-1}$ was applied. The phosphorus content declined with maturity.

Keywords: Salinity, grass, manure, unfertilized, forage

Introduction
Natural pasture is known to be the main source of feed in ruminant livestock production in Nigeria, as most stockowners can hardly afford to keep their animals on concentrate rations. The natural pasture, though cheap but is limited both in quantity and quality. In order to mitigate the problem of poor nutrition for ruminant animals because of its over dependence on the natural pasture, the use of sown and purposely managed pastures have been widely suggested (Olanite, 2003; Onifade *et al*., 2005; Dele, 2008). The nutritive quality of the forage has an important role in the productivity of the animals. The factors influencing the nutritive value of forage are many, and these factors may include, plant type, climate, season, weather, soil type and fertility and physiological and morphological characteristics, and may change depending on whether the plants are annuals perennials, grasses or legumes. The stage of growth seems to be the most important factor affecting the chemical composition of forage. This study is aimed at investigation the role of poultry manure rate and age at harvest on the mineral contents of a major grass (*Panicum maximum* var Ntchisi) in southwest Nigeria.

Materials and Methods
The research work was carried out at the Organic Research farms and Laboratory of Pasture and Range Management, Federal University of Agriculture, Abeokuta, Nigeria located on latitude 7^0 12' 15.35'N and longitude 30 20' 52.37'' E at 68 m elevation. The treatment combination comprised 4 poultry manure rates (0,100, 200 and 300 $KgNha^{-1}$) and 3 age at harvest (4, 8, 12 weeks after cutback) of *P. maximum* var Ntchisi which amounted to twelve (12) which were

randomly allotted. The experimental area was arranged in a 4 x 3 factorial experiment in a Randomized Complete Block Design (RCBD) with four replicates .The grasses were planted at 50 cm intra rows and 50 inter rows with each plot having a dimension of 3 m x 5 m. The samples of the grasses were dried in a forced draught oven at 105 ^{o}C for 24 hours and were analyzed for some macro minerals (Ca, P, K, Na and Mg) and micro minerals (Cu, Zn, Mn and Fe). The concentration of Potassium (K) was estimated with a flame photometer after wet digestion in nitric acid and per chloric acid. Concentration of Ca, P, Mg, Mn, Cu and Zn were determined with atomic absorption spectrophotometry (Fritz and Schenk, 1979). Data collected were subjected to two-way analysis of variance (ANOVA) and significant means were separated using Tukey's Studentized Range (HSD) of the SAS (1999) package.

Results

The main effect of poultry manure rate and age at harvest on the macro elements of *Panicum maximum* var. Ntchisi is as presented in Table 1. The macro elements were significantly ($p<0.05$) influenced by the manure rate and age at harvest. The unfertilized grass had the highest Ca and K values, while the highest values of P, Mg and Na were recorded for grass fertilized with 300 $KgNha^{-1}$ of poultry manure. The Ca content ranged from 2.76 gkg^{-1} DM in the grass fertilized with 100kgN/ha to 4.35 gkg^{-1} DM in unfertilized grass. The K content had similar trend with that of the Ca content ranging from 15.58 gkg^{-1} DM in grass fertilized with 100 $KgNha^{-1}$ to 30.80 gkg^{-1} DM in unfertilized grass. The P content increased with increasing rate of manure from 0.76 gkg^{-1} DM to 1.78 gkg^{-1} DM.

The effect of age at harvest was observed to be significant as the grass harvested at 4WAC recorded the highest macro element values. There was a decline in the content of the minerals with advancement in age at harvest.

The main effect of manure rate and age at harvest on the microelement content of *P. maximum* is as presented in Table 2. There were significance differences ($P<0.05$) as influenced by manure rate for the microelements, with the unfertilized grass had the highest value of 41.55 $mgKg^{-1}$DM for the Mn content and the grass fertilized with 300 $KgNha^{-1}$ recorded the highest values for Fe (104.67 $mgKg^{-1}$DM) and Cu (8.33 $mgKg^{-1}$DM). The Zn content was observed to be the highest with the grass fertilized with 200 $KgNha^{-1}$.

The effect of age at harvest was significant ($P<0.05$) for the microelements except for Cu content. The Mn content ranged from 28.08 $mgKg^{-1}$DM to 47.33 $mgKg^{-1}$DM with the grass harvested at 4WAC having the highest value. The grass harvested at 4WAC recorded the highest values for Fe and Zn with 86.42 $mgKg^{-1}$DM and 29.50 $mgKg^{-1}$DM, respectively.

Discussion

Minerals are known and required for their functional roles in all metabolic processes, but their amount either in excess or deficit can result in much economic losses in animal productivity (Spears and Weiss, 2014), the calcium content of the grass as affected by manure rate in this study is in line with that reported by Dele (2012) where zero manured grasses had higher Ca content than the manured grasses. This could be as a result of the salinity attached to manure application as reported by Chang *et al.* (1991). The decrease in the Ca content with advance maturity as observed in this study is in consonance with the report of Dele *et al*. (2018). The Ca content of the grass under study fell within the range (1.8 – 8.2 g/kg DM) reported by McDowell (1997) for different classes of ruminants. The grass fertilized with 300kgN/ha had the highest P content, though slightly lower than the recommended range for different classes of ruminants (McDowell, 1997). The low content of P in this study is a true reflection of tropical forages as

reported by McDowell (1984) which reported that tropical forages are generally low in P content and this could be as a result of the properties of tropical soils that are known to be deficient in major nutrient especially phosphorus (Oberson *et al.,* 2006). The Mg content increased with advanced maturity and is in line with the findings of Dele *et al*. (2018) and Kering *et al.* (2011). The Mg content of the grass in this study is higher than the range (1.0 to 2.0 g/kg DM) reported by McDowell (1997) as requirement different classes of ruminants. Minson and Norton (1984) reported that tropical forages contain sufficient Mg.

The K concentration in this study is above 8 g/kg recommended for grazing animals (Underwood, 1981). However, it has been suggested that ruminants with high producing ability in terms of milk and other animal products may require K level above 10 g/kg under stress particularly heat stress (McDowell, 1985) of which the grass in this study could be a good source of.

The Fe content is higher than the desirable threshold concentration for all classes of ruminants and could not lead to iron toxicity as reported by NRC (2001) as it is known that Fe generally low in terms of bioavailability in forages. Zinc is important to a variety of biological and metabolic processes in ruminant animals; it is widely distributed throughout the body as a component of metalloenzymes and metalloproteins (Vallee and Falchuk, 1993), with its germane roles, it was observed that the range recorded in this study is high enough to meet the nutritional requirements of all classes of ruminants. The Zn concentration of the grass in this study fell within the marginal (20-40 mg/kg) level for cattle nutritional requirement (MacPherson, 2000).

Table 1: Effect of manure rate and age at harvest on the macro-mineral (gKg^{-1} DM) of *P. maximum* var Ntchisi

Manure rate	Age at harvest	Ca	P	Mg	K	Na
0		4.35^{a}	0.76^{d}	6.61^{c}	30.80^{a}	0.90^{c}
100		2.76^{d}	1.18^{c}	5.58^{d}	15.58^{d}	0.73^{d}
200		2.99^{c}	1.55^{b}	7.31^{b}	22.01^{c}	0.98^{b}
300		3.11^{b}	1.78^{a}	8.43^{a}	28.57^{b}	1.04^{a}
SEM		0.01	0.1	0.03	0.04	0.01
	4	3.74^{a}	1.44^{a}	8.18^{a}	32.28^{a}	1.04^{a}
	8	3.27^{b}	1.41^{b}	6.89^{b}	21.40^{b}	0.96^{b}
	12	2.90^{c}	1.09^{c}	5.89^{c}	19.05^{c}	0.73^{c}
	SEM	0.02	0.01	0.02	0.03	0.00
0	4	5.05^{a}	0.88^{g}	7.84^{e}	42.10^{a}	1.01^{b}
	8	4.50^{b}	0.82^{h}	7.16^{g}	30.21^{c}	0.96^{c}
	12	3.49^{d}	0.58^{i}	4.84^{k}	20.10^{i}	0.72^{g}
100	4	3.86^{c}	1.45^{de}	7.57^{f}	15.81^{j}	1.00^{b}
	8	2.80^{g}	1.24^{f}	5.61^{j}	22.45^{g}	0.80^{f}
	12	1.62^{j}	0.85^{gh}	3.57^{l}	8.47^{k}	0.40^{h}
200	4	3.50^{d}	1.78^{b}	9.18^{a}	41.12^{b}	1.20^{a}
	8	2.48^{i}	1.40^{e}	6.06^{i}	4.72^{l}	0.87^{e}
	12	3.00^{f}	1.46^{d}	6.70^{h}	20.20^{h}	0.87^{e}
300	4	2.55^{h}	1.67^{c}	8.12^{d}	30.11^{d}	0.96^{c}
	8	3.27^{e}	2.18^{a}	8.74^{b}	28.22^{e}	1.20^{a}
	12	3.49^{d}	1.49^{d}	8.43^{c}	27.40^{f}	0.94^{d}
SEM		0.01	0.01	0.00	0.01	0.00

abc..: means with same superscript along same column are not significantly different (P>0.05); SEM=Standard error mean

Conclusion

From the result of this study, it could be concluded that application of organic manure and harvesting at a relatively younger age or stage do enhances quality of forage.

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Table 2: Effect of manure rate and age at harvest on the micro-mineral (mgKg^{-1} DM) of *P. maximum* var Ntchisi

Manure rate	Age at harvest	Mn	Fe	Cu	Zn
0		41.55^{a}	70.89^{c}	5.33^{b}	26.11^{a}
100		30.78^{c}	69.33^{c}	5.00^{b}	21.00^{b}
200		35.78^{b}	78.89^{b}	5.33^{b}	28.33^{a}
300		31.11^{c}	104.67^{a}	8.33^{a}	26.22^{a}
SEM		0.04	0.02	0.91	0.41
	4	47.33^{a}	86.42^{a}	6.00	29.50^{a}
	8	29.00^{b}	74.25^{c}	6.00	22.75^{b}

	12	28.08[b]	82.17[b]	6.00	24.00[b]
	SEM	0.05	0.03	0.99	0.50
0	4	52.00[a]	82.00[d]	5.00[ab]	30.33[ab]
	8	42.00[b]	70.00[e]	8.00[ab]	29.00[bc]
	12	30.67[c]	60.67[f]	3.00[b]	19.00[d]
100	4	52.00[a]	92.00[c]	6.00[ab]	29.00[bc]
	8	20.00[d]	62.00[f]	3.00[b]	21.00[d]
	12	20.33[d]	54.00[g]	6.00[ab]	13.00[e]
200	4	53.33[a]	100.67[b]	6.00[ab]	35.00[a]
	8	23.00[d]	65.00[ef]	4.00[ab]	22.00[d]
	12	31.00[c]	71.00[e]	6.00[ab]	28.00[bc]
300	4	32.00[c]	71.00[e]	7.00[ab]	23.67[cd]
	8	31.00[c]	100.00[b]	9.00[a]	19.00[d]
	12	30.33[c]	143.00[a]	9.00[a]	36.00[a]
SEM		0.06	0.04	1.00	0.40

abc..: means with same superscript along same column are not significantly different (P>0.05);
SEM=Standard error mean

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EFFECTS OF STAGES OF GROWTH ON DRY MATTER YIELD AND NUTRIENT COMPOSITION OF STYLOSANTHES IN THE YEAR OF ESTABLISHMENT IN VOM, NIGERIA

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ABSTRACT

An experiment was conducted in Jos to evaluate the effects of stages of growth on dry matter yield and nutrient composition of Stylo (Stylosanthes guianensis cv. Cook) in the year of establishment. Five stages of growth (5, 9, 13, 17 and 21) weeks after sowing (WAS) were the treatments arranged in a Randomized Complete Block Design replicated four times. The land was divided into twenty plots of 5m X 3m. The spacing between each block was 1m and 0.5m along the rows and columns, respectively. Growth components and DM yield were measured at the various stages of growth. There was no significant difference in plant height at 17 (99.90cm) and 21 (101.90cm) WAS. However, the two stages were significantly (P>0.01) higher than the other stages of growth. Leaf to stem ratio was however, significantly higher at 5WAS (1.86) compared to the other stages of growth, while 21WAS had the least value of 0.27. Forage DM yield was higher (P<0.01) at 17 WAS (14.15 t ha-1) compared with the other stages of growth. Crude protein content at 9WAS (18.98%) was higher (P<0.01) than the other stages of growth,while 21 WAS had the lowest value of 114.37 %. Crude protein content decreased from 9 to 21 WAS, while the fibre fractions increased from 9 to 21WAS. The legume grown in early June on Vom, Jos Plateau should be harvested at 17 WAS when the DM yield is maximum and crude protein content could also meet the requirements for ruminant animals.

Key words: Growth stage, nutrient composition, C. molle, Dry matter, yield

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INTRODUCTION

Stylosanthes guianensis cv. Cook is one of the forage legume well suited to the sub-humid tropical zone with a marked dry season (Heuzé,et al., 2015). It is a tropical herbaceous perennial legume, primarily used for pasture in humid tropical regions and over sowing the crop improves the quality of tropical rangeland and it can also be used as a cover crop, green manure crop and as fallow crop (Mannetje, 1992). It is fairly palatable to livestock when mature, can be easily established on very low fertile soils with yield between 10 - 20 t DM ha-1 (Heuzé,et al., 2015) ,while dry matter and crude protein digestibilities in West Africa Dwarf sheep were reported to be 71.82 and 71.80%, repectively (Ogunbode and Akinlade, 2012). Different locations have been found to influence the yield and quality of forage

crops, but the stage of growth at which a forage crop is harvested for livestock feeding is also important when the overall forage yield and quality are considered. As forage crop matures, the dry matter content increases, but digestibility of NDF, starch, sugar and crude protein contents, are all reduced (Kilcer at al., 2003). Therefore, there should be a growth/maturity stage to harvest in order to obtain optimum dry matter yield and forage quality in different environments. It has become important to evaluate forage yield and quality of Stylo (Stylosanthes guianensiscv. Cook) at different stages of growth to determine the optimum stage of growth for which the forage crop could be harvested for livestock feeding either as pasture, hay or silage. The study was therefore designed to examine the effect of stages of growth on dry matter yield and nutrient composition of Stylo (Stylosanthes guianensis cv. Cook) in the year of establishment in Vom, Jos Plateau, Nigeria.

MATERIALS AND METHODS

Location of the Study:

The experiment was carried out at the Nigerian Institute for Trypanosomiasis Research (NITR), Vom, (Lat 9° 43' 60N, Long 8° 46' 60E and 1,223m above sea level), (Ovimaps, 2014), Vom, Nigeria. The area is characterised by two major seasons (rainy and dry seasons). The rainy season starts in late-May and ends in early-October each year, while the dry season starts from late-October and ends in early- May. Peak of the rain is normally observed in the month of August each year. The soil is classified as sandy-clay loam. It is low in total nitrogen (0.33%), phosphorus (7.53 mg/litre), but fair in potassium (247.2 mg/litre)

Land Preparation and Experimental Design:

The land was ploughed and harrowed twice using tractor mounted implements. The field was levelled and all debris were removed to provide a clean seedbed. Five stages of growth (5, 9, 13, 17 and 21 weeks after sowing) were the treatments arranged in a Randomized Complete Block Design and replicated four times. The land was divided into twenty plots of 5 m X 3m each. The spacing between each block was 1m and 0.5m along the rows and columns, respectively. Growth components and dry matter (DM) were measured at the various stages of growth.

Pasture Establishment and Yield Measurement:

The trial was conducted when the rains were well established in the first week of June, 2015 rainy season. Seedrate was calculated using the method and formular provided by Karki (2013) as follows:

PLS Index = (% Germination x % Purity) ÷ 10,000

Kg of Seed per hectare = Recommended Seeding Rate ÷ PLS Index

Where; Kg= kilogram and PLS= Pure live seeds

Recommended planting spacing and depth were used. The seeds were drilled along the rows. Prior to planting, Single Superphosphate (SSP) fertiliser (18% P2O5) was applied at a rate of 30 kg ha-1 in both cropping seasons. The plots were manually weeded three times throughout the duration of the experiment using hoes. Five (5) plants in the middle of a row in each plot were tagged and used to determine the growth components which were plant height, number of leaves per plant and number of branches per plant at each stage of growth. The height of the tagged plants were measured from the

ground level to the top of the plant with the aid of graduated meter rule. The number of leaves per plant and branches of the tagged plants were counted. Other five plants within a row in each plot were harvested to determine leaf to stem ratio by separating the leaves of the harvested plants from the stem. The leaves and the stem were wighed immediately in the field after separation, and were thereafter oven-dried at a temperature of 65oC for 48 hours and weighed again until a constant weight was attained. Thereafter, the leaf dry weight was divided by stem dry weight to determine leaf to stem ratio (Tucak et al., 2013). Plants within 0.5 m2 quadrat placed in the middle rows of the plots at pre - determined points were cut at 5cm above the ground level to determine the forage yield at 9, 13, 17 and 21 WAS using 0.5 m2 quadrat. The cut forages samples were immediately weighed to determine fresh weight after which sub-samples were oven dried at a temperature of 65oC for 48 hrs to determine the dry matter yields. Forage dry matter yields were calculated as shown below;

Sub-sample dry weight X 100 X Total Harvest = Z

Sub-sample fresh weight

Z X *40,000 = Dry matter yield per hectare. *There are 40,000 quadrats (0.5m-2) per hectare

Analyses of Samples and Data:Proximate analysis (CP, ash, CF, EE and NFE) and mineral composition (Ca, P, Mg, K and Na) of the samples were determined using the method of (AOAC, 1990). All data generated were subjected to analysis of variance (ANOVA). The General Linear Model of SAS (2002). Statistical Software was used for the analyses and means were separated (Tukey, 1949).

RESULTS AND DISCUSSION

Growth components and dry matter yield of the legume at different stages of growth is presented in Table 1. Plant height was significantly higher at the later stages of growth compared to the early stages. The difference in height at 17(99.20 cm) and 21 (101.90 cm) WAS was not significant. The plant height obtained in this study was similar to the result reported by Njarui and Wandera (2004) in Kenya, but lower than 135 cm reported by Kiyothong et al. (2005) in Indonesia, probably due to difference in location. Number of leaves was higher ($P<0.01$) at 17 WAS (133.25), while 5WAS produced least value with 10.57. There was no record of number of branches at 5 WAS because, the legume was at the establishment stage. The plant produced significantly higher number of branches at 17WAS (35), while 9WAS had the lowest value (5.25). Leaf-to-stem ratio was significantly higher at 5WAS (1.86), and the lowest value of 0.83 was recorded at 21WAS. The decrease in leaf to stem ratio (5 – 21 WAS) observed in this study agrees with Ramírez et al. (2008) that leat-to-stem ration decrease as plant matures. The DM yield of the legume relatively increased from 9 WAS, reached a peak at 17 WAS, and then decreased at 21 weeks after sowing. Forage DM yields were significantly higher at 17 WAS (14 t ha-1) decreasing to 10.41 t ha-1 at 21 WAS. The DM yield of 14.15 t ha-1 in S. guianensis was within the range of 10 - 20 t DM ha-1 reported by Cook et al. (2005), but higher than 4.2 t ha-1 reported by Kiyothong et al. (2005) in Australia. During the growth stage and as the plant undergo morphological changes, leaf growth becomes slower, the stem increases in length and proportion of dry matter increases reaching a peak, and then decreases.

Table 1: Growth components and forage dry matter yield of Stylosanthes guinensis at different stages of growth

Weeks after sowing

Parameter	5	9	13	17	21	SEM
Plant height (cm)	15.20d	29.73c	64.40b	99.20a	101.90a	2.92
Number of leaves per plant	10.75c	23.75c	54.75c	133.25a	123.75b	1.64
Number of branches per plant	-	5.25d	25.00c	35.00a	34.25b	0.83
Leaf to stem ratio	1.86a	1.18b	0.72c	0.43d	0.27e	0.02
Forage DM yield (t/ha)	-	1.17d	5.75c	14.15a	10.41b	0.14

abcdmeans with different superscripts on the same row are significantly different.

Table 2 shows the nutrient composition at different stages of growth. Crude protein, ether extract and ash contents were significantly higher at 5 WAS with 18.98, 2.76 and 9.80 compared to 14.37, 1.03 and 7.13 % at 21 WAS, respectively. However, crude fibre fraction was significantly higher at 21 WAS. Similarly, NDF and ADF contents were significantly higher at 21 WAS (40.29 and 30.42 %) compared to 49.44 and 39.42 % recorded at 5WAS, respectively. The CP, NDF and ADF contents were similar to the result reported by Valarini and Possenti (2006), while ash (6.8%) was lower than the value obtained in this study. Ajayi and Babayemi (2008) at Ibadan in Southwestern Nigeria reported similar CP, EE and ash, higher NDF (50.66%), but lower ADF (28.52%) and NFE (25.54%) as compared to the result obtained in this study. All the mineral elements analysed were significantly higher at 9 WAS compared to 21 WAS. The forage legume can meet the Ca (0.3 - 0.8%) and Mg (0.18 - 0.4%) required for growth and all productive/physiological functions of small ruminants (Rashid, 2008). The legume could also meet requirements of 0.53 - 0.67% Ca, 0.22 - 0.44% P, 0.18 - 0.21 % Mg and 11% K for lactating cows (NRC, 2001).

Table 2: Effect of different stages of growth on nutrients composition Stylosanthes guianensis

	Stages of growth				
Parameter	9 WAS	13 WAS	17 WAS	21 WAS	SEM
	%				
Crude protein	18.98a	17.68b	16.22c	14.37d	0.12
Crude fibre	29.42d	32.60c	33.59b	36.86a	0.13
Ether extract	2.76a	2.10b	1.44c	1.03d	0.04
ash	9.80a	8.02b	7.70c	7.13d	0.06
Nitrogenfree extract	33.55d	34.20c	35.68b	36.82a	0.19
Neutraldetergent fibre	40.29d	43.41c	46.85b	49.44a	0.32

Acid detergent fibre	30.42d	33.95c	36.12b	39.42a	0.25
g/kg					
Calcium	12.16a	11.83b	10.15c	9.80d	0.03
Phosphorus	3.51a	3.17b	2.75c	2.39d	0.07
Magnessium	3.39a	3.07b	2.16c	1.54d	0.10
Potassium	19.54a	18.27b	17.78c	17.03d	0.04
Sodium	0.74a	0.53b	0.44c	0.28d	0.02

abcdmeans with different superscripts on the same row are significantly different

CONCLUSION

It is therefore concluded that stage of growth has influence on Stylosanthes guianensis DM yield and nutrient composition. The legume grown in early June on Jos Plateau should be harvested at 17 WAS when the DM yield is at maximum and crude protein content could also meet the requirements for ruminant animals.

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Blood profile of West African Dwarf goats fed *Zingiber officinale* supplemented diet

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Abstract

An experiment was conducted to assess the effect of ginger (*Zingiberofficinale*) supplemented diets on the blood profile of West African Dwarf (WAD)goats. Twelve (12) goats with an average weight range of 5.57-6.95kg were randomly allotted to four dietary treatments supplemented with ginger at different inclusion levels of 0, 0.2, 0.4 and 0.6% with each treatment having three animals which served as replicates in a completely randomized design. Prior to commencement of the study, blood was collected via the jugular vein into different sterilized specimen bottles with and without anti-coagulant (EDTA) for haematological and serum biochemical evaluations respectively. This was repeated at the end of the study period which lasted for 60 days. The haematological parameters results obtained at the post trials did not differ significantly while significant reduction was observed in the alanine amino transferase(ALT), aspartate aminotransferase (AST), cholesterol and creatinine values. It was therefore concluded that *Zingiber officinale* has the potential to maintain a good health status in the regulation of serum enzymes, cholesterol which might have adverse health implications if above normal.

Key words: *alanine aminotransferase, aspartate aminotransferase,haemoglobin, phytogenic feed*

Introduction

Ruminant production is vital in supplying man's protein requirement and in sustaining these animals as well as improving their production, they require quality feed and adequate management. The recently observed consumers' demand for quality food products has encouraged the use of Phytogenic feed additives (PFAs) in livestock production (Gardzielewska *et al.,* 2003). Phytogenic feed additives (PFA) are plant products added to livestock feeds in order to improve digestibility, nutrient absorption and elimination of pathogens residents in the animal's gut and by so doing, promote livestock performance (Athanasiadou *et al.,* 2007) as well as maintain the health status of the animals. Ginger (*Zingiber officinale*) a phytogenic feed additive is a rhizomatous herbaceous plant, whose rhizome is used medicinally. It contains several compounds and enzymes including gingerdiol, gingerol, gingerdione and shogaols (Zhao *et al*., 2011). Aside from nutrition, the health condition of an animal is a function of its blood and serum constituent as these determines its immunity to foreign bodies (Okunlola *et al.,* 2015). This study therefore centred on investigating the haematological and serum profile of West African Dwarf goats as affected by *Zingiber officinale* supplemented diets.

Materials and methods

Study area

The experiment was carried out at the sheep and goat Unit of the Teaching and Research farm of the Federal University of Technology, Akure, Ondo State, Nigeria and it lies on the geographical coordinates of longitude 4.944055°E and 5.82864°E, and latitude 7.491780°N and 6.96375°N with annual rainfall

ranging between 1300 mm and 1650 mm. Average maximum and minimum daily temperature of 38 °C and 27 °C in the wet season and 39 °C and 23 °C respectively (Daniel 2015)

Source of experimental materials

Twelve (12) West African dwarf goats were sourced from a local market in Osun state, Nigeria. Composite cassava peel was obtained from a cassava processing mill, the Moringa leaf were obtained from a nearby village in Akure while the Palm Kernel Cake was obtained from a feedmill in Akure. The ginger was purchased from a local market (Oja-Oba) in Akure.

Preparation of experimental diets

The experimental diets were grouped into four; Diet A; Cassava peel (65%) + Moringa leaf (15%) + PKC (20%) + Ginger (0%), Diet B; Cassava peel (65%) + Moringa leaf (15%) + PKC (20%) + Ginger (0.2%), Diet C; Cassava peel (65%) + Moringa leaf (15%) + PKC (20%) + Ginger (0.4%), Diet D; Cassava peel (65%) + Moringa leaf (15%) + PKC (20%) + Ginger (0.6%).

Cassava peel was chopped and the ginger was macerated into smaller size for easy mixing and compaction. All the ingredients were thoroughly mixed manually and compacted inside a 120L plastic silo weighted with a sand bag and sealed to prevent any possible entrance of air and then covered with the plastic lid and allowed to ferment for 21 days.

Management of the Experimental Animals and method of feeding

Twelve female West African Dwarf goats having an average body weight of between 5.57 and 6.95kg were used for the eight weeks feeding trial. The goats (3 per treatment) were assigned to the four dietary treatments in a completely randomized design and housed in individual pens. The goats were tagged and allowed 14 days adjustment period before the onset of the study. All the animals were treated for external and internal parasite**.** The experimental diets were fed to the goats at 8.00am and grass (*Panicum maximum*) was offered at 2.00pm and fresh cool water was supplied daily.

Blood sample Collection and Analysis

Blood samples (5 millimeters) were collected from the goats twice; prior to the feeding and post feeding. The haematological indices were determined as described by Dacie and Lewis (2001), serum total protein (Kohn and Allen 1995), albumin (Peter *et al* 1982), creatinine was determined as described by Ogunsanmi *et al.* (1984).

Results and Discussion

The haematological values obtained is shown in Table 1. There was no significant difference ($P>0.05$) among the treatments. The PCV was higher than 25.7±3.1 obtained for Red Sokoto goats Tambuwal *et al.* (2002) and within the range of 28.4 ± 0.9 obtained for West African Dwarf (WAD) goats by Opara *et al*. (2010) but slightly lower than 35-37.01% for WAD goats fed fermented maize cob based diets (Ibhaze, 2015). It could be said that these goats were maintained on adequate nutrition hence were not susceptible to nutritional stress. Although not significantly ($p>0.05$) different, the increase in the red blood cells when compared with the baseline values suggests that the inclusion of ginger could have improved the oxygen carrying capacity of the goats which indicates absence of anaemia. Moses (1999) associated anaemia with reduction in haemoglobin, accompanied by fall in red blood cell count and packed cell volume. Treatment B had higher value (12.6x106µl) for red blood cells which reflected in the haemoglobin value (10.0g/dl) attesting to the better utilization of the diet. The higher haemoglobin values obtained in diets with ginger inclusion were comparable with 9.9 g/dl reported by Opara *et al.* (2010) for healthy female WAD goats, indicating the absence of microcytic hypochromic anaemia caused by iron deficiency and improper utilization for the formation of haemoglobin (Olafadehan, 2011).The improved haemoglobin observed in animals at post trial implies efficient utilization of dietary protein by the animals. Additionally, increase in PCV, RBC and Hb is an indication of positive erythropoiesis (Okpuzor *et al* ., 2009). The decrease in WBC observed at post trials showed that the animals health were not challenged.

Table 2 shows the biochemical indices of West African Dwarf goats. Total protein level observed differed significantly ($p<0.05$) and was least (80.2g/l) in diet B fed animals. The higher levels of albumin observed in diets supplemented with ginger suggest that ginger could enhance the bioavailability of protein. Odunsi *et al.* (2009) opined that albumin synthesis in animals is related to the amount of available protein present in the diets. The highest reduction (59.51%) in cholesterol was observed in diet B (0.2% ginger) compared to the least reduction (6.38%) in diet A. This observation agrees with the findings of Akhani *et al*. (2004), Saeid *et al.* (2010) who reported that ginger treatment significantly decreased both serum cholesterol and triglycerides in diabetic rats and broilers. Increase in creatinine level is a signal of kidney damage. Although, values were not significantly ($p>0.05$) different, post trial value was highest (2.1mg/dl) in diet A (0%).These results therefore suggest absence of tissue wastage in animals fed ginger supplemented diets.

Conclusion

In this study, it was observed that the inclusion of *Zingiber officinale* in the diets of West African

Dwarf goats improved the packed cell volume,haemoglobin, red blood cells and resulted in effective regulation of serum enzymes and lipid metabolism in goats.

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Table 1: Haematological indices of West African Dwarf goats fed *Zingiberofficinale* supplemented diets

Parameters	Period	A(0%)	B (0.2%)	C(0.4%)	D(0.6%)	SEM
Packed cell volume (%)	BT	23.3	29.1	25.1	24.3	0.57
	PT	27.0	30.0	26.0	25.6	0.38
Red blood cell ($x10^6$µl)	BT	9.4	11.8	10.2	9.2	1.10
	PT	11.2	12.6	10.8	9.6	0.69
White blood cell($x10^3$µl)	BT	301.3	296.3	272.6	286.0	8.69
	PT	266.0	214.0	254.2	229.3	10.15
Haemoglobin (g/dl)	BT	7.9	9.6	8.3	8.1	0.91
	PT	8.3	10.0	9.8	9.9	0.13

Table 2: Pre and Post trial Biochemical indices of West African Dwarf goats

Parameters	Period	A(0%)	B (0.2%)	C (0.4%)	D(0.6%)	SEM
TP(g/l)	BT	83.6^a	63.0^b	52.9^c	59.3^c	0.62
	PT	87.5	80.2	89.1	81.8	4.81
ALB (g/l)	BT	21.9^b	23.5^a	24.9^a	32.2^a	3.43

	PT	25.4[c]	33.3[c]	30.1[b]	38.2[a]	0.69
GLO(g/l)	BT	61.7[a]	39.5[b]	28.0[c]	27.1[b]	6.04
	PT	62.1[a]	46.9[b]	59.0[b]	43.6[c]	5.37
AST(iu/i)	BT	83.0[d]	152.0[a]	104.5[b]	123.5[c]	8.27
	PT	35.0[d]	52.0[c]	94.3[a]	68.5[b]	4.74
ALT(iu/i)	BT	10.2	25.0	15.6	15.1	2.19
	PT	7.8[b]	12.4[a]	12.3 [a]	12.4[a]	3.50
CHOL(mg/dl)	BT	156.6[d]	349.0[a]	182.2[c]	262.1[b]	8.37
	PT	146.6	141.3	132.2	142.6	11.3
CRET(mg/dl)	BT	3.2	2.8	3.3	3.8	0.46
	PT	2.1	1.9	1.8	1.0	0.71

a, b, c, d = Means on the same row but with different superscripts are statistically different (P<0.05). AST = Aspartate aminotransferase, ALT = Alanine transferase, ALB = Albumin,
TP = Total protein, GLO = Globulin, CHOL = Cholesterol,CRET = Creatinine. BT: Pre-trial, PT: Post-trial.

NUTRIENTS PROFILE AND POST IN-VITRO PARAMETERS FOR DIETARY INCLUSION OF *Delonix regia* SEED MEAL FOR SUSTAINABLE RUMINANT ANIMAL PRODUCTION

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Abstract
This study was conducted to assess the nutrients profile and post in-vitro parameters for dietary inclusion of *Delonix regia* seeds meal (DSM) for sustainable ruminant animal production. Four experimental treatments were formulated with wheat offal 42%, orange pulp meal 20%, bone meal 2% and salt 1%, palm kernel cake (PKC) and DSM was varied as T1 (35/0), T2 (20/15), T3 (15/20) and T4 (0/35) respectively, each treatment were replicated and analyzed for the proximate composition and in-vitro analysis. Results shows that there was a significant difference ($P<0.05$) in the nutrients and fiber fractions (CP, EE, ash, OM, NFE, NDF, ADF and hemicellulose) across the experimental treatments, CP ranges between 10.50 – 13.60%, decreases as the inclusion of DSM increases. Similar ($P>0.05$) DM was recorded across the experimental treatments. Post in-vitro parameters indicated that the methane gas volume was significantly ($P<0.05$) influenced with the dietary inclusion of DSM across the experimental treatments, T2 had the highest volume of CH_4 (0.61ml), least was recorded for T1 (0.47 ml). Similar value ($P>0.05$) was recorded for 24hrs gas production, CH_4 percentage, CH_4 reduction percentage, dry matter digestibility (DMD), organic matter digestibility (OMD), metabolizable energy and fermentation efficiency across the experimental treatments. Conclusively, the nutrients profile of the experimental treatments justifies the utilization of DSM for sustainable ruminant animal production, similar value observed for the post in-vitro parameters is an indication that inclusion of DSM will go a long way to resolve the challenges of feed and feeding for ruminant animal production.
Key words: Nutrients profile, in-vitro, *Delonix regia*, Ruminant and sustainable

Introduction

The quest for alternative feed ingredients for sustainable ruminant animal production has been the priority of the farmers and ruminant nutritionist in recent years. Most of these alternative feedstuffs has to be the one that will meet the nutritional requirement of the animals and at the same time environmental friendly.
Delonix regia seed has been reported to have a potential as a feed resources for farm animals especially ruminant animal. Nutritional profile of *D. regia* seeds subjected to different processing methods has been reported by Evien (2017).
Nutrients composition alone cannot alone use to adjudge the nutritional potential or value of a particular feed ingredient. The in-vitro degradability method is a laboratory estimation of assessing the potential nutritive value of the feed. It is also a method that is reproducible and parameters obtained correlate well with in-vivo trials (Fajemisin, 2002).
Despite the nutritional values of this neglected seed, its dietary inclusion with different feed ingredients has not been exhausted. In lieu of these, this study intend to examine the nutrients profile and post in-vitro parameters for dietary inclusion of *Delonix regia* seed meal for sustainable ruminant animal production

Materials and method

Collection of experimental materials and composition of experimental treatments

Matured *Delonix regia* fruits was harvested from *Delonix regia* trees and the seeds were collected, discarded seeds was also being gathered within the University of Port Harcourt community, sundried and milled to have DSM. Citrus pulp were gathered within the university community sun dried and milled to have orange pulp meal. Palm kernel cake, wheat offal, bone meal and salt were purchased from feed mill within the Port Harcourt metropolis. Four different experimental treatments were composed on percentage level as shown in Table 1.

Table 1: Percentage composition (%) of dietary inclusion of *Delonix regia* seed meal

	Experimental treatments			
Feed ingredients	T1	T2	T3	T4
Wheat offal	42	42	42	42
Orange pulp meal	20	20	20	20
Palm kernel cake	35	20	15	-
Delonix regia seed meal	-	15	20	35
Bone meal	2	2	2	2
Salt	1	1	1	1

Three (3) replicates of each samples were grounded with a Thomas Willey Laboratory Mill-Model 4 and passed through 1-mm sieve. Proximate composition of the experimental treatments was determined according to AOAC (2000), while neutral detergent fibre (NDF) was determined according to Van Soest *et al*. (1991).

In-vitro Digestibility trial

The in-vitro trial was carried out at the laboratory of Department of Animal Science, University of Benin, Benin City, Edo State, Nigeria. The method adopted was as described by Babayemi *et al*. (2006).

Calculation for post incubation parameters

Organic matter digestibility (OMD) was estimated as: OMD = 14.88 + 0.889 GV + 0.45 CP + 0.651 ash (Menke and Steingass, 1988).

Short-chain fatty acids (SCFA) were estimated as: SCFA = 0.0239 GV − 0.0601 (Getachew *et al*., 1999).

Metabolizable energy (ME) was calculated as: ME = 2.20 + 0.136 GV + 0.057 CP + 0.00029 CF (Menke and Steingass, 1988).

The Fermentation Efficiency (FE) was calculated as: Fermentation Efficiency (FE) = Dry matter Digestibility (g/kg)/ Total Gas Volume (mL/g)

Statistical Analysis

The study was conducted using completely randomize design (CRD). All data obtained were subjected to the analysis of variance (ANOVA). Means were separated using Duncan's Multiple Range Test SAS (1999) package.

Results and Discussion

The nutrients profile and fiber fractions (DM%) of dietary inclusion of *Delonix regia* seeds meal was showed in Table 2. There was a significant difference ($P<0.05$) in the nutrients and fiber fractions (CP, EE, ash, OM, NFE, NDF, ADF and hemicellulose) across the experimental treatments. Similar ($P>0.05$) DM was recorded across the experimental treatments. The CP decreases as the inclusion of *Delonix regia* seeds meal increases, CP ranges between 10.50 – 13.60%. The CP contents of the experimental treatments (10.50 - 13.60%) were above the critical lower limit (7% CP) which forage intake by ruminants and rumen microbial activity could be negatively affected (Van Soest, 1994 and Norton, 2003). The CP content recorded for this experimental treatments was far above the 7 to 8 % CP suggested as threshold for sufficient utilization of feed by MacDonald *et al*. (1995). Therefore, the experimental treatments would provide the adequate nitrogen requirement for the rumen microorganisms to maximally digest the main components of dietary fibre leading to the production of volatile fatty acids (Trevaskis *et al*. 2001; Lamidi and Ogunkunle, 2016) which in turn facilitate microbial protein synthesis (Lamidi and Aina, 2013).

Table 2: Nutrients profile and fiber fractions (%) of dietary inclusion of *Delonix regia* seeds meal

	Experimental treatments				
Parameters	T1	T2	T3	T4	SEM
Dry matter	92.00	92.50	92.01	92.04	0.21
Crude protein	13.60^{a}	13.00^{b}	12.75^{b}	10.50^{c}	0.72
Ether extract	7.01^{c}	7.54^{bc}	8.85^{b}	10.30^{a}	0.63
Ash	5.00^{b}	12.50^{a}	7.50^{b}	7.50^{b}	0.96
Organic matter	95.00^{a}	87.50^{b}	92.50^{b}	95.00^{a}	0.93

Nitrogen free extract	58.74[a]	49.45[c]	55.40[b]	60.99[a]	1.62
Neutral detergent fibre	21.14[ab]	22.66[a]	22.70[a]	21.11[b]	0.60
Acid detergent fibre	19.77[a]	18.62[b]	18.74[b]	18.89[b]	0.36
Hemicellulose	2.34[c]	4.03[a]	3.96[b]	2.21[c]	0.41

a, b, c Means on the same row with different superscripts differ significantly (P<0.05).

Table 3 indicated the Post in-vitro parameters of dietary inclusion of *Delonix regia* seeds meal. The methane gas volume was significantly influenced with the dietary inclusion of *Delonix regia* seeds meal across the experimental treatments, T2 had the highest volume of CH_4 (0.61ml), least was recorded for T1 (0.47 ml). There was no significant difference (P>0.05) in the 24hrs gas production, CH_4 percentage, CH_4 reduction percentage, dry matter digestibility (DMD), organic matter digestibility (OMD), metabolizable energy and fermentation efficiency across the experimental treatments.

The gas production is a nutritionally wasteful product (Mauricio *et al*., 1999) but provides a useful basis from which ME, OMD and SCFA may be predicted (Fajemisin *et al*., 2015). Meanwhile, the similar value of SCFA in the experimental treatments probably showed an increased proportion of acetate and butyrate but may mean a decrease in propionate production (Babayemi *et al*., 2006).

Table 3: Post in-vitro parameters of dietary inclusion of *Delonix regia* seeds meal

	Experimental treatments				
Parameters	T1	T2	T3	T4	SEM
Gas production (24hrs)	45.33	41.33	44.00	49.33	1.59
Methane gas volume (ml)	0.47[c]	0.61[a]	0.53[ab]	0.54[ab]	0.02
Methane percentage (%)	21.33	24.67	23.33	26.67	0.51
Methane reduction percentage (%)	87.88	85.98	86.74	84.85	0.96
Short chain fatty acid	1.02	0.93	0.99	1.12	0.04
Dry matter digestibility (%)	66.93	61.00	78.03	82.30	1.63
Organic matter digestibility (%)	66.01	62.48	64.84	69.53	1.40
Metabolizable energy (MJ/kg DM)	9.58	9.03	9.40	10.12	0.22
Fermentation efficiency	1.48	1.48	1.81	1.67	0.05

a, b Means on the same row with different superscripts differ significantly (P<0.05)

Conclusion and recommendations

Conclusively, the nutrients profile of the experimental treatments justifies utilization of *Delonix regia* seeds meal for sustainable ruminant animal production considering the CP (10.50 – 13.60%). The similar value observed for the post in-vitro parameters is an indication that inclusion of *D. regia* seeds meal will be a perfect feed resources for ruminant animal production compared to other conversional feed resources such as palm kernel cake.

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Coefficient of Preference of *Panicum maximum* and Cassava Leaves Ensiled with Different Additives by West African Dwarf Goats

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Abstract

This study was carried out to investigate silage quality, chemical composition and coefficient of preference (CoP) of *Panicum maximum* and cassava leaves ensiled using four different additives such as cracked maize, pineapple, cassava peel, and sugarcane chaff at different ratio. Six treatments were formulated viz; A(50% *Panicum maximum*+30% cassava leaves +20% cracked maize), B(50% *Panicum maximum*+30% cassava leaves +20% pineapple peel), C(50% *Panicum maximum+*30% cassava leaves +20% cassava peel), D(50% *Panicum maximum* +30% cassava leaves +20% sugar cane), E(100% *Panicum maximum* and F(100% cassava leaves). Fermentation was done for 28days. Silage quality and chemical composition was determined. All the silages were fed to 13 WAD goats in a cafeteria method to determine the coefficient of preference (CoP). Data obtained were analyzed using ANOVA. Silages had pleasant and sweet odour, acceptable olive green colour, dry and moist texture, cool temperature at opening and pH range of 4.22 to 4.76. The crude protein (CP) ranged from 9.86% to 23.13%), Ash ranged from 8.81% to 11.40%), Ether extract (EE) ranged from 2.53% to 3.71%, Neutral detergent fiber (NDF) ranged between 57.43 and 69.19%, Acid detergent fibre (ADF) ranged between 38.13 and 53.15% while Acid detergent lignin (ADL) ranged between 13.46 and 19.56%. Tanin ranged between 0.017 and 0.37%, Saponin ranged from 0.217 and 0.289%. Feed intakes ranged from 0.55kg to 1.9kg. The highest COP was observed in treatment A (1.76) while the lowest was in treatment C (0.55).It was therefore concluded that treatment A was the most preferred among the diets.

Introduction

Ruminant livestock feeding system typically depends mainly on the use of native grasses, legumes and some foliage. During the dry season, the quantity and quality of these natural forages undergo drastic reduction (Babayemi, 2006) grasses wilt and most of the trees and shrubs lose their leaves. The consequent scarcity of forage thus compels the animals to consume higher quantity of less palatable species, which result in reduction of about 50% of the live weight gained during the wet season and consequently increases mortality. There is substantial restriction on the productivity of domestic goats despite ability to survive decrease in natural forage in dry seasons.

Over the years, innumerable ways of combating the problem of dry season feeding in ruminant production have been suggested. The exclusive use of roughages and concentrates has been identified as the major helping tool in this situation. Considering the current environmental degradation coupled with the recent increase in human population and their corresponding demand for animal protein, these solutions are becoming inadequate and can no longer guaranty an all year round production of animal protein. Ultimately, the critical economic situation of marginal farmers in developing countries often makes it impossible for them to afford concentrates for commercial feeding. Hence, this necessitates the use of local natural resources as sustainable alternatives (Baraza *et al*., 2008), Little research effort have been stimulated to explore the potential benefit of Guinea grass and Cassava leaves as silage for feeding ruminant in dry season. Several research results have also shown that fodders conserved in form of hay and silage also play significant role in the maintenance of ruminant productivity during this critical period. However in making silage, additive is needed to reduce oxygen and increase acidity

rapidly, so that lactic acid bacteria grow to stabilize and preserve the foliage, also to reduce the pH more rapidly so as to preserve protein and carbohydrates and inhibit the growth of micro organisms that might deteriorate the silage (Weinberg and Ashbell, 2000). The cost and availability of commercial silage additives especially molasses are often limiting factor. Crop residues or agro-industrial by-products can also serve as alternative additives. It is also important as crop residues contain polyphenoids and tannins that are known to inhibit microbial fermentation during ensiling. Four different additives for ensiling that are easily available in town were selected which have a nutritional value for ruminants animals. It includes Pineapple peel, Cassava peel, Sugarcane, and Maize.

Materials and methods

Silage Making

Guinea grass was harvested at 6week old re-growth from an established pasture land, Cassava leaves were also obtained from a post harvested cassava plantation. The two forages were chopped into 2 - 3cm length for ease of compaction and consolidation for silage and wilted for 12 hours in order to reduce the moisture content. 50% *Panicum maximum,* 30% cassava leaves and 20% each of the four different additives were ensiled. Filling and compaction was done simultaneously to eliminate inherent air. The silages were prepared in 10 kg polythene bags which serve as silo, the polythene bags were sealed and compressed with piles of heavy sand bag in 60 L buckets. Fermentation was done for 28 days. Six treatments were formulated viz; A(50% *Panicum maximum*+30% cassava leaves +20% cracked maize), B(50% *Panicum maximum*+30% cassava leaves +20% pineapple peel), C(50% *Panicum maximum+*30% cassava leaves +20% cassava peel), D(50% *Panicum maximum* +30% cassava leaves +20% sugar cane), E(100% *Panicum maximum* and F(100% cassava leaves). After 28 days, the fermentation was terminated and the silage was opened for silage quality. The assessed quality characteristics were colour, aroma, texture, pH and temperature according to Babayemi and Igbekoyi (2008). Immediately the silage was opened, a laboratory thermometer was inserted to determine the temperature; pH meter glass electrode was inserted to determine the pH. Colour assessment was ascertained using visual observation with the aid of colour charts. The aroma of the silage was relatively assessed as to whether nice, pleasant, fruity or pungent.

Chemical and statistical analysis

Crude protein, crude fiber, ether extract and ash content of the silages were carried out in triplicates as described by AOAC (1995). The fiber components including neutral detergent fiber, acid detergent fiber and acid detergent lignin were determined according to Van Soest *et al.,* (1991). Quantitative determination of tannins, saponnins and phytates were also carried out in triplicates, using the method of AOAC (1995). Data were analysed using descriptive statistics and ANOVA at $p = 0.05$.

Acceptability Study

The study was conducted at sheep and goats unit of Federal College of Animal Health and Production Technology. Eight healthy West African Dwarf goats were used to determine the coefficient of preference (CoP) of the silages in a cafeteria technique for seven days. 2kg each of the silages were served daily in six different feeding troughs to the animals. The amount consumed was monitored for four hours per day and quantity consumed was recorded. After then the animals were released to go for grazing. Feed preference was determined from the coefficient of preference (CoP) value calculated from the ratio between the intakes of each individual feed sample divided by the average intake of the all the feed samples (Karbo *et al.,* 1993). On the basis, a feed was taken to be relatively preferred if the CoP value is greater than unity.

CoP = intake of individual feed offered

Mean intake of all the feed offered

Results and Discussion

It was observed that the fermentation characteristics of the ensiled forages are normal and accepted, the temperature is cool, the texture is firm and moist, and the aroma is pleasant. The color is brownish green which shows the normal characteristics of good silage. pH ranged from 4.22 to 4.27. The crude protein content of all the silages ranged from 23.13% to 9.86% which can meet the protein requirement of ruminant and some exceed the minimum recommended range of 7.0% to 8.0% for efficient functioning of the rumen micro organism and higher than the range of 11.0% to 13.0% known to be capable of supplying adequate protein for maintenance and moderate growth in goats (NRC, 2000). It was also observed that treatment D has the highest fiber content while treatment F has the lowest which ranged from 33.29% to14.23%, high level of the fibre have been acknowledge to be inversely related to digestibility and nutrient availability (Mc Donald *et al*., 2005) Dietary fibre contribute significantly to be balancing of nutrient requirement in goats it plays a pivotal role in goats production through its influence in the interaction of the intake and digestion of nutrient. Dietary fiber intake influence mastication and rumen fermentation. In growing goat, high level of fibre depresses intake and reduces the growth rate, the ash content of the silages range from 11.29% to 8.87%. The anti nutritional factor of the ensiled forages were saponin, phytate and tannin, were determined in all the diets used. saponin is high in treatment (0.289) and low in E(0.217) . Tannin follow the same trend. The positive effect of tannin is to improve protein supply to the small intestine while the negative effect of high level of tannin reduces growth and causes health disorder. Phytate was high in E (0.245) and low in A (0.144), phytate helps preventing chronic disease in animals but it is considered anti nutrient because it binds minerals in the digestive tract making them unavailable to the body (Sehlemmer *et al*.,2009). Feed intake(kg) was highest in A (1.9kg) followed by C (1.17kg), D (1.07kg), F (0.97kg),B (0.92kg), and lowest in E (0.55kg).It was also observed that intake was directly proportional to coefficient of preference i.e. the higher the intake, the higher the co efficient of preference of (1.73kg), while F and B were similar .Coefficient of Preference (CoP) is a direct measure of acceptability and nutritional capabilities of a feedstuff. In recent times, cafeteria techniques have been used to assess the acceptability of some forage, Babayemi *et al*., 2006, silage with CoP ranging above unity were accepted or preferred.

Table 1**: fermentation characteristics of the ensiled forages**

Samples	A	B	C	D	E	F
Colour	Brownish green	Brownish green	Brownish green	Brownish green	Brownish green	Brownish green
Aroma	Pleasantly alcoholic	Pleasantly alcoholic	Pleasantly alcoholic	Pleasantly alcoholic	Pleasantly alcoholic	Pleasantly alcoholic
Texture	Firm	Firm	Firm	Firm	Firm	Firm
pH	4.26	4.25	4.23	4.22	4.26	4,27

Table 2 :Chemical Composition of the ensiled forages

SILAGE SAMPLE	%CP	%DM	%ASH	% CF	%EE	%NDF	%ADF	%ADL
A	12.68^{b}	55.15^{a}	9.22^{c}	31.20^{c}	3.18^{ab}	63.91^{c}	49.43^{c}	16.53^{c}
B	11.50^{bc}	26.21^{d}	8.81^{d}	33.29^{a}	2.53^{b}	69.19^{a}	53.15^{a}	19.56^{a}
C	12.70^{b}	30.85^{c}	9.77^{b}	32.29^{ab}	3.12^{ab}	61.49^{d}	47.35^{d}	15.76^{c}
D	11.86^{bc}	25.34^{d}	9.29^{c}	31.33^{bc}	2.85^{ab}	57.43^{e}	38.13^{e}	13.46^{d}
E	9.86^{c}	34.65^{b}	11.40^{a}	29.75^{d}	2.74^{b}	65.34^{b}	51.46^{b}	18.08^{b}
F	23.13^{a}	30.56^{c}	11.29^{a}	14.23^{e}	3.71^{a}	63.55^{c}	50.45^{bc}	16.88^{c}
SEM	0.389	0.168	0.063	0.181	0.158	0.232	0.297	0.209

Table3: Anti Nutritional Factors of the ensiled forages

SILAGE SAMPLE	%Saponin	%Tannin	%Phytate
A	0.237^{ab}	0.020^{b}	0.144^{e}
B	0.239^{ab}	0.017^{b}	0.162d^{e}
C	0.257^{ab}	0.026^{ab}	0.190^{c}
D	0.217^{b}	0.017^{b}	0.173^{cd}
E	0.289^{a}	0.037^{a}	0.245^{a}
F	0.270^{ab}	0.027^{ab}	0.222^{b}
SEM	0.010	0.003	0.003

Table 4: Feed Intake and CoP of Ensiled Forages

Silage Sample	**Feed Intake(Kg)**	**Cop**	**Ranking**

A	1.9	1.73	1
B	1.07	0.98	3
C	1.17	1.07	2
D	0.92	0.84	5
E	0.55	0.50	6
F	0.97	0.89	4

Conclusion

The chemical composition of ensiled forages revealed that they have good level of nutrient, the Crude Protein meet the protein requirement of ruminants and capable of supplying adequate protein for maintenance and moderate growth and coefficient of preference shows good acceptability level which is guaranteed in cracked maize silage.

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HAEMATOLOGICAL AND SERUM PARAMETERS OF WEST AFRICAN DWARF SHEEP FED CROP RESIDUE MIXTURES AND UNRIPE PLANTAIN PEELS

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Abstract

This study was conducted to determine the effect of feeding mixed ration of blended crop residues supplemented with unripe plantain peel on the haematological and serum biochemical parameters of West African dwarf (WAD) sheep. Sixteen (16) growing female WAD sheep with average live weight of 8.10 ± 0.16kg were randomly allotted into four (4) dietary treatments in a complete randomised design with four animals per replicate. The results showed that packed cell volume (PCV), Haemoglobin (Hb) and red blood cell (RBC) values of sheep fed diets 4 (52.00 %, 16.95 g/dL and 14.25 ($x10^6$ µL)) was significantly higher than the range of values of PVC (33.00-45.00%) and Hb (10.65-14.65 g/dL) and RBC (11.79-13.29 ($x10^6$ µL) obtained for sheep fed diets 1, 2 and 3, respectively. The Serum protein, albumin, and glucose differed ($p<0.05$) significantly across the treatments while other serum parameters (cholesterol, creatinine, and blood urea nitrogen) were not significantly ($p>0.05$) different. The results obtained in this study implied that mixed ration of blended crop residues supplemented with unripe plantain peel had no deleterious effects on the health status of the WAD sheep.

Keywords: Blood parameters, crop residues ration, unripe plantain peel, sheep.

Introduction

Crop residues and agro-industrial by-products are major alternative feed resources of small ruminant often utilized to salvage dry season feed challenges. However, arbitrary combination of crop residues as ration for ruminants in confinement by smallholder farmers without due consideration to the proportions and nutritive values results in poor performance. About 18% of annual dry matter intake of ruminants is from crop residues (Olayiwola and Olorunju, 1987). Prominent among these crop residues are cassava peel, cowpea husk, groundnut haulm, corncob and plantain peels whose abundance depend on the agro-ecological zones where they are cultivated. The nutritional quality of crop residues when incorporated into ruminant diets is well documented (Aregheore, 2000). The plane of nutrition interferes with the blood metabolites, other constituents in the blood and health status of an animal. Hence, haematological and serum biochemistry assays are necessary to diagnosing nutrient deficiency, physiology and health status of farm animals especially those kept under native husbandry system (Daramola *et al*., 2005). Considering the nutritional limitations of crop residues as rations for small ruminant particularly in the dry season, this study was designed to determine the effect of feeding mixed ration of blended crop residues supplemented with unripe plantain peel on the haematological and serum biochemical parameters of West African dwarf (WAD) sheep.

Materials and methods:

The experiment was conducted at the sheep and goat unit of the Institute of Agricultural Research and Training, Moor Plantation, Ibadan. Prior to commencement of the experiment, animals were given

prophylactic treatments against ecto and endo-parasites. The animals were adjusted to their treatments diets over a 2-week preliminary period, which was followed by 84-day feeding trial. Sixteen (16) WAD female sheep with the average live weight of 8.10 ± 0.16kg were randomly allotted to individual pens and to one of four (4) treatments diets in a complete randomized design with four animals per replicate.

Feeding and collection of blood

Crop residue mixtures as indicated in Table 1 (Diet 1 to Diet 4) were offered separately to individual animals at 3% body weight at 08:00h. Unripe plantain peel was offered to all the sheep at 2% body weight at 16:00h. Provision was made for a daily feed allowance of 10% above the previous week's consumption. Clean water was served *ad libitum*. At the end of the feeding trial, two sets of blood samples (approximately 10 ml) were collected from each sheep through jugular vein puncture using a 10mL syringe fitted with a needle before feeding. Blood, 5mL was drawn into labelled heparinized tubes to prevent coagulation for determination of haematological parameters. The remaining 5 mL blood sample for serum analysis was drawn into EDTA free bottles, allowed to coagulate at room temperature and centrifuged for 5 min at 3000 rpm. The supernatant sera were then stored in a freezer for subsequent biochemical analysis.

Table 2: Ingredient composition (g/100g DM) of the experimental diets

Ingredients (kg)	Diet 1	Diet 2	Diet 3	Diet 4
Dried Corn cob	53.0	-----	------	-----
Palm kernel sludge	30.0	30.0	30.0	30.0
Soya bean hull	12.0	12.0	12.0	12.0
Dried Cassava peel	----	53.0	-----	-----
Groundnut haulm	----	---	53.0	------
Cowpea husk	----	---	------	53.0
Gliricidia sepium	4.5	4.5	4.5	4.5
Salt	0.5	0.5	0.5	0.5
Total	**100**	**100**	**100**	**100**

Chemical analysis of experimental diet, blood samples and Statistical Analysis

Dried samples of the experimental diets (crop residue mixtures and unripe plantain peel) were analyzed according to the standard proximate procedures (AOAC, 2000). The packed cell volume (PCV) was estimated by the method of Jain (1993), and hemoglobin (Hb) concentration according to the method of Schalm *et al*. (1975). Red blood cell (RBC), total white blood cell count (WBC) and differential WBC counts were determined using the Neubauer hemocytometer counting chamber. Serum total protein and albumin were determined by the method of Peters *et al*. (1984) and globulin according to Coles (1986). Blood Urea Nitrogen and glucose were determined by an enzymatic colorimetric method (Helmut and Yvette, 1959). Creatinine was determined by the method of Bonsnes and Taussky (1945) while cholesterol was determined by the method of Allain *et al*. (1974). Data obtained were subjected to Analysis of Variance (ANOVA) for completely randomized design. Least significant difference (LSD) statistics were used to detect significant differences among means at $p< 0.05$.

Table 2: Proximate composition (g/100g DM) of experimental diets and unripe plantain peel

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	Plantain peel	SEM
Dry matter	86.11^{e}	88.50^{b}	88.35^{c}	89.43^{a}	87.17^{d}	0.30
Crude protein	5.20^{e}	15.34^{b}	14.82^{c}	17.33^{a}	5.42^{d}	1.39
Crude fibre	31.66^{a}	27.88^{c}	21.86^{d}	29.13^{b}	16.88^{e}	1.43
Ash	5.78^{b}	4.71^{c}	4.30^{e}	5.90^{a}	4.37^{d}	0.18
Ether extract	1.06^{e}	2.94^{c}	2.85^{d}	3.66^{a}	3.20^{b}	0.23
Nitrogen free extract	56.30^{b}	49.13^{d}	56.17^{c}	43.98^{e}	70.13^{a}	2.88

abcd= Means on the same row with different superscripts are significantly different (p<0.05)

Table 3: Haematological parameters of West African dwarf (WAD) sheep fed crop residue mixtures and unripe plantain peel

Parameter	T1	T2	T3	T4	SEM	P-value
PCV (%)	33.00[b]	43.50[ab]	45.00[ab]	52.00[a]	3.00	0.1517
Hb (g/dL)	10.65[b]	14.20[ab]	14.65[ab]	16.95[a]	1.00	0.1550
RBC (x10^6 µL)	11.79[b]	12.84[ab]	13.29[ab]	14.25[a]	0.39	0.1369
WBC (x 10^3 µL)	7.40	8.43	6.65	6.55	0.04	0.4049
Lymphocyte (%)	63.50	62.00	59.50	61.00	1.29	0.7937
Neutrophils (%)	32.50	33.50	34.00	35.00	1.14	0.9206
Platelets (10^3/µL)	156.0[bc]	184.0[ab]	122.0[c]	216.5[a]	12.04	0.0071

[abc]= Means on the same row with different superscripts are significantly different (p<0.05).
PCV= Packed cell volume; Hb= Haemoglobin; RBC= Red blood cell; WBC= White blood cell.

The results of haematological and serum parameters of West African dwarf sheep fed unripe plantain peel supplemented with crop residue mixtures is presented in Table 3. The Packed Cell Volume (PCV), Haemoglobin (Hb), Red Blood Cell (RBC) and platelets differed significantly (p<0.05), while the white blood cell (WBC), lymphocyte and neutrophils were significantly similar (p>0.05) across the treatments. Unlike the range of values of PVC (33.00-45.00%) and Hb (10.65-14.65 g/dL) obtained for sheep fed diets 1, 2 and 3, respectively, the PCV and Hb values of sheep fed diets 4 (52.00 % and 16.95g/dL) was above the normal reference values (27-45% and 9-15 g/dL) reported by Radosti *et al*. (2006) for sheep. However, the values of RBC, WBC, lymphocyte, neutrophils and platelets across the treatments fell within the normal reference values reported (Radosti *et al*., 2006) for sheep. Except for the higher values of PCV and Hb of sheep fed diet 4, other haematological parameters in this study agrees with the findings of Ogundipe and Akinlade (2016) for WAD sheep fed a basal diet of cassava peel supplemented with fresh *gliricidia sepium* leaves.

Table 4: Serum biochemical parameters of West African dwarf (WAD) sheep fed crop residue mixtures and unripe plantain peel

Parameter	T1	T2	T3	T4	SEM	P-value
Total protein (g/dL)	9.61[a]	9.06[ab]	8.68[b]	9.78[a]	0.17	0.0644
Albumin (g/dL)	2.69[b]	2.42[b]	2.49[b]	4.36[a]	0.28	0.0132
Globulin (g/dL)	6.92	6.64	6.19	5.42	0.28	0.2665
Cholesterol (mg/dL)	22.39	15.50	22.16	16.14	1.35	0.0988
Glucose (mg/dL)	32.68[c]	94.83[a]	41.38[c]	61.21[b]	7.32	<.0001
Creatinine (mg/dL)	1.55	1.80	2.00	1.45	0.12	0.3934
BUN (mg/dL)	23.49	20.62	21.48	20.89	0.53	0.2191

[abc]= Means on the same row with different superscripts are significantly different (p<0.05).
BUN= Blood Urea Nitrogen

Serum protein, albumin, and glucose differed (p<0.05) significantly across the treatments while the cholesterol, creatinine, and blood urea nitrogen levels were not significantly (p>0.05) different (Table 4). Total serum protein (8.68 to 9.78 g/dL) across the treatment in this study was above the normal range (6.0–7.9 g/dL), ditto the albumin (4.36 g/dL) of sheep fed diet 4, as reported by Mitruka and Rawnsley (1977) for healthy sheep. Serum glucose values of sheep fed diet 2 (94.83 mg/dL) and diet 4 (61.21 mg/dL) respectively, fell within the normal range (55.0-131.00 mg/dL) reported by Mitruka and Rawnsley (1977). However, the values of cholesterol (15.50-22.39 mg/dL) obtained across the treatments

was below the normal range (50.00-140.00 mg/dL) reported by Mitruka and Rawnsley, (1977). The low level of cholesterol is an indication that crop residues based diets are low in water soluble carbohydrate and energy, which could lead to deposition of fats in tissues. Although the range of values of blood urea nitrogen (20.62-23.49 mg/dL) obtained in this study differed from serum urea values (12.68-17.02 mg/dL) reported by Jiwuba *et al*. (2017), the range of creatinine (1.45-2.00 mg/dL) obtained in this study fell within the creatinine levels (1.61-1.89 mg/dL) for WAD sheep (Jiwuba *et al*., 2017). All the results obtained implied that the experimental diets had no deleterious effect on the health status of WAD sheep.

Conclusion

The haematological and serum biochemical parameters for West African dwarf sheep fed crop residues mixtures supplemented with unripe plantain peel fell within the normal reference values for apparently healthy sheep. Therefore, crop residue mixtures and unripe plantain peel can be fed to WAD sheep to reduce dry season feed crisis without any detrimental effect on nutritional and health status of the animal.

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HERBAGE, GRAIN AND LEAF DRY MATTER YIELD OF SOME TROPICAL FORAGE LEGUMES IN THE SOUTHERN GUINEA SAVANNA OF NIGERIA.

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ABSTRACT
The southern guinea savanna agro-ecological zone of Benue State is endowed with natural grassland dominated by un-improved forage species, mainly grasses. A two year study was therefore conducted at Makurdi, Southern Guinea Savanna Agro-ecological zone of Benue State, Nigeria to evaluate the adaptability and performance of ten (10) improved forage legume species obtained from National Animal Production Research Institute (NAPRI). Data collected include; fresh herbage yield, grain yield and leaf dry matter. The results showed significant (P<0.05) differences among the 10 forage legume species for fresh herbage yield, grain yield and dry matter yield. The Fresh herbage yield of the legume species in the field ranged from 15.85 t/ha to 216.16 t/ha for Leucaena leucocephala and Cajanus cajan. The grain yield in the field ranged from 0.81 t/ha for Leucaena leucocephala to 9.13 t/ha for Mucuna pruriens (white seeded). The leaf dry matter yield ranged from 0.37 t/ha for Leucaena leucocephala to 4.40 t/ha for Lablab purpureus. Generally, in the pot, mean values obtained were similar. In conclusion, the forage legume species under study have the ability to adapt, establish and yield favourably in the southern guinea savanna zone of Nigeria.

Keywords: Herbage, grains, Dry matter, Yield, Forage Legumes.

INTRODUCTION
Scientists in Nigeria have identified suitable pasture plants to meet the variations of the agro-ecological zones, therefore, different grasses and legumes are found in the different agro-ecological zones (Agishi, 1983). A wide range of legumes are available, with each species having its own agronomic requirements, thus, making it more or less suitable for a particular producer's purpose. Given that seedling establishment and growth can be influenced by multiple environmental factors (Zheng *et al*., 2005), detailed information on the emergence, growth and development of legume forage seedlings under different environmental factors are required for devising appropriate management practices and choosing the right species (Sanderson and Elwinger, 2004). Herdsmen and rural livestock farmers within the southern guinea savanna zone particularly in Benue state have been plagued with gross inadequacy of nutritious pasture. It has further led to the incessant resource conflicts between herdsmen and rural crop farmers as a result of indiscriminate and unconsented encroachment of farmlands with cultivated crops not yet harvested by grazing cattle in search for nutritious feed. Abayomi *et al.* (2001) have evaluated legume cover crops but this study will have a wider scope of forage legume species for performance evaluation.

MATERIALS AND METHODS
The study was conducted from May to November, in 2015 and 2016 cropping seasons at the Pasture field of the Livestock Teaching and Research Farm, College of Animal Science of the

University of Agriculture, Makurdi, Nigeria. Makurdi is located at latitude 07° 41' N, longitude 08° 37'E and altitude 106.4 m (NIMET, 2016). Seeds of ten (10) forage legume species: (*Cajanus cajan* (L) Millsp, *Stylosanthes hamata* (Verano), *Centrosema pubescens* (Centro), *Mucuna pruriens-white seeded, Alysicarpus vaginalis, Desmodium intortum, Lablab purpureus* (Rongai), *Mucuna pruriens-black seeded, Aeschynomene americanum and Centrosema pascuorum* (Centro) obtained from Feeds and Nutrition Research Programme of National Animal Production Research Institute (NAPRI), Shika, Zaria were used for the study. A digital weighing scale was used weight of the samples. The ten line plots were arranged in a randomized complete block design (RCBD) with three replicates for the field experiment, while a completely randomized design (CRD) was adopted for the pot experiment and replicated three times as well. The total plot size was 12 m x 6 m with each unit plot having a size of 1.5 m x 0.5 m. The seeds were sown using the sowing depth specifications for each legume species. Data on fresh herbage yield per plot per hectare was taken by weighing the fresh portion of the whole plant after harvest at maturity and grain yield (t/ha) was taken by weighing only the grains harvested at maturity. Data on leaf dry matter yield was taken by oven drying the leaves of the whole plant at constant weight. Data generated was subjected to analysis of variance (ANOVA) using the Minitab Statistical Software (MSS) (Version 16) (2016) for both field and pot experiments. Means that showed significant differences were subjected to mean separation using the Fisher's Least significant difference (LSD) of the MSS at the 5% level of probability ($P \leq 0.05$).

RESULTS AND DISCUSSION

Table 1: Mean Squares for Fresh Herbage Yield, Grain Yield and Dry Matter Yield after Sowing (Field Experiment).

Source of Variation	DF	(FHY)	(GY)	(LDM)
Replication	2	0.17	0.0315	0.00248
Treatment	9	8782.84*	25.8278*	3.74549*
Error	18	0.06	0.0186	0.00121

DF: Degree of Freedom; FHY: Fresh Herbage Yield; GY: Grain Yield; DM: Dry Matter

Table 2: Fresh Herbage Yield, Grain Yield and Dry Matter Yield after Sowing (Pot Experiment).

Source of Variation	DF	(FHY)	(GY)	(LDM)
Treatment	10	13764*	31.8338*	3.90800 *
Error	20	246	0.0340	0.00159

DF: Degree of Freedom; FHY: Fresh Herbage Yield; GY: Grain Yield; DM: Dry Matter

Table 3: Mean Values of Fresh Herbage Yield (t/ha), Grain Yield (t/ha) and Leaf Dry Matter Yield of the Forage Legumes Species at Maturity.

Specie	Herbage Yield		Grain Yield		Leaf Dry Matter	
	Field	Pot	Field	Pot	Field	Pot
Cajanus cajan	216. 16^{a}	267.33^{a}	3.52^{e}	3.67^{c}	1.53^{e}	1.61^{d}
Stylosanthes hamata	35.77^{j}	39.43^{de}	1.15^{i}	1.15^{g}	0.54^{j}	0.61^{h}
Centrosema pubescens	38.05^{h}	42.44^{de}	4.50^{c}	4.86^{b}	0.64^{i}	0.68^{g}
M. pruriens (white)	58.34^{g}	64.89^{cd}	9.13^{a}	9.95^{a}	1.63^{d}	1.72^{c}
Alysicarpus vaginalis	35.07^{j}	38.49^{de}	1.46^{h}	1.51^{f}	0.87^{g}	0.89^{f}
Desmodium intortum	36.12^{i}	39.82^{de}	1.84^{g}	1.74^{ef}	0.78^{h}	0.85^{f}
Lablab purpureus	74.17^{c}	79.93^{bc}	2.46^{f}	2.70^{d}	4.40^{a}	4.53^{a}
M. pruriens (black)	63.23^{e}	69.48^{c}	8.89^{b}	9.72^{a}	1.67^{c}	1.70^{c}
A. americanum	89.09^{b}	97.67^{b}	1.92^{g}	1.97^{e}	2.20^{b}	2.30^{b}
Centrosema pascuorum	65.32^{d}	72.18^{bc}	4.69^{d}	5.09^{b}	1.28^{f}	1.38^{e}
SEM	**0.252**	**15.69**	**0.136**	**0.184**	**0.035**	**0.040**

a, b, c = Means on the same column with different superscripts are significantly (P<0.05) different. SEM: Standard Error of Mean

The high fresh herbage and grain yield reported for *Cajanus cajan, Aeschynomena americanum, Lablab purpureus, Centrosema pascuorum, Centrosema pubescens* and *Mucuna pruriens* (White and black seeded) could be attributed to the favorable growing conditions in this location which can adequately provide feed for better livestock production in the location. This report agrees with Norton (1994b) which stated that animals with access to more leguminous forage crops perform better than those kept on natural grassland in milk yield, weight gain, reproductive performances and survival rates. Variations in the fresh herbage yield between *Centrosema pascuorum* and *Centrosema pubescens* could be attributed to differences in the genetic composition of both varieties. The high herbage and grain yield for *Centrosema pubescens, Mucuna pruriens* (white and black seeded) and *Centrosema pascuorum* indicates an advantage in forage legume production for livestock feeding as pasture producers can select for pasture establishment and seed production. The low grain yield reported for *Cajanus cajan, Lablab purpureus, Aeschynomena americanum* and *Stylosanthes hamata* indicates that these species can be selected for their potential for forage production only. The leaf dry matter (LDM) yield reported for *Lablab purpureus, Aeschynomena americanum, Mucuna pruriens* (white and black seeded) and *Centrosema pascuorum* was highest out of the ten forage legume species evaluated in this study which suggests that they have potential for producing adequate feed required for livestock production in the location. The LDM yield of *Lablab purpureus, Aeschynomena americanum* and *Centrosema pascuorum* were lower than that reported by Nworgu and Ajayi

(2005) which could be attributed to the level of soil fertility, climatic zones, seasons and agronomic practices adopted.

CONCLUSON

This work has demonstrated that the forage legume species under study have the tenacity to adapt and establish favourably in the southern guinea savanna zone of Nigeria. It is recommended that *Cajanus cajan, Lablab purpureus, Centrosema pascuorum, Centrosema pubescens* and *Mucuna pruriens* (White and black seeded) be adopted by livestock farmers and pasture agronomists in this location to establish ranches, fodder banks and produce seeds based on their ability to adapt, establish and to meet nutrient requirements for ruminants.

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INFLUENCE OF FICUS LEAF MEAL BASED DIET ON SOME BLOOD AND RUMEN METABOLITES OF GROWING BUNAJI BULLS

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Abstract
A study was conducted to evaluate the influence of inclusion of *Ficus thonningii* leaf meal (FTLM) in a CSC based diet for growing Bunaji bulls on some rumen metabolites. FTLM was included at 0 and 10, 20 and 30 % in the diets. The pH values observed in the rumen fluid was similar (P>0.05) across dietary treatments. Rumen ammonia nitrogen and total volatile fatty acid (TVFA) were higher (P<0.05) at 0 and 10 % inclusion levels as compared to 20 and 30 % inclusion levels. Blood urea nitrogen (BUN) was highest (P<0.05) at 30 % inclusion level (3.87 mmol/L) compared to 0% inclusion level (1.83 mmol/L). Creatinine level was also highest (P<0.05) in 30 % FTLM (55.00 µmol/L), while glucose level was highest (P<0.05) at 10 % inclusion level (7.13 mmol/L). Inclusion of FTLM in the diet of growing Bunaji bulls up to 10% has no any detrimental effect on some of rumen and blood metabolites.

Keywords: Bunaji bull, blood profile, *Ficus thonningii*, rumen indices, cotton seed cake.

Introduction

Leaf meal of browse trees and shrubs, when used as supplement, offers a good source of easily digestible and extractable protein (Iyayi, 1991). Apart from the protein, they contain 2-8 per cent fatty acids, which play an important role in ruminant nutrition. Browse fodder trees or shrub form an integral part of tropical and sub tropical farming system (Smith, 1993). Ficus species belong to the family Moraceae. The characteristic of this family have been described by Keay *et al.* (1964) but the main features include possession of latex, alternate leaves, paired stipules, minute flowers crowded in highly specialized inflorescences. The proximate analysis of the leaves of some Ficus species in northern Guinea Savannah of Nigeria to range from 8.9 to 25.9% (Abdu *et al.,* 2012). Abdu *et al.* (2012) reported significant effect of *F. sycomorus* leaf meal supplementation on voluntary feed intake, nutrient digestibility and nitrogen balance in Yankasa bucks. Majority of work reported on Ficus has been on (Bamikole *et al.,* 2001), goats (Abdu *et al,.* 2012) and (Bamikole *et al.,* 2001) on WAD goat and rabbit (Jokthan *et al.,* 2003). These works have revealed the potentials of Ficus as dry season feed but there is scanty information on the use of Ficus foliage for feeding cattle in literature. The aim of this work was to evaluate some blood and rumen metabolites in Bunaji bulls fed *F. thonningii* leaf meal.

Materials and Methods

The study was conducted at the National Animal Production Research Institute, Ahmadu Bello University, Zaria. It is located within the northern Guinea Savannah zone of Nigeria at latitude 11^0 09' 06'' N, longitude 7^0 38' 55" and altitude of 706m above sea level (E-trex legent GPS instrument, 2016). Twelve growing Bunaji bulls, between the age of 12 and15 months and with an average body weight of 150 kg, were randomly grouped into four groups of three animals per group, and each group were assigned randomly to one of four dietary treatments. The dietary treatments consisted of inclusion levels of *Ficus thoningii* leaf meals at 0, 10, 20, and 30 percent in a concentrate diet and fed at 1.5% of their body weight in addition, they were fed basal diet of D. Smutsii hay adlibitum at two instalment. The experiment lasted for 90 days. The ingredient and chemical composition of the feeds is shown in (Table 1). Rumen fluid samples were collected, strained through double layers of cheese cloth and stored in plastic bottles containing equal quantity of 0.1N H_2SO_4 to trap the ammonia. Immediately after collection, temperature and pH were recorded using digital hand thermometer and Henna Digital Hand

EVALUATION OF THE QUALITY OF SOME PROCESSED MEAT PRODUCTS: KILISHI, BEEF SUYA AND CHICKEN SUYA

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ABSTRACT

Ready to eat kilishi, beef suya and chicken suya samples were collected from different locations within Enugu state and Abuja district part of Nigeria. Studies on the physicochemical properties, lipid profile and microbiological of kilishi, beef suya and chicken suya quality were carried out. The study was conducted using a completely randomized design (CRD). Results showed that there were significant differences in all the physiochemical properties (moisture content, water activity, and relative humidity, protein and water absorption capacity) of all the meat samples. There were also significant differences among the samples in total cholesterol and triglycerides. Significant differences equally showed in microbial counts (total microbial count and coliforms. The results revealed that meat products have inherent capacity of being contaminated by microorganisms.

Keywords: quality, processed meat, Kilish, Beef suya and Chicken suya

INTRODUCTION

Meat is the edible part of an animal used as food obtained after slaughter (Lawrie, 1998).According to Hui *et a*l. (2001) it is the whole or part of the carcass of animals. Processed meat means a product containing no less than 30% moisture, that has undergone a method of preservation other than freezing, and includes manufactured meat and cured and/or dried meat (e.g. sausages, salami, canned meats) (Brown, 2009). The quality of these processed meats has to be taking into consideration for healthy living. This study therefore aimed at evaluating the quality of some processed meat in the market.

MATERIAL AND METHODS

The study was conducted in the Food Science and Technology Laboratory University of Nigeria Nsukka.

Sample collection

Beef suya was procured from Ogige market, along Enugu road, Nsukka.

Kilishi was procured from Abuja Northern part of Nigeria.

Chicken suya was procured from Ogige market, along Enugu road, Nsukka.

Determination of pH: The pH was determined using pH meter model 20 (Denver instrument).

Determination of water activity: The water activity (aW) of the meat was determined using water activity meter (Model 5803

Determination of moisture content: This was determined by the hot air oven method of AOAC (2010).
Determination of soluble proteins: The nitrogen content of each fraction of the filtrate (T_1) and the residue (T_2) were determined according to micro – kjeldahl method.
Relative humidity: The relative humidity of the meat sample was measured using digital relative humidity indicator (Vaisala temperature and relative humidity indicator HM131, Vantaa, Finland).
Mould count determination: this was determined according to Harrigan and McCance (1976),
Determination of total microbial count: Nutrient agar was used to determine total microbial count.
Experimental design and data analysis: The study was conducted using a completely randomized design (CRD). Data generated were subjected to the analysis of variance (ANOVA) using statistical product for social sciences (SPSS 2003) version 16.0.

Result and Discussion

The analysis of physicochemical properties (moisture content, water activity, pH, relative humidity, protein and water absorption capacity) of kilishi, beef suya and chicken suya are presented in **table 1 below**.

Moisture content (MC): Smoked chicken had significantly ($p<0.05$) higher moisture content (59.05±0.14%) than suya (29.9±0.01%) and kilishi at (4.52±0.01%). Kilishi had the least moisture content.

Water activity (WA): The water activity (0.13±0.01) of kilishi was significantly ($p<0.05$) lower than that of suya (0.25±0.01) and that (0.55±0.01) chicken. This result indicated that smoked chicken had the highest water activity, while kilishi had lowest water activity.

pH: The results indicated that the pH (8.0±0.03) of smoked chicken was significantly ($p<0.05$) higher than the Ph of suya (7.10±0.14) and the pH of kilishi (5.80±0.14). This showed that kilishi was slightly acidic with pH 5.8; suya meat had a neutral pH at 7.1, while smoked chicken was slightly alkaline.

Relative humidity (RH): Smoked chicken had significantly ($p<0.05$) higher percentage of water vapour (55.0±1.41) than suya and kilishi, followed by suya with water vapour %of (25.0±1.41). Kilishi had the least percentage of water vapour (5.80±0.14).

Protein (%): The result showed that the protein content (95.19±0.01) of suya was significantly ($p<0.05$) higher than those of kilishi and smoked chicken, followed by kilishi with a protein content of (43.37±0.01). Smoked chicken had least protein content.

Water absorption capacity (WAC): The water absorption capacity value of kilishi was significantly ($p < 0.05$) higher than the values for chicken (167 ± 1.41) and suya (95.19 ± 0.01).

Table1. Shows the physicochemical properties of the meat samples evaluated

Samples	MC%	WA	pH	RH%	Protein	WAC%
KS	4.52^{c}±0.01	0.13^{c}±0.01	5.80^{c}±0.14	13.2^{c}±0.14	43.37^{a}±0.01	175.0^{a}±1.41
BS	29.9^{b} ±0.01	0.25^{b}±0.01	7.10^{b} ±0.14	25.0^{b}±1.41	95.19^{b}±0.01	95.19^{b}±0.01

CS	59.70 [a]±0.14	0.55 [a]±0.01	8.0 [a]±0.03	55.o [a]±1.41	24.0 [c]±0.01	167.0[b]±1.41

MOISTURE CONTENT: Kilishi had the least moisture content. The low moisture content of kilishi compared to that of raw meat could be attributed to the step-wise drying in kilishi processing technique (Ogunsola and Omojola, 2008)**.** The reduction in moisture content of kilishi is desirable as this can affect the storage quality (Apata *et al.,* 2013). The essential feature of this method of preservation is that the water activity of the meat is reduced to a level below that at which microorganisms cannot grow (Konieczny and Bilska, 2006).

Water activity: In this present study, the lower value of the water activity of kilishi implied that klish is likely to last long in terms of storage and its quality conserved than beef and chicken suyas. This is in agreement with Van Den Berg and Bruin (1981) who reported that water activity plays a critical role in the fungal spoilage of meat.

PH: The results of the present study indicated that the pH of smoked chicken was higher than the pH of suya and Ph of kilish. This showed that kilishi was slightly acidic with pH of 5.8. This supports the assertion of FAO (2007) that reported that the shelf-life of meat and meat products will be longer when the pH-value is low. This indicates that the process of drying kilish more than other sample affected it and it suggests that it will last longer in preservation.

Protein (%): The result of this study indicates that suya had higher nutritional value (in terms of protein) than kilishi and smoked chicken. According to Ikeme (1990), the protein content of fresh meat is 19%. This indicates that processing meat into suya improves the percentage protein of the product thus increasing nutrient density. The protein content obtained can be attributed to the various ingredients utilized in the suya and *kilishi*preparation like groundnut cake paste, which was not used in smoked chicken and this is in agreement with report by Igene *et al.* (1993) that reported that Groundnut cake has 55.85% crude protein.

Relative humidity: Smoked chicken had significantly higher percentage of water vapour at than suya and kilishi. Generally, the higher humidity, the more rapid the chemical attack. However, shelf-life is limited by water-vapour loss, which is diminished in the presence of high humidity (Rabinow and Roseman, 2000). Contamination from liquid moisture can then encourage mould and bacterial growth.

Table 2 shows the results of lipid profile of the meat samples evaluated

The Lipid contents of the beef suya, kilishi and chicken suya were analysed in terms cholesterol and triglyceride contents of the meat samples.

Total cholesterol (TCH): This result showed that the cholesterol of suya (113.0±7.07) was significantly higher than the total cholesterol in kilishi (85.00±1.41) and smoked chicken (79.00±7.07

Triglycerides (TRG): Results indicated that the triglyceride content of (98.50±13.43) suya was significantly ($p<0.05$) higher than that of smoked chicken (1.18±1.41) and kilishi (1.25±1.41).

Table 2: shows the lipid profile of the meat samples evaluated

SAMPLES	TCH(Mg/dl)	TRG(Mg/dl)

Kilishi	85.00[b]±1.41	1.25[a]±1.41
BS	113.00[a]±7.07	98.50[b]±13.43
CS	79.00 [b]±7.07	1.18 [b]±0.71

Total cholesterol: The high cholesterol in beef suya from this experiment may be due to the known fact that red meat is high in cholesterol as proposed by (Hui *et al*.., 2000).

Triglycerides: Higher fat content of suya in this study could be due to the residual oil in the defatted groundnut cake used in the preparation of suya and kilishi coupled with the fact that beef has more lipid content than chicken. Igene (1988) noted that kilishi is very high in lipid content on dry matter basis (25.23%), this consisting mostly of triglycerides.

Table 3 shows the results of microbial counts of the meat samples evaluated

Total microbial count (TMC): The colony formimg unit per gram of the total microbial count were determined and the results indicated that the total microbial count (2.50±0.01) of smoked chicken was significantly ($p<0.05$) higher than that of (1.70±0.01) suya and that of (2.00±0.01) kilishi. While the TMC of (2.00±0.01) kilishi is significantly ($p<0.05$) higher than (1.70±0.01) suya.

Coliforms: The results of the coliforms indicated that the colony forming unit per gram of meat of suya was significantly ($p<0.05$) higher than that of smoked chicken (3.00±0.01) and kilishi (0.00±0.00).There was also a significant difference between the cfu values of smoked chicken and kilish

Table 3: The microbial counts of the meat samples evaluated

Samples	TMC(cfu/g)	Coliforms(cfu/g)	Mould(cfu/g)
KS	2.00±0.01[C]	0.00±0.00[c]	0.00±0.00
BS	1.70±0.01[b]	6.00±0.01[a]	0.00±0.00
CS	2.50±0.01[a]	3.00±0.01[b]	0.00±0.00

Total microbial count: The results signified that that there was bacterial contamination of smoked chicken, kirishi and suya. This contamination could be as a result of processing method used or cross contamination by meat handlers or due to the unsanitary condition of the workers. This is in agreement with the report of Clarence *et al.* (2009) who stressed on the need to improve the hygienic and sanitary practices employed in production of ready to eat food products.

Coliforms: The relatively higher bacterial counts on smoked chicken could be due to higher moisture content and methods of processing. This supports the findings that the degree of meat spoilage is usually influenced in part by the microbial load at the beginning of production, packaging and handling of the finished product Uzeh *et al.*, (2006).

.**CONCLUSION**

The results revealed that meat products have inherent capacity of being contaminated by microorganisms. It is therefore recommended that effective precautionary measures must be taken to prevent the contamination of sampled meat ready to eat by microorganisms.

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Animal Products and Processing

MICROBIOLOGICAL ANALYSIS OF READY-TO-EAT *BALANGU* MEAT SOLD IN HADEJIA LOCAL GOVERNMENT AREA, JIGAWA STATE, NIGERIA

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Abstract
Ready-to-eat *balangu* samples were collected from three popular 'meat spots' within Hadejia Local Government Area, Jigawa State, Nigeria. Three samples from each outlet were collected fortnightly from 3rd to 17 April, 2018 into sterile plastic bags, stored at 4 ^{O}C in ice chest filled with ice and transported immediate to the laboratory for total viable count, total coliform count, total staphylococcus count and total fungal count analyses using nutrient agar, mac conkey agar, mannitol salt agar and potato dextrose agar, respectively and incubated at 37 ^{0}C for 24 hours except for the detection of fungi, which was incubated at 25 ^{0}C for 5 days. Microbiological analysis of the samples was carried out and the isolate was *Staphylococcus aureus.* Total viable count of raw meat and *balangu* ranged from 6.8 x 10^6 to 8.7 x 10^6 and 1.7 x 10^6 to 5.0 x 10^3, respectively. *Balangu* samples from Atafi had the highest total coliform count and total fungal count of 4.0 x 10^2 and 2.0 x 10^2, respectively while that from Yayari has the lowest total coliform count and total fungal count of 2.9 x 10^2 and 0.0 x 10^1, respectively. The presence of bacteria on raw meat and *balangu* sold in the study area is an indication of low standard of animal and meat handling practices from pre-slaughter to post–slaughter, sales of meat, abattoir facilities and equipment.
Keywords: *Balangu*, Microbiological, Sold, Hadejia and Jigawa

Introduction

Meat is a flesh of animals which serves as food. It is obtained from sheep, cattle, goat and swine (Haman, 1977). Meat is a major source of protein and important source of vitamins for most people in many parts of the world thus it is essential for the growth, repair and maintenance of body cells which are necessary for our everyday activities. Consumption of meat could be traced back in history to the period when primitive man ate raw flesh of animals and later developed the art of domestication of wild animals (Hassan *et al.*, 2014).

Balangu is a boneless meat of a sizeable cut roasted by placing it on a brown paper over a wire mesh. The pieces of meat were sliced into thin sheets of not less than 1 cm in thickness. Groundnut oil, spices and salt were sprinkled during roasting. The meat was continuously turned over until it was well roasted (Abubakar *et al.,* 2011).

Meat contaminate to unsafe level at the point of consumption with air flora and other microorganisms from handlers, equipment and utensils (trays, spoons, knives etc) is possible, although epidemiological evidence on outbreaks of meat-borne diseases is scarce but pathogenic microorganisms have been implicated in roasted meat products (Abdullahi *et al*., 2006; Edema *et al*., 2008; Ogbonna *et al*., 2012).

The microbial load in meat and meat products increase as long as growth conditions are favorable. The factors influencing microbial growth include acidity, pH, temperature, water activity, gaseous requirement, nutrients and competition of microbes for the nutrients. Controlling these factors implies maintaining long shelf life of meat and meat product but proper preservation of meat could be achieved by the combination of two or more preservation methods which includes drying, salting and high temperature (Nester *et al.*, 2001). This work is aimed at microbiologically analyzing the quality of *balangu* sold in Hadejia Local Government Area, Jigawa State, Nigeria.

Materials and Methods

This study was carried out in Hadejia Metropolitan of Jigawa State. Fifty four samples of *Balangu* were obtained randomly from meat vendors at popular meat spots in Hadejia metropolis namely: Atafi, Yankoli and Yayari (Table 1). The samples were collected aseptically with the help of sterilized knives. Freshly slaughtered beef and *Balangu* samples from the various outlets were obtained fortnightly from 3rd to 17 April, 2018 into sterile plastic bags, stored at 4 ^{O}C in ice chest filled with ice and transported immediate to the laboratory for Total Viable Count (TVC), Total Coliform Count (TCC), Total Staphylococcus Count (TCS) and Total Fungal Count (TFC) analyses using Nutrient Agar, Mac Conkey Agar, Mannitol Salt Agar and Potato Dextrose Agar, respectively and incubated at 37 ^{0}C for 24 hours except for the detection of fungi, which was incubated at 25 ^{0}C for 5 days.

Meat samples were mashed in a sterile laboratory mortar and pestle. 1g of the mashed sample was weighed and then aseptically introduced into 9 ml of sterile distilled water, properly shaken and sieved before a twofold dilution was performed. The samples were inoculated aseptically using streak technique and the plates were read for growth of organisms. The counts for each plate were expressed as colony forming unit (cfu/g) of the suspension ie

$$\text{Colony forming unit/g} = \frac{\text{Number of colony counted x Reciprocal of dilution factor}}{\text{Volume of sample inoculated}}$$

Results

Mean total viable count, total coliform count, total *staphylococcus* count and total fungal count of raw meat and *balangu* from the different outlets were presented in Tables 2 and 3. TVC of raw meat and *balangu* ranged from 6.8 x 10^6 to 8.7 x 10^6 and 1.7 x 10^6 to 5.0 x 10^3, respectively. *Balangu* samples from Atafi has the highest TCC and TFC of 4.0 x 10^2 and 2.0 x 10^2, respectively while that from Yayari has the lowest TCC and TFC of 2.9 x 10^2 and 0.0 x 10^1, respectively.

Table 1: Total Number of Samples Collected for Assessment of Microbial Contamination

S/N	Type of meat	Number of Samples
1	Raw	27
2	*Balangu*	27
	Total	54

Table2: Microbial Load of Raw Meat (cfu/g)

Sample Location	Total Viable Count	Total Coliform Count	Total Staphylococus Count	Total Fungal Count
Atafi	8.7 x 10^6	7.2 x 10^6	4.5 x 10^3	6.0 x10^6
Yankoli	6.8 x 10^6	2.7 x 10^5	1.3 x10^1	3.0 x 10^1
Yayari	8.7 x 10^6	5.5 x 10^5	4.6 x 10^2	2.0 x 10^1

Table 3: Microbial Load of *Balangu* (cfu/g)

Sample Location	Total Viable Count	Total Coliform Count	Total Staphylococus Count	Total Fungal Count
Atafi	1.7 x 10^6	4.0 x 10^4	0.0 x 10^1	2.0 x10^2
Yankoli	3.2 x 10^5	1.5 x 10^4	7.0 x10^1	0.0 x 10^1
Yayari	5.0 x 10^3	2.9 x 10^2	0.0 x 10^1	0.0 x 10^1

Discussion

Meat basically contains all the nutrients for microbial growth and metabolism, making it very susceptible to microbial contamination. In view of the microbial quality of meat and meat products; proper hygiene

must be ascertained to ensure safety from infections after consumption of such products and to promote quality assurance (Egbebi and Muhammad, 2016).

In this study, the microorganism isolated (*Staphylococcus species*) is in consonance with the report of Chukwura and Majekwu (2002), which stated that microbiological analysis of meat samples in Awka urban of Anambra State, indicated contamination with various bacterial species including *Staphylococcus aureus* and some enteric bacteria. Gilbert and Harrison (2001) also affirmed that meat preserved with certain amount of salt permits the growth of *Staphylococcus aureus* whereas, the presence of some members of *Enterobacteriaceae* is due to contamination from the intestines of slaughtered animals.

The presence of *Staphylococcus species* agrees with the report of cross contamination from meat handlers during processing, since it is a normal flora of the skin (Gilbert and Harrison, 2001). Most butchers in Nigeria, lacking knowledge of hygiene, usually carry raw meat on the body and use contaminated water (usually coliform) to wash the raw meat.

The organism isolated in this study was the organism usually implicated in meat spoilage and unhygienic condition of meat handling. This is also in agreement with the report of Umoh (2004) that the presence of microbes may probably arise from the use of non portable water during washing of raw meat (Postgate, 2000 and Field, 2002).

On the whole, the major sources of microbial contamination of meat appear to come from butchers and the use of contaminated water and equipment. So control of meat contamination can be achieved if aseptic techniques are employed during meat preparation (Hassan *et al.,* 2014).

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ANIMAL PRODUCTS IMPORTATION, LOCAL INDUSTRY AND ECONOMIC DEVELOPMENT – A REVIEW OF THE CURRENT TREND IN NIGERIA

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Abstract
Nigeria is an import dependent country and its excessive importation of animal products has seriously affected the Nigerian livestock sector. The reliance on imported items has led to a huge demand for foreign exchange and a depreciation of the naira through the years. Nigeria's total food and agricultural imports are growing and estimated at more than $10 billion in 2015. Wheat, rice, brown sugar, frozen fish, dairy products, vegetable oil, intermediate and consumer-oriented products are the largest imports. By continent, Nigeria imported goods mostly from Asia (44.6 %), EU (33.6 %), America (14.1 %), Africa (6.5 %), and others (1.2 %). By country, Nigeria's most significant suppliers include China (23 %), United States (10%), India (8 %), Belgium (6 %), Netherlands (6 %), and others countries across the world. This paper discussed the Nigerian production capacity of the beef, dairy and poultry sub-sectors, import substitution and its impact on local production including destruction of local products, decline in revenue and demand, smuggling of frozen poultry meat and high cost of feed input as it affects local industry and economic development in Nigeria. It is recommended that there should be a continuous ban on importation of frozen animal products, improvement of dairy breed, subsidy to assist dairy producers/processors, organization of producer groups (pastoralists), investment in cold chain technology, development of semen collection centre and fodder farms.
Keywords: Animal Product, Importation, Livestock Production, Economic Development

Introduction
The current exchange rate crisis facing Nigeria stems from the country's high import content (FDC, 2016). The reliance on imported items has led to a huge demand for foreign exchange and a depreciation of the naira through the years. Nigeria's total food and agricultural imports are growing and estimated at more than $10 billion in 2015. Wheat, rice, brown sugar, frozen fish, dairy products, vegetable oil, intermediate and consumer-oriented products are the largest imports. By continent, Nigeria imported goods mostly from Asia (44.6 %), EU (33.6 %), America (14.1 %), Africa (6.5 %), and others (1.2 %). By country, Nigeria's most significant suppliers include China (23 %), United States (10%), India (8 %), Belgium (6 %), Netherlands (6 %), and others countries across the world (ITA, 2017). In a bid to protect the local industry and encourage job creation, some animal product are ban from import; they include live or dead birds including frozen poultry, pork, beef, birds eggs, excluding hatching eggs (NCS, 2018).
There has been an increasing demand for beef and milk, the main sources of domestic animal protein in Nigeria, and this has resulted in a domestic supply gap owing to poor production and productivity levels of the indigenous production systems. The current economic situation in Nigeria indicates that domestic supply of animal protein is growing at 1.8 % per annum while the overall demand is estimated to be rising at 5.1 % annually. In spite of its importance and the existence of an unsatisfied internal demand for livestock products, the livestock sub sector has suffered from inadequate investment by both the public and the private sectors (FAO *et al*, 2016)

Discussion

Production Capacity in Nigeria

Nigeria is a major hub of animal product consumption in West Africa. It is also one of the largest livestock-raising countries in the region. Meeting the ever-increasing domestic demand and access to these flourishing markets are major economic stakes for Nigeria.

- **Beef Production**

  There are about 50,000 meat wholesale/retail businesses in Nigeria with average annual turnover estimated at 25 million Naira which is equivalent to trading 160-180 cattle carcasses. Red meat prices have increased sharply at a rate of 20 % per annum for the last twenty years against an underlying inflation rate around 12 % (FAO, 2005). This is representative of the demand-supply shortfall in an era of rapid population growth especially in the Lagos-Ibadan Axis (the economic powerhouse of West Africa): at current growth rates, Nigeria's population is expected to double to around 340 million by 2030 (FAO *et al*, 2016). At a livestock level, the red meat sector is worth an estimated N1.1 trillion and at retail level about 1.3 trillion (FAO *et al*, 2016).

- **Dairy Production**

Unit: USD thousands

	2014	**2015 (estimated)**	**2016 (estimated)**	**2017**
Total Market Size	900,000	770,000	660,000	695,000
Total Local Production	80,000	50,000	60,000	65,000
Total Exports	0	0	0	0
Total Imports	820,000	700,000	600,000	630,000
Imports from the U.S.	15,000	10,000	8,000	12,000

Total Market Size = (Total Local Production + Total Imports) – (Total Exports)

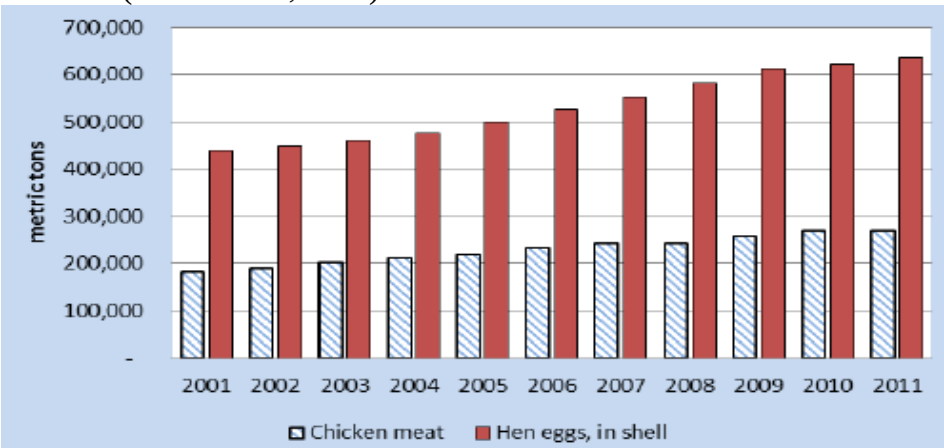
Source: ITA (2017)

U.S. export of dairy products to Nigeria had continued to the rise since 2011. However, Nigeria's declining revenue since 2015 is expected to affect market growth adversely. At the moment, domestic production remains insufficient due to increasing production/processing costs, non-competitiveness of the industry, and the failure to incorporate more advanced technologies (ITA, 2017). Dairy is a major import to Nigeria. In 2016, it accounted for 6 % of the total food import bill. With an estimated annual consumption of 1.7 million tones, Nigeria milk production is low at an estimated 0.6 million tones. To close this production deficit, a significant amount of foreign exchange is spent on the importation of milk (PWC, 2016).

- **Poultry Production**

  From a market size perspective, Nigeria's egg production is the largest in Africa (South

Africa is the next largest at 540,000 MT of eggs) and it has the 2nd largest chicken population after South Africa's 200 million birds (Sahel, 2015). The poultry industry has emerged as the most dynamic and fastest growing segment in the animal husbandry subsector (Heinke *et al*, 2015).



Nigeria: Chicken Meat and Shell Egg Production
Data Source: FAOSTAT | © FAO Statistics Division 2013 | 29 January 2013

Impact of Animal Product Importation on Local Production

1. **Local products are destroyed**: Nigeria is importing what it can produce in abundance. In 2016, Nigeria spent over 480 million USD importing milk, cream and milk products (PWC, 2016). Spending such huge amounts to import has led to a dearth in local animal production. Import dependency is hurting Nigerian livestock farmers, displacing local production and creating rising unemployment (FAO *et al*, 2016).
2. **Smuggling of frozen poultry meat**: Although importation of frozen poultry meat has been banned, Nigeria still spends about 600 billion naira annually on smuggled frozen foods (Falaju, 2015). This is due to the porous nature of the Nigerian borders; where unwholesome food items still find their way to tables of many Nigerians. Local producers of poultry continue to face daunting obstacles posed by activities of smugglers of poultry meat into the country. These are cheaper and majority of Nigerians who are poor or have a low purchasing power will buy/patronize the cheaper alternative (Falaju, 2015).
3. **High cost of feed input:** The irregular and limited supply of all raw materials grown in Nigeria presents serious problems for local producers. As a result, the majority of feed millers in the country are turning to imported soft wheat to satisfy their energy requirements in feed ratios as an alternative to corn. Most of the corn and soybean used is imported, as well, since the quantity and quality of the corn and soybean cultivated in Nigeria does not meet the demands of the population. But still, the scarcity and high cost of the imported feed force producers to reformulate the poultry diet in favor of low quality substitutes such as peanut cake, cottonseed, and palm kernel meal (World Poultry 2013).

Conclusion

Importation of animal product is not just creating a conduit pipe that is constantly draining the country's economy. The increasing consumption trends have cost the government a substantial amount of foreign exchange to import dairy products into Nigeria. With an estimated annual

milk consumption of 1.7 million tons, production only meets about 34% of demand while importation makes up for the deficit. Nigeria has spent an over 480.3 million USD on importation of milk annually (PWC, 2016). Addressing the issue of animal product importation especially in the dairy sub-sector will guarantee a better economy and food security for the citizenry.

Recommendations

Continuous ban on importation of frozen poultry products: In a bid to reduce the influx of smuggled poultry product, Federal Ministry of Agriculture and Rural Development (FMARD), Nigerian Customs Service, National Agency of Food, Drug, Administration and Control and Standard Organization of Nigeria and other relevant MDAs should launch a massive campaign to discourage Nigerians from consuming smuggled frozen animal products by educating them on the negative health, economic and socio-political impacts of illegal frozen poultry products.

Organization of producer groups (pastoralists): Difficulty in assessing pastoralists has discouraged commercial processors from sourcing milk from traditional producers. The formation of producer groups/cooperatives will improve accessibility to the pastoralists as processors can work directly with the cooperatives towards increasing the processing of domestic milk. Also, extension services can be facilitated via the cooperatives to increase the quality of pastoralist milk output.

Development of fodder farms: Government should encourage the development of fodder farms to help solve the problem of availability of fodder for ruminants; this will in turn help to reduce the clash between pastoralists and crop farmers.

Investment in cold chain technology: Agriculture infrastructure should be developed to accommodate the storage needs of the dairy industry. This will ease the transportation and distribution of dairy products across the country.

Innovative financing for agriculture.

Import substitution: Excessive importation has led to a near decimation of the country's livestock sector. In order to curtail Nigeria's reliance on imports as well as reduce the deleterious effects of excessive importation, the federal government should implement its import substitution strategy that on one hand limits the access to forex (which then makes it difficult to import) and on the other hand, supports the country's livestock sector.

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COMPARATIVE ESTIMATION OF CHOLESTEROL CONTENT IN THE EGGS OF LOCAL BREED HEN, GUINEA FOWL, QUAIL, DUCK AND DOVE

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ABSTRACT

This research was aimed at comparing the level of cholesterol present in the eggs of five different breed of birds which include quail (salwa), guinea fowl, local breed hen, duck and dove. The cholesterol level was determined using enzymatic method (spectrophotometer), ***the result showed that, the cholesterol level was significantly higher (P<0.05) in quail eggs compared to that of duck, dove, guinea fowl and local breed hen. While local breed hen contains low level of cholesterol (P<0.05). It was concluded that local breed hen egg has lowest cholesterol content and it is the recommended be taken by human due to its less danger to the health as indicated in the study result.***

Keywords: Chicken, ducks, quail, dove, guinea fowl and cholesterol.

INTRODUCTION

Poultry are groups of domestic bird, these include chickens, turkeys and ducks among others. They are kept for food, meat and eggs as well as fiber, Poultry egg consist of three main parts; shell, albumen and yolk (Aratz, 1979). Egg yolk of poultry contains about 50% solid with lipids to protein ratio of about 2:1 (Haines, 2001). The major component of yolk lipid is triglycerol (neutral lipids), followed by various types of phospholids and cholesterol (Bran and Allan, 1982). Cholesterol is a steroid hormone and play a vital role in body metabolism such as bile metabolism, synthesis of biological membrane and it's the precursor for the synthesis of steroid hormone. High level of cholesterol is associated with atherosclerosis, Hypertension heart attack, and stroke (Thankachan, 2011). This study aimed to compare the cholesterol contents in the eggs of local breed hen, guinea fowl, quail, duck and dove

METHODOLOGY

Preparation of Samples

A total of 30 eggs of local chickens, guinea fowl, Dove, Duck, and Quail were used in the experiment, six (6) eggs were randomly selected from each group of birds. The eggs were procured from Gusau central market and were utilized for the study, the cholesterol content (mg/g yolk) was estimated according to (Wybenga, ***Pileggi, Dirstine, Giorgio,*** 1970). The egg albumen adhered to the yolk membrane was removed by rolling the intact egg yolk over a filter paper carefully without breaking the yolk membrane. The egg yolk was then transferred into a glass container and homogenized using a glass stirring rod. 2.5ml of each sampled egg yolk was taken and mixed with 5ml of methanol. The mixture was vigorously shacked and kept for five minutes in the test-tube. The samples were analyzed using spectrophotometer.

Estimation of Total Cholesterol

Serum total cholesterol (TC) was estimated by enzymatic method using Randox kit (Allain, Poon, Chan, & Richmond, 1974).

Three test tubes were set up and labelled blank, test and standard. In to test tubes labelled test, standard and blank, 10 µl of serum, standard (200 mg/dl) and distilled water were respectively pipetted in to the test tubes. Each test tube is then followed by 1000 µl of the reagent as shown above. The test tubes were mixed, incubated at 37^{o}C for 5 minutes and the absorbance of the standard and test were read against the blank at 500 nm against the reagent blank.

Calculation

Cholesterol concentration was obtained using the relation:

$$\text{Serum total cholesterol (mg/dl)} = \frac{Absorbance\ of\ Test}{Absorbance\ of\ \text{Standard}} \text{ x Conc of Standard}$$

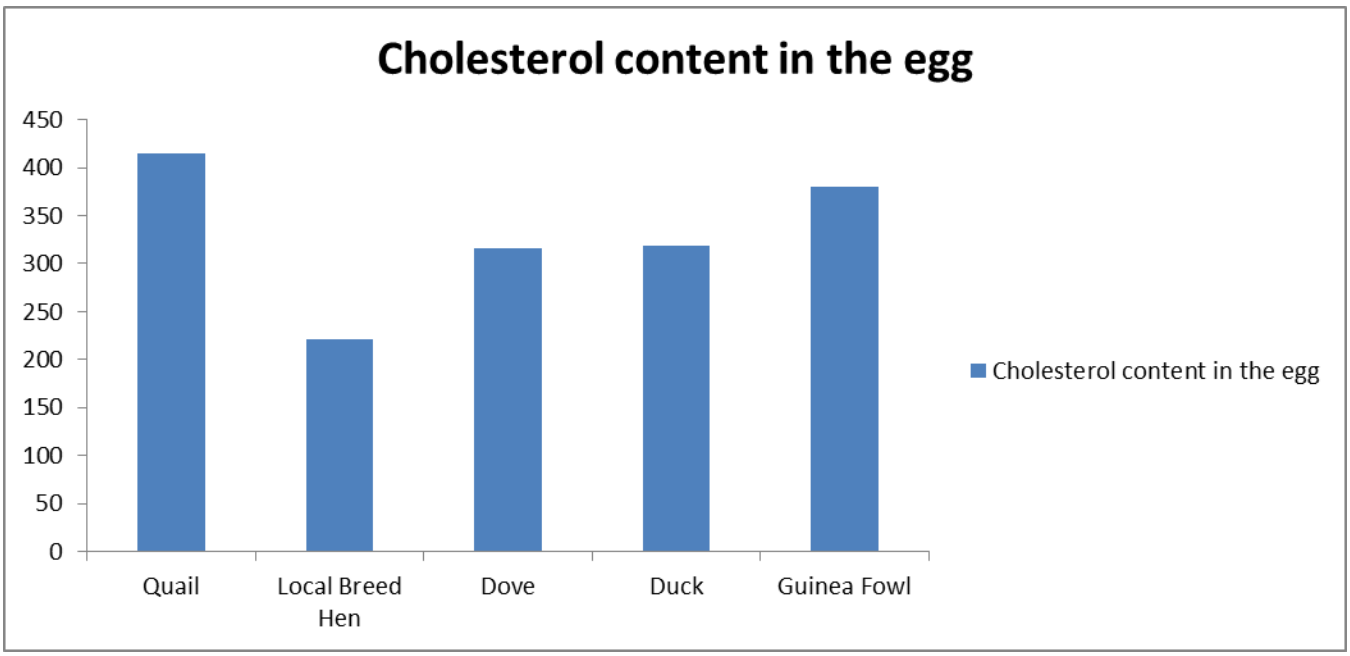
RESULT

The result of this research presented in table 1 has shown that Quail (Salwa) egg has a higher significant ($p<0.05$) cholesterol level (414 ± 17) compared with local breed hen (220 ± 87), Dove (315 ± 83), Duck (318 ± 53) and Guinea Fowl eggs (379 ± 70). While local breed hen (220 ± 87) has the lowest ($p<0.05$) cholesterol content

Table 1.Cholesterol content in the sample selected

S. No	Sample	Cholesterol Content Mg/g
1	Salwa	414 ± 17 *
2	Local breed hen	220 ± 87 **
3	Dove	315 ± 83 **
4	Duck	318 ± 53 **
5	Guinea fowl	379 ± 70 **

*significantly different at $p<0.05$ ** highly significant different



DISCUSSION

The comparative analysis of cholesterol contents in different bird eggs shows a significant differences between them, it was observed that Quail egg has the highest cholesterol level (414+17) compared to Local breed hen, Dove, Duck and Guinea fowl. The higher intake of cholesterol is associated with chronic heart diseases, and stroke, the concentration of cholesterol in guinea fowl is significantly higher ($P<0.05$) compared to duck, dove, and Local breed hen. But there is no significant difference ($P>0.05$) of cholesterol level between dove, and duck. However Local breed hen has the lowest ($P>0.05$) of cholesterol.

CONCLUSION AND RECOMMENDATION

Conclusively quail egg has the highest level of cholesterol while local breed hen has the lowest level. So it is recommended that since local breed hen egg is the one that seems to have low level of cholesterol content and it is readily available, it can be consume by the populace. It is also recommended that another research should be carried out in Oder to see fact about the cholesterol content present in different bird eggs.

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CARCASS CHARACTERISTICS AND SENSORY ASSESSMENT OF FUNNAB ALPHA BROILER CHICKENS FED DIFFERENT PROTEIN LEVELS

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ABSTRACT
This experiment was conducted to determine the carcass characteristics and sensory attributes of FUNAAB Alpha broiler chickens fed diets containing different protein levels. A total of one hundred and twenty (120) day-old FUNAAB Alpha chicks were used for the study. The chicks were randomly allocated to four varying dietary protein levels of 14, 17, 20 and 23 % CP and were tagged CP_{14}, CP_{17}, CP_{20} and $CP_{23,}$ respectively. The birds were allocated to the four treatments using a Completely Randomized Design (CRD). Each treatment group was replicated thrice with ten birds per replicate. The birds were housed in deep litter system where they received uniform care and management. The experiment lasted for thirteen weeks. Light was provided 24 hours daily, while feed and clean drinking water were given *ad libitum*. At the thirteenth week, data on carcass and sensory attributes were taken. Results showed that dietary treatment did not influence ($P>0.05$) all carcass characteristics measured except wing weight. Sensory assessment results showed that there were no significant differences ($P>0.05$) in all the parameters measured except in Aroma. Meat from birds fed CP_{23} diet had better ($P<0.05$) aroma than those fed other diets. It is, thus recommended that a CP level of 23 % can be used in diet of FUNAAB Alpha chickens for improved wing weight and better aroma.

Keywords
FUNAB Alpha, dietary protein, carcass, sensory

INTRODUCTION
Local chickens play an important role as household food supply in rural areas of developing countries (Zaman *et al.,* 2004). It is also a means of providing additional income to the generally resource-poor small holder farmers (Gueye, 2004), thereby helping to alleviate poverty. Despite the fact that more than 90 % of the Nigeria poultry production system consists of local chickens, their contribution to human nutrition, gross domestic products and export earnings are disproportionately low. These problems are mainly due to nutrition and poor growth rate (King'ori *et al.,* 2003). Jafarnejad **and** Sadegh **(2011) reported that dietary protein had effect on the body weight gain on broiler chickens.**
Chemjor (1998) reported that a dietary protein level of 13 % was adequate for indigenous chickens aged between 14 and 21 weeks. King'ori *et al.* (2003) observed that indigenous chickens require a protein level of 16 % to optimize feed intake and growth between 14 and 21 weeks of age. Furthermore, Ndegwa *et al.* (2001) reported that indigenous chickens fed diets containing 17 to 23 % CP had similar growth rates and feed intakes, suggesting that a 17 % CP diet was sufficient for these chickens. Moreso, Makinde and Egbekun (2016) reported that the optimal dietary crude protein for Fulani Ecotype chickens is 22 % CP for 0-6 weeks of age and 20 % CP for 6-12 weeks of growth. Information on the protein requirements of indigenous chickens is inconsistent. Furthermore, FUNAAB Alpha is a new breed of Indigenous chicken in Nigeria with high potentials. This breed has almost the same potential with imported

Sasso and Kuroiler chickens but is superior to Fulani Ecotype and the Shika brown. The protein requirements for this chicken has not been established especially its effect on the carcass and sensory attributes, therefore, this study was aimed at evaluating the carcass characteristics and sensory properties of FUNAAB Alpha broiler chickens fed different dietary protein levels.

MATERIALS AND METHODS

Location of the Experiment site

The study was carried out in the poultry section of the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Minna, Niger State. Minna is located between latitude 4^{o} 30 and 9° 37 North and longitude 6°33 and 06^{o}45 East with an altitude of 1475 m above sea level (Niger State Agricultural Development Project; NSADP, 2009). The study was conducted between May and September, 2018.

The experimental ingredients used for the research were obtained from Minna Ultra-Modern Market, Minna Niger State. The FUNAAB Alpha chicks were obtained from Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. A total of one hundred and twenty (120) day-old of FUNAAB Alpha chicks were used for the study. The chicks were graded and randomly allocated to four varying dietary protein levels of 14, 17, 20 and 23 % CP and were tagged CP_{14}, CP_{17}, CP_{20} and $CP_{23,}$ respectively. The birds were allocated to the four treatments using a Completely Randomized Design (CRD). Each treatment group was replicated thrice with ten birds per replicate. The birds were housed in deep litter system where they received uniform care and management. The experiment lasted for thirteen weeks. Light was provided 24 hours daily, while feed and clean cool drinking water were given *ad libitum.* The diet was isocaloric containing 3100kcal of energy.

Carcass Characteristics and Sensory Evaluation of Birds

At the end thirteen week, two birds per replicate were randomly selected from each of the treatment pen and used for the carcass and organ measurements. The birds were starved overnight to empty the gut before weighing and slaughtering the next morning. Carcasses were defeathered and the inner organs were removed. The birds were dressed and the dressed weight and dressing percentage (carcass yield) were computed. Cut-up parts were all weighed and expressed as percentage of live weight. The visceral organs for each bird which include full gizzard, liver, full intestine, heart, spleen, abdominal fats and caeca were also weighed and expressed as percentage of live weight.

The sensorial evaluation was performed according to the methodology of Dutcosky (2007). The cut sample of the breast was cooked for twenty minutes in 500 mls of water with a pinch of common salt in an aluminium pot without any spices added. The meats were served to 30 semi-trained panellists, comprising of staff and students which were randomly selected from the School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Nigeria. A 9- point hedonic rating scale from 1 to 9 (1: disliked extremely; 2: dislike very much; 3: dislike moderately; 4: dislike slightly; 5: neither like nor dislike; 6: like slightly; 7: like moderately; 8: like very much; 9: like extremely) was used to evaluate the aroma, flavour, colour, texture and over all acceptability of the meat from the experimental birds. All data collected on carcass characteristics and sensory attributes were analysed by one-way analysis of

variance (ANOVA) in a Completely Randomized Design (SAS, 2015), where mean differences occurred, they were separated using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Carcass characteristics of FUNAAB Alpha Chickens fed Different Levels of Crude Protein

Table 1 shows the carcass characteristics of FUNAAB Alpha chickens fed different levels of protein diets. The results showed that there were no significant differences ($P>0.05$) in all the parameters measured except the wings weight which was influenced ($P<0.05$). Wing weight values of chickens fed diets having 17 and 23 % crude protein were higher ($P<0.05$) than those fed 14 % CP diet. The reason for this is not well known, it might be that 14 % CP is inadequate to improve wing weight. Leeson and Summers, (2000) did not observe any significant different in broiler chickens fed different dietary protein and that dietary protein levels have no effect on the quality of protein deposited in the carcass. Varying dietary protein levels did not affect carcass yield of the FUNAAB Alpha chickens and this result is in agreement with Leeson *et al.* (1996) and Smith and Pesti (1998), who found that levels of protein in diet did not affect carcass yield and protein deposition. Similarly, Renden *et al.* (1992) found no significant effect of protein levels on carcass quality of broiler chickens.

Table 1: Carcass characteristics of FUNAAB Alpha Chickens fed Different Levels of Crude Protein

PARAMETERS	CP_{14}	CP_{17}	CP_{20}	CP_{23}	SEM
Live Weight	2133.33	2366.67	2366.67	2300.00	80.21
Carcass Weight	2000.00	2266.67	2200.00	2133.33	70.17
Dress Weight	1900.00	2166.67	2100.00	2033.33	70.17
Breast	15.98	15.13	15.05	15.43	0.48
Drum Stick	8.18	8.89	8.54	8.75	0.34
Thigh	9.75	12.41	13.08	12.46	0.61
Wings	7.95^{b}	10.84^{a}	10.24^{ab}	10.67^{a}	0.47
Gizzard	2.98	2.41	2.42	2.55	0.18
Liver	1.33	1.93	1.92	1.83	0.11
Heart	0.30	0.25	0.24	0.23	0.23

^{a,b}; Means in the row not showing a common superscript are significantly different ($P<0.05$)
CP= Crude protein levels; SEM= Standard error of mean

Sensory Evaluation of FUNAAB Alpha chickens fed Different Levels of Crude Protein

The results of sensory evaluation of FUNNAB Alpha chickens meat fed different levels of crude protein are presented in Table 2. The results showed that there were no significant

differences (P>0.05) in all the parameters measured except in Aroma. The aroma results showed that as the level of dietary protein increases the aroma improved. The meat from chickens fed CP23 diet had the best aroma and it was significantly higher (P<0.05) than the other treatments. The meat from birds on dietary CP20 was better (P<0.05) than those on dietary CP17 and CP14 which had similar values. The improved aroma at high CP level might be as a result of fat deposited in chickens on high CP diets. Rabie *et al.* (2017) found that among all food constituents, lipids generally have the greatest influence on production of aroma flavour components, as they do not reduce the vapour pressure of most flavoured compounds. Kinsella (1990) showed that aroma compounds are more lipophilic than hydrophilic therefore fats act as a solvents for aroma compounds reducing their volatility.

Table @=2: Sensory Evaluation of FUNAAB Alpha chickens fed Different Levels of Crude Protein

Parameter	CP_{14}	CP_{17}	CP_{20}	CP_{23}	SEM
Colour	6.46	6.85	7.15	6.58	0.41
Juiciness	6.62	6.92	7.08	6.73	0.13
Appearance	6.88	7.04	7.38	7.00	0.26
Flavor	6.19	6.69	7.08	6.92	0.15
Aroma	6.42^{c}	6.58^{c}	6.77^{b}	7.23^{a}	0.13
Tenderness	7.00	7.04	7.58	7.11	0.13
Overall Acceptability	7.27	7.27	7.77	7.13	0.13

^{a,b}; Means in the row not showing a common superscript are significantly different (P<0.05)
CP= Crude protein, SEM= Standard error of mean

CONCLUSION AND RECOMMENDATION

The results of the present study showed that dietary crude protein affects only the wing weight and the aroma of FUNAAB Alpha chickens. Birds on dietary crude protein level of 23 % did better in both parameters. It is, thus recommended that a CP level of 23 % can be used in diet of FUNAAB Alpha chickens for improved wing weight and better aroma.

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MICROBIAL QUALITY OF *TSIRE* OFFERED FOR SALE AT HADEJIA LOCAL GOVERNMENT AREA, JIGAWA STATE

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Abstract

Microbial quality of raw meat and *tsire* sold at retail outlets from Yayari, Yankoli and Matsaro of Hadejia metropolis, Jigawa State were evaluated. Three samples from each outlet were collected fortnightly from 3rd to 17 April, 2018 into sterile plastic bags, stored at 4 ^{O}C in ice chest filled with ice and transported immediately to the laboratory for Total Viable Count (TVC), Total Coliform Count (TCC), Total Staphylococcus Count (TCS) and Total Fungal Count (TFC) analyses using Nutrient Agar, Mac Conkey Agar, Mannitol Salt Agar and Potato Dextrose Agar, respectively and incubated at 37 ^{0}C for 24 hours except for the detection of fungi, which was incubated at 25 ^{0}C for 5 days. *Tsire* samples collected from Matsaro have the highest TVC (6.0 x 10^4) while that from Yankoli has the highest TCS (4.0x10^2). The presence of bacteria on raw meat and *tsire* sold at the study area is an indication of low standard of animal and meat handling practices from pre-slaughter to post–slaughter, sales of meat, abattoir facilities and equipment.

Key words: Microbial, *Tsire,* Sale, Hadejia and Jigawa

Introduction

Tsire is a roasted or smoked beef or other boneless animal meat. It is rich in protein, mineral (zinc, selenium and phosphorus) and is also a good source of niacin, vitamin B6 (pyridoxine) and iron (Koffi-Nevry *et al*., 2011). It is one of the most street-vended meat products in Nigeria and sub-Saharan Africa (Abdullahi *et al*., 2006). The preparation processes of *tsire* involve de-fatting and slicing the meat on a slab or table, after which it is staked into sticks, spiced and roasted for about twenty (20) minutes, thereafter, the products is spiced again and briefly reheated for about two (2) minutes. It's then displayed for marketing on table tops or trays where it can be street-vended (Edema *et al.*, 2008). *Tsire* preparation process in Nigeria lacks standard or hygienic quality control: therefore there is increase in food safety risks (Odusole and Akinyanju, 2003; Inyang *et al*., 2005 and Adzitey *et al*., 2010). Notwithstanding the major role meat plays in our meals, it can also serve as a rich medium of growth for harmful microorganisms. Meat infected with microorganisms is the cause of many food-borne diseases (WHO, 1997). The source of this pathogenic microorganism may be the animals themselves or from outside the surroundings where these animals are kept as well as the way they are processed after slaughtering can also result in contamination with microorganisms (Adeyemo, 2002). Meat infected with microorganisms is normally poor in quality (Mukhopadhyay, 2009). Microbes such as *Staphylococcus* spp., *Aspergillus* spp., *Salmonella* spp., *Enterococcus* spp., *Streptococcus* spp. and *Escherichia coli* have all been found on contaminated meat (James *et al*., 2005).The study is aimed to examine the microbial quality of *tsire* offered for sale at Hadejia Local Government Area of Jigawa State.

Materials and Methods

This study was carried out in Hadejia Metropolitan of Jigawa State. Meat outlets from three locations namely Yayari, Yankoli and Matsaro were randomly selected. A total of fifty four meat samples (Table 1) were collected aseptically with the help of sterilized knives. Freshly slaughtered beef and *tsire* samples from the various outlets were collected fortnightly from 3rd to 17 April, 2018 into sterile plastic bags, stored at 4 ^{O}C in ice chest filled with ice and transported immediately to the laboratory for Total Viable Count (TVC), Total Coliform Count (TCC), Total Staphylococcus Count(TCS) and Total Fungal Count (TFC) analyses using Nutrient Agar, Mac Conkey Agar, Mannitol Salt Agar and Potato Dextrose Agar, respectively and incubated at 37 ^{0}C for 24 hours except for the detection of fungi, which was incubated at 25 ^{0}C for 5 days.

Tsire piece from each sample was removed from the skewers and mashed in a sterile laboratory mortar and pestle. 1g of the mashed sample was weighed and then aseptically introduced into 9ml of sterile distilled water, properly shaken and sieved before a twofold dilution was performed. The samples were inoculated aseptically using streak technique and the plates were read for growth of organisms. The counts for each plate were expressed as colony forming unit (cfu/g) of the suspension ie

$$\text{Colony forming unit/g} = \frac{\text{Number of colony counted x Reciprocal of dilution factor}}{\text{Volume of sample inoculated}}$$

Results and Discussion

The microbial load of raw meat was presented in Table 2. Highest TVC ($9.0x10^6$cfu/g) and TCC ($5.0x10^6$cfu/g) were reported at Matsaro while highest TSC ($3.8x10^3$cfu/g) and TFC ($4.2x10^2$ cfu/g) were reported at Yayari.

Table 1: Total number of samples collected for assessment of microbial contamination

S/N	Type of meat	Number of Samples
1	Raw	27
2	*Tsire*	27
	Total	54

Table 2: Microbial load of raw meat (cfu/g)

Sample Location	Total viable count ($x10^6$)	Total coliform count ($x10^6$)	Total staphylococcus count ($x10^3$)	Total fungal count ($x10^2$)
Yayari	7.5	4.5	3.8	4.2
Yankoli	3.5	3.0	2.4	1.3
Matsaro	9.0	5.0	1.0	3.5

The microbial load of *tsire* was presented in Table 3. No growth of TCC and TSC were reported at Matsaro, equally no growth of TSC and TFC were reported at Yankoli. On the other hand Matsaro had the highest TVC ($6.0x10^4$) while Yankoli had the highest TSC ($4.0x10^2$).

Table 3: Microbial load of *tsire* (cfu/g)

Sample Location	Total viable count	Total coliform count	Total staphylococcus count	Total fungal count
Yayari	$1.8x10^4$	$1.0x10^2$	$0.0x10^1$	$0.0x10^1$
Yankoli	$2.6x10^5$	$1.7x10^3$	$4.0x10^2$	$2.0x10^2$
Matsaro	$6.0x10^4$	$0.0x10^1$	$0.0x10^1$	$1.0x10^2$

The various meat outlets have different hygienic levels as far as transportation, handling and processing is concerned. This might have accounted for the variations in TVC, TCC, TSC and TFC as shown in tables 2 and 3. This is in line with the work of Ruban and Fairoze (2011) and Obeng *et al.* (2013) who attributed the higher microbial levels from non-sophisticated outlets compared to sophisticated ones. This may be due to unhygienic handling of meat right from slaughtering, butchering equipment, handling, transportation and processing (Warris, 2010). Similarly Abubakar *et al*. (2011) isolated four fungal species (*Aspergillus niger, Aspergillus fumigatus, Rhizophus nigricans* and *Hansenula anomala)* after seven days storage of meat products at ambient temperature. Other workers such as Ologhobo *et al*.

(2010) and Salihu *et al*. (2010) have also reported that meat products sold in Nigeria were contaminated with various species of bacteria and fungi.

The high levels of microbes presence on meat increase the chances of the meat getting spoiled within the shortest possible time. Although microbial load on the meat samples were within the safe limits of 10^7 cfu/ g specified for meat products by the ICMSF (1978). It can therefore be said that meat sold in the study areas were not spoiled. Nevertheless the isolation of *Staphylococcus* spp. is worrying because certain strains of this bacterium cause food-borne infections. *Staphylococcus* spp. infections can be contracted through consumption of contaminated chevon and mutton (Adzitey *et al*., 2010). It is an important cause of gastroenteritis. *Staphylococcus* spp. can be present on the skin of humans and animals and can be transmitted from person to product through unhygienic practices (Postgate, 2000). *Staphylococcus* spp. cause infections such as arthritis, black pox, boil, bronchitis, carbuncle, cystitis, endocarditis, meningitis, osteomyelitis, pneumonia and scalded skin (Stuart, 2005). To ensure good microbial quality of meat products, proper hygiene must be ascertained to guarantee safety from infection and to promote quality assurance. On the whole, the major sources of microbial contamination of meat appear to be handling by processor and the use of contamination water and equipment. So control of meat contamination can be achieved if aseptic techniques are employed during the production of meat (Field, 2002). The variation in the microbial count may be attributed to the sample used, contamination by flies, method of handling and transportation and the air flora of the environment. Processing operations such as heating, boiling, filtration, freezing, irradiation of finished product, addition of condiment and condition of storage affect both bacterial and fungal loads (Igyor and Uma, 2005). High microbial loads lead to spoilage of foods that have not been properly stored (Nester *et al.*, 2001).

Conclusion and Recommendation

The study concluded that *tsire* sold at Hadejia Local Government Area was safe for consumption, due to it less microbial load. It is recommended that meat sellers and handlers should as often as possible be enlightened on proper animal handling, hygienic slaughter, proper meat transportation, sanitation of utensils, equipment and proper storage of meat. This would help reduce the rate of meat contamination.

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EFFECTS OF REPLACING DIETARY VITAMIN MINERAL PREMIX WITH COMPOSITE LEAF MEAL ON LIPID PEROXIDATION OF BROILER CHICKEN MEAT DURING STORAGE

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Abstract
Effects of replacing dietary vitamin mineral premix (VMP) with composite leaf meal CLM) on lipid peroxidation of broiler chicken meat during storage was assessed in this study. Four leaves (Celosia argentea, Telfairia occidentalis, Moringa oleifera, Vernonia amygdalina) purposively selected based on their established phytochemical composition, were air-dried to constant weight. They were individually milled to powder and combined in equal proportions to a composite test sample. Diets containing 0, 0.125, 0.25, and 0.375% levels of commercial VmP were formulated and the composite sample incorporated to replace the dietary VmP at 1.5, 3.0 and 4.5% of diets. In an experiment lasting six weeks, one-day old Arbor Acre broiler chicks (n=936) were randomly allotted to 13 dietary treatments. Each treatment was replicated eight times and a replicate comprised nine chicks. At week six of the experiment, eight chicks per treatment were selected, sacrificed and carefully dissected into primal cuts. Breast meat was collected and degree of lipid oxidation determined as TBARS (mg/100g) at days 2, 4 and 7 of storage. However, at day 2, effects of combination (LMC+VMP) on TBARS differed significantly ($P<0.05$). The BC meat from Diet 1 with the combination of 1.5% LMC + 0% VMP had significantly higher ($P<0.05$) TBARS *(mg/100g)* of 4.21 compared with those from diets 3 (1.7), 4 (1.54), 5 (1.68) and 7 (1.48). Dietary combination of VMP and LMC was only beneficial to initial storage in the first two days. The meat had the same levels of peroxidation thereafter, irrespective of VMP and LMC combination.
Keywords: Supplemental vitamin mineral premix, Arbor Acre broiler chickens, Meat lipid peroxidation, Leaf meal composite

Introduction

Vitamin-mineral premix (VMP) is a vital feed ingredient for bone growth, development and oxidative stability of meat of broiler chickens (BC). It is therefore necessary to source for cheaper alternative feedstuff such as leaf meal that can efficiently replace the expensive conventional VMP.

Plants such as *Vernonia amygdalina, Moringa oleifera, Occinum spp, Celocia argentea, Manihot spp, Telferia occidentalis, Chromoleana odorata* amongst others are rich in reasonable quantity of vitamins, minerals, amino acids and antioxidants (Aro *et al.,* 2009; Ogbe and John, 2011; Adegbenro *et al.,* 2012a). Adegbenro *et al.,* (2012b) reported that the leaves of these plants could adequately replace conventional vitamin- mineral premix in livestock diet either singly or as composite mixture and helps to lower dependence of farmers on the imported VMP, reduce the cost of production and reduce the consumer's concern on the toxicity of synthetic origin of the VMP (Botsoglou *et al.,* 2002).

Most studies in BC production where LMC have been used to replace dietary VMP in Nigeria delved mainly on performance, blood profile (Aro *et al.,* 2009; Ogbe and John, 2011; Adegbenro *et al.,* 2012a) with none focused on lipid peroxidation during storage which therefore was the aim of this study.

Materials and Method

Experimental Site

The experiment was carried out at the Poultry Unit, Teaching and Research Farm, University of Ibadan, Ibadan Nigeria. It is located at latitude 7° 20^{1}N, longitude 3° 50 NE, and 200m above the sea level, in tropical rain forest zone.

Test Materials

The leaves used for this study were *Moringa oleifera* (drumstick tree), *Celosia argentea* (African spinach), *Veronia amygdalina* (Bitter leaf), and *Telfaria occidentalis* (Fluted pumpkin). The leaves were plucked, cleaned, and air dried to constant weight. They were milled and mixed in equal proportion into a composite mix then incorporated to replace commercial VMP in the experimental diets.

Experimental Animals and Management

One-day old Arbor Acre chicks (n=936) were purchased from Farm Support Hatchery, Ibadan, Nigeria. The chicks were randomly allotted to thirteen treatments of eight replicate with nine chicks each. They were raised in a deep litter system with separate feeders and drinkers. The experimental diets and water were offered *ad-libitum* to chicks.

The isocaloric and iso-nitrogenous basal diets comprised three levels of CLM (1.5, 3.0, and 4.5%) and four levels of VMP (0, 0.125, 0.25, and 0.375%) in an (3x4)+1 augumented factorial arrangement and a completely randomised design. Starter and finisher diets contained 3038.39 Kcal/Kg; 22.89% and 2915.39 Kcal/Kg; 19.65% metabolizable energy; crude protein, respectively. The diets layout were as follows; Diet 1: 0% VMP + 1.5% CLM; Diet 2: 0% VMP + 3.0% CLM; Diet 3: 0% VMP + 4.5% CLM; Diet 4: 0.125% VMP + 1.5% CLM; Diet5: 0.125% VMP +with 3.0% CLM; Diet 6: 0.125% VMP + 4.5% CLM; Diet 7: 0.25% VMP + 1.5% CLM; Diet 8: 0.25% VMP + 3.0% CLM; Diet 9: 0.25% VMP + 4.5% CLM; Diet 10: 0.375% VMP + 1.5% CLM; Diet 11: 0.375% VMP + 3.0% CLM; Diet 12: 0.375% VMP + 4.5% CLM; Diet 13: 0.25% VMP + 0% CLM

Thiobarbituric aicd reactive substances Assay (TBARS)

At week six of the experiment, eight chicks per treatment were selected, sacrificed and carefully dissected into primal cuts. Breast meats were collected stored in a freezer. After thawing, 1 grams of the breast meat was measured into test tubes. The degree of lipid oxidation was determined by measuring the TBARS at days 2, 4 and 7 of storage. Percentage lipid oxidation inhibition was calculated using the equation of Saikat *et al.* (2010) (Absorbance of control – Absorbance of sample) / Absorbance of control ×100

Statistical Analysis

Data were subjected to analysis of variance, (SAS, 2002). Means were separated using orthogonal contrast at $\alpha_{0.05}$.

Results and Discussion

The main effect of dietary CLM on TBARS of BC meat is shown in Table 1. Meat TBARS were not significantly affected (P>0.05) by CLM inclusion in days of storage. The main effect of varying dietary VMP inclusion on TBARS of BC meat is shown in Table 2. At day 2 of storage, TBARS differed significantly (P<0.05) with a higher value of 3.15 at 0% inclusion of VMP. The meat TBARS were however not significantly different (P>0.05) at days 4 and 7 of storage.

Effect of interaction of dietary composite CLM and VMP on lipid peroxidation of BC meat during storage is shown in Table 3. There was no significant effect of interaction of the two dietary condiments (P>0.05) on TBARS at days 4 and 7 of storage. However, at day 2, the values were significantly different (P<0.05). Meat of BC from Diet 1 with the combination of 1.5% LMC + 0% VMP had significantly higher TBARS of 4.21 compared with meat from BC on diets 3 (1.7), 4 (1.54), 5 (1.68) and 7 (1.48).

Table 1: Main Effect of CLM on Lipid Peroxidation of Broiler Chickens meat during Storage

	Percentage Inclusion					
Days of Storage	0	1.5	3.0	4.5	SEM	P values
2	2.77	2.34	2.37	2.26	0.019	0.83

4	1.75	1.27	1.42	1.37	0.01	0.44
7	1.49	1.93	1.90	1.89	0.01	0.54

a,b,c,: means with different Superscript within the same row differs significantly (P<0.05)
SEM = standard error of means

Table 2: Main Effect of VMP on Lipid Peroidation of Broiler Chickens Meat during Storage

		Percentage Inclusion					
Days of Storage	Control	0	0.125	0.25	0.375	SEM	P values
2	2.77^{ab}	3.15^{a}	1.77^{b}	2.00^{b}	2.38^{ab}	0.019	0.004
4	1.75	1.55	1.25	1.28	1.33	0.01	0.82
7	1.50	2.00	2.02	1.93	1.67	0.01	0.47

a,b,c,: means with different Superscript within the same row differs significantly (P<0.05)
SEM = standard error of means

Table 3: Effect of Interaction of Varying Inclusion of CLM and VMP on TBARS of BC in Storage

	VMP (%)	CLM (%)	Day 2	Day 4	Day 7
Diet 1	0	1.5	4.21^{a}	1.50	1.84
Diet 2		3.0	2.55^{ab}	1.69	2.09
Diet 3		4.5	1.70^{c}	1.60	2.07
Diet 4	0.125	1.5	1.54^{c}	1.11	2.08
Diet 5		3.0	1.68^{c}	1.40	1.95
Diet 6		4.5	2.09^{bc}	1.25	2.04
Diet 7	0.25	1.5	1.48^{c}	1.09	1.70
Diet 8		3.0	1.56^{c}	1.30	2.17
Diet 9		4.5	2.98^{abc}	1.44	2.91
Diet 10	0.375	1.5	2.17^{bc}	1.50	2.10
Diet 11		3.0	2.70^{abc}	1.31	1.37
Diet 12		4.5	2.28^{bc}	1.19	1.53
Diet 13	0.25	0	2.77^{abc}	1.75	1.50
	P value		0.012	0.858	0.402
	SEM		0.019	0.01	0.01

a,b,c: means with different Superscript within the same row differs significantly (P<0.05) SEM = standard error of means

The TBARS is a measure of lipid peroxidation in meat and meat products, hence a high level of TBARS indicate a toxic condition or high oxidative rancidity. The TBARS values at days 4 and 7 of storage were similar to 1.07-1.57 reported (Moravej *et al.*, 2013). The meat from the BC were however of low oxidative rancidity analogous to meat from goats fed diets supplemented with *Moringa oleifera* leaf meal which was reported to exhibit high antioxidant capacity (Qwele *et al.*, 2013). The meat TBARS were affected by the inclusion levels of VMP at day 2 of storage and were slightly higher than those reported by Moravej *et al.* (2013). This is in agreement with the report of Moravej *et al.* (2013) that reduction of VMP in broiler finisher diet would lower meat quality during storage. This is due to a slight drop in the TBARS obtained with increasing levels of VMP in the storage periods.

Conclusion

Dietary combination of VMP and LMC was beneficial to the initial storage of meat of BC in the first two days. Thereafter, the meat had the same levels of peroxidation irrespective of the combination of VMP and LMC.

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TRENDS AND CHALLENGES OF ANIMAL PRODUCTS PROCESSING TECHNOLOGY IN NIGERIA

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Abstract
Animal products continue to play significant role in food and nutrition security as well as employment generation all over the world. However, the issue of processing and associated regulations requires more attention especially in developing countries including Nigeria. The quality of these products depends to a large extent on the availability and level of technological development. This review discussed the trends in animal products processing technology and its impact on food security and economic development. The first and most important aspect is the processing infrastructure especially the abattoir. The state of most public abattoirs and slaughter slabs in Nigeria are below the required standard for animal processing, yet millions of cattle are being slaughtered daily for human consumption across the Nation. An animal product is any material derived from the body of an animal. Examples are fat, flesh etc. The majority of the meat traded in urban areas are processed through public abattoirs. Traditionally, meat are processed to *suya, kundi, kilishi.* With gradual development in meat processing, meat comminuted are been used in products like sausages, hamburger, minced meat, corned beef etc. Poultry meat processing involves five operations namely: slaughtering, scalding & de-feathering, eviscerating, washing & chilling and packaging. The corresponding development of processing capacity in West Africa as developed countries will be significant in contributing to solving serious food shortages and safety that exists. Also, development of animal products processing industry will bring a desired positive change in the livestock sector of our economy. Also, the public health will be safe from diseases most especially the zoonotic ones.
Keywords: Animal products, processing, trends, technology, infrastructure

Introduction
Animal protein currently provides 13 percent of the calories produced globally from agriculture and represents 26 percent of the world's dietary protein (Fraser, 2014). It is well-known that Nigeria's per capita intake of high quality animal protein is too low (Olayide *et. al*, 1972; Oyenuga, 1974; FAO, 1990). Meat is any flesh of animal that is used for food. It is nutritious and highly attractive in appearance. There are different kinds of meat depending on the source from which they are obtained, for example, mutton from sheep, chevon from goat, beef from cattle, and pork from pig and chicken from birds (Soniran and Okunbanjo, 2002).

An animal product is any material derived from the body of an animal Examples are fat, flesh, blood, milk, eggs etc. Animal by-products, as defined by the United State Department of Agriculture (USDA, 2007) are products harvested or manufactured from livestock other than muscle meat. In the European Union (EU), Animal by-products (ABPs) are defined somewhat more broadly, as materials from animals that people do not consume. Animal products are responsible for one-sixth of the human food energy and also more than one-third of the protein requirement on a global basis (Bradford,1999). Animal production trends are said to be influenced by strong demand-driven factors such as population growth, urbanization, income growth and changing customer services. Traditional technologies of food processing and preservation date back thousands of years and, unlike the electronics and other modern high technology industries, they long preceded any scientific understanding of their inherent nature and consequences (Hulse, 1983).

Milk is a major source of dietary energy, protein and fat, contributing on average 134 kcal of energy/capita per day, 8 g of protein/capita per day and 7.3 g of fat/capita per day in 2009 (FAOSTAT, 2012).

Animal products processing

The animal processing industry has evolved into a large, corporate, automated industry. Animal processing industry origin can be traced back to the time when small, privately-owned processing plants processed a few animals each day. Today, the majority of animals are processed in large state-of-the-art facilities that handle thousands of animals per day. The first and most important aspect is the processing infrastructure especially the abattoir. An abattoir is a facility or a premise approved and registered by the controlling authority for hygienic slaughtering and inspection of animals, processing and effective preservation and storage of meat products for human consumption (Gail, 1997). The state of most public abattoirs and slaughter slabs in Nigeria are below the required standard for animal processing. Despite availability of legislature on animal slaughter in the country, diverse problems such as slaughtering animals on untidy floors, absence of stunning and ripening operations, inadequate slaughtering facilities, and lack of sewage disposal systems, inadequate clean water supply abound with meat handling procedures in abattoir. In furtherance, most slaughter slabs in the country are dilapidated laden with inadequacies which include substandard poor waste disposal system, poor drainage system etc. Standards are also compromised; inadequate supervision of operations such as animal handling, slaughter and processing; and lack of proper meat inspection.

Meat

Meat industry development is an integral part of the strategy for the advancement of the entire livestock value chain development with a strong degree of integration of the producers and consumers (Osadebamwen, 2015). The majority of meat traded in urban areas is processed through public abattoirs. Local slaughter slabs are open air slaughter locations owned and operated by local government, operating conditions are poor to very poor with medium operation volume. The private abattoir is privately owned infrastructure that slaughters livestock for self and/or others using employed operating labour. Traditional meat preservative & processing techniques involved sun drying, then drying over burning wood fire, and salting could be done in order to preserve meat for future use. Advances in preservation technology especially refrigeration and packaging provided opportunities for many new processed products. Some of Traditionally processed meat are discussed below:

Suya (*tsire or balangu*), banda (*kundi*) and *kilishi* are the most important traditional processed meats in Nigeria and other West African countries including Chad, Niger and Mali. The meat chunks are pre-cooked before smoking/kiln drying or sun drying. The traditional smoking kiln for banda is usually an open-top, 50-gallon oil drum fitted with layers of wire mesh that hold the product, and fired from the bottom. Banda is a poor quality product, stone-hard and dark in color. Unlike banda, suya and kilishi are made by roasting spiced, salted slices/strips of meat (usually beef). Kilishi is different from suya in that a two-stage sun-drying process precedes roasting. Consequently, kilishi has a lower moisture content (6-14 %) than suya (25- 35 %) and a longer shelf life.

A model pilot plant for improved processing of kilishi has been established in Benin City, Nigeria.

The pilot plant uses improved technology involving cabinet (tray) drying and vacuum packaging and has clearly demonstrated the benefits arising from upgrading traditional food processing technologies in terms of improved product quality, shelf life, consumer acceptance, export potential and income generation (Ahmadu *et al.* 2004). All processed meat products have been in one way or another physically and/or chemically treated. Meat processing technologies include: Cutting/chopping/comminuting, Mixing/tumbling, Salting/curing, Utilization of spices/non-meat additives, Stuffing/filling into casings or other containers, Fermentation and drying, Heat treatment, Smoking.

Milk

Milk produced by their cattle are mainly for consumption and the remnant processed by their women into products such as *nunu* (sour milk), *kindirmo* (thicker nunu), *maishanu* (local butter), *cuku* (Fulani cheese) and *wara* (Yoruba cheese). The nomadic Fulani has, since ancient times, processed milk into a soft cheese known as warankasi in Nigeria as a means of preserving excess milk. Warankasi is a good source of

animal protein and is used to replace meat or fish, or in combination with them, in various food recipes. The traditional West African cheese-making process was developed (presumably empirically) by the nomadic Fulani and is based on the milk-coagulating properties of juice from the leaves of the Sodom apple plant [*Calotropis procera*]. The process is very unhygienic; there are numerous opportunities for product contamination and there are no quality standards. Starting with pasteurized milk and applying scientific knowledge of the biochemical properties of sodom apple proteinases, an improved cheese-making procedure based on the traditional process has been developed (Aworh 1990, Aworh, & Muller 1987, Aworh *et al.* 1994). Modern cheese making; Vegetable rennet prepared by precipitating the milk clotting proteinases in sodom apple leaves with ammonium sulfate is used as coagulant (Aworh, *et al.* 1986). This allows better control of the coagulation process and reduces product contamination. Following coagulation, the curd pieces are drained in stainless steel hoops instead of raffia baskets, salted and pressed in a hydraulic press to reduce the moisture content and extend the shelf life.

Modern milk processing techniques start from milk collection, the use of milking machine. The teat cups present on the milking machine are attached to teat. The cups alternate between vacuum and normal air pressure to extract the milk. The milk is filtered and cooled before being added to a large bulk tank of milk storage. Milk through technology intervention are now being processed into varieties of dairy product. Such products may be dry or wet, wet milk product: Ice cream, butter, cheese, Yoghurt. Dry milk products: powdered milk, dry ice cream powder, dry ice cream etc. For most products, there are processes that are common to them all, among these are; Filtration, Clarification, Standardization, Homogenization, Pasteurization & Cream separation.

Egg

Eggs are consumed domestically and are also used for Industrial purposes (Confectionaries, Baking, etc.) Eggs are consumed raw, fried, or boiled in various homes. Industrial egg products are manufactured in liquid, frozen and dried forms using either whole egg (white and yolk) or white or yolk. Dried egg products or powdered eggs are eggs that have been dehydrated (usually dried in a spray dryer) and made into a simple powder, with a texture similar to that of powdered milk. Powdered eggs have a longer shelf life than fresh eggs and can be stored for almost 10 years and it is not necessary to store the eggs under refrigeration; all that is required is a cool to moderate temperature and a dark environment. Powdered eggs are also easier to transport, handle (no breakage), and occupy less storage space than fresh eggs. Frozen eggs are whole, yolk or white that is frozen at very low temperatures after purification. The specific product is frozen at between -23 to -25oC and subsequently stored at -15oC. This can keep for between eight to ten months. In Nigeria, the egg industry is not well developed and is rudimentary. The egg products mentioned above are not produced in the country

Drivers of the trends in animal products processing

1) A rapid and dynamic increase in consumption of animal products in developing countries.

A change in livestock production practices from a local multipurpose activity to an increasingly market-oriented and vertically-integrated business.

3) Due to increasing pressure on, and competition for, natural resources in terms of production.

4) Urbanization and advancement in science and technology.

Challenges Associated With Animal Products Processing In Nigeria

Moribund state of Abattoir/Infrastructure, Lack of Technical expertise, Low Product Production, Lack of competitiveness and Risk factors, Rural- Urban Migration, The Role of the Government, Lack of Mechanized Animal farming

Conclusion and Recommendation

Continuous development and application of processes that ensure the quality of meat and meat products have significant bearing on use as food. Corresponding development of processing capacity in West Africa as developed countries will be significant in contributing to solving serious food shortages and safety that exists. There has been significant change in the trends of processing animal products in West Africa. It is concluded that the change trend should continue as the traditional processing techniques has proven not only to be unsustainable but its cumbersome, inefficient and microbial growth cannot be controlled effectively using the crude techniques.

The development of animal products processing industry will improve the livestock sector of our economy. Also, the public health will be safe from diseases most especially the zoonotic ones. The challenges should be addressed by all levels of government and stakeholders both private and public, policies enforcement should be fully activated as these will guarantee a better economy, food security and safety for citizens.

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MEAT PRODUCTS PREFERENCE AMONG STUDENTS OF BINYAMINU USMAN POLYTECHNIC HADEJIA, JIGAWA STATE

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Abstract

The research was conducted to examine Meat Products Preference among Students of Binyaminu Usman Polytechnic, Hadejia, Jigawa State. Ten (10) students from seven (7) departments were randomly selected. Seventy (70) copies of structured questionnaires were administered to each of the respondent. The result was analysed using simple descriptive statistics. Results showed that majority (65.71%) of the respondents were between 15-20 years, male (85.71%), single (78.57%) and studying different programmes at National Diploma level (84.29%). Most of the respondents preferred Tsire (35.71%) and reason given for the choice was due to its taste (57.14%). It is concluded that Tsire is the most preferred meat type and it is recommended that more Tsire production should be encouraged in the study area.

Key words: Meat, Preference, Students, Hadejia and Jigawa State

Introduction

Meat is the edible flesh of an animal consumed by human (Babayemi et al., 2014). Most often it refers to the skeletal muscles, associated fat and other tissue (Herren, 2013). Humans have hunted and killed animals for meat, since prehistoric times (Karen, 2009). The advent of civilization allowed the domestication of animals such as chickens, sheep, rabbit, pig and cattle which eventually led to their use in meat production on industrial scale with the aid of slaughter houses (Felisiak, 2012). Meat is mainly composed of protein, fat, vitamins and water. It is eaten

after it has been cooked and seasoned or processed in a variety of ways (Virginia, 2015). The aim of the study was examine the socio-economic parameters of the respondents, as well as to identify their most preferred meat products.

Materials and Methods

The study was conducted at the Department of Animal Health and Production, Binyaminu Usman Polytechnic, Hadejia, Jigawa State. The area is located in the sudan savannah zone. Hadejia town lies between 100 02'28. 14" E Longitude and 120 27'12.49" N Latitude, it is bounded on the immediate south by River Hadejia. The area is covered by deposit of silt, sand and clay soils. The soil formation gave the area a great influence on agricultural development. The area has an annual rainfall ranging from 100-110mm per annum and accompanied by heavy wind. The temperature ranges between 31 to 40°C. There are two seasons in a year, it has about 6-8 months of dry season and the raining season lasts for about four months.

All the seven Departments under the School of Agriculture comprising of Agricultural Extension and Management, Agricultural Technology, Animal Health and Production, Fisheries Technology, Forestry Technology, Horticulture and Landscape Technology, and Wildlife and Eco-Tourism Management constitute the study area. In each Department, ten respondents were randomly selected making a total of seventy respondents. Each respondent was administered with a structured questionnaire. Information on the socio-economic background, most preferred meat type and reasons given for the choice were sourced.

The data generated were analyzed using simple descriptive statistical tool, in which results were transformed into frequency and percentage.

Results and Discussion

Tables 1 showed that majority (65.71%) of the respondents were between the ages of 15-20 years, followed by those that have age ranged between 21-26 years (21.43%). Most of the respondents were male (85.71%) and single (78.57%). Table 2 indicated that most (84.29%) of the respondents were National Diploma students. Result from Table 3 showed that the most preferred meat type were Tsire (35.71%), followed by Dambu (21.42%), then Suya (14.28%), Kilishi (7.14%) and Ragadada (7.14%). Table 4 showed that most of the respondents attached their

reasons for consuming a particular meat type due to its taste (57.14%), followed by health reason (28.57%) and availability (7.14%) and there was no taboo against it (7.14%).

The highest age range (15-20 years) in this study is similar to that reported by Adesina and Farinde (2012) who reported that most of the respondents were above 20 years in a survey conducted in some selected Local Government Areas of Borno State. Abdurrahaman et al., (2014) conducted a survey from the same institution and reported that majority of the respondents were between 21-30 years which is contrary to the finding of this research, possibly due to differences in time, when the research was conducted.

Yuguda et al., (2013) conducted a survey in Zaria, Kaduna State and reported that most (52.46%) of the respondents were married and majority (35.73%) were above 25 years old, which is contrary to the finding of this work, partly due to the fact that they carried out their research on cattle marketing activity and the respondents were relatively older.

A global tendency for rapid increase in demand for Tsire was reported by Sanusi et al., (2014). Tsire is one of the most preferred and consumed meat by diverse social and religious groups and this has placed an ever increasing high demand on it (Abubakar and Ibrahim, 2016). The trend observed in the preference for meat which give high preference to Tsire and Balangu may be due to the more availability of sheep and goat compared to other classes of livestock (Adesina and Farinde, 2012).

Conclusion and Recommendation

It is concluded that most of the respondents preferred Tsire (35.71%) and reason given for the choice was due to its taste (57.14%). It is recommended that more Tsire production should be encouraged in the study area.

Table 1: Socio-economic parameters of the respondents

Parameter	Frequency	Parameter	Frequency

Age (Years)		Marital status	
12-20	46 (65.71)	Single	55 (78.57)
21-26 (14.29)	15(21.43)	Married	10
27-31 (7.14)	5 (7.14)	Divorced	5
32-36 (100.00)	4 (5.71)	Total	70
>37	0 (0.00)		
Total	70 (100.00)		
Sex			
Male	60 (85.71)		
Female	10 (14.29		
Total	70 (100.00)		

Figures in the parenthesis are the percentages

Table 2: Academic (Program) distribution of the respondents

Program	Frequency	Percentage (%)
Higher National Diploma	12	17.14
Pre-HND	6	8.57
National Diploma	59	84.29
Ordinary Diploma	0	0.00

Certificate	0	0.00

Table 3: Most preferred meat type by the respondents

Most preferred	Frequency	Percentage (%)
Tsire	25	37.71
Kilishi	5	7.14
Dambun Nama	15	21.42
Ragadada	5	7.14
Balangu	10	14.28
Banda	0	0.00
Suya	10	14.28
Total	70	100.00

Table 4: Reason given by respondents for the meat choice

Reason given	Frequency	Percentage (%)
It is relatively cheaper	0	0.00
It is very available	5	7.14
I like its taste	40	57.14

Health reason	20	28.52
There is no taboo against it	5	7.14
Because I rear the animal	0	0.00
Total	70	100.00

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Financing small scale Agribusiness in Nigeria; challenges and potentials of animal products processing

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Abstract
In Nigeria, Agriculture is the largest sector for decades that has employed over 60% of its workforce and its growth rate is still below the potentials of the country's natural and human resources due to high cost of agricultural inputs, poor funding , inadequate functional and infrastructural facilities, inconsistencies in government agricultural policies, inadequate private sector participation, poor mechanized farming and little or no adoption of simple agricultural technologies developed by scientists. Trends in the demand for livestock products have been largely driven by a number of factors including human population growth, income growth, urbanization as well as different livestock systems in response to science and technology. Small scale agribusiness in animal products has the potential for employment generation, food and nutrition security and contribution to the country's gross domestic product (GDP) among others. However, this aspect of the livestock industry is still faced with a lot of problems associated with poor business financing such as poor electricity, high cost of agricultural processing machines and poor access to funding. Despite expanding markets for livestock products, the developing countries continues to import livestock products at the expense of local industries. A lot of reviews have been written on small scale enterprises, however, the enormous potential of the animal products processing sector has not been given due attention. Therefore, this review is focused on the challenges facing the development of small-scale businesses, the role and contribution of government in facilitating the growth of small business enterprise as well as the potentials of the animal product and processing sector. The paper concludes by stressing the need for increased investment in livestock production.
Keywords; Agribusiness, animal product, processing, prospects, fiscal policy

Introduction
Small scale enterprises have long believed to be catalysts for economic growth and national development both in developed and developing countries. In Nigeria where private sector is not well-developed, small-scale businesses is assumed to play the role of employment generation, facilitator of economic recovery and national development. The term SMEs has no universally accepted definition. The definition and criteria for classification of an enterprise as small, medium or large varies from one country to another, depending on whether it is developed or developing country. A small business for example to one country may be a large-scale business to another. Chukwemeke (2004), defines small scale business as one whose total asset in capital, equipment, plant and working capital are less than N250,000 and employing fewer than 50 full time workers. The Central Bank of Nigeria (CBN, 2004) defines small-scale business as an enterprise whose annual turnover ranges between N25, 000-N50, 000. Ogundele (2007) defines SMEs as one who has a minimum of 5 employees with minimum capital outlay of not less than N5, 000.00 ($33).
Sources of finance available to SMEs were enumerated by Ewiwile, S. Azu, B. and Owa, F. (2011) as follows:

i. The owner-savings and his or her associates including family and friends who may or may not be partners or shareholders in the venture.
ii. Partners and shareholders in the venture
iii. Banks and lending institutions
iv. The small business administration and financial assistance programme.
v. Small Business Administration licensed small business investment companies.
vi. Members of the trade, including suppliers of materials such as manufacturers and wholesalers, and in some instances, customers who prepay their contracts.
vii. Other businesses, local capitalist sales finance companies, factor and other sources.

Small-scale enterprises source their finance from the following financial institutions in Nigeria.

Micro Finance Bank or Community Banks: These financial institutions are owned and managed by their respective communities. They are self-sustaining financial institutions within their communities; hence the sourcing of funding for small-scale business is made even less cumbersome and much cheaper.

Development Banks: These specialized financial institutions are mostly established by government for the purpose, of financing commercial agricultural and industrial enterprises. Nigerian government has set up a number of development banks.

Nigeria Bank of Industry; This bank formed in 2001 through the merger of the following development financial institutions.

Animal production industry is very essential to food security and the development of any nation. It provides: (a) foreign exchange for the economy (b) employment for the citizens (c) rich source of protein which is essential for human nutrition (d) it is a source of prestige (e) provides income for the citizens (f) provides draught power (g) transportation (h) provides raw materials for the clothing and shoe industry and by-products can be used in various other industries such as the cosmetic industry.

Animal products are responsible for one-sixth of the human food energy and also more than one-third of the protein requirement on a global basis (Bradford 1999). Livestock, including poultry are usually raised for their meat or egg. However, other areas of interest are dairy, bone, wool/feather, and hide/skin. Due to the very large market for meat, there has been a tremendous growth in the meat processing industry. Slaughter houses are built where a large number of animals are processed daily which include but not limited to goats, sheep, cow, rabbit and pigs.

A dairy is a business enterprise established for the harvesting of animal milk – mostly from cows or goats, but also from buffalo, sheep, horses or camels – for human consumption. A dairy farm produces milk and a dairy factory processes it into a variety of dairy products. These establishments constitute the dairy industry. The Director General of National Office for Technology Acquisition and Promotion (NOTAP) Engr. Umar Bindir observed that if half of the Nigerian population estimated at a hundred million consume a glass of milk estimated at only N100 per glass, it could generate N10 billion per day which in turn could create millions of jobs and translate into a N300 billion monthly revenue. Examples of dairy products include milk in its various forms, cheese, yoghurts, ice cream, curds and a host of others.

Challenges of animal product processing

Below are listed the major challenges facing the animal product processing sector in Nigeria and possible solutions which when incurred will help curb these challenges.

Source Verification, Identity Preservation and Food Traceability Systems: It is critical to better understand the benefits, costs and functionality of food product traceability and identity

preservation systems. In the absence of government edicts, economics will dictate the type of traceability system used in each segment of each industry. Developing technology continues to reduce costs and increase the technical feasibility of enhancing information collection and product and animal tracking. Increased assessment of market implications of government mandated vs. market-driven animal and/or meat product traceability systems is needed.

New Markets/Niche Markets: The scope of niche and highly differentiated markets for meat products is yet uncertain. Understanding consumers' willingness to pay for extrinsic attributes is critical to assess the implications of differentiated product markets on the competitive position and growth opportunities for producers and processors.

Regulatory Costs: The significant impact that regulatory costs have on cost competitiveness, relative to size of firm and location, is essential to understanding the global competitiveness of the livestock industry. Uniform regulations are not size-neutral because it is generally less costly per unit of output for larger firms to comply than it is for small firms. Different regulations in various communities will differentially impact costs.

Role of government in facilitating small scale business

Government fiscal policy towards taxation has a positive effect on small scale business. However, this effect is not significant. The positive influence taxation has on small scale business owners showed that the tax policy on small scale businesses is not detrimental to their operations and they do not encounter multiple taxation. The statistical insignificance of government fiscal policy implies that it is not a government action that determines the growth of small scale businesses. (Adeusi,S.O)Also, small scale business owners believe government has been effective in encouraging financial institutions to lend to them due to the positive effect. This finding is in agreement to (Aluko O. A) who suggested that without the role of government on financial institutions, small scale business owners might have encountered difficulty in accessing credit facilities from financial institutions. The infrastructural facilities provided by the government have contributed to the growth of small scale businesses. This is because the result showed that infrastructural development by the government has a positive and significant effect on small scale businesses.

Discussion

Onwukwe and Ifeanacho (2011) evaluated the impact of government intervention on SME growth in Imo State, Nigeria and found that in spite of various specialised institutions in charge of micro credit and policy instruments, SMEs are being inhibited by the gap between policy and policy implementation in contributing to meaningful economic development. Hassan and Olaniran (2011) examined how assistance institutions contributed to the development of SMEs in Nigeria, with special reference to Industrial Development Centre (IDC), Osogbo. The outcome showed that the assistance institutions have enormously contributed to the promotion of SMEs and entrepreneurship development.

Mobolaji (2010) conducted a study on the impact of SMEs on economic development in Nigeria (1980- 2008). Employing a time series econometric approach, the study found that though SME is a catalyst for development and its impact on the development path in the country is still negligible. The study suggested that the poor performance of SMEs may be due to inadequate funding facilities, low education level and poor government support amongst others. Ekot (2010) adopted the survey design focused on small business ownership and management in UyoAkwa Ibom State, Nigeria and identified that lack of funds and interest by the young and literate people to undertake small businesses and poor government and institutional support constitute part of the problems plaguing small businesses in Uyo metropolis and Akwa Ibom State generally.

This is not in claim with Adeusi,S.O(2015) who carried out a survey in kabba metropolis of Kogi state showing responses from small scale business proprietors that the role government plays cannot be overlooked in the growth and survival of their businesses. This study identified that without government intervention, most small scale businesses would have gone into extinction. Measures taken by the government in time past have been seen to have a significant and positive impact on their businesses. This portends that policy actions implemented by the government towards promoting small scale businesses produce a favourable outcome on their operations. Government initiatives related to entrepreneurship development has had a significant and positive influence on the performance of small scale businesses. Small scale businesses are widely seen as a training ground for the development of entrepreneurship skills. Government has identified them and has taken initiatives to develop entrepreneurship abilities in them. These initiatives have improved the performance of small scale business operations and encouraged them to continue doing business.

CONCLUSION

The government contribution towards the development of small scale business cannot be over emphasized as government fiscal policy towards taxation has a positive effect on small scale business. Also small scale business owners believe government has been effective in encouraging financial institutions to lend to them due to the positive effect. Also the infrastructural facilities provided by the government have contributed to the growth of small scale businesses. This is because the work carried out shows that infrastructural development by the government has a positive and significant effect on small scale businesses.

RECOMMENDATION

It is pertinent to recommend policy measures so as to ensure that small businesses in animal products and processing sector can continue to grow and impact on the economy. The recommendations includes

- More efforts should be made by the government to channel more funds to small businesses towards their development. This can be done by compelling banks to set aside certain percentage of their credit distribution for lending to small businesses.
- Government should consider the ability to pay tax by small business owners when implementing tax policies on them. This can be done by taking into consideration the size of the business and profit generated.
- Government should continually provide small scale businesses with the necessary infrastructural facilities to enhance the growth of their businesses.
- Government should establish more agencies meant to grant small scale businesses credit facilities as well as financial and technical advice.

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SENSORY QUALITY OF VACUUM-PACKED CURED-SMOKED CHICKEN FILLETS AS INFLUENCED BY *Capsicum annuum* EXTRACT

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Abstract
This study evaluated the effect of red pepper (*Capsicum annuum*) extract on sensory quality of vacuum-packed cured-smoked chicken fillets from improved indigenous meat-type chickens over a 60-day storage at room temperature. Experimental treatments had batches of chicken fillets cured with brine solution containing 0.015% nitrite (T1-positive control), no nitrite/extract (T2-negative control), 0.15% (T3), 0.30%(T4), 0.45% (T5), 0.60% (T6) and 0.75% (T7) capsicum extract. Sensory evaluation on day 0 and quality assessment over storage was carried out using a 9-point hedonic scale and a 3-point descriptive scale, respectively. Data were analysed using two-way ANOVA ($p<0.05$). Significant ($p<0.05$) effect of treatments were observed in colour, flavour tenderness and overall acceptability (OA) for sensory evaluation on day 0 only. Highest values for colour (5.30) and flavour (5.25) were recorded for T3 and T5, respectively while T7 had highest values for tenderness (6.20) and OA (7.50). For quality changes over storage, rate of slime formation and colour change were significantly affected by treatments while visible microbial growth, odour, muscular elasticity and overall quality were not ($p<0.05$) affected. Duration of storage, however had ($p<0.05$) effect on all parameters measured. No slime formation was observed on day 0 for most treatments up to day 60, darker brown colour was observed as storage days progressed, on-set of off-odour at day 45 (2.39) and softer fillets with average muscular return up to day 60 (2.54). Overall quality reduced from excellent (3.00) on day 0 to acceptable/unacceptable (range of 1.3 to 2.1) for all treatments on day 60.
Inclusion of *Capsicum annuum* extract and duration of storage influenced the sensory quality of vacuum-packed cured-smoked chicken fillets to varying degrees. Overall quality of fillets during shelf storage was assessed as acceptable up to day 30 of storage.

Key words: sensory quality, *capsicum annuum* extract, vacuum packaging, shelf storage, chicken fillets
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Introduction
Developing countries like Nigeria are constantly faced with inconsistent power supply which exposes meat and meat products to temperature abuses during refrigerated and frozen storage. Also, increased concern about the relationship between processed meat products and non-communicable diseases has increased demand for healthy products, relevant researches relating to identification of alternatives and motivation of the meat industry to engage in reformulation strategies (Kraus, 2015; Yang *et al.*, 2015). Some of the most relevant trends regarding product reformulation are replacement of artificial additives/preservatives by natural alternatives, salt reduction and the addition of ingredients with potential positive effects on health (Jiang and Xiong, 2016; Perry and Grace, 2015; Strijbos *et al*., 2016; Valenzuela and Pérez, 2016). Red peppers are rich sources of phenolic compounds, carotenoids, ascorbic acid, and Vitamin A (Davis *et al*., 2007), giving rise to their preservative potential (Jimenez *et al.,* 2003). Developing meat products, using spices such as red peppers which have natural preservatives, and vacuum-packaging can extend their shelf life and ensure continuous supply of wholesome products to consumers.
Sensory analysis, as one of the tools for quality control in meat product development allows for effective quality and acceptability assessment over a storage period. It is an evaluation process used to measure, analyse and interpret human responses to food products. Perception occurs through the senses of touch, taste, sight, smell and sound (Meilgaard *et al*., 1999). Sensory evaluation allows for understanding of consumers' reactions to a new or existing product. It is important to measure the sensory characteristics of a new or modified product since consumers' acceptance is driven mainly by the quality of the product

(Chapman *et al*., 2001). This study was therefore carried out to determine the preservative effect of red pepper (*Capsicum annuum*) extract on sensory quality of vacuum-packed cured-smoked chicken fillets during storage.

Materials and methods

This study was carried out at the Animal Products and Processing Laboratory of the Department of Animal Science, University of Ibadan.

Test ingredient (Red pepper extract or oleoresin) was obtained by drying matured *Capsicum annuum* fruits until crispy. Dried red pepper fruits were thereafter ground and extracted using methanol at a ratio of 5ml methanol:1g of dried red pepper. Extract was thereafter concentrated and kept in the dark until further usage.

Fifteen (15) kg de-boned chicken meat obtained from matured improved indigenous meat-type chickens (*Funaab-α II*) was equally divided and submerged in curing solution containing 0.015% nitrite (T1-positive control), no nitrite/extract (T2-negative control), 0.15% (T3), 0.30%(T4), 0.45% (T5), 0.60% (T6) and 0.75% (T7) capsicum extract. Curing was done for 36-48h at 4^{o}C. After the curing period, cured chicken meat (according to treatments) were transferred into a smoking chamber for 2-2.30hrs at 60-80^{o}C for hot-smoking and subsequently cooled and sliced. Cured-smoked chicken fillets were vacuum-packed, labelled and stored for 60 days at room temperature. Sensory evaluation and quality assessment was carried out on stored vacuum-packed fillets on day 0, 15, 30, 45 and 60 of storage.

Sensory evaluation

Two distinct sensory evaluation procedures were carried out on prepared cured-smoked chicken fillets. Firstly, freshly prepared cured-smoked chicken fillets samples were assessed by a twenty-member semi-trained sensory panellists using a 9-point hedonic scale (Cross *et al*., 1978) on day 0 (zero) only. Panellists assessed randomly coded fillet samples for colour (1=extremely dark/red; 9=extremely light/pale), flavour-smoky (1=not perceptible 9=extremely intense), hotness (1=extremely hot; 9=extremely mild), tenderness (1=extremely tough; 9=extremely tender), juiciness (1=extremely dry; 9=extremely juicy) and overall acceptability (1= dislike extremely; 9=like extremely). Evaluation was carried out in a naturally illuminated/well-ventilated laboratory and panellists were offered crackers and clean water between samples to cleanse their palates.

Secondly, a ten-member trained panellists evaluated cured-smoked chicken fillet samples for different sensory quality attributes using a 3-point descriptive scale (Octavian and Octavian, 2010), vis external quality attributes - slime formation (3=without slime; 1=slime on all surfaces) and microbial growth (3=not visible; 1=visible on all surfaces), odour (3=normal/characteristic; 1=foreign/rancid/putrid), colour (3=pink to light red; 1=dark brown), muscular elasticity (3=fast return; 1=no return) and overall quality (3=excellent; 1=unacceptable) on day 0, 15, 30, 45 and 60 of storage.

Experimental design and statistical analysis

Experimental design was a completely randomised design in a factorial arrangement. First sensory evaluation data were analysed using one-way ANOVA (curing treatments effect only) while the second sensory evaluation data were analysed using two-way ANOVA (curing treatments and storage day effects) procedure of SAS v9.2 (SAS, 2012) at 5% significance level. Significant means were separated using Duncan Multiple Range Test of the same software.

Results and discussion

Sensory evaluation of freshly prepared cured-smoked chicken fillets (table 1) shows significant ($p<0.05$) effect of treatment on colour, flavour, tenderness and overall acceptability of fillets. No significant ($p>0.05$) effect of treatment was however observed in hotness and juiciness values of the freshly prepared cured-smoked chicken fillets. Colour and flavour values ranged from 3.05 (moderately dark) and 3.75 (slightly perceptible) in treatment 2 to 5.30 and 5.25 (intermediate belt) for treatment 3 and 5, respectively.

Table 1: Sensory evaluation of freshly prepared cured-smoked chicken fillets

Parameters (%)	1	2	3	4	5	6	7	SEM

Colour	3.55^{bc}	3.05^{c}	5.30^{a}	3.60^{bc}	5.10^{a}	3.90^{bc}	4.70^{ab}	0.19
Flavour	4.40^{ab}	3.75^{b}	4.70^{ab}	5.05^{a}	5.25^{a}	5.00^{ab}	4.80^{ab}	0.15
Hotness	7.35	6.65	6.75	7.05	6.90	6.60	7.35	0.17
Tenderness	5.70^{ab}	6.00^{ab}	5.50^{ab}	4.80^{b}	5.90^{ab}	5.40^{ab}	6.20^{a}	0.60
Juiciness	4.90	5.40	4.80	4.85	5.10	4.95	5.35	0.16
Overall acceptability	6.30^{b}	7.20^{ab}	6.85^{ab}	6.70^{ab}	6.95^{ab}	7.20^{ab}	7.50^{ab}	0.11

$^{a,b,c,\cdots}$-means along same row with different superscripts are significantly ($p<0.05$) different; SEM- Standard Error of Mean
1 - Nitrite; 2 - 0% nitrite/capsicum extract; 3 - 0.15% capsicum extract; 4 - 0.30% capsicum extract; 5 - 0.45% capsicum extract; 6 - 0.60% capsicum extract; 7 - 0.75% capsicum extract

Fillets in T7 were toughest (6.20) while T4 had the least tender score (4.80). Overall acceptability was highest (7.50) for treatment 7 and least (6.30) for treatment 1.

Sensory quality assessment of cured-smoked chicken fillets over storage presented in table 2 shows significant ($p<0.05$) effect of treatments on rate of slime formation and colour of chicken fillets while no significant ($p>0.05$) effect was observed in rate of visible microbial growth, odour, muscular elasticity and overall quality of fillets. Significant ($p<0.05$) effect of storage day was however observed for all parameters measured. Interaction effect of treatments and storage days was observed for slime formation, colour and muscular elasticity. Values for parameters measured were highest (3.00) on day 0 for all treatments and gradually decreased in time. No slime formation was observed on day 0 for most treatments up to day 60 (ranged from 3.00 on day 0 to 2.40 on day 60), darker brown colour was observed as storage days progressed, on-set of off-odour at day 45 (2.39) and softer fillets with average muscular return up to day 60 (2.54). Overall quality reduced from excellent (3.00) on day 0 to acceptable/unacceptable (range of 1.3 to 2.1) for all treatments on day 60.

Decrease in sensory quality could be as a result of development of slime and onset of microbial growth leading to increased off odours and fillets with slow muscular elasticity. The muscular elasticity assesses the period of muscular return to quantify the quality of meat. This is done by lightly pressing the fillets with the forefinger. Colour of fillets from all treatments rapidly dropped from 3.00 (pink to light red) to 1.49 (dark brown) over storage, although T1 (nitrite only) had recorded highest colour rating (2.24) followed by T5 (2.08) and T4 (2.04). Overall quality of chicken fillets was reported by panellists to be between excellent and acceptable on day 15 (2.07) and 30 (2.29) while it was between acceptable and unacceptable by day 45 (1.84) and 60 (1.70). The findings of this study agrees with reports by Deepshikha *et al.* (2016) who observed decreased ratings of colour and other sensory quality parameters in stored vacuum-packed smoked pork product cured in different curing solutions. Colour ratings observed during the storage period do not however agree with results reported by Lachamliani *et al.* (2015) in *Vawksa rep* (smoked pork product) meat samples. It also contradicts the statement by Parra *et al.* (2012) who stated that under vacuum packaging conditions, meat is protected from colour fading due to the low level of oxygen.

Table 2: Sensory quality assessment of cured-smoked chicken fillets over storage

	Slime Formation	Microbial Growth	Odour	Colour	Muscular Elasticity	Overall Quality
Treatments						
1	2.60^{b}	2.86	2.42	2.24^{a}	2.50	2.10
2	2.58^{b}	2.92	2.60	1.79^{b}	2.50	2.16
3	2.90^{a}	2.94	2.56	1.90^{b}	2.52	2.26

4	2.22^{c}	2.78	2.44	2.08^{ab}	2.44	2.06
5	2.64^{ab}	2.76	2.50	2.04^{ab}	2.55	2.16
6	2.70^{ab}	2.84	2.42	1.90^{b}	2.52	2.26
7	2.66^{ab}	2.86	2.58	1.90^{b}	2.66	2.26
SEM	0.07	0.05	0.08	0.07	0.08	0.08
Storage Day						
0	3.00^{a}	3.00^{a}	3.00^{a}	3.00^{a}	3.00^{a}	3.00^{a}
15	2.46^{bc}	2.96^{ab}	2.44^{bc}	1.91^{b}	2.59^{b}	2.07^{bc}
30	2.67^{b}	2.87^{ab}	2.49^{b}	1.60^{c}	2.21^{c}	2.29^{b}
45	2.54^{bc}	2.81^{b}	2.39^{bc}	1.86^{b}	2.27^{c}	1.84^{cd}
60	2.40^{c}	2.63^{c}	2.20^{c}	1.49^{c}	2.54^{b}	1.70^{d}
SEM	0.06	0.05	0.07	0.06	0.07	0.06
P-value						
Treatments	<0.0001	0.1754	0.5180	0.0003	0.6887	0.3077
Storage day	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Treatment*SD	<0.0001	0.0626	0.0518	0.0086	0.0438	0.1172

$^{a,b,c,\cdots}$-means along same column with different superscripts are significantly (p<0.05) different; SD- storage day; SEM- Standard Error of Mean

1 - Nitrite; 2 - 0% nitrite/capsicum extract; 3 - 0.15% capsicum extract; 4 - 0.30% capsicum extract; 5 - 0.45% capsicum extract; 6 - 0.60% capsicum extract; 7 - 0.75% capsicum extract

Conclusion

Capsicum annuum extract inclusion in curing solution influenced the sensory quality of fresh and stored vacuum-packed cured-smoked chicken fillets to varying degrees. Highest overall acceptability was observed for chicken fillets in treatment 7 which had highest inclusion level of the extract. Overall quality of fillets during shelf storage was assessed as acceptable up to day 30 of storage. Also, it was observed that most sensitive attributes for panellists during the period of assessment was colour and overall quality.

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STATE OF INFRASTRUCTURE, TECHNOLOGY AND ANIMAL PRODUCTS PROCESSING IN NIGERIA: THE MISSING LINK

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Abstract
Animal product and processing is a very important aspect of animal production and Nigeria is a major hub of animal product consumption in West Africa. It is also one of the largest livestock-raising countries in the region. Animal products are responsible for one-sixth of the human food energy and also more than one-third protein requirement on the global basis. The average Nigerian still consumes less than 9 grams of animal protein per capita per day compared to over 50 grams per capital per day in North America and Europe. Meeting the ever-increasing domestic demand and access to these flourishing markets are major concern for Nigeria and for the neighboring Sahel countries that raise livestock. The fast growing population of Nigeria is threatened with the problem of food insecurity and poverty which can be addressed with a more developed animal production and processing sector in addition to other sectors. However, post-harvest processing and infrastructural management of the food production chain remains a major challenge. Imported milk accounts for 75% of milk processing inputs and the high utilization of imported milk does not encourage backward integration within the value chain Some of the factors militating against successful animal products and processing amongst many include: need for trained human capital, low level of education, product safety and quality, effective communication, adoption of new knowledge, information and technology and lack of facilities. This paper aims at reviewing the state of infrastructure, technology and animal products and processing in Nigeria.
Key words: products,processing, infrastructure, technology, challenge.

Introduction
Science and technology are central to developmental prospects of poor countries. They can provide tools that help alleviate the specific problems that afflict many countries and which impede their development prospects, such as disease, infrastructural (energy, communication, transport etc.) decay and loss of agricultural produce and products (Olukayode and Shangodayo, 2011). Nigeria is a major hub of animal product consumption in West Africa. It is also one of the largest livestock-raising countries in the region. Meeting the ever-increasing domestic demand and access to these flourishing markets are major status for Nigeria and for the neighboring Sahel countries that raise livestock (Christophe *et al.,* 2010a).The strong rise in demand for animal products is due not only to the high rate of urbanization (60% of Nigerians are city dwellers), but above all, consumer's greater purchasing power and emergence of a new middle class. (Christophe *et al.,* 2010b). Although the meat-processing industry is growing, meat consumption in Nigeria is still below the regional average (2kg per person and per year in Nigeria, compared to 8kg per person per year in ECOWAS).To meet the protein requirement per person per day in Nigeria, infrastructure and technology is very crucial to prevent post-harvest loss in animal production, ensure value addition of animal product and safety. This paper reviews the state of infrastructure, technology and animal products processing in Nigeria.

Literature review

Animal production is very essential to food security and development of any nation. It provides: foreign exchange for the economy, employment for the citizens, rich source of protein which is essential for power, transportation, provides raw material for clothing and shoe industry and by products that can be used in various other industries such as cosmetic industry (Obeta 1990, Babatunde, Quim 2010, Agbola and Baleilue, 2012).Animal products are responsible for one-sixth of the human food energy and also more than one-third protein requirement on the global basis (Bradford, 1990). Martin Philip (1994) noted that many different businesses are involved in the animal processing industry. Some processors purchase the raw animal product (mineral, milk or eggs) from the producers and process into wholesale products. Other processors purchase the raw product and do all the processing needed to make the edible products available at retail level. Still many other processors not only process the edible produce but process the by products as well.

Nigeria has 36 states and is the most populous country in Africa with a population of about 170 million as of 2012 (Population, 2012) with over 70% of the population living on less than a dollar a day (Walts, 2006). By the year 2050, the projected population of Nigeria will be 402 million making Nigeria the 4th most populous country on earth after India, China and United State (Population, 2012). Fagoyero and Taiwo (2012) stated that the fast growing population of Nigeria is threatened with the problem of food insecurity and poverty which can be addressed with a more developed animal production and processing sector in addition to other sectors. The average Nigerian still consumes far less animal protein than their counterparts in the developed world because the animal production industry is still in its infancy due to hydra-headed problems and the per capita income is low leading to a consumption of less than 9 grams of animal protein per capita per day compared to over 50 grams per capital per day in North America and Europe (Grigg 1995, Beland et al, 2013). Milk and meat are the most important source of protein and calcium in human nutrition (G. Heinz).

In northern Nigeria, most local milk processing farms operate at a small scale with a capacity of about 50 litres per day. The local processor utilizes semi-mechanical processors to produce traditional milk products which include nunu (soar milk), kindirmo (soar yoghurt), manshanu (local butter), cukwi (Fulani cheese). The lack of advances technology and inadequate dairy infrastructure has resulted in substandard milk products (Celestine A, 2015). Imported milk accounts for 75% of milk processing inputs and the high utilization of imported milk does not encourage backward integration within the value chain (Nigeria Dairy Enterprise Initiative Final Report, 2007). Our primary research identified lack of cold chain infrastructure, exchange rate fluctuations and logistics as major challenges encountered by dairy processors in Nigeria (PwC, 2017).

Factors that may affect the ability of a nation to meet the demand for animal products are: need for trained human capital, product safety and quality, effective communication, adoption of new knowledge, information and technology and lack of facilities (NAP, 2015). These factors are further elucidated as described below:

Need for Trained Human Capital:

Training is one of the important issues in meat technology, facilitating the introduction of proper meat processing and meat preservation methods (FAO, 1990). The Federal Ministry of Agriculture and Rural Development is the principal government body with the responsibility for articulating national policy on animal husbandry. The ministry performs the role through its various departments and agencies. However, institutions and key stakeholders has created huge gaps between policy and practice in Nigeria meat industry. (Kolawole Talabi, 2015). The

training could be strategically positioned at farmers who command a lot of market and fellowship who will in turn influence other farmers. Unfortunately, in Nigeria, the number of qualified agricultural extension workers is grossly inadequate make meaningful impacts on the nation's economy through products and processing. (Pwakeno H Bamaiyi, 2013).

Low Level of Education:

It is a well-known fact that farmers have a low level of education or are illiterates making it difficult for them to employ modern animal production techniques where traditional techniques have failed (Pwaveno, 2013). A study carried out in Osun State has found that education level had significant and positive relationship with average production (Adebayo and Adeola, 2005). In Nigeria today animal product and processing is still at its lowest output per capital income as a result of the poor state of education of farmers and local processors. As a result, some farmers can not adopt new methods of processing technology and value additions evolving in counterparts' countries.

Poor Hygiene and Handling of Animal Products during processing:

Unhygienic issues related to food animals could emanate from slaughtering processes, inefficient standard operating procedures, marketing and improper meat handling practices (Olanike, 2002). In developing nations like Nigeria, abattoirs are not maximally utilized and even the meat passed for human consumption in many instances is not adequately monitored (Kundu et al, 2015). One of the major constraints in the improvement of hygiene and technical quality of slaughtering, meat handling and by-product utilization is the lack of adequately trained personnel at all level (FAO, 1993).

Poor Transportations:

Transportation is very important to the animal products and processing industry. Lack of access roads to farms and from farms to the market hampers the development of the animal production industry. The movement of animal produces from production to consumption point requires good transport networks that are either not existing or in very bad shape in the Nigerian context (Ibitayo, 2012, Gujbu et al, 2013). There is a need to improve on these transport systems for maximum animal production and product processing because good road transport is essential for food security (Prie, 1993).

Lack of Processing Equipment:

Many countries have problems with infrastructure for animal production (Van Der Zijpp, 1999) and Nigeria is not an exception. There is generally lack of proper mechanized farming using modern infrastructure such as improved milking machines that could reduce the incidences of zoonotic diseases and improve shelf life of milk and milk products (Pwaveno H Bamoiyi, 2013). Lairage facilities available in most abattoirs in Nigeria are grossly inadequate and most time animals are slaughtered in the lairage instead of rested as result of congestion in the slaughter houses (O. O. Omotosho *et al,* 2016). Most fish processing communities in Nigeria still employ the use of traditional technologies and crude equipment in the processing of harvested fish and this has resulted in high level of post-harvest loss in fish production. Tawari (2006) and Davies and Davies (2009).

Poor Storage and power supply:

Storage is a problem for Nigeria as a large number of food produce perishes, because of the lack of storage and processing facilities (Kelvin Akpososo Ufiober, 2017). Animal products such as meat, milk and egg provides a major medium for microbial proliferation without immediate processing and storage. Unfortunately, in Nigeria, the state of infrastructure and technology does not encourage backward integration within the value addition chain through storage.Ayuba and

Omeji (2006) is of the opinion that lack of adequate processing techniques and storage facilities contribute significantly to the low supply of fish to poor rural dwellers that form three quarters of the population in developing countries like Nigeria. The epileptic nature of power supply on Nigeria industries affect virtually all aspects of production. Animal production and processing equipment require electricity to function and this is either in little or no supply. The effect is seen in post-harvest losses and spoilage of animal produce and products from poor storage.

Conclusion

Agricultural performance in Nigeria is greatly impaired by low level of development of infrastructure. In the rural areas where majority of the small holders operate, inadequate infrastructure constitutes a major constraint to agricultural investment. The infrastructure inadequacy is mirrored by poor road transport system, epileptic electricity and poor communication system(Oni Timothy Olakunle, 2013).Agricultural losses are caused by poor handling in the fields, lack of proper transportation, inadequate storage facilities and slow movements of produce compounded by lack of infrastructural development and/ or poorly maintained infrastructure(Banake Elisha *et al* ., 2016).

In Nigeria today, post-harvest (processing) and infrastructural management of the food production chain remains a major challenge.

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MENACES IN MANAGEMENT PRACTICES, PROCESSING AND TRANSPORTATION OF MEAT IN THE SEMI ARID OF KANO METROPOLIS ABATTOIRS

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Abstract
The study was conducted at Kano abattoirs/slaughter slabs to determine and evaluate the management practices, meat processing techniques/handling and conveyance of the meat to various points of sale in the metropolis. A structured questionnaire and visual inspection were adopted. It covered a period of three months (December, 2017 - February, 2018). The results showed that goat, sheep, cattle, and camel are the animals usually slaughtered. A total of 54.33% goats, 23.87% sheep, 14.24% cattle and 7.46% camels were slaughtered. There were menaces in abattoir practices such as absence and improper use of lairage and antemortem examination, rough control of animals, unhygienic practices and brutality to fetal losses. Others include insufficient postmortem examinations on the slaughtered animals, and brutal attitudes of the animal owners. The commendable abattoir practices include method of cutting-up and byproduct processing. The finding of the present study showed that the meat carrying equipment are not wash regularly. The most means of meat transportation within the abattoirs are carrying on shoulder/head by pan (18.18%) or by wheelbarrow (9.09%), then the butchers convey the meat on motorcycle (30.91%), tricycles (34.55%), as well as use of few meat vans and taxis (7.27%) under very unhygienic conditions. Hence, more veterinarians, para-veterinarians and environmental health workers should be employed. People should be enlightened through media on meat hygiene and sanitary measures. Legislation prohibiting selling of unhygienic meat should be enforced, and modern means of transportation should be provided.
Key words: Abattoir Management Practices; Meat Processing; Meat products; Head-pan; Wheel-barrow

Introduction

Satisfactory meat handling practices in Nigeria at thousands of village and town slaughter slabs are almost absent. The production, distribution and marketing of good quality raw and processed meat and meat products are the major preoccupation of the meat industry. Edible meat from small and large ruminants slaughtered at various abattoirs remains the major meat consumed and source of protein for the Nigerian populace (Ademola, 2010). However, the most important issue in all meat-processing plants is maintenance of proper hygiene and adequate sanitary conditions (Adeyemo, 2002). The handling of meat in Nigeria is generally unsatisfactory attributable to the fact that slaughtering is generally carried out on the floor and outside the abattoir by butchers; whose knowledge of hygiene is low, while slaughtering and processing facilities are inadequate (Lawan *et al*., 2013). Ideally, meat hygiene services are functions in such a way as to satisfy consumers and at the same time safeguard public health and animal hygiene (Kebede, 2010). The abattoir design should be such that will ensure correct sequence of operation that encourages efficiency while discouraging contamination and cross-contamination (Igwe, 2000 and 2005). It is imperative that good sanitation is required in abattoir practice (Ikeme, 1990). Unlike in developing

countries, these are easily achieved in developed countries (Dandago *et al.*, 2009). The major objective of this research is to investigate nuisances in management practices, processing and transportation of meat in Kano metropolis abattoirs in order to understand at what extent the above standard prescriptions have been attained in Nigeria.

Materials and Methods

Kano central, Yanawaki, Tudun Fulani and Bachirawa abattoirs were selected areas of the study. Kano is located between latitude 110N and longitude 140N, it has a landmass of about 43,000 Km^2 and fall under the semi-arid zone of the country (Nigeria). It has an average rainfall of 600mm-1000mm annually. The region has about 4-8 months of dry season, the maximum and minimum temperature are 33^0C and 15-18^0C respectively and fall down as low as 10^0C during harmattan season. The relative humidity range between 20 and 40 respectively in January and rising to 60-80 in July. The experimental animals used were goat, sheep, cattle and camel. The data collection was carried out through questionnaire survey and visual inspection between December, 2017 to February, 2018.

Questionnaire survey and visual inspection

A structured questionnaire was used as sample materials and administered to veterinary health workers, meat transporters and butchers. A total of 180 respondents (60 questionnaires each for veterinary health workers, meat transporters and butchers, respectively) were distributed within Kano state metropolis abattoirs. The procedure of visual inspection was done by regular two days visit a week early in the morning (6:00am – 10:00am) to abattoir over a period of 3- months. At slaughter houses, goat, sheep, cattle and camel were brought onto the slaughter slab continuously and their number was recorded. Other relevant information was collected through visual observation of operations; such as method of slaughter, evisceration, de-skinning and carcass cut operations. The questionnaires received and records collected from visual inspection were there after collated and analyzed using Microsoft Excel, 2016 (MS Excel).

Result and Discussion

The percentage of animals slaughtered at four Kano metropolis abattoirs and ranking are presented in Table 1. Within the period of this study, Kano central abattoir recorded highest animal slaughtered (71.59%), followed by Bachirawa abattoir (20.18%), then Yan'awaki abattoir (6.44%), while Tudun Fulani abattoir recorded the least (1.79%). In ranking of animal slaughtered Goats were highest (54.33%), followed by Sheep (23.87%), then Cattle (14.24%), while Camels recorded the least (7.46%).

Table 1. Percentage of animals slaughtered at four Kano metropolis Abattoirs and Ranking

Abattoir	% of Goat	% of Sheep	% of Cattle	% of Camel	**% T.A.S.**
Kano Central	67.65	58.12	95.99	96.99	**71.59**
Bachirawa	24.21	27.46	2.31	1.39	**20.18**
Yan'awaki	6.99	9.64	1.46	1.62	**6.44**
Tudun Fulani	1.15	4.78	0.24	0.00	**1.79**
Total	100	100	100	100	**100**
Ranking	**54.33**	**23.87**	**14.24**	**7.46**	**100**

%T.A.S. Percentage of total animals slaughtered. Source: Field survey December 2017 – February 2018

The outcomes of our result is similar with the findings of Lamidi et al. (2017) who worked at Trans-Amadi abattoir in Port Harcourt metropolis, Rivers State, Nigeria. They recorded highest percentage of animal slaughtered (68.26%) and goat had highest percentage (38.43%). However, in our result camel recorded the least animals slaughtered (1.79%), while their findings recorded pig (1.91%). This indicated that in both Northern and Southern part of the country people are consuming more number of small ruminant, suggesting livestock farmers to engage in small ruminant production for better economic return.

The respond of veterinarians, butchers and meat transporters on management practices, processing and transportation of meat at Kano abattoirs was harmonized and presented in Table 2. We observed that most of the abattoirs are under-staff. There is presence of liarage, though it is not properly used. The veterinary workers are attending slaughter slab to check suspect animals and offer action for treatment or rejection. At the abattoirs, Halal is the method of slaughter and boreholes are the main source of water to clean meat for subsequent processing to whole sale cut; however, no standard modern vehicles for meat transportation. Gude et al. (2014) reported that few places in Nigeria accommodated the modernized means of transporting meat. Thus our result revealed similar findings of Lamidi et al. (2017) with few variations and information.

Table 2. Respond of Veterinarians (A), butchers (B) and meat transporters (C) on Management practices, processing and transportation of meat at Kano abattoirs

Categories	**Variable**	**Frequency**	**Percentage (%)**
(A) Lairage facilities	Yes	20	66.7
	No	10	33.3
Regular visit to slaughter slab	Yes	25	83.7
	No	5	16.7
Record of suspect animal /action	Treatment	10	33.3
	Rejection	20	66.7
Method of slaughter	Stunning	0	0
	Halal	30	100
Source of water	Borehole	25	83.3
	Tap water	0	0
	Other sources	5	16.7
Processing meat to wholesale cut	Yes	30	100
Standard transportation vehicle	No	30	100
(B) Sterilization of tools	Yes	10	17.7
	No	50	83.3
Processing meat to wholesale cut	Yes	60	100
(C) Means of transportation	Wheel/barrow	5	9.09
	Motorcycle	17	30.91

	Tricycle	19	34.55
	Car	4	7.27
	Carrying on shoulder/head	10	18.18
Regular cleaning of vehicle	Yes	45	75
	No	15	25
Meat spoilage due to uncleanness	Yes	50	83.33
	No	10	16.67
Need of refrigerating van	Yes	40	66.67
	No	20	33.33
Need of Government intervention	Yes	57	95
	No	3	5

Source: Field survey December 2017 – February 2018

We observed that the butchers were regularly attending the slaughter house and they are actively specialized in de-skinning, evisceration and other processing activities. Butchers were mostly not sterilizing their tools, probably due to their informal learning (of profession) at the abattoir. As we reported 83.3% of the respondents did not sterilized tools, it was 77.71% of the butchers did not sterilized their tools in Part Harcourt metropolis abattoirs, Southeast of Nigeria (Lamidi et al., 2017).

The mode of meat transport in the abattoirs were by carrying on shoulder/head-pan, wheel barrow, tricycles, motorcycles and few cars. Previously, Gude et al, (2014) reported that in Kano state, abattoir attendants were carry meat on their head using head pan from inside the abattoir and then to be trans loaded into either motor vehicles or motor/tri cycles respectively. However, Lamidi et al. (2017) reported that in South West of the country (Lagos State), the government in partnership with Skye Bank introduced Eko meat van (EMV) used in the transportation of meat. Thus approach is recommendable and should be encourage to be adopted across the country.

Conclusion and Recommendations

It is concluded that the management practices, processing and transportation of meat in Kano metropolis abattoirs in particular and all slaughter slabs across the country (Nigeria) in general, need greater attention in order to be improved and modernized to reach standard. Public enlightenment through media should be encouraged. Regular cleaning of vehicles is very important to avoid contamination and meat spoilage. Thus necessitate Government/NGO's interventions to add manpower and provide facilities like modern refrigerating van that can protect and improve meat quality and its safety to consumers.

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MICROBIAL LOAD AND SENSORY EVALUATION OF BROILER BREAST MEAT PRESERVED BY REFRIGERATION, SUNDRYING AND GROUNDNUT OIL

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Abstract
Many Nigerians are involved in poultry production whether at subsistence or commercial level yet, there is unavailability of quality poultry meat. This has been adduced to unstable power supply for preservation of dressed carcass and inadequate knowledge of alternative processing or preservation techniques. This study aimed at the possibility of immersing broiler meat in groundnut oil as a medium of preservation. Dressed carcasses were processed and preserved by refrigeration (Control: T1), sun-drying (T2) and immersion in groundnut oil (T3). Samples from each of the treatments were processed for microbial load and sensory evaluation using 9-point Hedonic Scale. The data were collected on preservation days 0, 7, 14 and 21. It was shown that *Proteus mirabilis, Bacillus firmus, Staphylococcus aureus, Klebsiella aerugenes* and *Aeromonas hydrophila* were recorded in all the treated samples. The responses of the panellists indicated that the meat samples appearance, was liked extremely (66.7%) and very much (33.3%) in all the treatments except, in T2 where 33.3% disliked the meat samples extremely. Also, it was observed that colour, aroma and texture were best in T3, fairly followed by T2 and T1 in that order. Consequently, broiler breast meat embedded in groundnut oil may be preferred to other form of processing and preservation methods hence, the need to intensify more efforts in improving on this inexpensive technique of broiler meat preservation.

Keywords: Broiler meat, microbial spoilage, processing and preservation,

Introduction

According to FAO (2010), poultry production is gaining popularity in the developing countries, due to its role in bridging the protein malnutrition and economic empowerment of the resources poor segment of the society. Poultry production is practiced in all levels ranging from subsistence to large scale commercial operations. Poultry meat and eggs are the most consumed animal protein unrestricted by any religion or culture in Nigeria. It was recorded that the poultry industry contributed about 25% to the country's Agricultural Gross Domestic Product. Nigeria presently produces above 550,000mt of poultry meat and 700,000mt of eggs per annum. Despite this, Nigeria is far from meeting her domestic demand when compared with developed countries. This situation has been worsened by animal product spoilage hence, the necessity to preserve the little available meat by preventing its contamination and spoilage.

The pathways by which such deterioration and spoilage occur are diverse including microbial, chemical and physical processes (FAO, 1990). Thus, meat preservation necessarily involves the application of measures to delay or prevent certain changes which render meat unsafe for consumption. Common methods of meat preservation include drying, curing, smoking, thermal processing, and refrigeration (chilling and freezing). Smoking is one of the most effective processes of meat preservation in Nigeria because, apart from its consequent flavour and colour attraction, it does not require high costs and electric power supply which is difficult to maintain in developing countries of the world but, it has led to deforestation for search of fire wood. Over the past years, there has been an on-going development of curing processes with natural ingredients designed to meet consumer demands and safety requirements

for natural and organic processed meat (Heinz and Hautzinger, 2007). Bio-preservation has gained increasing attention as a means of naturally controlling the shelf-life and safety of meat products (Ogunbanwo and Okanlawon, 2006). The utilization of spices possessing antimicrobial and antioxidant properties in various forms, like powder and essential oils (especially groundnut oil) have been reported (Shaltout *et al.,* 2016) yet, little is known about the use of groundnut oil as fat embedment in meat preservation. Although, refrigeration and sun-drying are common techniques, a lot is still required in poultry meat preservation particularly, in the rural areas with irregular power supply and inadequate sun-drying platforms. As a result, the present study examined the possibility of using groundnut oil embedment as preservative, compared to the conventional refrigeration and sun-drying techniques.

Materials and methods

The study was conducted at the Federal College of Animal Health and Production Technology Vom, Plateau State on Latitude 9^0 43'N and Longitude 8^0 45'E, altitude of about 4,200 FT (1280m) with average rainfall between 1,300 and 1,500. The average daily maximum temperature is 83.4^0F (28.6^0 C) and minimum of 62.6^0F (17^0C) with mean relative humidity of 14 and 74% (Wikipedia, 2018). Three broiler chickens of Cobb strain weighing 2.9kg, 3.0kg and 3.2kg at 12 weeks of age were procured from a reputable farm in Jos, fasted overnight, slaughtered, bled and scalded at temperature of about 56^0C to ease defeathering. The carcasses were eviscerated and the breast part was deboned and processed for refrigeration (Control: T1), sun-drying (T2) and groundnut oil embedment (T3). In Control, the carcass was placed in a sterile zip-lock bag free of air and refrigerated, the carcass in T2 (sun-drying) was cut into thin filets using knife and sun-dried on a clean sun-drying platform at the Poultry Division, NVRI and in T3 (refrigeration) the carcass was cut into pieces and then submerged in groundnut oil as preservative.

Samples from different areas of the broiler breast meat were cut from each of the treatments, ground and one gram (1g) each was homogenized in 225ml peptone water to form stock solution. In each stock, 1ml was transferred aseptically into 9ml of peptone water for serial dilution as described by Moshood *et al.* (2012). Thereafter, 0.3ml of the serial diluted stock solution was transferred aseptically into a mixture of nutrient agar and Mac Conkey agar. The inoculated culture media were incubated inversely for overnight at 37^oC. The bacteria were identified and the number of bacterial colonies recorded was expressed as colony forming unit per gram (CFU/g) according to the procedure of Bhandari *et al.* (2013). The data were collected on days 0, 7, 14 and 21. Also, samples from each of the treatments were prepared (without seasoning) for sensory evaluation on appearance, colour, aroma and texture (without tasting) based on 9-point Hedonic Scale by 9 semi-trained panellists drawn from within NVRI according to Wichchukit and O'Mahony, (2014). On the first day (day 0) of data collection, samples were taken and prepared for sensory evaluation before processing and preservation. On the last day of data collection (day 21) samples were taken, broiled without seasoning and prepared for sensory evaluation after preservation. In this case, data were collected only on day 0 and 21. All the data collected were analysed using simple descriptive statistics according to Adesoye (2006).

Results and discussion

Table 1 shows microbial load of broiler meat preserved by refrigeration, sun-drying and groundnut oil embedment on preservation days 0, 7, 14 and 21. On day 0, it was observed that the microbial load was very low in all the treatments. The bacteria detected in the broiler breast meat samples on day 0 of preservation were *Bacillus firmus* and *Staphylococcus aureus* (T1), *Proteus mirabilis* (T2) and *Klebsiella aerugenes* in T3. Meanwhile, on days 7, 14 and 21 of preservation, *Proteus mirabilis, Bacillus firmus, Staphylococcus aureus, Klebsiella aerugenes* and *Aeromonas hydrophila* were recorded in all the treatments. This observation was similar to what Suleiman *et al*. (2017) reported when five bacteria genera were isolated in fresh and frozen poultry chicken parts. The microbial load increased tremendously on preservation days 7 (32 CFU/g, 102 CFU/g, 82 CFU/g), 14 (60 CFU/g, 186 CFU/g, 100 CFU/g) and 21 (82 CFU/g, 222 CFU/g, 130 CFU/g) in T1, T2 and T3 in that arrangement even in refrigeration (Control). This probably suggested that the contaminations were from the environment, handlers and the materials used during data collection. In any case, T1 (Control) was comparatively lower throughout the

study period corroborating the reports of Perez-Chabela *et al*. (2004) and Rahman (1999) that freezing improved meat quality and shelf life. Unfortunately, the broiler breast meat in T2 (sun-dried) had the highest bacteria load followed by T3. This was probably due to exposure of the meat samples to the ubiquitous microbes in the environment. This observation suggested that groundnut oil embedment of broiler breast meat may be a suitable method of preservation.

Table 1: Microbial load of broiler meat preserved by different methods

Parameters		**Treatments (CFU/g)**		
Day	**Bacteria detected**	**T1**	**T2**	**T3**
0	*Proteus mirabilis* (x 10^2)	0	1	0
	Bacillus firmus (x 10^2)	1	0	0
	Staphylococcus aureus (x 10^2)	1	0	0
	Klebsiella aerugenes (x 10^2)	0	0	1
	Aeromonas hydrophila	0	0	0
	Total	**2**	**1**	**1**
7	*Proteus mirabilis* (x 10^3)	0	19	25
	Bacillus firmus (x 10^2)	12	26	21
	Staphylococcus aureus (x 10^4)	5	34	16
	Klebsiella aerugenes (x 10^4)	9	15	12
	Aeromonas hydrophila (x 10^2)	6	8	8
	Total	**32**	**102**	**82**
14	*Proteus mirabilis* (x 10^3)	11	40	23
	Bacillus firmus (x 10^3)	14	48	22
	Staphylococcus aureus (x 10^4)	8	37	30
	Klebsiella aerugenes (x 10^2)	5	32	8
	Aeromonas hydrophila (x 10^2)	22	29	17
	Total	**60**	**186**	**100**
21	*Proteus mirabilis* (x 10^4)	9	52	26
	Bacillus firmus (x 10^4)	11	34	28
	Staphylococcus aureus (x 10^3)	19	57	33
	Klebsiella aerugenes (x 10^2)	23	32	27
	Aeromonas hydrophila (x 10^2)	20	49	16
	Total	**82**	**222**	**130**

Presented in Table 2 is the sensory evaluation of broiler breast meat before refrigerating, sun-drying and embedding in groundnut oil. According to the semi-trained panellists, none of the meat samples in all the treatments was liked extremely except the aroma in T2 where 33.3% was recorded. More so, it was observed that the aroma in T1 and T3 was placed on less than 5 on the Hedonic Scale. The colour of the meat sample in T2 was liked by all the semi-trained panellists (100%).

Table 2: Sensory evaluation of the broiler breast meat before preservation

Hedonic Scale	**Treatments (%)**											
	T1				**T2**				**T3**			
	A	**C**	**AR**	**T**	**A**	**C**	**AR**	**T**	**A**	**C**	**AR**	**T**
9	0	0	0	0	0	0	33.3	0	0	0	0	0
8	33.3	0	0	33.3	66.7	100	33.3	66.7	33.3	0	0	0
7	66.7	66.7	0	0	33.3	0	33.3	0	0	33.3	0	33.3
6	0	0	0	33.3	0	0	0	33.3	0	0	0	0
5	0	0	66.7	0	0	0	0	0	0	0	33.3	0
4	0	33.3	0	33.3	0	0	0	0	33.3	0	33.3	33.3

3	0	0	0	0	0	0	0	0	33.3	66.7	33.3	33.3
2	0	0	33.3	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0

Parameters measured (A: Appearance; C: Colour; AR: Aroma; T: Texture); Hedonic Scale used (9: like extremely; 8: like very much; 7: like moderately; 6: like slightly; 5: neither like nor dislike; 4: dislike slightly: 3: dislike moderately; 2: dislike very much; 1: dislike extremely); T1 (Refrigeration); T2 (Sun-drying); T3 (Fat embedment).

About 33.3% of the semi-trained panellists liked the meat sample texture very much in T1, 66.7 (T2) and 33.3% moderately in T3. Based on the responses of the panellists, T2 meat samples seemed to be more preferred in all the parameters evaluated, followed by T1 and T3 in that order. This probably buttressed the fact that unprocessed broiler meat, might not be palatable hence the need to process, season and preserve prior to cooking and consumption (USDA, 2005).

Sensory evaluation of the preserved broiler breast meat by refrigeration, sun-drying and groundnut oil embedment is given in Table 3. It was shown from the panellists' responses that the meat samples appearance, was liked extremely (66.7%) and very much (33.3%) in all the treatments except, in T2 where 33.3% disliked the meat samples extremely.

Table 3: Sensory evaluation of broiler breast meat preserved by refrigeration, sun-drying and groundnut oil embedment

Hedonic Scale	Treatments (%)											
	T1				T2				T3			
	A	C	AR	T	A	C	AR	T	A	C	AR	T
9	66.7	0	66.7	0	33.3	33.3	66.7	100	66.7	66.7	66.7	33.3
8	33.3	33.3	0	66.7	33.3	33.3	33.3	0	33.3	33.3	33.3	33.3
7	0	33.3	33.3	33.3	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	33.3
5	0	0	0	0	0	0	0	0	0	0	0	0
4	0	33.3	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	33.3	0	0	0	0	0	0
1	0	0	0	0	33.3	0	0	0	0	0	0	0

Parameters measured (A: Appearance; C: Colour; AR: Aroma; T: Texture); Hedonic Scale used (9: like extremely; 8: like very much; 7: like moderately; 6: like slightly; 5: neither like nor dislike; 4: dislike slightly: 3: dislike moderately; 2: dislike very much; 1: dislike extremely); T1 (Refrigeration); T2 (Sun-drying); T3 (Fat embedment)

This observation contradicted the negative responses by the respondents when fish oil and tallow were used in broiler breast meat processing (Hugo *et al*., 2009). It was observed that colour, aroma and texture were best in T3, fairly followed by T2 and T1 in that order. This partly concurred with the report of Shaltout *et al*. (2016). This apparently suggested that broiler breast meat that was broiled and embedded in groundnut oil, may be preferred to other form of processing and preservation methods except, for the microbial load that was seemingly high.

Conclusion

Although, the broiler breast meat immersed in groundnut oil had the highest bacteria load throughout the study period the colour, aroma and texture were seemingly best after broiling and preservation. Apparently, broiler breast meat that was broiled and embedded in groundnut oil may be preferred to other form of processing and preservation methods. Therefore, more research investigations are required in order to improve on this inexpensive technique of broiler meat preservation.

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MICROBIAL QUALITY OF *TSIRE* MEAT OFFERED FOR SALE AT HADEJIA LOCAL GOVERNMENT AREA, JIGAWA STATE

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Abstract
Microbial quality of raw meat and *tsire* sold at retail outlets from Yayari, Yankoli and Matsaro of Hadejia metropolis, Jigawa State were evaluated. Three samples from each outlet were collected fortnightly from 3rd to 17th April, 2018 into sterile plastic bags, stored at 4 ^{O}C in ice chest filled with ice and transported immediate to the laboratory for Total Viable Count (TVC), Total Coliform Count (TCC), Total Staphylococcus Count(TCS) and Total Fungal Count(TFC) analyses using Nutrient Agar, Mac Conkey Agar, Mannitol Salt Agar and Potato Dextrose Agar, respectively and incubated at 37 ^{0}C for 24 hours except for the detection of fungi, which was incubated at 25 ^{0}C for 5 days. *Tsire* samples collected from Matsaro had the highest TVC (6.0×10^4) while those collected from Yankoli had the highest TCS (4.0×10^2).The presence of bacteria on raw meat and *tsire* sold at the study area is an indication of low standard of animal and meat handling practices from pre-slaughter to post–slaughter, sales of meat, abattoir facilities and equipment.
Keywords: Microbial, *Tsire*, Sale, Quality and Raw Meat

Introduction
Tsire is a roasted or smoked beef or other boneless animal meat. It is rich in protein, mineral (zinc, selenium and phosphorus) and is also a good source of niacin, vitamin B6 (pyridoxine) and iron (Koffi-Nevry *et al*., 2011). It is one of the most street-vended meat products in Nigeria and sub-Saharan Africa (Abdullahi *et al*., 2006). The preparation processes of *tsire* involved de-fatting and slicing the meat on a slab or table, after which it is staked into sticks, spiced and roasted for about twenty (20) minutes, thereafter, the products is spiced again and briefly reheated for about two (2) minutes. It's then displayed for marketing on table tops or trays where it can be street-vended (Edema *et al.*, 2008). *Tsire* preparation process in Nigeria lacks standard or hygienic quality control: therefore there is increase in food safety risks (Odusole and Akinyanju, 2003; Inyang *et al*., 2005 and Adzitey *et al*., 2010). Notwithstanding the major role meat plays in our meals, it can also serve as a rich medium of growth for harmful microorganisms. Meat infected with microorganisms is the cause of many food-borne diseases (WHO, 1997). The sources of these pathogenic microorganisms may be the animals themselves or from outside the surroundings where these animals were kept as well as the way they were processed after slaughter (Adeyemo, 2002). Meat infected with microorganisms is normally poor in quality (Mukhopadhyay, 2009). Microbes such as *Staphylococcus* spp., *Aspergillus* spp., *Salmonella* spp., *Enterococcus* spp., *Streptococcus* spp. and *Escherichia coli* have all been found on contaminated meat (James *et al*., 2005).The study is aimed to examine the microbial quality of *tsire* offered for sale at Hadejia Local Government Area of Jigawa State.

Materials and Methods

This study was carried out in Hadejia Metropolitan of Jigawa State. Meat outlets from three locations namely Yayari, Yankoli and Matsaro were randomly selected. A total of fifty four meat samples (Table 1) were collected aseptically with the help of sterilized knives. Freshly slaughtered beef and *tsire* samples from the various outlets were collected fortnightly from 3rd to 17th April, 2018 into sterile plastic bags, stored at 4 ^{O}C in ice chest filled with ice and transported immediate to the laboratory for Total Viable Count (TVC), Total Coliform Count (TCC), Total Staphylococcus Count (TCS) and Total Fungal Count (TFC) analyses using Nutrient Agar, Mac Conkey Agar, Mannitol Salt Agar and Potato Dextrose Agar, respectively and incubated at 37 ^{0}C for 24 hours except for the detection of fungi, which was incubated at 25 ^{0}C for 5 days.

Tsire piece from each sample was removed from the skewers and mashed in a sterile laboratory mortar and pestle. 1g of the mashed sample was weighed and then aseptically introduced into 9 ml of sterile distilled water, properly shaken and sieved before a twofold dilution was performed. The samples were inoculated aseptically using streak technique and the plates were read for growth of organisms. The counts for each plate were expressed as colony forming unit (cfu/g) of the suspension ie

$$\text{Colony forming unit/g} = \frac{\text{Number of colony counted x Reciprocal of dilution factor}}{\text{Volume of sample inoculated}}$$

Results and Discussion

The microbial load of raw meat was presented in Table 2. Highest TVC ($9.0x10^6$ cfu/g) and TCC ($5.0x10^6$ cfu/g) were reported from samples collected at Matsaro while highest TSC ($3.8x10^3$ cfu/g) and TFC ($4.2x10^2$ cfu/g) were reported from samples collected at Yayari.

Table 1: Total Number of Samples Collected for Assessment of Microbial Contamination

S/N	Type of meat	Number of Samples
1	Raw	27
2	*Tsire*	27
	Total	54

Table 2: Microbial Load of Raw Meat (cfu/g)

Sample Location	Total viable count ($x10^6$)	Total coliform count ($x10^6$)	Total staphylococcus count ($x10^3$)	Total fungal count ($x10^2$)
Yayari	7.5	4.5	3.8	4.2
Yankoli	3.5	3.0	2.4	1.3
Matsaro	9.0	5.0	1.0	3.5

The microbial load of *tsire* was presented in Table 3. No growth of TCC and TSC were reported from samples collected at Matsaro, equally no growth of TSC and TFC were reported from samples collected at Yankoli. On the other hand, samples collected from Matsaro had the highest TVC (6.0×10^4 cfu/g) while that collected from Yankoli had the highest TSC ($4.0x10^2$ cfu/g).

Table 3: Microbial Load of *Tsire* (cfu/g)

Sample Location	Total viable count	Total coliform count	Total staphylococcus count	Total fungal count
Yayari	$1.8x10^4$	$1.0x10^2$	$0.0x10^1$	$0.0x10^1$

Yankoli	$2.6x10^5$	$1.7x10^3$	$4.0x10^2$	$2.0x10^2$
Matsaro	$6.0x10^4$	$0.0x10^1$	$0.0x10^1$	$1.0x10^2$

The various meat outlets have different hygienic levels as far as transportation, handling and processing is concerned. This might have accounted for the variations in TVC, TCC, TSC and TFC as shown in tables 2 and 3. This is in line with the work of Ruban and Fairoze (2011) and Obeng *et al.* (2013) who attributed the higher microbial levels from non-sophisticated outlets compared to sophisticated ones. This may be due to unhygienic handling of meat right from slaughtering, butchering equipment, handling, transportation and processing (Warris, 2010). Similarly Abubakar *et al*. (2011) isolated four fungal species (*Aspergillus niger*, *Aspergillus fumigatus*, *Rhizophus nigricans* and *Hansenula anomala)* after seven days storage of meat products at ambient temperature. Other workers such as Ologhobo *et al*. (2010) and Salihu *et al*. (2010) have also reported that meat products sold in Nigeria were contaminated with various species of bacteria and fungi.

The high level of microbes presence on meat increase the chances of the meat getting spoiled within the shortest possible time. Although microbial load on the meat samples were within the safe limits of 10^7 cfu/g specified for meat products (ICMSF, 1978). It can therefore be said that meat sold in the study areas were not spoiled. Nevertheless the isolation of *Staphylococcus* spp. is of great concern because certain strains of this bacterium cause food-borne infections. *Staphylococcus* spp. infections can be contracted through consumption of contaminated chevon and mutton (Adzitey *et al*., 2010). It is an important cause of gastroenteritis. *Staphylococcus* spp. can be present on the skin of humans and animals and can be transmitted from person to product through unhygienic practices (Postgate, 2000). *Staphylococcus* spp. cause infections such as arthritis, black pox, boil, bronchitis, carbuncle, cystitis, endocarditis, meningitis, osteomyelitis, pneumonia and scalded skin (Stuart, 2005). To ensure good microbial quality of meat products, proper hygiene must be ascertained to guarantee safety from infection and to promote quality assurance. On the whole, the major sources of microbial contaminate of meat appear to be handling by processor and the use of contamination water and equipment. So control of meat contamination can be achieved if aseptic techniques are employed during the production of meat (Field, 2002). The variation in the microbial count may be attributed to the sample used, contamination by flies, method of handling and transportation and the air flora of the environment. Processing operations such as heating, boiling, filtration, freezing, irradiation of finished product, addition of condiment and condition of storage affect both bacterial and fungal loads (Igyor and Uma 2005). High microbial loads lead to spoilage of foods that have not been properly stored (Nester *et al.*, 2001).

Conclusion and Recommendation

The study concluded that *tsire* sold at Hadejia Local Government Area was safe for consumption, due to it less microbial load. It is recommended that meat sellers and handlers should as often as possible be enlightened on proper animal handling, hygienic slaughter, proper meat transportation, sanitation of utensils, equipment and proper storage of meat. This would help to reduce the rate of meat contamination.

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HYGIENIC FACTORS THAT INFLUENCE MEAT QUALITY: A REVIEW

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ABSTRACT

Meat as an important source of protein in the diet of man cannot be overlooked. Animal-source foods are choice foods worldwide as they are relished for their tastes, aroma, texture and nutritional values in both human and animal diet. Livestock systems occupy about 30 per cent of the planet's ice-free terrestrial surface area. Animal source foods are rich in high quality protein and other bio-available micro-ingredients like iron, zinc and vitamins A and B12 that could be deficient in the diets of low-income and undernourished individuals. The amino acids in meat, milk and egg proteins are readily available and balanced to meet human requirements. They also contain lipids; hence contribute to dietary energy supply. As a livestock product, the safety depends on the health of the animal and the factors affecting its production which include animal shed and environment, feeding and nutrition factors, slaughter house and slaughtering process with the equipment, water supply etc. This paper discusses these factors from the perspective of hygiene and its safety for human consumption. It was concluded that ensuring on-farm health status of the animals is vital to the quality of their products entering the food chain.

INTRODUCTION

Livestock can be defined as farm animals such as cattle, sheep, goat and chicken that are kept on a farm as assets to a farmer with the aim of making profit or for domestic uses (Johannesen and Skonhoft, 2011). An animal product is any material derived from the body of an animal. Examples are flesh, blood, milk, eggs etc (Unklesbay, 1992). They are sources of animal protein for human nutrition. In general, hygiene according to the World Health Organization (WHO), "refers to conditions and practices that help to maintain health and prevent the spread of diseases (Buncic, 2006). Farm hygiene is the way of protecting the farm environment by preventing the introduction and spread of microbes and diseases which may adversely affect livestock.Optimising the health of animals increases productivity, and majorly protects human health by ensuring that food of animal origin are safe for consumption. Poor hygiene affects not only the farmer's productivity in terms of quantity and quality of product but it also negatively impacts the status of the country. Quality is expressed of as a degree of excellence; in terms of a product (farm product in this instance), it is referred to as a specification or set of specifications which are to be met, within given tolerance or limits, and which will make the product to be acceptable to the buyer at an economic cost to the producer (David, 2005).This write up thus reviews the hygienic factors that influence the quality of meat.

Keywords: animal products, meat, hygiene, quality

Meat and its Hygiene

Meat is defined as all parts of warm-blooded animals, in fresh or processed form, which are suitable for human consumption in the Regulation (EC) 853/2004. Usually, the muscles of healthy animals are essentially sterile at the point of slaughter (Krämer, 2002). However, during slaughtering and processing the meat surface is contaminated with a variety of microorganisms (Krämer, 2002; Olsson *et al*., 2003; Kleer, 2007). Meat hygiene programmes are primarily instituted to ensure that meat and meat products are "safe and wholesome". When meat is considered as spoiled, it is no longer acceptable for human consumption which is mainly attributed to sensory changes e.g. in colour, odour, flavour, aroma or texture (Mead, 2004; Singh and Anderson, 2004). Meat is among the most highly nutritious foods and a good source of protein, fat and minerals. It is also a highly perishable product because cooked and especially raw meat is a good substrate for the growth and multiplication of harmful microorganisms. As a result, several diseases may be transmitted to humans through the consumption of infected meat or meat products.

Hygienic factors that influence the quality of meat

Building/ Facility (Housing)

Ideally the slaughterhouse should be located away from residential areas to prevent possible inconvenience to dwelling-places either by way of pollution from slaughter wastes or by way of nuisance from noise. There must be free access for animals to the site by road and the slaughterhouse should be situated in areas where flooding is unlikely to happen. The number of animals to be slaughtered should take into account the size of slaughter facility and the number of animals to be slaughtered is of great importance to avoid sanitary problems due to overcrowding. Materials that are absorbent and difficult to keep clean must not be used. Examples of unacceptable materials include wood, plasterboard and porous acoustic-type boards. Walls should be provided with suitable sanitary-type bumpers or sloped curbs to protect them from damage by hand trucks or lifters (Critical Design, Operational and Equipment Guidelines for Licensed Abattoirs, 2012).

Lairage is a place where livestock are kept temporarily (Critical Design, Operational and Equipment Guidelines for Licensed Abattoirs, 2012). This is a specific area inside the premises of a slaughter house where the animals are conveyed for rest. Rest is an important factor because when animals are stressed, carcasses of lower quality result from slaughter. There should be sufficient space for the animals and a good supply of potable water for drinking purposes.

Feeding and nutrition factors

Traditionally, feed is preferably withheld from ruminants immediately before and during periods of transporting to, and lairaging at, abattoir. However, water is offered to animals throughout the pre-slaughter period. The reasons for feed withdrawal include difficulties which overfilled guts would cause during dressing (evisceration) of slaughtered animals, as well as economic aspects (Gracey, *et al.*, 1999). Generally, the two main foodborne pathogens associated with beef, *Salmonella* and verocytotoxic *E. coli*, do not proliferate in the rumen environment, except under conditions of extended starvation, which leads to a reduction of the volatile fatty acids concentration (Rasmussen, *et al.*, 1993). The higher occurrence or levels of pathogens in rumen can increase their occurrence or levels in faeces, which increases microbial beef safety risks associated with those animals. On the other hand, it could be expected that some feeds (e.g. silage) increasing physical spread ability of the faecal excreta in the environment also could enhance spread of microbial hazards both on-farm and during transport-lairaging.

Animal cleanliness

Microorganisms including foodborne pathogens present in cattle faeces are frequently transferred, through direct or indirect routes to the hide, which is now recognised as the major source of microbial contamination with these organisms. Total viable counts of bacteria, occurrences of inoculated marker *E. coli* (Collis, *et al.*, 2004),and prevalence of *E. coli* O157 (Elder, *et al.*, 2000) on beef carcasses, all can be significantly affected by, and even correlated with those present on respective hides. Also, it has been demonstrated that degree of visual coat soiling has a significant effect on the contamination level of the finished carcass (Byrne, *et al.*, 2000; Hadley, *et al.*, 1997).

Hygienic status of cattle hides significantly depends on maintenance of clean stables, and is also influenced by type of their diet. It has been widely accepted that animal cleanliness is crucial to avoid the introduction of potentially pathogenic microorganisms in the beef processing line, so it is necessary to ensure that only clean cows are presented for slaughter (Bolton *et al.*, 1998).

Water supply

Water is a vehicle for the transmission of several agents of disease and continues to cause significant outbreaks of disease in developed and developing countries (Kirby *et al*., 2003), several instances were purported to have been affiliated with poor quality water. Since slaughtering is a process which generates a lot of wastes, to cater for the good running of the processes and minimize contamination, there should be a good supply of water of drinking quality to allow processing and cleaning procedures which will ensure hygienic quality products. Working routines should be planned in such a way as to economically use the consumption of water because of waste water disposal (Kirby *et al*., 2003). It is also important to ensure that water storage vessels are properly covered, and cleaned regularly to maintain the water in a potable state.

Sanitation in the slaughter house

Sanitation may be defined as the process involved in the ensuring of good health by means of preventing human contact with the hazards of wastes. Such hazards can be physical, microbiological, biological or chemical agents of disease (Hui *et al., 2003*). The major goal for the food processing industries is to provide safe, wholesome and acceptable food to the consumer and control of microorganisms is essential to meet this objective (Baggen *et al*., 2003). In line with this, a slaughterhouse should be designed to ensure the flow of operations from the live animal holding area through to discharge areas. Meat products should, therefore, proceed progressively through cleaner areas of the operation, without backtracking to areas where the product was previously handled. Edible and inedible areas must be physically and operationally separate. Sources of meat contamination during slaughter may be classified as those associated with the animal, processing practices, abattoir facilities and employees.

Equipment

Equipment for undergoing slaughtering process, have to follow certain norms and regulations, it has been reported that such equipment have to be of non-corrosive materials, for example stainless steel. Structures like tables, hooks and machines should be positioned such that, they will be easy to relocate to facilitate cleaning and disinfection.

Slaughtering Processing

The hallmark for hygiene principle in processing is that the procedures considered as clean and unclean should be efficiently separated. This requires a well-structured plant layout, where the purpose of any structure should be the protection of the end product against accidental contamination (CAC, 1997).

Personnel

The personal hygiene of the workers is a primordial factor in slaughtering operations. The reason is simply that, contamination of food and disease transmission, depend upon the human factor as well as on the tools and mode of operation. Transfer of microorganisms by personnel particularly from hands is of vital importance (Bloomfield, 2003). During handling, bacteria are transferred from contaminated hands of workers to the food and subsequently to other surfaces.I t is important to limit access into the premises during the time of slaughter. All personnel that are allowed access should also be dressed in the appropriate personal protective clothing, e.g. clean trousers and wearing appropriate waterproof aprons. Boots should be worn with the trousers neatly folded inside. The hallmark is that the workers must strictly abide to a formal code of hygiene.

Conclusion

Good hygienic practices (GHP) including provision of optimal animal health status in form of housing, feeding, water supply etc enhance the animals' resistance to infections, productivity and reduces on-farm spread of food safety hazards, such as poor growth, diseases and unwholesome meat and meat products.

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CARCASS CHARACTERISTICS AND SENSORY ASSESSMENT OF FUNNAB ALPHA BROILER CHICKENS FED DIFFERENT PROTEIN LEVELS

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ABSTRACT

This experiment was conducted to determine the carcass characteristics and sensory attributes of FUNAAB Alpha broiler chickens fed diets containing different protein levels. A total of one hundred and twenty (120) day-old FUNAAB Alpha chicks were used for the study. The chicks were randomly allocated to four varying dietary protein levels of 14, 17, 20 and 23 % CP and were tagged CP_{14}, CP_{17}, CP_{20} and CP_{23}, respectively. The birds were allocated to the four treatments using a Completely Randomized Design (CRD). Each treatment group was replicated thrice with ten birds per replicate. The birds were housed in deep litter system where they received uniform care and management. The experiment lasted for thirteen weeks. Light was provided 24 hours daily, while feed and clean drinking water were given *ad libitum*. At the thirteenth week, data on carcass and sensory attributes were taken. Results showed that dietary treatment did not influence (P>0.05) all carcass characteristics measured except wing weight. Sensory assessment results showed that there were no significant differences (P>0.05) in all the parameters measured except in Aroma. Meat from birds fed CP_{23} diet had better (P>0.05) aroma than those fed other diets. It is, thus recommended that a CP level of 23 % can be used in diet of FUNAAB Alpha chickens for improved wing weight and better aroma.

Keywords

FUNAB Alpha, dietary protein, carcass, sensory

INTRODUCTION

Local chickens play an important role as household food supply in rural areas of developing countries (Zaman *et al.,* 2004). It is also a means of providing additional income to the generally resource-poor small holder farmers (Gueye, 2004), thereby helping to alleviate poverty. Despite the fact that more than 90 % of the Nigeria poultry production system consists of local chickens, their contribution to human nutrition, gross domestic products and export earnings are disproportionately low. These problems are mainly due to nutrition and poor growth rate (King'ori *et al.,* 2003). Jafarnejad **and** Sadegh **(2011) reported that dietary protein had effect on the body weight gain on broiler chickens.**

Chemjor (1998) reported that a dietary protein level of 13 % was adequate for indigenous chickens aged between 14 and 21 weeks. King'ori *et al.* (2003) observed that indigenous chickens require a protein level of 16 % to optimize feed intake and growth between 14 and 21 weeks of age. Furthermore,

Ndegwa *et al.* (2001) reported that indigenous chickens fed diets containing 17 to 23 % CP had similar growth rates and feed intakes, suggesting that a 17 % CP diet was sufficient for these chickens. More so, Makinde and Egbekun (2016) reported that the optimal dietary crude protein for Fulani Ecotype chickens is 22 % CP for 0-6 weeks of age and 20 % CP for 6-12 weeks of growth. Information on the protein requirements of indigenous chickens is inconsistent. Furthermore, FUNAAB Alpha is a new breed of Indigenous chicken in Nigeria with high potentials. This breed has almost the same potential with imported Sasso and Kuroiler chickens but is superior to Fulani Ecotype and the Shika brown. The protein requirements for this chicken has not been established especially its effect on the carcass and sensory attributes, therefore, this study was aimed at evaluating the carcass characteristics and sensory properties of FUNAAB Alpha broiler chickens fed different dietary protein levels.

MATERIALS AND METHODS

Location of the Experiment site

The study was carried out in the poultry section of the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Minna, Niger State. Minna is located between latitude 4^{o} 30 and 9° 37 North and longitude 6°33 and 06^{o}45 East with an altitude of 1475 m above sea level (Niger State Agricultural Development Project; NSADP, 2009). The study was conducted between May and September, 2018.

The experimental ingredients used for the research were obtained from Minna Ultra-Modern Market, Minna Niger State. The FUNAAB Alpha chicks were obtained from Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. A total of one hundred and twenty (120) day-old of FUNAAB Alpha chicks were used for the study. The chicks were graded and randomly allocated to four varying dietary protein levels of 14, 17, 20 and 23 % CP and were tagged CP_{14}, CP_{17}, CP_{20} and $CP_{23,}$ respectively. The birds were allocated to the four treatments using a Completely Randomized Design (CRD). Each treatment group was replicated thrice with ten birds per replicate. The birds were housed in deep litter system where they received uniform care and management. The experiment lasted for thirteen weeks. Light was provided 24 hours daily, while feed and clean cool drinking water were given *ad libitum.* The diet was isocaloric containing 3100kcal of energy.

Carcass Characteristics and Sensory Evaluation of Birds

At the end thirteen week, two birds per replicate were randomly selected from each of the treatment pen and used for the carcass and organ measurements. The birds were starved overnight to empty the gut before weighing and slaughtering the next morning. Carcasses were defeathered and the inner organs were removed. The birds were dressed and the dressed weight and dressing percentage (carcass yield) were computed. Cut-up parts were all weighed and expressed as percentage of live weight. The visceral organs for each bird which include full gizzard, liver, full intestine, heart, spleen, abdominal fats and caeca were also weighed and expressed as percentage of live weight.

The sensorial evaluation was performed according to the methodology of Dutcosky (2007). The cut sample of the breast was cooked for twenty minutes in 500 mls of water with a pinch of common salt in an aluminium pot without any spices added. The meats were served to 30 semi-trained panellists, comprising of staff and students which were randomly selected from the School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Nigeria. A 9- point hedonic rating scale from 1 to 9 (1: disliked extremely; 2: dislike very much; 3: dislike moderately; 4: dislike slightly; 5: neither like nor dislike; 6: like slightly; 7: like moderately; 8: like very much; 9: like extremely) was used to evaluate the aroma, flavour, colour, texture and over all acceptability of the meat from the experimental birds. All data collected on carcass characteristics and sensory attributes were analysed by one-way analysis of variance (ANOVA) in a Completely Randomized Design (SAS, 2015), where mean differences occurred, they were separated using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Carcass characteristics of FUNAAB Alpha Chickens fed Different Levels of Crude Protein

Table 1 shows the carcass characteristics of FUNAAB Alpha chickens fed different levels of protein diets. The results showed that there were no significant differences ($P>0.05$) in all the parameters measured except the wings weight which was influenced ($P<0.05$). Wing weight values of chickens fed diets having 17 and 23 % crude protein were higher ($P<0.05$) than those fed 14 % CP diet. The reason for this is not well known, it might be that 14 % CP is inadequate to improve wing weight. Leeson and Summers, (2000) did not observe any significant different in broiler chickens fed different dietary protein and that dietary protein levels have no effect on the quality of protein deposited in the carcass. Varying dietary protein levels did not affect carcass yield of the FUNAAB Alpha chickens and this result is in agreement with Leeson *et al.* (1996) and Smith and Pesti (1998), who found that levels of protein in diet did not affect carcass yield and protein deposition. Similarly, of Renden *et al.* (1992) found no significant effect of protein levels on carcass quality of broiler chickens.

Table 1: Carcass characteristics of FUNAAB Alpha Chickens fed Different Levels of Crude Protein

PARAMETERS	CP_{14}	CP_{17}	CP_{20}	CP_{23}	SEM
Live Weight	2133.33	2366.67	2366.67	2300.00	80.21
Carcass Weight	2000.00	2266.67	2200.00	2133.33	70.17
Dress Weight	1900.00	2166.67	2100.00	2033.33	70.17
Breast	15.98	15.13	15.05	15.43	0.48
Drum Stick	8.18	8.89	8.54	8.75	0.34
Thigh	9.75	12.41	13.08	12.46	0.61
Wings	7.95^{b}	10.84^{a}	10.24^{ab}	10.67^{a}	0.47

Gizzard	2.98	2.41	2.42	2.55	0.18
Liver	1.33	1.93	1.92	1.83	0.11
Heart	0.30	0.25	0.24	0.23	0.23

[a,b]; Means in the row not showing a common superscript are significantly different (P<0.05)

CP= Crude protein levels; SEM= Standard error of mean

Sensory Evaluation of FUNAAB Alpha chickens fed Different Levels of Crude Protein

The results of sensory evaluation of FUNNAB Alpha chickens meat fed different levels of crude protein are presented in Table 2. The results showed that there were no significant differences (P>0.05) in all the parameters measured except in Aroma. The aroma results showed that as the level of dietary protein increases the aroma improved. The meat from chickens fed CP23 diet had the best aroma and it is was significantly higher (P<0.05) than the other treatments. The meat from birds on dietary CP20 was better (P<0.05) than those on dietary CP17 and CP14 which had similar values. The improved aroma at high CP level might be as a result of fat deposited in chickens on high CP diets. Rabie *et al.* (2017) found that among all food constituents, lipids generally have the greatest influence on production of aroma flavour components, as they do not reduce the vapour pressure of most flavoured compounds. Kinsella (1990) showed that aroma compounds are more lipophilic than hydrophilic therefore fats act as a solvents for aroma compounds reducing their volatility.

Table @=2: Sensory Evaluation of FUNAAB Alpha chickens fed Different Levels of Crude Protein

Parameter	CP_{14}	CP_{17}	CP_{20}	CP_{23}	SEM
Colour	6.46	6.85	7.15	6.58	0.41
Juiciness	6.62	6.92	7.08	6.73	0.13
Appearance	6.88	7.04	7.38	7.00	0.26
Flavor	6.19	6.69	7.08	6.92	0.15
Aroma	6.42^{c}	6.58^{c}	6.77^{b}	7.23^{a}	0.13
Tenderness	7.00	7.04	7.58	7.11	0.13
Overall Acceptability	7.27	7.27	7.77	7.13	0.13

[a,b]; Means in the row not showing a common superscript are significantly different (P<0.05)

CP= Crude protein, SEM= Standard error of mean

CONCLUSION AND RECOMMENDATION

The results of the present study showed that dietary crude protein affects only the wing weight and the aroma of FUNAAB Alpha chickens. Birds on dietary crude protein level of 23 % did better in both parameters. It is, thus recommended that a CP level of 23 % can be used in diet of FUNAAB Alpha chickens for improved wing weight and better aroma.

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ASSESSMENT OF MICROBIAL STATUS OF COOKED PORK SOLD IN KASIT INTERNATIONAL PIG MARKET, KADUNA STATE, NIGERIA.

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Abstract

This study analysed the quality and microbial load of cooked pork sold in Kasit International Pig Market, Zangon-Kataf Local Government Area Kaduna State. A total of 24 cooked pork samples were randomly collected from 8 pork vendors around the market and analysed for their microbial status. Analysis carried out on each sample includes; Total Aerobic Plate Count for mesophilic bacteria, Coliform Bacteria Count, Fungal Count and selective plating of identified colonies to confirm the organisms. The results from this study shows that the mean microbial load (Total Aerobic Plate Count) on the cooked pork ranged between 44333.3 - 53000.0 cfu/g and Total Coliform Count between 0.0000 -2366.7cfu/g. The bacteria isolated includes: *Staphylococcus spp* (27.58%) which was predominant followed by *Bacillus spp* (24.16%), *Eschericha coli* (20.69 %), *Klebsiella spp* (10.34 %), *Salmonella spp* (10.34%) and *Streptococci spp* (6.89%). Fungi isolated includes: *Aspergillus flavus* (62.50 %), *Fusarium spp* (12.50 %), *Aspergillus niger* (12.50%) and *Penicillum* (12.50 %). From the results of this study, it can be concluded that cooked pork samples obtained from the market were all contaminated with microorganisms. However, the microbial load was found to be within satisfactory limit.

Key words: Microbial Status, Pork, Kasit Pig market.

Introduction

Pork is meat obtained from Pig. It is a major and excellent source of protein and fats, and also an important source of vitamins for most people in many parts of the world (Yannick *et al*, 2013). Pork contains quantities of essential amino acids in forms of protein, it contains B group vitamins especially niacin and riboflavin, iron, phosphorus ash and calcium.

FAO (1990) recommended that the average of 55 g animal protein is required per day for healthy living in developing countries. In developing world, food borne infection has accounted for many deaths in children, and the reoccurring cases of diarrhoea disease linked to poor food handling have long-term effects on children's growth as well as on their physical and cognitive development (Adak *et al.,* 2005).

Food borne diseases are diseases resulting from ingestion of bacteria, toxins or cells produced by microorganisms present in food. Pork is the most perishable of all important foods since it contains sufficient nutrient needed to support the growth of microorganisms (Magnus, 1995). In most cases, during slaughter, dressing and cutting, microorganisms come chiefly from the exterior of the animal and its intestinal tract but more comes from knives, cloths, air, and equipment in general (Adak *et al.,* 2005). Retail cut could also result in greater microbial load because of the large amount of exposed surface area, more readily available water, nutrient and greater oxygen penetration available (Forest *et. al*., 1996).

Food borne microbial hazards may be responsible for many cases of illness as possible each year and are thus an important food safety challenge (Yannick *et al,* 2013). It has been reported that Gram negative bacteria account for approximately 69% of the cases of bacterial food borne disease (Clarence *et al.,* 2009).

There is need for more information as to the level of microbial contamination in ready to eat pork retailed in Kasit International Pig Market of Kaduna State.

The objective of this study was to assess the microbial load and also to identify the types of fungi and bacteria associated with cooked pork sold in Kasit International Pig Market of Kaduna State.

Materials and Method

Description of the research area:

The study area is the International Pig market of Kasit popularly known as Tunga. Kasit Pig market is one of the biggest in Nigeria and located in Zangon-Kataf Local Government Area of Kaduna State.

Sample collection:

Twenty four (24) samples of ready to eat pork were randomly purchased from 8 different vendors in the market. The samples were aseptically collected in clean polyethylene bags and transferred immediately to the laboratory for analysis.

Sample preparation:

Ten grams (10g) obtained from each sample were homogenized vigorously for 5 minutes in sterile 0.1% peptone water using a sterile food blender. Serial dilutions of homogenates were made (to 10^{-3}), 0.5 ml of each set was pipetted onto the surfaces of two plates; Mac Conkey for Coliforms and Nutrient agar for Total viable count and immediately spread out with a sterile glass spreader i.e. using a standard pour plate technique, according to the procedure of ISO, (2001). The Total viable count was calculated from the average colony count/plate after incubation.

Microbial load guide in animal food product, according to Wilson et al., (1991) is shown in table 1.

Table 1: Standard Microbial Load Specification on Animal Food Product.

Grades	Total Viable Count/g at 30°C	Description
1	<½million	Satisfactory
2	½millionto<10million	Passable
3	10million and more	Unsatisfactory

Source: Wilson *et al*., (1991).

Statistical Analysis:

Data obtained were subjected to Analysis of Variance (ANOVA), and significant means were separated using the Least Significant Difference test. Statistix 9.0 statistical package was used for all statistical analysis

Results and Discussion:

The Total Plate Count and Coliform Count for Bacteria are shown in Table 2 below. The Total Aerobic Plate count ranges from 44333.3 to 53000.0 Cfu/g with cooked pork from retail point one (T1) having the highest value while T8 has the lowest. T 2 and 6 were statistically similar, while T 4, 5 and 7 were also statistically similar. Total Plate count for mesophilic aerobic bacteria of all cooked pork samples were within satisfactory limit with reference to standard microbial load specification (Wilson *et al.,* 1991). The presence of these aerobic bacteria can be linked to their ability to survive in the presence of oxygen. All samples were displayed in an open air environment hence the possible source of contamination. This report agrees with the findings of Yannick *et al.,* (2013) on ready to eat Suya. The results obtained in this experiment are equally comparable to report by Venia *et al*., (2006) for dehydrated pork stored for 2 days post production. However, Ekanem (2000), reported lower values on street vended meat product. The higher values could be because the meat samples were exposed for longer periods in Ekanem's (2000) study as compared to this study. Generally, possible sources of these Micro-organisms in the pork could be inherent micro-flora in normal tissues of animals, air, environment, or contamination due to unhygienic slaughtering, handling and processing conditions as suggested by Zattola, (1982). Although the Bacteria count recorded are within the acceptable limit, there is need to further reduce the number. The number could be further reduced by raising the number of Lactic Acid Bacteria (LAB) which are not as destructive as the non-acid-tolerant species of Micro-organism (Apata and Akinfemi, 2010).

The Coliform unit ranged from 1533.3 to 2366.7 Cfu/g with the highest value from retail point one (T1) while lowest count was observed in T3. Samples from T 1, 4 and 5 were statistically the same, so as T 2 and 8. Coliform count from all pork samples were equally within satisfactory limits (Wilson *et al.,* 1991). Coliform bacteria are non-spore forming rods that occur in large number in human and animal faeces. They are usually present on raw product such as meat, milk, egg and on surfaces of plants. They are heat sensitive and die rapidly during blanching and pasteurizing. Large number of Coliform after a heat process indicates and unacceptable degree of post heating contamination, it could also indicate time – temperature insufficiency in food which permits Coliform growth. Thus, high Coliform levels mean recontamination or temperature mishandling. The number of Coliform count form this study disagrees with the findings of Yannick *et al.,* (2013) who recorded higher values. The Coliform bacteria observed could be due to improper heating since Coliform bacteria are very sensitive to heat. The absence of Coliform bacteria in T 3 could be due to sufficient heating and frying by the vendor.

Table 2**:** Total Aerobic Plate Count and Coliform Count for Bacteria on cooked pork from different retail point in Kasit Market.

Treatment	Aerobic bacteria count Cfu/g	Coliform count Cfu/g
T 1	53000.0^{a}	2366.7^{a}
T 2	45000.0^{bc}	2000.0^{ab}
T 3	51330.3^{ab}	0.0000^{c}
T 4	49333.3^{abc}	2333.3^{a}

T 5	50660.7^{abc}	2066.7^{a}
T 6	45330.3^{bc}	2233.3^{a}
T 7	46333.3^{abc}	1533.3^{b}
T 8	44333.3^{c}	2000.0^{ab}

All values are means from triplicate determinations. Means in the same column with different superscripts are significantly different at p<0.05
T=Vendor/Retailer point

The result for Total Fungal Count on ready to eat pork sold in Kasit International Pig Market is shown in Table 3. The mean fungal count ranges from 916.67 to 2100 Cfu/g with values from retail point one (T1) having the highest count while T 8 had the lowest count. Samples from T 2 and T 7 were statistically the same, T 4 and T 8 were also statistically the same. Results from the statistical analysis obtained shows that T 5 and T 6 are similar.

Fungi isolated include *Aspergillus niger*, *Aspergillus flavus, Fusarium sp.* and *Penicillium sp.* Some of the isolated Micro-organisms are directly or indirectly involved in spoilage, although some may have been present as opportunistic contaminants which may not play any role in the spoilage of the meat samples. Taniwaki *et al.*, (2001) reported that fungi are capable of growing at a very low moisture content or low water activity of less than 0.83 $_{aw}$ and can adapt to dry and partially dry food. *Aspergillus spp.* among the fungal isolates has been associated with disease conditions (Talaro, 2009). Results from this study are in agreement with findings of Talaro (2009), revealing that *A. flavus* and *A. niger* are some of the fungal isolates of pork.

Table 3**:** Fungal count for cooked pork from different retail point in Kasit Market

Code	Fungal count Cfu/g
T 1	2100.0^{a}
T 2	1866.7^{ab}
T 3	1233.3^{cd}
T 4	1083.3^{d}
T 5	1766.7^{abc}
T 6	1466.7bcd
T 7	1933.3^{ab}
T 8	916.67^{d}

All values are means from triplicate determinations. Means in the same column with different superscripts are significantly different at p<0.05
T=Vendor/Retail point

The graphical representation on the frequencies of fungi isolate are shown in figure 1.The result shows that *A. flavus* was the highest constituting 62.50% while *A. Niger*, *Fusarium spp.* and *Penicellium* spp. had 12.50%, 12.50%, and 12.50 % level of occurrence respectively. The high percentage of *Aspergillus flavus* (62.50%) indicates likely contamination from the environment as reported by Gandi *et al.*, (2015).

Results from this study are also in agreement with findings of Talaro, (2009) who reported that *A. flavus* and *A. niger* are some of the fungal isolates of pork.

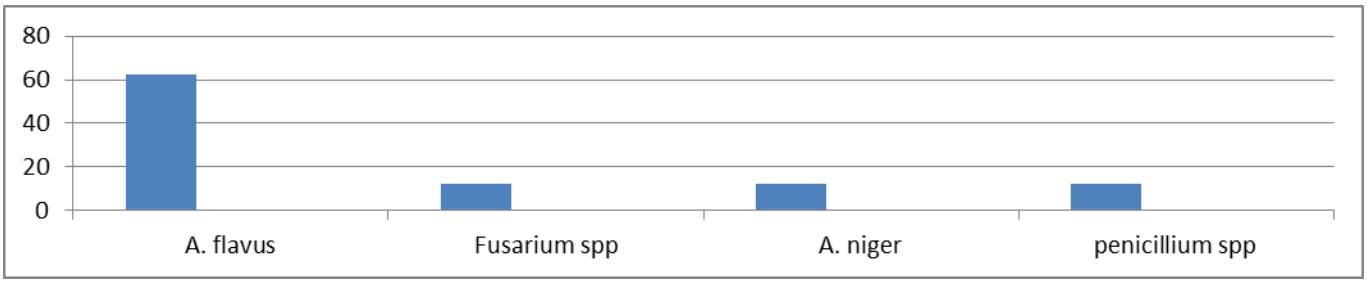

Figure 1**: G**raphical representation of fungal distribution in percentage from pork sold in Katsit Market.

The distribution of microbial isolates are shown in Figure 2. The result shows that the samples were found to be contaminated with varying degree of bacteria. *Staphylococcus spp* form 27.58 % while *Bacillus spp.* had 24.13 %, *Escherichia coli* accounted for 20.69 %, *Klebsiella* and *salmonella* spp. had 10.34% and 9.21 %, respectively. *Streptococci spp.* had the lowest frequency (8.57 %). The presence of these organisms could possibly be due to poor hygiene during processing or faecal contamination. These isolate were equally identified in reports by Gandi *et al.,* (2015) and Clearance *et al.,* (2009) on processed meat. These organisms when present in high amount can cause serious health challenge to individual. Therefore effort should be made to reduce their number.

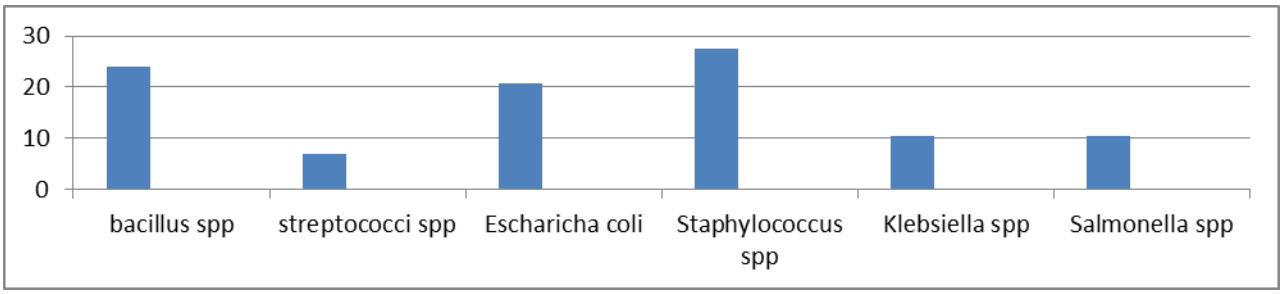

Figure 2: Graphical representation of microbial distribution from pork sold in Katsit Market.

Conclusion:

Ready to eat pork sold in Kasit International Market of Kaduna State were all contaminated with disease causing micro-organisms. However, the levels of contamination were within acceptable limits posing no real threat to consumers' health.

Recommendations

Although all samples were found to contain microorganism within the acceptable limit for consumption, cases of diarrhoea and food poisoning are still recorded. Thus, the need to maintain good hygiene during processing and also ensure adequate time – temperature ratio during cooking.

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CATTLE (SOKOTO GUDALI, WHITE FULANI AND RED BORORO) SHOULDER MUSCLES EVALUATION

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ABSTRACT
Effect of meat quality from composition of different muscle or breeds is a food for thought. Do muscles from same breed differ in chemical and mineral composition? Or different taste preference to consumers? This study evaluates the composition of different shoulder muscles from three breeds of cattle and the different muscles within their shoulder. Nine male cattle of one-year-old, comprising of 3 Sokoto Gudali (SG), 3 White Fulani (WF) and 3 Red Bororo (RB) breeds were reared semi – intensively, fed with concentrate and allowed to graze for 10 weeks. Shoulder muscles evaluated are; Triceps brachi – TB, Trapezius – T, Infraspinatus – IF, Supraspinatus – S, Pectoralis – P, Latissimus dorsi – LAD and Longissimus dorsi – LOD, for proximate, minerals and palatability status, in a completely randomized design. SG had the highest nutritional quality especially in CP, Ash, Mg Fe and P with lowest amount of ether extract ($P<0.05$) than WF and RB. IF muscles performed better from all the other shoulder muscle evaluated ($P<0.05$). Physico-chemical evolution had highest WHC ($P<0.05$) in SG (497.29%) than WF (456.01%) and RB (490.77%). Same was experienced with IF muscle compared with other muscle evaluated. SG had the highest values ($P<0.05$) for flavour (6.01), tenderness (6.10), juiceness (5.91), texture (5.86) and overall acceptability (6.39) than values obtained for WF and RB. SG appeared to be the best breed while IF performed well in shoulder muscles of cattle evaluated.
Keywords: Breeds of cattle, Red Bororo, White Fulani, Sokoto Gudali and Shoulder muscles.

INTRODUCTION
Most African countries have major problems of malnutrition in certain sectors of their population. FAO (2009) recorded that the diet of an average Nigerian contains about 20% less than the recommended requirement. Protein intake is very low, mostly from vegetable sources which contains little or no protein and meat is the antidote of malnutrition. Consumers purchase meat and process them into desirable products without full knowledge on the breeds, type of muscles or nutritional values they might get from the product bought (Fakolade *et al*., 2018). Animal breeds can influence the nutritive qualities of meat in some ways, which could affect the muscles structure and meat physiology. Steven Jones (2018) recorded major muscles in the shoulder which are: Longissimus dorsi, Triceps brachii, Infraspinatus, Supraspinatus, Trapezius, Latissimus dorsi and Pectoralis muscle. The characteristics possessed by each will dictate differences in meat quality produced from different shoulder muscles. Therefore, this study will access shoulder muscles from three breeds of cattle and differences in muscles of cattle shoulder.

MATERIALS AND METHOD
Experimental Animals
Nine male live animals of a year old, comprising of 3 White Fulani, 3 Sokoto Gudali and 3 Red Bororo were purchased from Osun State University Teaching and Research Farm. Thereafter, the cattle were quarantined, dewormed, given anti – stress and antibiotics. The animals were raised under a semi – intensive housing system for ten weeks and tagged for easy identification (White Fulani – WF, Sokoto Gudali – SG and Red Bororo – RB). Immediately after exsanguination, skinning took place (removal of animal's skin) in order to access and identify muscles in the shoulder for experimental study.
Identification of muscles in the shoulder
The muscles obtained were identified in the Meat Science Laboratory as Triceps brachii – TB, Trapezius – T, Infraspinatus – IF, Suspraspinatus – S, Pectoralis – P, Latissimus dorsi – LAD and Longissimus dorsi – LOD.
Proximate and Mineral Composition

Protein, ether extract, moisture contents and ash composition and Calcium, Phosphorus and Magnesium were analysed chemically according to the Official Analytical Chemist (AOAC, 18TH EDITION, 2005).

Physico – chemical evaluations

Water Holding Capacity

The WHC of meat samples was determined by the press method as slightly modified by Suzuki *et al*., (1991). Using the calculation below:

$$WHC = \frac{\{(Aw - Am \times 9.47)\}}{Wm - Mo}$$

Where, Aw = Area of water released from meat samples (cm^2)
Am = Area of meat samples (cm^2)
Wm = Weight of meat samples (%)
Mo = Moisture content of meat samples (%)
9.47 = a constant factor

Cold Shortening and Thermal Shortening

Meat samples of known weight and length were stored in refrigerator for 24h at 4^0C for cold shortening, or broiled in an oven for thermal shortening (Fakolade *et al*., 2016). After refrigeration, the final length was taken and calculated thus

$$\text{Cold shortening (\%)} = \frac{\text{Initial length of meat} - \text{length of frozen meat}}{\text{Initial length of meat}} \times 100$$

Cooking Loss and Thaw Rigor

Meat samples of known length and weight were taken and broiled in an oven at 175^0C for 20mins (Fakolade *et al*., 2016). Afterwards, the final weight was taken and calculated thus:

$$\text{Cooking loss (\%)} = \frac{\text{Initial weight of meat} - \text{weight of broiled meat}}{\text{Initial weight of meat}} \times 100$$

Palatability

A total number of forty trained panellists aged 27 to 45 years were selected based on their past performance in consuming meat and were randomly allocated to the samples. Each panellists was presented the blind coded samples and asked to score each sample for flavour, tenderness, juiciness, colour and overall acceptability (Fakolade *et al*., 2016).

Statistical Analysis

The experimental design adopted was complete randomized design (CRD). All data were subjected to analysis of variance (ANOVA) and means were separated with Tukey HSD using the same analytical software.

RESULTS AND DISCUSSION

Table 1: Proximate and mineral composition of SG, WF and RB cattle shoulder

Variables	SG	WF	RB	SEM
CP	21.33[a]	20.73[b]	20.85[b]	0.20
Ash	0.97[a]	0.92[b]	0.90[b]	0.10
Ether extract	3.28[b]	3.47[a]	3.45[a]	0.23
Moisture Content	74.52[a]	74.27[a]	73.66[b]	0.19
Magnesium	84.45[a]	82.14[c]	83.19[b]	0.06
Iron	22.84[a]	20.31[b]	22.95[a]	0.05
Phosphorus	276.52[a]	266.86[b]	265.23[b]	0.16

[abc]: mean within the same row with different superscripts are significantly different (P<0.05)

Table 2: Proximate and mineral composition of different muscles of cattle shoulder

Variables	TB	T	IF	S	P	LAD	LOD	SEM
CP	22.48[a]	19.98[c]	21.24[ab]	20.57[b]	21.37[b]	21.12[ab]	19.02[c]	0.31

Ash	0.90[b]	0.99[a]	0.95[a]	0.92[b]	0.87[c]	0.92[b]	0.96[a]	0.02
Ether extract	3.74[a]	3.32[c]	3.55[b]	3.47[b]	3.25[c]	3.15[d]	3.32[c]	0.04
Moisture content	71.33[c]	74.52[a]	75.76[a]	74.89[a]	75.12[a]	73.67[b]	73.72[b]	0.29
Magnesium	83.56[a]	83.91[a]	83.78[a]	82.82[b]	84.34[a]	83.12[a]	82.99[c]	0.10
Iron	22.49[a]	21.95[a]	21.97[a]	22.48[a]	20.53[b]	22.65[a]	22.18[a]	0.07
Phosphorus	272.35[a]	270.00[a]	274.05[a]	276.01[a]	261.33[b]	269.89[b]	263.13b[e]	0.24

[abcdef]: mean within the same row with different superscript are significantly different (P<0.05)

Table 3: Physico – chemical status of shoulder muscles of SG, WF and RB cattle

Variables	SG	WF	RB	SEM
Thermal shortening	41.86[c]	53.10[a]	46.32[b]	2.35
Cooking Loss	67.34[c]	75.88[a]	71.81[b]	2.32
Cold shortening	21.98[b]	41.42[a]	22.72[b]	0.84
Thaw Rigor	35.10[b]	61.34[a]	34.70[b]	2.24
Water holding capacity	497.29[a]	456.01[b]	490.77[b]	39.75

[abc]: mean within the same row with different superscript are significantly different (P<0.05)

Table 4: Physico – chemical status of different muscles in cattle shoulder

Variables	TB	T	IF	S	P	LAD	LOD	SEM
Thermal hortening	44.17[c]	44.68[c]	43.10[d]	48.89[b]	56.96[a]	44.26[c]	47.58[b]	3.60
Cooking loss	77.31[a]	69.45[c]	69.68[c]	69.57[b]	73.34[b]	74.50[b]	71.90[c]	3.54
Cold shortening	36.16[c]	21.02[d]	30.15[c]	23.99[c]	23.99[d]	32.39[b]	33.48[b]	1.28
Thaw Rigor	43.75[c]	46.11[b]	43.96[b]	36.49[d]	36.49[d]	43.82[b]	55.04[a]	3.42
WHC	471.90[c]	549.14[b]	638.93[a]	546.18[b]	457.05[c]	420.76[c]	245.52[d]	60.7

[abcd]: mean within the same row with different superscript are significantly different (P<0.05)

Table 5: Palatability status of SG, WF and RB shoulder muscle.

Variables	SG	WF	RB	SEM
Colour	5.08[b]	5.44[a]	5.04[b]	0.21
Flavour	5.01[b]	4.43[c]	5.58[a]	0.18
Tenderness	6.10[a]	5.86[b]	5.70[b]	0.19
Juiciness	5.91[a]	5.18[c]	5.66[b]	0.17
Texture	5.86[a]	4.19[b]	5.99[a]	0.19
Acceptability	6.39[a]	5.74[b]	5.88[b]	0.18

[abc]: mean within the same row with different superscript are significantly different (P<0.05)

Table 6: Palatability scores of different muscles in cattle shoulder

Variables	TB	T	IF	S	P	LAD	LOD	SEM
Colour	5.50[b]	4.61[c]	5.19[b]	5.97[a]	4.94[c]	4.97[c]	5.11[bc]	0.33
Flavour	4.94[b]	4.39[c]	5.53[a]	5.53[a]	4.81[b]	4.94[b]	4.92[b]	0.28
Tenderness	6.77[a]	5.08[d]	6.67[a]	6.19[ab]	5.94[b]	5.67[b]	5.42[c]	0.29
Juiciness	5.92[b]	5.14[c]	5.94[b]	7.06[a]	5.28[c]	4.53[d]	5.19[c]	0.25
Texture	5.86[b]	4.89[d]	5.47[c]	6.67[a]	5.39[c]	5.44[c]	5.36[c]	0.29
Acceptability	6.14[b]	6.11[b]	6.78[a]	6.22[b]	5.86[ab]	6.06[b]	5.78[c]	0.28

[abcd]: mean within the same row with different superscript are significantly different (P<0.05)

The shoulder muscle of SG gave the best ($p < 0.05$) composition values for CP. Values obtained corroborates the findings of Adeniyi *et al*., (2011) with beef protein ranges from 18 – 22 %, moisture 68 to 75 % and 2 to 15 % who worked on proximate composition and economic values of four common sources of animal protein. Ether extract obtained was in agreement with the report of Tonberg (2005) who evaluated the effect of heat on meat protein. SG shoulder muscle had the best nutrient qualities breeds. Infraspinatus IF muscles of cattle shoulder performed best in the proximate and minerals composition evaluated having the highest ($p < 0.05$) values in Ash, minerals composition and lowest percentages in Ether extract.

Kim *et al*., (2008) obtained a low fat values as in Table 2, TB (3.44%), IF (3.55%), S (5.35%) which is also fell within the range obtained, this could only indicate that shoulder muscle are lean. IF appeared best for proximate analysis, while TB, T, and LAD had significant values ($P<0.05$) in minerals composition, Protein content for TB 22.48 % corresponds with 22.13 % obtained by FAO (2009) for longissimus dorsi of cattle meat. WF has the highest values in all parameters evaluated for physico-chemical except in WHC, this indicates that most of the nutrients of the meat are lost during processing therefore, WF has a poor meat quality since it cannot retain water and nutrients while SG proved to be the best. Kauffman (1992) reported that, higher thaw rigor reduces juiciness, texture and nutrient in meat. IF muscle had the highest WHC and considerably low in other parameters evaluated. Parameters like thermal, cooking loss, cold shortening and thaw rigor affect quality of meat if it is ($P>0.05$) higher, could affect the organoleptic properties of the consumers, as there will be reduction in the nutrients of the meat (Fakolade *et al*., 2018). SG was most acceptable by the panellist since it had the highest ($P>0.05$) flavour, tenderness, juiceness and texture, which influences its acceptability more over WF and RB. This results could be due to high protein and mineral content of SG.

In Table 6, panellists gave IF the higher score probably because its muscle was able to retain water and nutrients than every other muscles evaluated and because it had the highest proximate and mineral composition, which in turn may have influenced the organoleptic properties of the panellists.

CONCLUSION

SG breed of cattle and IF proved to be the best quality breed of cattle and muscle with best nutritional qualities than the other breeds or muscles evaluated.

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PREVALENCE OF *CYSTOISOSPORA* OOCYSTS INFECTION IN LOCAL BREED OF DOGS IN ENUGU STATE, NIGERIA

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Abstract
Cystoisospora are apicomplexan protozoan parasites that cause diarrheoa, and even death in severe cases especially in puppies. This study was aimed at determining the prevalence of *Cystoisospora* oocysts in faeces of dogs presented in veterinary hospitals, clinics and dogs at home in rural areas in Enugu State, Nigeria. A total of 203 fresh faecal samples were collected from domestic dogs in 6 local government area of Enugu State from February to August 2015. All the samples were processed for detection of *Cystoisospora* oocysts using flotation technique and examined under light microscopy. Results showed that 21 % (*n = 44*) of the faecal samples were positive for *Cystoisospora* oocysts. There was no significant association ($p > 0.05$) between the presence of the *Cystoisospora* oocysts and age, sex and faecal consistency distribution. The findings of this work showed that domestic dogs in Enugu State harbour and shed *Cystoisospora* oocysts in the environment. This faecal shedding is particularly so in those animals not showing clinical signs of enteritis and therefore poses greater health risk to immunocompromised adult dogs and puppies. Awareness creation amongst dog owners and breeders is therefore of paramount importance in Enugu State in particular and Nigeria in general, to educate them on the potential economic loss this protozoan can cause to puppy farms.
Key Words: Dogs, *Cystoisospora*, Oocysts, Enugu State, Prevalence

Introduction

*Cystoisospora species (*Formely known as *Isospora)* are apicomplexan protozoa of the order Eucocidiorida, subclass coccidiansina and class sporozoasida (Gajadhar *et al*., 2015). These intracellular parasites affect the epithelial cell linings of the digestive tract of wide variety of mammalian hosts including domestic dogs where they cause severe diarrhoea and even deaths (O'Dongue; 1995; Fayer, 2010). Canine intestinal coccidiosis can result in serious or even fatal enteritis and colitis especially in puppies and immunocompromised adult dogs (Dunbar and Foreyt, 1985; Cynthia, 2005). Clinical infection of dogs with *Cystoisospora* species is severe in pups less than 4 months of age (Buehl *et al*., 2006; Dubey *et al*., 2009) where it causes enteritis with diarrhoea which can be haemorrhagic, tenesmus, vomiting, abdominal pain and inappetence with resultant poor health and impaired development. Death could result from excessive loss of electrolyte and dehydration (Daugschies *et al*., 2000; Lappin., 2010). In Nigeria, especially in rural areas, most dog owners have little commitment towards the health of their pet. This attitude results in domestic dogs harbouring parasitic infections including zoonoses; thus posing public health risks to humans especially children who play around in the environment contaminated with dog faeces (Robertson *et al*., 2002).

Despite the high prevalence of the disease in domestic animals, it is not usually seen as a possible cause of gastroenteritis and therefore not included in routine diagnosis of gastroenteritis in domestic dogs.

The importance of enteric protozoan infections in dogs and their public health implications cannot be overemphasized. However, there is dearth of information and research on Cystoisosporiasis in domestic

dogs in Enugu State, Nigeria. This study was therefore designed to determine the occurrence of shedding of *Cystoisospora* oocysts in faeces of dogs in Enugu State, Nigeria.

Materials and Methods

Ethics

Animal owners were contacted and permission obtained to include their animals in the study. The animal experimental protocol was approved by the Experimental Animal Ethics Committiee of the Faculty of Veterinary Medicine, University of Nigeria, Nsukka

Study Area

The study was undertaken in Enugu State which covers approximately 7617.82 km^2 and is located between latitude 6^o 45^l and 7^oN and longitude $7^o12.5^l$ and 7^o 36^l W in the Southeast geopolitical zone of Nigeria. It has three Senatorial zones and 17 local government areas. Simple random sampling technique was used to select two senatorial zones- Enugu West and Enugu North out of the three senatorial zones in Enugu State. Samples were then collected in 3 local governments from each senatorial zone.

Sample collection

Fresh faecal samples were collected from January to August 2015 from homes of dog owners, small animal hospitals and clinics. A total of 203 dogs were included in this study. Faecal samples were collected *par rectum* from each dog using well lubricated disposable gloves into pre-labelled plastic containers. Field identity, including sex, age and source were recorded for each dog. The faeces were examined visually and their consistencies categorized into formed, semi-formed, and watery. The samples were analyzed immediately after collection.

Faecal examination

Faecal examination was done using simple faecal centrifugation flotation technique (Foryet, 2001). Briefly, 2 g of faeces was mixed with 60 ml of sugar solution; the sample was strained through a coffee strainer into test tubes and single-step centrifugation was carried out at 3000 rpm for 10 minutes (Weber, 1992). A plastic pipette was used to pick few drops from the top layer for a wet mount. Identification of *Cystoisospora* oocysts was carried out as described by Kassai, (1999).

Statistical Analysis

Results were analysed descriptively and presented in percentages using tables. Chi square (χ^2) test was used to determine the association between the presence of the parasites and age, sex, faecal consistency distribution. Significance was accepted at $P < 0.05$.

Results

Frequency of *Cystoisospora* oocysts in faecal samples of dogs and their associated risk factors

Of the 203 faecal samples examined, 44 (21.7%) contained oocysts of *Cystoisospora*. Statistical analysis showed that there was no significant association ($P > 0.05$) between the presence of parasites and age, sex and faecal consistency (Table 1).

Table 1: Age, Sex and faecal consistency distribution of *Cystoisospora* oocysts in dogs in Enugu State (n=203)

Variable	Number examined	*Cystoisospora* oocysts	
		Number positive (%)	χ^2
Age			
Puppy	55	13 (23.6)	0.81
Adult	148	31 (20.9)	
Total	**203**	**44 (21.7)**	
Sex			
Male	102	20 (23.5)	0.41
Female	101	24 (19.8)	

Total	**203**	**44 (21.7)**	
Faecal consistency			
Formed	125	33 (26.4)	3.2
Semi-formed	56	8 (14.3)	
Watery	22	3 (13.6)	
Total	**203**	**44 (21.7)**	

P-value > 0.05

Discussion

The shedding of *Cystoisospora* oocysts in faeces of dogs in Enugu State was determined in this study, with a high prevalence rate of 21%. The prevalence recorded in this study was in agreement with a the prevalence of 32.9 observed in Ibadan Nigeria (Ayinmode *et al*., 2016), but in contrast with the results of Mirzaei (2010), who got a prevalence of 5.1% in Iran; Vanparijs *et al*., (1991), who observed a prevalence of 5.2% in dogs in Belgium, also a low prevalence was observed in Venezuela by Ramirez-Barrios *et al.*, (2004) and in Sao Paulo State, Brazil by Oliveira-Sequeira *et al.,* (2002) who found 8.1% and 8.5% prevalence, respectively. This may be due to the fact that we sampled dogs in rural areas were some of the dogs are allowed to roam the streets with little attention paid to their health care and welfare, hence the high prevalence.

In this study we observed no statistical significant association between the presence of *Cystoisospora* oocysts and the age of dogs. However, a higher prevalence of the parasites was seen in puppies than in adult dogs. *Cystoisospora* spps have been reported to be higher in puppies as a result of undeveloped immunity (Buehl *et al*., 2006; Dubey *et al*., 2009).

Sex had no influence on gastrointestinal protozoan infection as there were no significant associations (P > 0.05) between them. However, there is a higher prevalence of *Cystoisospora* oocysts in male than female dogs which could be attributed to the fact that males move around more often than females in search of mating partners and also establishing territory. However, other workers reported higher infection in females than in males and attributed it to reduced immunity at certain periods in the female's physiologic cycle (Wang *et al.*, 2008; Zelalem *et al*., 2012; Olabanji *et al*., 2016).

Oocysts were seen more in apparently healthy dogs (26.4%) than those having signs of enteritis (diarrhoea) – 13.6% (watery faeces) and 14.3% (semi-solid faeces). It appeared that the more formed the faeces, the more chances of seeing oocysts. Therefore it may be that the oocysts were less concentrated in diarrhoeic faeces and therefore chances of missing the oocysts are high.

Conclusion,

This study has established that there is faecal shedding of *Cystoisospora* oocysts by domestic dogs in Enugu State Nigeria. This study has also shown that faecal shedding is higher in apparently healthy dogs, thus posing health risk to immunocompromised adult dogs and puppies.

Recommendation

Health education and awareness on the economic importance of this enteric protozoan parasite should be created among dog owners and dog breeders. The infection should also be included in the list of routinely diagnosed diseases in veterinary hospitals and clinics as a possible cause of enteritis and diarrhoea as seen in this study.

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THE USE OF GENTAMICIN AND DETECTION OF ITS RESIDUE IN COMMERCIAL BROILERS IN NSUKKA, SOUTHEAST, NIGERIA

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Abstract
The study aimed to determine the use of gentamicin by poultry farmers and the presence and prevalence of gentamicin residue in tissues of commercial broilers in Ikpa slaughter house Nsukka. The study adopted cross-sectional survey using questionnaire and immunological screening. A total of 108 broilers were sampled, testing 108 each of Muscle, liver and kidney tissues for gentamicin residue using Enzyme-linked immunosorbent assay (ELISA). The questionnaire survey revealed that in the management practice, 55.2% of the farms use intensive deep litter, 21% intensive battery cage, and 23.6% extensive farming system. 27 (71%) farms rear only broilers, 10.5% layers, and 18.4% both. The feeding management showed that 21.1% of farmers produce their own feed (medicated) while 78.8% use commercial feed, of which 11.5% incorporate antibiotics. hundred (100%) of the respondents use gentamicin and only 47.3% are aware of the consequences of antimicrobial residue in food with knowledge of the legislation on the prudent use of antimicrobials in food animals. The prevalence of gentamicin residue in surveyed birds was 65% with tissue distribution as follows: muscle (44.4), liver (51.9) and kidney (59.3%). 18.5% of muscle, 33.3% of liver. Poultry Farms in the study area make constant use of gentamicin without observing its withdrawal period before sale and a high percentage of the commercial birds meant for human consumption contain gentamicin residue.

Keywords: *gentamicin, residue, poultry, ELISA, farm management*

Introduction
The intensification in agricultural sector in modern times showed that increase of livestock production and crop yield have been aided using veterinary medicinal products, especially, anti-infective drugs and chemicals like herbicides and pesticides (Tatsadjieu *et al*., 2009). About 42% of all veterinary pharmaceuticals used in poultry and livestock industry are used as feed additives, 19% as anti-infectives, 13% as parasiticides, 11% as biologic, 15% as other pharmaceuticals (Biswas, *et al*. 2010). These veterinary products are used either as a chemotherapy applied individually or collectively to animals with microbial infections, or as a preventive measure against the onset of certain diseases. Preventive measures (using anti-infectives as a medicine) is a more recent development and seen as big breakthrough in medicine because the incidence of morbidity and mortality caused by many infectious diseases can be reduced by it (Sanders *et al*., 2001). Following the administration of drugs to animals and subsequent non-observance of withdrawal periods, drugs remain in the tissues of the animals and food products derived from them (Fagbamila *et al*., 2010). Amongst the most widely used antimicrobials in livestock and poultry production is gentamicin. It is an antimicrobial with bactericidal activity against most gram-negative bacteria. It has problems of toxicity and resistance when misused. Gentamicin residue in foods of animal origin is of great public health importance worldwide, mainly because of the health risk associated with it especially its nephrotoxic and ototoxic effect (Moore, *et al*, 1984).

Materials and Method
Study area
The study was carried out in Nsukka and Enugu metropolis representing 2 of the 3 agricultural zones in Enugu State, being the major cities in Enugu State, they were purposively selected. Samples for gentamicin residue detection were collected from Ikpa slaughter, which is the major slaughter house within the Nsukka local government area, serving the whole of Nsukka and environs.

Study Design
The study adopted a cross sectional survey using questionnaire to extract information on poultry farm management and gentamicin drug use, and Immunological screening for the presence of gentamicin residue in commercial birds using Enzyme linked Immunosorbent Assay (ELISA).

Sample Source, Size and Sampling Technique
Forty (40) of the listed farms from both metropolises were selected for the questionnaire survey using systematic random sampling technique, 15 from Nsukka and 25 from Enugu. Samples for creening were collected from the poultry processing unit at Ikpa slaughter house. The slaughter was visited weekly for a period of eight weeks and on the first six weeks, systematic random sampling technique was used to select 14 birds from a daily slaughter capacity of about 30 birds. 12 birds were selected on the last two weeks. A total of 108 birds were sampled. 3 major organs (liver, muscle and kidney) serving as post slaughter matrix, were harvested from each bird making a total of 324 organ specimen.

Sample Preparation, extraction
Gentamicin ELISA kit used for screening was procured from Shenzhen Lvshiyuan Biotechnology company limited. Juices from the organs were extracted following the instruction of the ELISA kit manufacturer. One gram (1±0.5g) of each organ was macerated using sterile pestle and mortar, emulsified with 5mls of diluted extraction solution and after shaking for 3 mins, centrifuged at 4000 rpm at room temperature for 10 mins, 50µl of the supernatant was decanted into Eppendorf tubes and stored for analysis.
The test kit is based on competitive enzyme immune-assay for the detection of gentamicin in the sample. The coupling antigen is pre-coated on the micro-well strips. The gentamicin in the sample and pre-coated coupling antigen on the micro-well strips compete for the anti-gentamicin antibody. After the addition of the enzyme conjugate, the TMB (3,3',5,5'-tetramethylbenzsidine) substrate is added for coloration. The optical density (OD) value of the sample has a negative correlation with the gentamicin in it. The value is compared to the standard curve and the gentamicin concentration is subsequently obtained (manfacturer's guide).

Statistical analysis
Data from the study are presented in tables, frequencies, and proportions and analyzed in GraphPad Prism Statistical Software Version 5.02 (www.graphpad.com). Chi square test (p value) was used for statistical significance and inference. The alpha value of significance was set at the probability level of <0.05

Result and Discussion
From the Questionnaire survey, out of the 40 farms evaluated, 38 (95%) responded while 2 (5%) did not. In the management practice, 55.2% of the farms use intensive deep litter, 21% intensive battery cage, and 23.6% extensive farming system. 27(71%) farms rear only broilers, 10.5% layers, and 18.4% both. The feeding management showed that 21.1% of farmers produce their own feed with inclusion of antibiotics while 78.8% use commercial feed, of which 11.5% incorporate antibiotics. almost half of the farms surveyed use intensive deep litter which allows for cross infection among birds within and across pens, this management system may make the use of antibiotics for prevention and treatment inevitable. Some farmers that produce their feeds as well as some commercial feeds incorporate antibiotics not only for prophylactic purposes but also for growth promotion, as maximum growth for the shortest amount of time is desirable for economic gains in poultry business (Oluwasile, 2014).

Table I: Gentamicin drug usage by farms in Nsukka and Enugu metropolis, Enugu, South East Nigeria.

Drug	Frequency (n=38)	Proportion (%)
Doxygen 20/20 WSP	38	100

Gentaryl D	34	90
Bio-doxygen	34	90
Inter-gendox WS	30	80
Intergen- 200WS	30	80
Gentreat genta	29	75
Centre-gentatylo	19	50

Doxy-gen, bio-doxygen, intergendox=doxycycline & gentamicin; Gentaryl D = gentamicin, doxycycline & multiviatmins, intergen and Gentreat genta = gentamicin sulphate; Centre-gentatylo = gentamycin & tylosin

Table I shows that all (100%) the farms in the last 6 months have used gentamicin either as single formulation (Intergen and gentreat genta) or in combination with other antibiotics (Doxy-gen, bio-doxygen, intergendox, Gentaryl D & Centre-gentatylo). This is at par with the findings of Adebowale et al, 2015, who recorded that Gentamicin is the mostly widely used drug in poultry production in Ogun State, Nigeria. The easy availability of these drugs over the counter makes them easy reach for farmers.

Table 2: Awareness to prudent use of antimicrobial in poultry and livestock production and observance of withdrawal period

Awareness	Yes (%)	No (%)
Awareness to antimicrobial residues	20 (54.6))	18 (45.4)
Awareness to legislation on the prudent use of antimicrobials	12 (31.5)	26 (68.5)
Awareness to antimicrobial withdrawal periods	25 (65.8)	13 (34.2)
Observance of withdrawal period	0 (0)	100 (38)

Although more than half of the respondents (54.6%) are aware of antimicrobial residues and know about withdrawal period (65.8%), yet none of them (0%) observes withdrawal periods when drugs are used for treatment, before selling the birds or eggs for human consumption. Non-observance of drug withdrawal periods (which are boldly stated as part of a drugs manufacturer's instructions for use), is the major cause of antimicrobial residues in foods of animal origin (Doyle, 2006). This is largely due to non-implementation of available legislation on the prudent use of antimicrobials in food animals and may also be a possible cause of low (31.5%) awareness to prudent use of antimicrobials.

Table 3: Frequency of occurrence of Gentamicin residue in different organs

Sample type	**No**	**Frequency of occurrence**		**Proportion detected (%)**
		< 0.05 (µg/kg) (undetected)	**> 0.05 (µg/kg) (+)**	
Muscle	108	60	44	44.4
Kidney	108	44	64	59.26
Liver	108	52	56	51.85
Total	**162**	**78**	**84**	**51.85**

Sixtyfive (65%) of Commercial broilers investigated were positive for gentamicin residue. They had detectable levels of gentamicin residues at the point of purchase indicating that consumers sourcing broilers from Ikpa abattoir are being exposed to violative levels of the drug residue. A similar work done in Gaza by Albayoumi *et al*. (2015) recorded 27.36% prevalence of aminoglycosides in slaughtered broilers. The disparity in the findings may be attributed to a stricter regulation for antimicrobial use in Iraq. The high prevalence of gentamicin residue detected is at par with the 100% usage of gentamicin either alone or in combination with other antibiotics from the questionnaire. This is not only due to failure to adhere to withdrawal periods (Doyle, 2006) but also, overuse, as well as the practice of self-medication by poultry farmers. Among the organs tested, liver and kidney had higher prevalence of gentamicin residue at 51.85% and 59.26% respectively (Table 3). The high prevalence of gentamicin residue observed in liver and kidney may be attributed to the fact that the liver and kidney are organs of drug detoxification and excretion of gentamicin and other drugs (Beyene, 2016) respectively. Although the occurrence of gentamicin residue in tissues appears to be dependent on the type of tissue as presented in the result, but there is no significantl association existing between occurrence of gentamicin and the type of tissue, χ^2 (2) =1.82; (p = 0.4)

Conclusion and recommendation

There is constant use of gentamicin without observance of withdrawal period in the study area thereby causing a high prevalence of gentamicin residue in tissues of commercial birds meant for human consumption. It is then recommended that an integrated drug resistant surveillance and control program in other to protect the public from health hazards associated with drug residue should be established as well as enforcement of laws guarding the prudent use of antimicrobials in food animals.

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CATTLE (SOKOTO GUDALI, WHITE FUMANI AND RED BORORO) SHOULDER MUSCLES EVALUATION.

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ABSTRACT
Effect of meat quality from composition of different muscle or breeds is a food for thought. Do muscles from same breed differ in chemical and mineral composition? Or different taste preference to consumers? This study evaluates the composition of different shoulder muscles from three breeds of cattle and the different muscles within their shoulder. Nine male cattle of one-year-old, comprising of 3 Sokoto Gudali (SG), 3 White Fulani (WF) and 3 Red Bororo (RB) breeds were reared semi – intensively, fed with concentrate and allowed to graze for 10 weeks. Shoulder muscles evaluated are; Triceps brachi – TB, Trapezius – T, Infraspinatus – IF, Supraspinatus – S, Pectoralis – P, Latissimus dorsi – LAD and Longissimus dorsi – LOD, for proximate, minerals and palatability status, in a completely randomized design. SG had the highest nutritional quality especially in CP, Ash, Mg Fe and P with lowest amount of ether extract ($P<0.05$) than WF and RB. IF muscles performed better from all the other shoulder muscle evaluated ($P<0.05$). Physico-chemical evolution had highest WHC ($P<0.05$) in SG (497.29%) than WF (456.01%) and RB (490.77%). Same was experienced with IF muscle compared with other muscle evaluated. SG had the highest values ($P<0.05$) for flavour (6.01), tenderness (6.10), juiceness (5.91), texture (5.86) and overall acceptability (6.39) than values obtained for WF and RB. SG appeared to be the best breed while IF performed well in shoulder muscles of cattle evaluated.
Keywords: Breeds of cattle, Red Bororo, White Fulani, Sokoto Gudali and Shoulder muscles.

INTRODUCTION
Most African countries have major problems of malnutrition in certain sectors of their population. FAO (2009) recorded that the diet of an average Nigerian contains about 20% less than the recommended requirement. Protein intake is very low, mostly from vegetable sources which contains little or no protein and meat is the antidote of malnutrition. Consumers purchase meat and process them into desirable products without full knowledge on the breeds, type of muscles or nutritional values they might get from the product bought (Fakolade *et al*., 2018). Animal breeds can influence the nutritive qualities of meat in some ways, which could affect the muscles structure and meat physiology. Steven Jones (2018) recorded major muscles in the shoulder which are: Longissimus dorsi, Triceps brachii, Infraspinatus, Supraspinatus, Trapezius, Latissimus dorsi and Pectoralis muscle. The characteristics possessed by each will dictate differences in meat quality produced from different shoulder muscles. Therefore, this study will access shoulder muscles from three breeds of cattle and differences in muscles of cattle shoulder.

MATERIALS AND METHOD
Experimental Animals
Nine male live animals of a year old, comprising of 3 White Fulani, 3 Sokoto Gudali and 3 Red Bororo were purchased from Osun State University Teaching and Research Farm. Thereafter, the cattle were quarantined, dewormed, given anti – stress and antibiotics. The animals were raised under a semi – intensive housing system for ten weeks and tagged for easy identification (White Fulani – WF, Sokoto Gudali – SG and Red Bororo – RB). Immediately after exsanguination, skinning took place (removal of animal's skin) in order to access and identify muscles in the shoulder for experimental study.
Identification of muscles in the shoulder
The muscles obtained were identified in the Meat Science Laboratory as Triceps brachii – TB, Trapezius – T, Infraspinatus – IF, Suspraspinatus – S, Pectoralis – P, Latissimus dorsi – LAD and Longissimus dorsi – LOD.
Proximate and Mineral Composition

Protein, ether extract, moisture contents and ash composition and Calcium, Phosphorus and Magnesium were analysed chemically according to the Official Analytical Chemist (AOAC, 18TH EDITION, 2005).

Physico – chemical evaluations

Water Holding Capacity

The WHC of meat samples was determined by the press method as slightly modified by Suzuki *et al*., (1991). Using the calculation below:

$$WHC = \frac{\{(Aw - Am \times 9.47)\}}{Wm - Mo}$$

Where, Aw = Area of water released from meat samples (cm^2)
Am = Area of meat samples (cm^2)
Wm = Weight of meat samples (%)
Mo = Moisture content of meat samples (%)
9.47 = a constant factor

Cold Shortening and Thermal Shortening

Meat samples of known weight and length were stored in refrigerator for 24h at 4^0C for cold shortening, or broiled in an oven for thermal shortening (Fakolade *et al*., 2016). After refrigeration, the final length was taken and calculated thus

$$\text{Cold shortening (\%)} = \frac{\text{Initial length of meat} - \text{length of frozen meat}}{\text{Initial length of meat}} \times 100$$

Cooking Loss and Thaw Rigor

Meat samples of known length and weight were taken and broiled in an oven at 175^0C for 20mins (Fakolade *et al*., 2016). Afterwards, the final weight was taken and calculated thus:

$$\text{Cooking loss (\%)} = \frac{\text{Initial weight of meat} - \text{weight of broiled meat}}{\text{Initial weight of meat}} \times 100$$

Palatability

A total number of forty trained panellists aged 27 to 45 years were selected based on their past performance in consuming meat and were randomly allocated to the samples. Each panellists was presented the blind coded samples and asked to score each sample for flavour, tenderness, juiciness, colour and overall acceptability (Fakolade *et al*., 2016).

Statistical Analysis

The experimental design adopted was complete randomized design (CRD). All data were subjected to analysis of variance (ANOVA) and means were separated with Tukey HSD using the same analytical software.

RESULTS AND DISCUSSION

Table 1: Proximate and mineral composition of SG, WF and RB cattle shoulder

Variables	SG	WF	RB	SEM
CP	21.33^a	20.73^b	20.85^b	0.20
Ash	0.97^a	0.92^b	0.90^b	0.10
Ether extract	3.28^b	3.47^a	3.45^a	0.23
Moisture Content	74.52^a	74.27^a	73.66^b	0.19
Magnesium	84.45^a	82.14^c	83.19^b	0.06
Iron	22.84^a	20.31^b	22.95^a	0.05
Phosphorus	276.52^a	266.86^b	265.23^b	0.16

^{abc}: mean within the same row with different superscripts are significantly different ($P<0.05$)

Table 2: Proximate and mineral composition of different muscles of cattle shoulder

Variables	TB	T	IF	S	P	LAD	LOD	SEM
CP	22.48^a	19.98^c	21.24^{ab}	20.57^b	21.37^b	21.12^{ab}	19.02^c	0.31
Ash	0.90^b	0.99^a	0.95^a	0.92^b	0.87^c	0.92^b	0.96^a	0.02
Ether extract	3.74^a	3.32^c	3.55^b	3.47^b	3.25^c	3.15^d	3.32^c	0.04

Moisture content	71.33[c]	74.52[a]	75.76[a]	74.89[a]	75.12[a]	73.67[b]	73.72[b]	0.29
Magnesium	83.56[a]	83.91[a]	83.78[a]	82.82[b]	84.34[a]	83.12[a]	82.99[c]	0.10
Iron	22.49[a]	21.95[a]	21.97[a]	22.48[a]	20.53[b]	22.65[a]	22.18[a]	0.07
Phosphorus	272.35[a]	270.00[a]	274.05[a]	276.01[a]	261.33[b]	269.89[b]	263.13b[e]	0.24

[abcd][ef]: mean within the same row with different superscript are significantly different (P<0.05)

Table 3: Physico – chemical status of shoulder muscles of SG, WF and RB cattle

Variables	SG	WF	RB	SEM
Thermal shortening	41.86[c]	53.10[a]	46.32[b]	2.35
Cooking Loss	67.34[c]	75.88[a]	71.81[b]	2.32
Cold shortening	21.98[b]	41.42[a]	22.72[b]	0.84
Thaw Rigor	35.10[b]	61.34[a]	34.70[b]	2.24
Water holding capacity	497.29[a]	456.01[b]	490.77[b]	39.75

[abc]: mean within the same row with different superscript are significantly different (P<0.05)

Table 4: Physico – chemical status of different muscles in cattle shoulder

Variables	TB	T	IF	S	P	LAD	LOD	SEM
Thermal hortening	44.17[c]	44.68[c]	43.10[d]	48.89[b]	56.96[a]	44.26[c]	47.58[b]	3.60
Cooking loss	77.31[a]	69.45[c]	69.68[c]	69.57[b]	73.34[b]	74.50[b]	71.90[c]	3.54
Cold shortening	36.16[c]	21.02[d]	30.15[c]	23.99[c]	23.99[d]	32.39[b]	33.48[b]	1.28
Thaw Rigor	43.75[c]	46.11[b]	43.96[b]	36.49[d]	36.49[d]	43.82[b]	55.04[a]	3.42
WHC	471.90[c]	549.14[b]	638.93[a]	546.18[b]	457.05[c]	420.76[c]	245.52[d]	60.7

[abcd]: mean within the same row with different superscript are significantly different (P<0.05)

Table 5: Palatability status of SG, WF and RB shoulder muscle.

Variables	SG	WF	RB	SEM
Colour	5.08[b]	5.44[a]	5.04[b]	0.21
Flavour	5.01[b]	4.43[c]	5.58[a]	0.18
Tenderness	6.10[a]	5.86[b]	5.70[b]	0.19
Juiciness	5.91[a]	5.18[c]	5.66[b]	0.17
Texture	5.86[a]	4.19[b]	5.99[a]	0.19
Acceptability	6.39[a]	5.74[b]	5.88[b]	0.18

[abc]: mean within the same row with different superscript are significantly different (P<0.05)

Table 6: Palatability scores of different muscles in cattle shoulder

Variables	TB	T	IF	S	P	LAD	LOD	SEM
Colour	5.50[b]	4.61[c]	5.19[b]	5.97[a]	4.94[c]	4.97[c]	5.11[bc]	0.33
Flavour	4.94[b]	4.39[c]	5.53[a]	5.53[a]	4.81[b]	4.94[b]	4.92[b]	0.28
Tenderness	6.77[a]	5.08[d]	6.67[a]	6.19[ab]	5.94[b]	5.67[b]	5.42[c]	0.29
Juiciness	5.92[b]	5.14[c]	5.94[b]	7.06[a]	5.28[c]	4.53[d]	5.19[c]	0.25
Texture	5.86[b]	4.89[d]	5.47[c]	6.67[a]	5.39[c]	5.44[c]	5.36[c]	0.29
Acceptability	6.14[b]	6.11[b]	6.78[a]	6.22[b]	5.86[ab]	6.06[b]	5.78[c]	0.28

[abcd]: mean within the same row with different superscript are significantly different (P<0.05)

The shoulder muscle of SG gave the best (p <0.05) composition values for CP. Values obtained corroborates the findings of Adeniyi *et al*., (2011) with beef protein ranges from 18 – 22 %, moisture 68 to 75 % and 2 to 15 % who worked on proximate composition and economic values of four common sources of animal protein. Ether extract obtained was in agreement with the report of Tonberg (2005) who evaluated the effect of heat on meat protein. SG shoulder muscle had the best nutrient qualities breeds. Infraspinatus IF muscles of cattle shoulder performed best

in the proximate and minerals composition evaluated having the highest ($p < 0.05$) values in Ash, minerals composition and lowest percentages in Ether extract.

Kim *et al*., (2008) obtained a low fat values as in Table 2, TB (3.44%), IF (3.55%), S (5.35%) which is also fell within the range obtained, this could only indicate that shoulder muscle are lean. IF appeared best for proximate analysis, while TB, T, and LAD had significant values ($P<0.05$) in minerals composition, Protein content for TB 22.48 % corresponds with 22.13 % obtained by FAO (2009) for longissimus dorsi of cattle meat. WF has the highest values in all parameters evaluated for physico-chemical except in WHC, this indicates that most of the nutrients of the meat are lost during processing therefore, WF has a poor meat quality since it cannot retain water and nutrients while SG proved to be the best. Kauffman (1992) reported that, higher thaw rigor reduces juiciness, texture and nutrient in meat. IF muscle had the highest WHC and considerably low in other parameters evaluated. Parameters like thermal, cooking loss, cold shortening and thaw rigor affect quality of meat if it is ($P>0.05$) higher, could affect the organoleptic properties of the consumers, as there will be reduction in the nutrients of the meat (Fakolade *et al*., 2018).

SG was most acceptable by the panellist since it had the highest ($P>0.05$) flavour, tenderness, juiceness and texture, which influences its acceptability more over WF and RB. This results could be due to high protein and mineral content of SG.

In Table 6, panellists gave IF the higher score probably because its muscle was able to retain water and nutrients than every other muscles evaluated and because it had the highest proximate and mineral composition, which in turn may have influenced the organoleptic properties of the panellists.

CONCLUSION

SG breed of cattle and IF proved to be the best quality breed of cattle and muscle with best nutritional qualities than the other breeds or muscles evaluated.

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EFFECT OF METHANOLIC STEM BARK EXTRACT OF *AZADIHIRACTA INDICA* ON MORBIDITY AND MORTALITY OF CHICKENS EXPERIMENTALLY INFECTED WITH VELOGENIC NEWCASTLE DISEASE VIRUS (KUDU 113)

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Abstract

Newcastle Disease (ND) is an important disease of poultry all over the world. Economically, the disease is characterized by mortality which may reach up to 100% in affected poultry farms. This study was designed to evaluate the protective properties of crude methanolic extract of *Azadihiracta indica* in chickens inoculated with a velogenic strain of ND virus. A hundred- day old cockerels were brooded for three weeks before being randomly divided into five equal groups (I, II, III, IV and V). They were not vaccinated with ND vaccine LaSota. At six weeks of age, each bird in groups I-IV were inoculated with 0.2ml of the live ND viral inoculum intramuscularly while group V was not inoculated with the virus. Thereafter groups I, II and III were daily given in drinking water 200mg/kg, 400mg/kg and 600mg/kg of *Azadihiracta indica* extract respectively whereas groups IV and V were not treated with the extract. All the groups were monitored for the onset of clinical signs, morbidity and mortality rate. In all the groups inoculated with the ND virus, the birds showed signs of depression, gasping, coughing, increased thirst, complete inappetence, huddling, diarrhoea, partial/complete paralysis on day 2 post inoculation (PI). A hundred percent (100%) mortality rate was recorded for groups I and IV by day 5 PI and in groups II and III on day 6 PI. Therefore, under the conditions of this study, oral administration of *Azadihiracta indica* extract does not protect birds from ND.
Key words: *Azadihiracta indica* stem bark; methanolic extract; chickens; Newcastle disease.

Introduction

Newcastle disease (ND) is a highly contagious viral disease affecting wild and domestic avian species (Seal et al., 2000, Alexander, 2003). ND is caused by an avian paramyxovirus serotype of the genus Avulavirus belonging to the family paramyxoviridae. The disease is distributed worldwide (Alexander et al., 1997). ND is still one of the most important diseases of chickens in Nigeria since the first outbreak at Ibadan in 1952 (Ezema *et al*., 2009), not only due to the high flock morbidity and mortality but because of the incessant reoccurrence of the disease in vaccinated flocks, hence the need for an alternative remedy to prevent the devastating activity of this disease on the poultry industry. Ethnoveterinary medicine is the animal health care which encompasses the knowledge, skills, methods, practices and beliefs about animal healthcare found among the members of a community (Mccorkle, 1986). There is an increasing awareness on the use of various plants in treatment and control of animal diseases (Atawodi and Spiegelhalder 1994), since herbal medicine is no longer viewed as a myth or an ungodly practice (Wanzala *et al*., 2005). Neem (*Azadirachta indica* A juss), a Meliaceae family tree, is a hardy evergreen tree commonly found in South Asia and some parts of Africa, have been found useful in the treatment of various conditions in man and animals (Schmutterer, 2002; Subapriya and Nagini, 2005).During harmattan in the south-eastern Nigeria, the stem of Neem is traditionally used in prevention of Newcastle disease by soaking in the drinking water of birds and it is believed that neem bark has both protective and curative property against Newcastle Disease. Neem seed extract was reported to be effective in inhibiting NDV and IBV replication in Vero cells and chicken embryo (Waafa *et al*.,

2007) . Hence, the need for an in-vivo study, to evaluate the effects of methanolic neem stem bark extract on the morbidity and mortality of chickens experimentally infected with the velogenic strain (Kudu 113) of Newcastle disease virus.

Materials and methods

One hundred day-old white harco cockerels were procured from CHI Ltd., a commercial breeder farm in Ibadan, south–west Nigeria. They were housed in the poultry disease research unit of the Department of Veterinary Medicine, University of Nigeria, Nsukka. The birds were reared in deep litter system and were given feed and water *ad libitum*. They were not vaccinated against ND. The bark of *Azadirachta indica* was collected in March 2014, at Nsukka, in Enugu State, Nigeria and authenticated by a taxonomist and extract prepared using standard methods. The velogenic Newcastle Disease virus (VNDV) strain, duck/Nigeria/903/KUDU-113/1992 (Echeonwu *et al*. 1993), was obtained from the National Veterinary Research Institute Vom, Jos, Plateau State, Nigeria. The virus is a genotype XVII NDV (Shittu et al., 2016). The inoculum had a median embryo infective dose (EID_{50}) of $10^{6.46}$ per ml.The birds were brooded for 3 weeks after which they were randomly divided into five groups (20 chicks each) I, II, III, IV and V. Group V was isolated. At 6 weeks of age, groups I, II, III and IV were inoculated with 0.2ml challenge dose of VNDV (Kudu 113) while Group V was inoculated with 0.2mls of phosphate buffered saline (PBS) intramuscularly and thereafter, groups I, II and III were daily given 200mg/kg, 400mg/kg and 600mg/kg body weight of the *Azadirachta indica* extract respectively through drinking water while groups IV and V were not treated with the extract. The birds were clinically monitored twice daily. Morbidity and mortality were recorded.

Ethical approval

Ethical approval for this research was given by the Experimental Animal Committee of the Faculty of Veterinary Medicine, University of Nigeria, Nsukka.

Results and Discussion

The effect of the extract on the birds challenged with the VNDV was observed for 6 days post challenge. Clinical signs were first observed on day 2 post inoculation (PI) in groups I,II,II and IV. The clinical signs observed included ruffled feathers with depression, coma, lethargy, prostration inappetence, whitish-greenish diarrhoea with soiling of the vent , Coughing with frothy sounds and serous ocular discharges were evident in 20%, 10%, 10% and 20% while nervous signs of jerking of head and paralysis were observed in 30%, 20%, 15% and 25% of the experimental birds in groups I, II, III and IV respectively. By day 3 PI morbidity was 87.5%, 62.5%, 58.5% and 93.7% of the birds in experimental groups I, II, III and IV respectively, by day 4 PI, birds in experimental groups I and IV had 100% depression with clinical signs prominent in most of the birds, while groups II and III had morbidity rate of 83.3% and 62.5% respectively. By day 5 PI, 100% morbidity was also observed in birds of the experimental groups II and III (Fig. 1). Mortalities of 20%, 20%, 17.6% and 20% were first observed in group I, II, III and IV respectively on day 3 PI. Peak mortalities of 100% occurred on day 5 PI in groups I and IV, while it occurred in groups II and III on day 6 PI (Fig.2).The 2 days incubation period of experimental ND observed in this study has also been reported by other researchers (Ezema et al., 2009; Wan et al., 2004; Okoye et al., 2000) shows that despite the treatment with the extract, the manifestation of the disease was not prolonged.,The clinical signs observed in groups I-IV were notable and similar to the clinical signs of those already described for VNDV by Alders and Spradbrow (2001), who observed depression, partial /complete paralysis, inappetence, listlessness, and huddling followed by greenish diarrhoea as an indication of Gastro Intestinal tract (GIT) lesion. Severe nervous signs which included ataxia, paralysis, torticollis was also observed in groups I-IV. This suggests that the treatment with the plant extract could not reduce the clinical manifestation of the disease may probably be due to the highly virulent nature of the virus (Alexander,2003). Despite treatment with *Azadirachta indica* extract, Morbidity rate and mortality rate were up to 100% with a survival rate of 0% on day 4PI in group I and groups II and III on day 5PI is consistent with the reports of Okoye et al. (2000), who stated that morbidity and mortality rate of VVND outbreak could be up to 100% in non-immunized birds. However, birds in groups II and III with the higher doses of the extract died later than those in group I with a lower dose of the extract, an indication that higher doses of methanolic extract of *Azadihiracta indica* may prolong the survival rate of the birds.

In conclusion, under the conditions of this study, the methanolic extract of *Azadirachta indica* stem bark did not reduce the severity of the clinical signs ,Therefore, the extract may not be used in prophylaxis or treatment of Newcastle disease caused by velogenic Newcastle disease in poultry.

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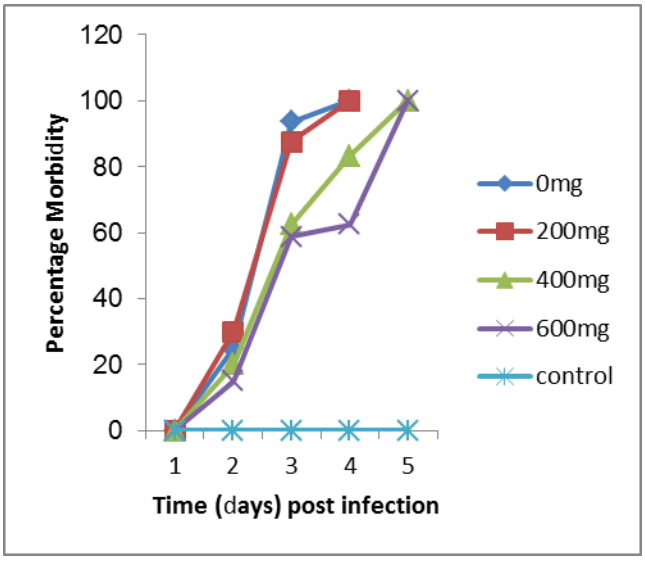

Figure 1: Morbidity profile following inoculation with NDV

***GRP I- Inoculated/treated with 200mg, GRP II- Inoculated/treated with 400mg, GRP III- Inoculated/treated with 600mg,GRP IV- Inoculated/untreated with 0mg, GRP V (control)- Uninoculated/untreated**

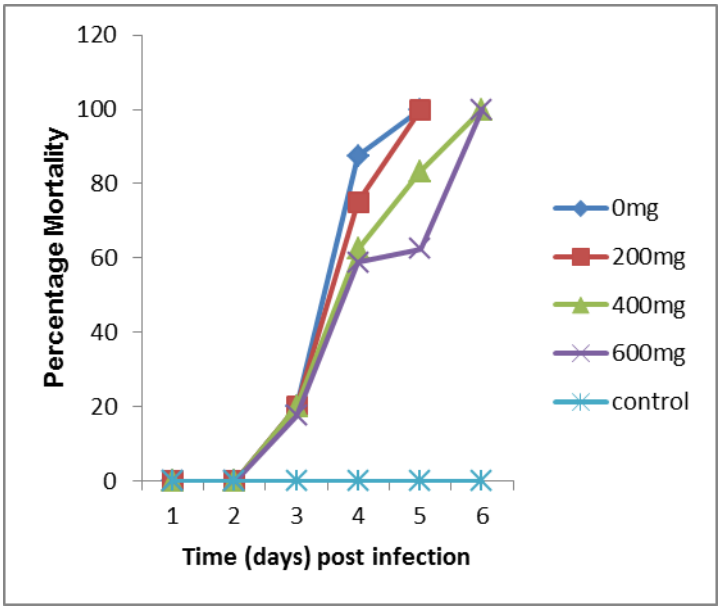

Figure 2: Mortality profile of birds following inoculation with NDV

***GRP I- Inoculated/treated with 200mg, GRP II- Inoculated/treated with 400mg, GRP III- Inoculated/treated with 600mg, GRP IV- Inoculated/untreated with 0mg, GRP V (control)- Uninoculated/untreated**

PREVALENCE OF TICK INFESTATION ON THE ONE - HUMPED CAMELS (*CAMELUS DROMEDARIUS*) IN SEMI- ARID REGION OF SOKOTO STATE, NIGERIA

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Abstract

The objective of this study was to determine the prevalence of tick infestation on the one - humped camels (*Camelus dromedarius*) in semi- arid region of Nigeria (12^0N, 700 to 800mm annual rainfall). The study included 208 camels made up of 116 (55.8%) males and 92 (44.2%) females of varying age groups from seventy three 73 herds and a municipal abattoir in seven Local Government Areas (Illela, Gada, Tangaza, Gwadabawa, Kware, Goronyo and Sokoto North) of the State. The four genetic strains of camels available were sampled (Ja, baki, bule and kurri). Ticks were pulled out gently from camels using forceps and identified accordingly. The overall prevalence of ticks recorded in this study was 32.2%.Three species of ticks encountered were *Hyalomma dromedarii* (n= 49 or 23.6%), *Rhipicephalus sanguineus* (n=12 or 5.8%) and *Amblyomma varriegatum* (n=8 or 3.8%).This study indicates the prevalence of some tick species encountered on extensively managed camels in semi – arid zone of Nigeria and the need for timely and effective ectoparasite control.

Key words: camels, ticks, prevalence, Sokoto, Nigeria.

Introduction

Ticks are known to affect the health of camels leading to anaemia, vectoring of infections and physical irritation. There are several reports of prevalence of ticks of camels from some parts of Nigeria, Africa and Asia with predilection sites as mammary, prepuce, anal, ear and abdominal regions respectively (Lawal *et al*, 2007; Biu and Konto, 2012; Bebe, 2001; Abdelrahman *et al.*, 2001; Dinka *et al.,* 2010 and Akhtar *et al.,* 2011). Camel meat consumption which is currently on the increase in some parts of the world including Sokoto - Nigeria, where an average of five camels are slaughtered daily (Khalid *et al.,* 2015), may be affected by the debilitating effects of tick infestation. The increase in use of camels for farm work due to their greater tractive efficiency when compared with work bulls and donkeys (Mohammed and Mansoor, 2013), may also suffer decline if ticks are not controlled. This study was conducted to determine the

prevalence of tick infestation on the one - humped camels (*Camelus dromedarius*) from herds and those slaughtered in Sokoto State (semi- arid region of Northern Nigeria).

Material and Method

Sokoto State is located at the extreme north-western, semi-arid part of Nigeria between latitudes 12^0N and 13^0N and longitudes 4^0E and 4^0E. Purposive sampling technique was used to sample camels of all sexes and age groups belonging to camel herders and those brought to the abattoir for slaughter. The study included 208 camels made up of 116 (55.8%) males and 92 (44.2%) females of varying age groups from seventy three 73 herds and a municipal abattoir in seven Local Government Areas (Illela, Gada, Tangaza, Gwadabawa, Kware, Goronyo and Sokoto North) of the State. The four genetic strains of camels available were sampled (Ja, baki, bule and kurri).Camels were physically examined carefully and ticks seen were pulled out gently using forceps. All ticks collected were identified and preserved in 70% alcohol in the laboratory.

Results and Discussion

The overall prevalence of tick infestations recorded in this study was 32.2%. The three common tick species encountered were *Hyalomma dromedarii,* leading with (n= 49 or 23.6%), *Rhipicephalus sanguineus* (n=12 or 5.8%) and *Amblyomma varriegatum* (n=8 or 3.8%). There were no significant associations (P> 0.05) for tick infestation on camels between sexes (Table 1) and age groups (Table 2). The study however, recorded highest prevalence of tick infestation (40%) for growing camels up to 5- years of age (Table 2), month of October (96%) and the *Hyalomma dromedarii* tick species (23.6%) (Table 3).

Table 1: Overall prevalence of tick infestation in relation to sex of camels in study areas in Sokoto State, Nigeria

Variable	Total no. examined	No. Observed n (%)	X^2	P-value
Sex				
Male	116	38 (32.8)	0.036	0.85
Female	92	29 (31.5)		
Total	**208**	**67 (32.2)**		

Not significant at P> 0.05

The finding of growing camels (five years) with highest prevalence could be attributed to possibility of early introduction of young camels to grazing fields (Dinka *et al.,* 2010). However, low prevalence in adult camels may suggest development of acquired immunity in older animals with effects ranging from interference to feeding, inhibition of egg lying, decreased viability of eggs and death of the tick on the host (Akhtar *et al.,* 2011). This agreed with the reports of Van and Jongejan (2000) and Biu and Konto (2012).

Table 2: Overall prevalence of tick infestation in relation to age of camels in study areas in Sokoto State, Nigeria

Variable	Total no. examined	No. Observed n (%)	X^2	P-value
Age				
<5 years	90	29 (32.2)	0.209	0.901
5 years	25	10 (40.0)		
>5 years	93	28 (30.1)		
Total	**208**	**67 (32.2)**		

Not significant at P> 0.05

The finding of higher prevalence of tick infestation during the month of October which was still part of the rainy season in Sokoto State could be due to the fact that, rainy season provides a favorable environmental conditions as rainfall, temperature and relative humidity which are considered to be the major determining factors (Biu and Konto, 2012) for the tick's life cycle and increases their rate of infestation (host -vector contact) during browsing on green pasture. This agreed with the report of Abdelrahman *et al.,* (2001), while the least number of ticks per camel observed during the driest months of this study agreed with the report of Zeleke and Bekele (2004). During rainy season the immature stages (nymph) of ticks are mainly found in pasture while the adult stages are found on the camel's body. The finding of *Hyalomma dromedarri* with highest prevalence (23.6%) from the sampling units (Local Government Areas) in this study agreed with the finding of Salem *et al.,* (2011), but however contradicted

Table 3: Overall monthly (2016-2017) prevalence of tick infestation on camels in Sokoto State, Nigeria

			Types of ticks n (%)		
Month of year	**Total no. of camels examined**	**No. of ticks Observed**	***A.varriegatum***	***H.dromedarri***	***R.sanguineus***

October	25	24(96)	2(8.3)	21(87.5)	1(4.2)
November	45	34(75.6)	5(14.7)	21(61.8)	8(23.5)
December	38	8(21.1)	1(12.5)	5(62.5)	3(37.5)
January	32	1(3.1)	0(0.0)	1(100)	0(0.0)
February	37	0(0.0)	0(0.0)	1(100)	0(0.0)
\March	31	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Total	**208**	**67(32.2)**	**8(3.80)**	**49(23.6)**	**12(5.80)**

The earlier reports of 91.28% by Lawal *et al.,* (2007) from the same study area and 88.1% reported from Borno (Biu and Konto, 2012). It was higher than 15.36% reported from Euthopia (Dinka *et al.,* 2010) and 20.44% (Bebe, 2001). Though, *Rhipicephalus sanguineus* was found on camels in this study, it could be attributed to close association between camels and dogs as the former was used as guard animal.

Conclusion and Recommendation

The overall prevalence of tick infections was 32.2%.Ticks of three different species were encountered with prevalence as *Hyalomma dromedarri* 49 (71.0%), *Rhipicephalus sanguineus* 12 (17.4%) and *Amblyomma varriegatum* 8 (11.6%). Further study on tick infestation of camels in the area is recommended

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VACCINATION IN LIVESTOCK PRODUCTION: A VERITABLE TOOL IN THE CAMPAIGN FOR FOOD SECURITY IN NIGERIA. A REVIEW

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Abstract

The impact of diseases and its outbreak on livestock production has necessitated the need for vaccination in livestock production. Farmers worldwide are embracing the use of animal vaccines to improve health of animals and reduce losses resulting from animal diseases. This is crucial so as to ensure food security and meet the demand of the growing global population for livestock products. Livestock accounts for one third of Nigeria's agricultural GDP. Animal vaccination continues to play a key role in disease control programmes in livestock production and may also aid in the responsible use of antibiotics. Investment in making vaccines available to farmers and innovative research into development of effective and safe veterinary vaccines is highly recommended for continued benefit to livestock production, so as to increase the production of safe and affordable livestock products in Nigeria. Recent studies have recommended continued research, awareness, development and availability of vaccines in the rabbit, pig, cattle and poultry industries in Nigeria. These can be achieved through collaborative efforts of stakeholders of veterinary health in Nigeria.

Keywords: Vaccination, Livestock, Veritable, Tool, Food Security.

Introduction

Livestock account for one third of Nigeria's agricultural GDP. It provides income, employment, food, farm energy, manure, fuel and transport. Livestock is also a major source of government revenue. . From the year 1961 to 2011, average meat consumption in the world increased from 23 to 43kg per capita/year, while milk consumption increased from 75 to 87 kg per capita/year (FAOSTAT. 2013). Meat and milk production is also consistently increasing at approximately 2.2% per year. Several studies demonstrate the importance of inherent losses from infectious animal diseases and emerging zoonotic risks threatening humanity. The death of a single animal can have dire consequences on vulnerable households by reducing their ability to withstand food crises and to emerge from poverty. (Comfort et al., 2018; FAO, 2016). This can cumulatively affect the gross economy of a nation, most importantly, developing countries like Nigeria still grappling with high poverty level.

According to Fadiga et al., 2013, it was estimated that Newcastle disease (NCD) in unvaccinated village poultry has 45% background mortality. Peste des petits ruminants (PPR) in sheep and goats, Contagious Bovine pleuropneumonia (CBPP) in cattle and African swine fever (ASF) in pigs have background morbidity rates of up to 50%, with mortality rates of about 50% for PPR, 25% for CBPP and 100% for ASF. The report indicated the following as the livestock losses

recorded in Nigeria as a result of vaccinable diseases; Newcastle disease, Peste des petits ruminants, contagious bovine pleuropneumonia, African swine fever and Trypanosomiasis.

(N million)

Value of dead animals – 17,841

Treatment cost - 3376

The overall financial burden of the five diseases on the national economy in 2009 was N29.2 billion, while the model outputs indicated that the cost of targeted intervention was N15.5 billion with 28.4% devoted to vaccination. The report states that the loss analyses include: 50percent in Newcastle disease in chickens and 80percent in small ruminants, which leads to decreased productivity including decreased quantity and quality of eggs, decreased milk yield, increased calf mortality, poor growth rate and increased calf mortality among others.

Proper vaccination of livestock could have prevented this colossal economic loss credited to only five animal diseases. The loss was not only limited to financial terms but also includes loss in food and nutrition which could have been available to feed the human population.

Among all the livestock that makes up the livestock in Nigeria, ruminants, comprising sheep, goats and cattle, constitute the livestock largely reared by farm families in the country's agricultural system. Nigeria's livestock population comprises 34.5million goats, 22.1million sheep and 13.9million cattle (Lawal-Aebowale, 2011). These agricultural resources possess great economic values which must be protected in order to sustain steady growth in the agricultural sector of the economy, and avert losses that can lead to huge deficits in animal-based food.

Vaccination practices is a tool that can be employed in preventing such losses. Vaccinating 70% of animal population against these animal diseases will ensure herd immunity and subsequent protection of the animal population and humans from them. Nigeria produces only a few veterinary vaccines which is not sufficient to address animal health issues in our country. For example, vaccines are yet to be produced to face certain challenges in the rabbit production industry which is in its infancy (Ume *et al*., 2016; Table 1). There is therefore the need for continued investment in animal vaccine research; improved image of veterinary vaccine and its use through campaigns, legislation and policies that support its coverage. (Musa *et al*., 2013).

Table 1: Information on Emerging Diseases in Nigeria and Availability of their Vaccines in Nigeria.

Animal	Disease	Vaccine developed	Developed in Nigeria	Accessibility to village farmers in Nigeria
Cattle	Lumpy Skin Disease	Yes	No	No
Rabbit	Hemorrhagic	Yes	No	No

	disease			
Pig	African Swine fever(ASF)	No	No	No
Chicken	Avian influenza(HPA1)	Yes	No	No

Source: (Agnes et al., 2018; Lawal-Adebowale, 2011 and Oluwole et al., 2012).

Vaccination research in Nigeria and focus for future research

In recent times, rabbit farming has been encouraged as its meat is a rich source of protein, low in cholesterol, have rapid growth rate as in broiler chicken and therefore can be a fast source of income to farmers and improve food security in Nigeria. However, Nigerian farmers are faced with challenges of untimely death of fryers from infectious diseases and parasites of rabbits not known to the extension agents who could enlighten them since rabbit farming is in its infancy in Nigeria (Baruwa, 2014).

Vaccines have been developed to protect poultry from fowl typhoid and cholera diseases (NVRI, 2016). However, continued research can be carried out on brucellosis. The research carried out by Joseph *et al*., 2018, in Anambra State reveals that there is an urgent need for control programme against avian brucellosis which frequently cause enormous loss in animal agriculture in Nigeria. Also, development of thermostable Newcastle disease vaccine to support poultry industry in Nigeria, where there is no stable electricity supply to keep the cold chain of vaccines (Shahid Mahmood *et al.*, 2014) although in 2008, a field trial of Malaysian thermostable Newcastle disease vaccine was carried out in village chickens in Kaduna State, Nigeria (Nwanta *et al*., 2008).

More vaccination research on bovine brucellosis is required in Nigeria. The study carried out in Adamawa, Kaduna and Kano states, northern Nigeria and Enugu state, South east Nigeria revealed a high prevalence of brucellosis in cattle herds (Hassan*et al*., 2012; Samuel *et.al*., 2018). Also, a recent research on *Mycobacterium bovis* in cattle by abbatior surveillance in Bauchi and Gombe states revealed its high prevalence , urgent and intensive investment in Mycobacterium vaccination is important; especially because of its zoonotic potential(Ibrahim *et al*., 2018). According to Adedeji et al., 2017, twenty-three (23) Holstein Friesan calves died during repeated outbreaks of lumpy skin disease(LSD) with estimated value of N3, 180, 000 ($17,377.05) in the year 2010, 2013 – 2014 on a dairy farm in Jos, Nigeria. The outbreak of lumpy skin disease was also recorded in 2016 in Sokoto Gudali and Holstein Friesan cross in a dairy farm in Nasarawa State; caused by Lumpy skin disease virus (LSDV) of the genus capripoxvirus; which requires animal health workers attention as reported by Adedeji *et al*., 2018.

Worldwide Porcine Reproductive and Respiratory Syndrome virus (PRRSV) and porcine parvovirus (PPV) are known to infect and cause economic loss in the pig industry, according to Comfort et al., 2018.Vaccination against these viruses are not yet available in Nigeria. However, the study conducted on the prevalence of PRRSV and PPV antibodies in 368 commercial pigs in Southwest, Nigeria revealed 53.8% and 36.1% antibody prevalence of PRRSV and PPV respectively.(Comfort et al, 2018) Therefore, there should be continuous monitoring of this virus

in pigs in Nigeria for early detection, awareness and control measures. A study conducted by Aiki-Raji *et al*., 2018 revealed that pigs in Ibadan, southwest Nigeria shows infection from porcine circovirus type 2(PCV2) which is one of the major agents of mortality in the swine industry. This indicates that the pigs are carriers of the virus, and there is no routine vaccination against it. It is therefore recommended that Nigeria conduct continuous surveillance of the PCV2 in pigs for control measures. Porcine pneumonia is also of economic importance in pig industry in Nigeria, the study conducted on pigs from farms in Lagos, Osun, Oyo and Ogun revealed high prevalence of bronchointestitial pneumonia. Knowledge of the causative agents and production of vaccines to protect pigs should be considered in Nigeria (Emikpe *et al*., 2018).

Recommendation

With the consistently growing human population in Nigeria, food security is seriously challenged and must be addressed quickly. All stakeholders must promote livestock vaccination to improve herd immunity against diseases, promote livestock health, thereby increasing animal-food production and by extension, human health.

Conclusion

The availability of veterinary vaccines in Nigeria should be a key priority for the Veterinary Medicines and Allied Product and the National Veterinary Research Institute, VOM in charge of veterinary vaccines with the continued support of government; in order to prevent animal diseases, protect public health and also provide healthful and affordable food.

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DYSTOCIA: A MENACE TO RUMINANT PROCUCTIVITY - A REVIEW

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ABSTRACT
Ruminants contribute significantly to meat production in Nigeria as animal protein source in human nutrition. And thus there is ever increasing demand on this product due to ever increasing human population. Hence, there is need to intensify the production to meet the demand. However, these animals are faced with some reproductive problems that adversely affect the production and well-being of the animal. Dystocia is one of the most paramountreproductive problems affecting ruminants especially cattle and sheep. Statistics revealed that approximately 77% incidence of dystocia occurs in sheep and 23% in goats and these could be due to fetal mal-presentation, infection-ringworm, heredity, prolapse, poor nutrition, sex, age of the female animal, gestation length and so on. This reproductive disorder leads to economic loss. In order to reduce the incidence of dystocia (difficulty at birth) in ruminant animals, various methods like good/controlled nutrition, adequate breeding knowledge, and good hygiene management practices could be employed. Thus, this review x-rays the causes and management of dystocia in ruminants.
Key words: Breeding,neonate, fetal cause, maternal cause, ruminants.

INTRODUCTION
Livestock are of different species and fulfill different functions in the household economy and poor families often keep a diversity of species for this reason (Anderson, 2003). Facilitating increases in the productivity and production of such livestock is one of the major means of improving the livelihoods of poor livestock keepers, reducing poverty, and attaining sustainable animal agriculture and universal food security.Ruminants are mammals that are able to acquire nutrients from plant-based food by fermenting it in a specialized stomach prior to digestion, principally through microbial actions(Fernández and Vrba, 2005).Dystocia, or difficult birth, is a contributory factor in peri-natal death of newborns because of damage to the birth canal and use of excessive traction forces (Brountset *al*., 2004; Scott, 2005). Generally, dystocia may be of fetal or maternal origin (Noakeset *al*., 2009,Aroet *al*., 2016and Ahmed *et al*., 2017). However, the successful treatment / management of dystocia depend upon correct diagnosis of the cause of dystocia and treatment technique. This write up therefore reviews the meaning, causes and treatment of dystocia in ruminants.

Dystocia in Ruminants
Dystocia is termed difficulty at birth or parturition. This occurs when the first or second stages of parturition are delayed or when the first stage fail to progress to the next stage within 30 minutes (Purohit, 2006 and Bhattacharyya *et al*., 2015) and requires assistance for delivery. There are a variety of risk factors for dystocia such as breed, parity, weight and body condition at parturition stage, sex and birth weight of newborn, mal-presentation, multiple calving, and year and season of calving (Zaborski, 2009). Dystocia is much more common in primiparousthan in multiparous ruminants (Benti and Zewdie, 2014) and results from the smaller stature and the slow maturation of pelvic dimensions of young heifers. Also, in small ruminants especially goat, it is considered of low incidence worldwide (<5%) (Brountset *al*., 2004).Hence,forceful abdominal contractions become stronger and more frequent toward the end of first stage. The second stage of parturition marks the expulsion of the fetus which usually occurs within 15-30 minutes. The third stage of parturition follows and ends by the expulsion of the fetal membranes which usually takes place within 4-6 hours (Brountset *al*., 2004).

Predisposing factors of dystocia in ruminants

(a) Gender and gestation length: Male animals (calves, kids and lambs) have more difficult births than females. This occurs as a result of their bigger size and heaver birth weight. Gestations with males are usually longer, which also influence the risk of dystocia. An increased incidence of dystocia resulting from longer gestation period was observed in beef cows (Heins*et al*., 2006). Aro*et al*. (2016) opined that sex of the foetus is alsoone of the high risk factors of dystocia.

(b)Season: The incidence of dystocia is higher during the winter than during the summer, however, the exact definition of these seasons is different. As reported by Ahmed *et al.* (2017), more cases of dystocia in Northern part of Nigeria were recorded in November. This is a period which coincides with the dry season when there is little in the field for animals to graze on and this, coupled with poor nutrition and management owners. However, an easier access to a pasture encourages more physical exercises and longer days are suggested factors of seasonal differences. The rate of dystocia in Holsteins Friesian is 15% higher in winter than in spring and summer (Johanson and Berger, 2003). Cold weather (air and wind chill temperatures of approximately -5 and -10°C, respectively) during the last trimester has been associated with increased dry matter intake, thyroid hormone concentration, blood flow to the uterus, gestation length and reduced plasma estradiol concentrations leading to increased birth weight and dystocia.

(c)Poor nutrition: Improper feeding contributes to retarded body and pelvic growth. High nutritional feeding levels may favor dystocia especially in heifers, by excessive deposition of fat in the pelvis (Laster*et al*., 2009). However, too intensive administration of vitamin D during a dry period may be the reason for more dystocia in a similar way as too low administration of Calcium. It is also important to administer the adequate amounts of vitamins A, D and E. Moreover, the type of diet may directly affect the level of dystocia (Mollalign and Nibret, 2016).

(d)Infection: Any type of infection or disease affects the pregnant uterus and its contents may cause abortion, uterine inertia, fetal death and occasionally septic metritis of pregnancy. In severe cause of infection of the uterus, the uterine wall may lose its ability to contract a condition resulting in incomplete dilation of the cervix and uterine inertia (Roberts, 2004).

Causes of dystocia

Maternal Causes

(a) Feto-Maternal Disproportion: Feto-maternal disproportion can be described as an obstruction of calf expulsion originated by the calf size or weight or pelvic dimensions (if the bony pelvis are too small to allow passage of the fetus) of the mother especially cow (Plate 1), which may have several factors in its origin (Srinivas*et al*., 2007 and Mee, 2008). This is most commonly caused by maternal immaturity and often occurs as a result of heifers being served at too young age. In a study involving 70 sheep and goats suffering from dystocia, the highest prevalence was recorded in primiparous females, during the winter season and in dams carrying large male fetuses. The most common fetal-related causes of dystocia were head deviation, forelimb flexion, breech presentation, dog sitting position and fetal malformations. Maternal causes were mostly associated with failure of cervical dilation or ringworm (Bhattacharyya *et al*., 2015).

(b) Incomplete Cervical Dilation: The failure of the cervix to completely dilate is a relatively common cause of dystocia in the dairy cow(Plate 2) and also in goats (Ali, 2011; Aro*et al*., 2016). It may occur both in the heifer and multiparous cows (Benesch and Wright, 2001; Anderson, 2012). An increase in inflammatory cytokines during parturition is also having effect on cervical dilation (Kemp *et al*., 2002).

(c) Uterine Inertia: This is a condition where the uterine fail to deliver a fetus.Primary uterine is failure of uterine muscle to contract normally at parturition which may occur due to failure of the muscle to respond to hormonal stimuli and disease of muscle or to release hormones such as estrogen and possibly oxytocin that initiate normal uterine muscles contraction (Roberts, 2004). The most common cause of primary uterine in dairy cows is considered to be hypocalcaemia.

(d) Uterine Torsion: Torsion of uterus usually occurs in a pregnant uterine horn and is defined as the twisting of the uterus on its longitudinal axis. The exact etiology of uterine torsion is poorly understood. It appears that instability of the uterus and inordinate fetal or dam movements probably are the basic reasons for rotation of the uterus on its own axis lateral (Nejash and Wahid, 2016).

Plate 1.Dystocia in a Friesian cow due to cow-calf size mismatch.
Source: Frame, (2006)

Plate 2.Incomplete cervical dilation leading to dystocia.
Source: Frame, (2006)

Fetal Causes

(a) Fetal Oversize: The weight of fetus is usually the major factor causing calving problems. This indicated that birth weight is the trait most highly correlated with dystocia, followed by sex of calf, pelvic area and gestation length and cow weight. Genetics and breed of sire play the most important role in determining calf birth weight; however, the maternal genetic influence should not be overlooked. Therefore, by putting selection pressure on bulls for birth weight and calving ease, would be possible to alleviate many existing calving problems (Mollalign and Nibret, 2016).

(b) Twinning: Twin gestation especially in cow often culminates in dystocia. Twin dystocia include both fetuses present simultaneously and become impacted in the maternal pelvis, one fetus only is presented but cannot be born because of defective posture, position or presentation; posture is often most at fault, the lack of extension of limbs or head being due to insufficient uterine space, uterine inertia, defective uterine contractions are caused, either by the excessive fetal load, or by premature birth. When inertia is present, birth of the first or second fetus cannot proceed, even though presentation is normal (Noakes*et al*., 2001).

(c) Fetal Diseases: Various diseases of the fetus can result in the altered shape of the fetus and dystocia in the cow. Dropsically conditions of fetus resulting in dystocia include hydrocephalus, ascites, hydrothorax and anasarca (Purohit*et al*., 2011). A prolonged dystocia due to fetal ascites in a crossbred cow which is successfully managed with antibiotics, anti-inflammatory and supportive therapy following manual puncturing of fetal abdominal cavity with guarded knife to relieve dystocia (Honparkhe*et al*., 2003)

Preventive management of dystocia

Ensuring that bulls, bucks and rams used for yearling mating are of the same breed, have low birth weight and estimated breeding values (Fordyce and Burns, 2007).

Replacement heifers should be well developed and fed adequately to reach 65% of their mature weight at breeding (Nejash and Wahid, 2016).

Ruminant farm owners should implement a dystocia monitoring program and employmanagement practices (good hygiene condition, balanced nutrition) that could limit the occurrence and impact of dystocia.

Prompt intervention by administration of oxytocin, calcium gluconate and subsequent caesarian section in case of severe cases (Ahmed *et al*., 2017) has proven effective.

Conclusion

Judging from this review, dystocia has a lot of economic and health implications on animal, its newborn (calf or lamb or kid) and livestock farm, which are due to some predisposing factors and causes that have been x-rayed above. It includes reduction in milk yield in the subsequent lactation. Early intervention can result in the delivery of live newborns and much healthier mothers.

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CUTANEOUS PAPILLOMATOSIS IN WEST AFRICAN DWARF GOATS AND ITS ECONOMIC IMPORTANCE: CASE REPORT

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Abstract

Cutaneous papillomatosis is a contagious neoplastic viral disease of animals characterized by the presence of multiple skin tumours or growths, principally on the head part. Although they regress spontaneously, the furtherance to the malignant form may necessitate culling or slaughtering of the animal which is problematic and of economic significance. The gross features of this condition were described in West African dwarf (WAD) goats and compared with those of cattle.

Keywords: Cutaneous papillomatosis, West African Dwarf Goat, Economic importance

Introduction

Papillomaviruses are species-and site-specific double stranded DNA-viruses that infect all species of animals. The viruses are both epitheliotropic and mucosotropic, infecting the squamous epithelium and causing benign proliferative lesions that often undergo malignant transformation. Malignant transformation occurs when the virus becomes integrated into the host's genome causing damage to the host's DNA, inactivating the tumour suppressor protein and promoting keratinocyte cell growth (Hargis and Gin, 2012).

Mucosal papillomaviruses are estimated to cause 5.2% of all human cancers. Papillomaviruses have been strongly associated with sqaumous cell carcinomas of the cervix, vagina, penis, anus, and oral cavity in humans, as well as with feline and equine sarcoids. (Gillison *et al*., 2000; Teifke *et al*., 2003; Parkin, 2006; Nasir and Campo, 2008; zur Hausen, 2009).

Cutaneous papillomatosis is not common in goats unlike cattle. However, papillomavirus associated skin lesions have frequently been observed in the West African Dwarf (WAD) goats in our local environment. The present study is aimed to evaluate the gross pathological features of cutaneous papillomas in the WAD goats and highlight the economic importance of the disease.

Case Description

Two male WAD goats, aged 2-3 years and weighing average of 12kg, belonging to the Veterinary Teaching Farm, University of Nigeria, Nsukka were observed to be off feed, listless and with rapidly proliferating skin lesions. They were brought to the Veterinary Teaching Hospital, University of Nigeria, Nsukka for diagnosis and treatment. On physical examination, prominent papilliferous

projections which bled freely were observed around the oral commissures and tip of the ears, ventral, lateral and dorsal aspects of the thoracic region as well as within the inter-digital spaces (Figure 1).

Case Management

Based on the gross morphology of the lesions, cutaneous papilloma was suspected and the diagnosis was confirmed by biopsy and histopathology. At microscopy, fonts of keratinized epidermis were observed. Although the body condition scores of both goats were not necessarily too poor, however, they were recommended for euthanasia to avoid the spread of the infection. Euthanasia was achieved by intravenous injection of Na-pentobarbitone at the dose of 150mg/kg body weight. Necropsy did not reveal any form of visceral involvement.

Discussion

The lesions of papillomatosis occurred in the WAD goats as papilliferous projections differs from the gross morphology of the lesions in cattle known to take the form of flat plaque-like masses, proliferating either to the exterior (exophytic masses) or to the interior (endophytic masses). The difference in the morphology of the lesions has been attributed to the papillomavirus type causing the disease in a particular animal species. At microscopy, the cytopathology of the disease in goats and cattle may be worsened by secondary bacterial infection. This was not the case in this report probably due to timely presentation of the animals for medical attention.

It is generally believed that dissemination of cutaneous papillomavirus infection is by contact via skin abrasions. However, bovine papillomavirus (BPV) DNA sequences were detected in uterine and ovarian fragments as well as in semen of infected ruminants showing cutaneous lesions and those apparently healthy but only exposed to the endemic environment (Yaquiu *et al*., 2006). This finding has been said to suggest an alternative route of transmission that could contribute to the widespread incidence of BPV infection in ruminants and the complexity of its pathology.

In one study, it was observed that 76.92% of cattle diagnosed of BPV infection had tick infestation, and majority had PGE nematodes and *Fasciola* helminthes (Salib and Farghali, 2008). Papillomaviruses, however, have not been isolated from these parasites and their role in the spread of the infection remains unclear.

Over the years, various molecular diagnostic techniques have been employed to characterize papillomaviruses and these include *in situ* hybridization, PCR and gene sequencing. So far, eight (8) viral types, defined by serology or nucleotide sequences of the L1 gene, have been identified and these are associated with different geographical regions (Silva *et al*., 2010).

The economic importance of the disease is related to the severe skin injuries and inability of affected animals to thrive; especially when the lesions interfere with feeding, secondary bacterial infection, distortion of milk canals; when the udder is affected, and poor market value due to aesthetic reasons (Freitas *et al*., 2011).

Conclusion

The most logical management approach to the spread of cutaneous papillomatosis is culling of the affected animals, although some cases have been managed by a combination of ivermectin injection, manual excision and application of topical antiseptic (Feyisa, 2018).

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Figure 1: West African Dwarf (WAD) goat with cutaneous papillomatosis

DISEASE MANAGEMENT PRACTICES OF BROILER FARMERS IN OWERRI WEST LOCAL GOVERNMENT AREA, IMO STATE

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Abstract

The aim of the study was to determine disease management practices of broiler farmers in Owerri West Local Government Area (LGA) of Imo state. Multi-stage sampling technique was used to select a sample size of 60 broiler farmers for the study. Structured questionnaire was carefully developed and used for data collection. Data analysis was done using descriptive statistics using frequency distribution and percentages. Results showed that intensive system of management on deep litter was the most popular (66.67%) system, Majority of the farmers (61.66%) use wood shavings as litter material and also (50.00%) changed their litter covering every 2months while 55.00% allowed a maximum of 25 to 42days resting period for pens before restocking. Again most of the farms restrict visitors in and around their farms as a bio security measure. All farmers perform routine vaccination of their birds and identified loss of appetite as the major sign of ill health among birds. Again majority of the farmers (38.33%) store poultry waste in bags. Incidence of sell-off of sick bird was revealed as a measure applied in handling sick bird. The results indicate that the management practices by broiler farmers in the study area will help reduce the high mortality rates that have plagued the industry in recent times by keeping diseases infestation to a minimal.

Keyword: broiler, mortality, diseases, production.

Introduction

Modern-day broiler chicken production is a broad and swiftly developing sector, supplying the market with relatively cheap and high-quality dietetic food (Hristakieva *et al.,* 2014). Almost 3 in every 12 household is engaged in some sort of broiler production and this industry contributes up to 15% to the country's gross domestic product (GDP) and accounts for 36% of total protein intake (Akintunde *et al.,* 2015). Poultry diseases remain one of the major challenges faced by broiler farmers which hamper poultry production in Nigeria (Adewole, 2012)**.** Disease prevention management and control programs are limited in this industry and high mortality rates caused by drug and vaccine failures are common even among vaccinated birds (Ambali *et al*., 2003). Also, many authors have carried out studies on the economic analysis of poultry production in Nigeria (Obi *et al*., 2008; Fasina *et al*., 2008; Ajetomobi and Adepoju, 2010; Bawa *et al*., 2010). However, there is limited research on assessment of disease management practices adopted by broiler farmers and how it affects production in the broiler industry. With the continued increase in poultry production in Nigeria (FAO, 2000) as shown by the uncontrolled establishment of broiler farms and coupled with the different strains of broilers bred over time, this study aim at evaluating the disease management practices of broiler farmers in Owerri North LGA of Imo State.

Materials and methods

The study was carried out in Owerri west LGA of Imo State. The state lies within latitudes $4^0 45^0$ N and 7^0 15^0 N and longitudes 6^0 50^0E and 7^0 25^0E with an area of around 5.100sq km and annual

rainfall varying from 1500mm to 2200mm. The State has an average annual temperature above 20^0C with humidity reaching 90% in the raining season. Purposive sampling technique was used. The areas were selected after pre-survey to identify major farms that meet with the criteria of farms with minimum stocking capacity of fifty (50) broiler birds and above. Multi-stage sampling technique was used. A total of 60 farmers (10 from each communities) was randomly selected from 6 communities in the L.G.A. The primary data was collected using structured questionnaire which was distributed among broiler farmers in Owerri West Local Government Area. The primary data include information on their disease management practices. The secondary data were sourced from published and unpublished literature, thesis, journals, magazines, proceedings and bulletins. Data was analysed using descriptive statistics using tables, frequencies and percentages.

Results and discussion

Result on the disease management practices of broiler farmers is shown in Table 1. Intensive system of management on deep litter was the most popular (66.67%) among farmers followed by use of cages in intensive system (33.33%). This result agrees with the trend in modern day commercial poultry production, were birds are kept in confinement (Ogundipe, 2002). Akidarju *et al.* (2010) also reported the deep litter system as the most popular system of chicken keeping. Majority of the farmers (61.66%) use wood shavings as litter material and also (50.00%) changed their litter covering every 2months while 55.00% allowed a maximum of 25 to 42days resting period for pens before restocking. Again most of the farms (45.00%) restrict visitors in and around their farms as a bio security measure, 35.00% sterilise work wears and equipment before and after use while 16.67% provide foot dips at the entrances to their farm. All farmers perform routine vaccination of their birds and identified loss of appetite as the major sign of ill health among birds followed by diarrhoea (30.00%) ruffled feather (13.33%), and others (18.33%). Again majority of the farmers (38.33%) store poultry waste in bags while 13.33% disposed of the waste around their farm house. Incidence of sell-off of sick bird was revealed as a measure applied in handling sick birds, 23.33% cull the sick birds, 20.00% administer modern drugs to sick birds, 11.67% quarantine and vaccinate the birds while 16.67% treat their birds using traditional medicine.

Conclusion

The results indicate that broiler farmers in the study area employed standard disease management practices which will help prevent and equally control disease outbreaks in their flock.

Table 1: Disease management practices of broiler farmers

Parameters	Frequency	Percentages(%)
Management system practiced		
Intensive on deep litter	40	66.67
Intensive on cages	20	33.33
Semi-intensive	0	0.00
litter change		
Every 2weeks	6	10.00
Every 4weeks	14	23.33
Every 2months	30	50.00
>2months	10	16.67
Routine vaccination of broilers		
Yes	60	100.00
No	0	0.00
Common Signs of ill health		
Loss of appetite	23	38.33
Ruffled feather	8	13.33
Drowsiness	0	0.00
Diarrhea	18	30.00
Others	11	18.33
Method of handling the sick birds		
Culling	14	23.33
Sell-off	17	28.33
Kill sick birds	0	0.00
Treat with modern medicine	12	20.00
Treat with traditional medicine	10	16.67
Quarantine and vaccinate	7	11.67
Waste management		
Store in bags	23	38.33
Dispose around farm house	8	13.33
Others	29	48.34
Litter type used		
Wood shavings	37	61.66
Saw dust	10	16.67
Others	13	21.67
Biosecurity measures		
Foot dip at all entrances	10	16.67
Sterilizing work wears and equipment	21	35.00
Restricting visitors	27	45.00
Others	2	3.33
Resting period for pens before restocking		
0-7days	6	10.00
8-14days	21	35.00
25-42days	33	55.00

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IMMUNE RESPONSE OF CHICKS TO INFECTIOUS BURSAL DISEASE VIRUS BOOSTER VACCINATION

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Abstract

Study involving the rate at which chicks respond to repeat vaccination with Infectious Bursal Disease (IBD) vaccine was investigated. Eight groups of chicks aged 10 days were given first dose of IBD vaccination. Three weeks post first vaccination (PV), the vaccination was repeated in four groups while the remaining 4 groups served as controls. Starting from three weeks after the repeat vaccination, sera were collected from a pair of the groups every week for analysis using Qauntitative Agar Gel Precipitation Test (QAGPT) to assess antibody levels. Antibody titre rose to peak 3 weeks post repeat vaccination in the boosted groups. Also, mean antibody titre was higher and lasted longer in the groups boosted than in the groups with single vaccination ($P < 0.05$).

Key words: Chicken, Agar Gel Precipitation ,Antibody levels, IBD, Booster vaccination

Introduction

Main method for control of IBD is vaccination of susceptible avian species with the IBD vaccine (Ezeibe, *et al* , 2009). However, it has been observed that IBD outbreak among vaccinated flocks is now common due to emergence of mutants of the causative virus (Jackwood *et al*., 2008, Jackwood *et al*., 2011) and due to suboptimal response of chicks to vaccination (Abdu, 2001).

Lin – Yusher *et al* (1997) reported that in China, a combination ot IgG and hyper immune serum is now employed in prevention and managment of IBD. In USA, IBD virus strain 2512 is being combined with bursal disease antibodies to produce IBDV – BDA complex vaccine which has proved effective even in chicks that have maternal antibodies (Aliyu *et al*., 2016). IBD is reported to cause higher mortality among chicks in the tropics than it causes in temperate countries (Musa *et al*., 2012). So, the need exists for researchers in the tropics to also look for new methods to improve immune response of chicks to IBD vaccination. This involves appraissal of factors that effect immune responses of animals to infections or vaccinations.

Viral vaccines provoke production of antibodies (White, 1984) which prevent viral infections , in most cases, by inhibiting viral attatchment to host cells (Victoria, 2010). Such active immune responses are specific (Liao, 2013) and can recognize previously encountered antigens. When animals` immune systems recognize a repeat encounter with an antigen, it initiats vigorous memory immune response specifically against that antigen (Paul, 1989).

Antibody response to first experience with an infection or vaccination is usualy IgM which wanes fast but when there is repeat experience of the same infection or vaccination, the antibody response is more rapid, higher in level and is mainly IgG which lasts longer (Klein, 1990).

The experiment was therefore, designed to study immune response of chicks to repeat (Booster) vaccination with IBD vaccine in a tropical environment as a step towards suggesting more effective methods of vaccination to control the epizootic.

Materials and Methods

Eighty chicks were used for the study. The chicks were vaccinated with IBD vaccine (National Veterinary Research Institute, Vom, Nigeria) at age of 10 days. They were then divided into 8 groups of 10 chicks each. Three weeks post vaccination, the IBD vaccination was repeated in 4 groups of the

chicks. The remaining 4 groups served as controls. One group of chicks with booster IBD vaccination and a control group were bled each week and and their sera used for Qauntitative Agar Gel Precipitation Test (QAGPT) as described by Herbert (1974) . Means of antibody titres of the groups of chicks given booster dose of IBD vaccine and those left with only the initial vaccination were compared by students T – test.

Results and Discussion

The groups in which IBD vaccination was boosted had higher antibody response ranging from AGPT 4 – 16 than the control groups which ranged 1 – 2 ($P < 0.05$).Antibody titre of AGPT 8 and above persisted in chicks with booster IBD vaccination up to 8 weeks of live.

Antibody responses of the 8 groups of chicks are as shown on Table 1.

Table 1: Effect of booster vaccination on antibody response of chicks to IBD vaccine (AGPT Titre)

Time post vaccination (Wks)	Boosted Group	Control group
1	**8**	**2**
2	**4**	**1**
3	**16**	**1**
4	**8**	**1**
$\bar{X}$	9 ± 2.52	1.5 ± 0.29

Booster vaccination improved IBD immune response ($P < 0.05$)**.**

Report of outbreaks of IBD in vaccinated flocks is now common occurence in Nigeria (Abdu *et al*, 2001). A recent survey of chicks hatched in the country also revealed that they lack maternal immunity against IBD. Low level of IBD antibodies in the parent stock hens is suspected to be responsible for this lack of maternal immunity in chicks. These may explain high incidence of IBD in the country.

Since boosting IBD vaccination improved circulating antibody titre of the chicks from 1.5 ± o.29 to 9 ± 2.52, repeating IBD vaccination will help reduce incidence of IBD in the country. Also, a recent study showed that Nigerian chicks need antibody titre of at least AGPT 8 to protect them from local isolates of the IBD virus. This means that the mean AGPT titre of 1.5 ± 0.29 got in the group with single vaccination may not protect them to IBDV challenge.This may be responsible for outbreaks of IBD in vaccinated flocks which is often reported (Abdu *et al*, 2001).

Another study has also shown that giving Nigerian chicks multivitamine medication for for 3 days before IBD vaccination and for another 3 days after the vaccination, raised the immune level to as high as AGPT 32 and above.

Conclusion and Recommendation

It is therefore recomended that Nigerian farmers revaccinate their flocks with IBDV 3 weeks after first IBD vaccination, give their flocks pre and post vaccination medication with multivitamines and repeat IBD vaccinaton of parent stock hens annually. These measures may reduce incidence of IBD in the country.

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HISTOMORPHOLOGY OF SPLEEN OF RATS SUB-ACUTELY ADMINISTERED WITH *AVERRHOA CARAMBOLA* JUICE EXTRACT

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Abstract

Averrhoa carambola otherwise called Star fruit is a sweet juicy and succulent fruit that is cherished and consumed by many people. The juice extract is also used in folkloric medicine in treatment of certain ailments such as skin rashes, inflammatory conditions and diabetes. However, anecdotal evidence indicates that the fruit may be toxic to some vital organs in the body. This study therefore, was designed to investigate possible toxicity profile of *Averrhoa carambola* juice extract in the spleen of female albino rats. Twenty (20) rats were assigned to 4 groups (A –D) of 5 rats each. Rats in group A received distilled water at 10 ml/kg to serve as normal control while rats in groups B-D were administered the extract at 600, 300, 150 mg/kg body weight respectively *Per Os* for 28 days. On 29th day, the spleens were collected under mild ether anaesthesia for histopathology assessment. The spleen histomorphology of the rats treated with the juice extracts showed no lesions and were comparable with that of the normal control. In conclusion, the result of this study suggested that the juice extract of *Averrhoa carambola* has no effect on the spleen histo-architecture.

Keywords: *Averrhoa carambola*; Histopathology, Rats, Spleen

Introduction

Averrhoa carambola L also known in English language as star fruit, Chinese ooseberry, belongs to the family Oxalidaceae (Carreira and Schatzmayr, 1982). The fruit which is star-shaped, contains sweet juicy liquid. *Averrhoa carambola* L is found preponderantly in Malaysia, Brazil, China and India (Ghani, 2003). Studies on the fruit, by some researchers, have indicated the presence of phytochemicals such as flavonoids, tannins, saponins and alkaloids, gallic acid, epicatechin, ascorbic acid and proanthocyanidins (Guanghou and Leong, 2004).

In folkloric medicine, the juice from the fruit is useful in management of fever and in stimulation of appetite. Brazillians' use the juice for diuretic purposes while the Chinese use it to promote digestion. Researched studies have reported analgesic properties, anti-inflammatory effects and hypoglycaemic potentials (Ahmed and Das, 2012; Sripanidkulchai *et al.,* 2002). *A.carambola* also exhibit anthelmintic, antioxidant, hypolipidemic, antimicrobial, hypotensive, anti-ulcer and anti-tumour activities (Shah *et al*., 2011; Shui and Leong, 2004).

Histopathology of various organs always reveals any pathological lesions of such test substance on the organs of interest. The spleen is the largest organ in the body saddled with the responsibility of blood filtration, storage, production and destruction (Steinger and Barth, 2000). It is also involved in adaptive immunity (Bronte and Pittet, 2013). People consume this fruit greatly, probably because of its sweetness or because of its nutritional and medicinal values. However, certain contents of the fruit juice such as oxalic acid and caramboxin have been noted to be highly toxic in uraemic patients precipitating encephalopathy (Garcia-Cairasco *et al*., 2013). We embark on this study to investigate the effects of juice extract of *A.carambola*, grown in our environment- Nsukka, Enugu state, southeast Nigeria, on the spleen histo-architecture and by extension its function.

Materials and methods

Plant material

Averrhoa carambola fruits were obtained from the University of Nigeria Nsukka teaching farm and authenticated by a botanist in the Department of Plant Science and Biotechnology.

Animals

Albino rats used for this study were obtained from the Department of Veterinary Physiology and Pharmacology animal house. They were acclimatized for two weeks before the commencement of the experiment. They were fed with standard rat feed and clean water *ad lib*.

Preparation of plant material

The *Averrhoa carambola* fruit extract was obtained by aseptically expressing out the juice from the fruit using juice extractor machine and the concentration of the juice determined using a lyophilizer. The crucible was weighed and recorded. Thereafter 1ml of the extract was placed into the crucible, and then weighed. This was frozen and then lyophilized until the water content of the juice was completely sublimed. The crucible and the dried extract were weighed again and the concentration of the juice extract calculated as follows:

Weight of crucible alone $=A_1$

Weight of crucible + liquid extract $=A_2$

Weight of crucible + dried extract $=A_3$

Weight of dried extract alone = A_3-A_1

Concentration of the fruit juice = weight of the dried extract (in mg)per ml= A_3-A_1/ml

Experimental design

Twenty (20) female albino rats were assigned into 4 groups (A-D) consisting of 5 rats per group. Rats in group A received distilled water (10 mg/ml) to serve as normal control while rats in group B – D were administered 600, 300 and 150 mg/kg of the juice extract of *Averrhoa carambola* respectively. All treatments were *Per Os* using gastric gavage or 28 days. The rats were humanely euthanized using ether. Thereafter the spleens were collected, weighed and preserved for histopathology studies.

Histopathology

The histological examination of the tissues of Wistar albino rats was done using the method of Drury *et al.*,(1967)

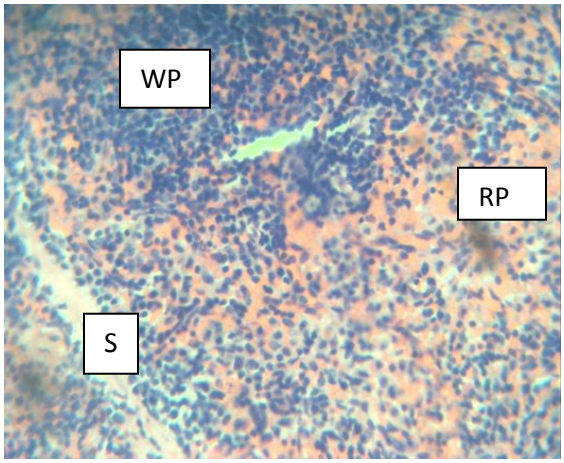
Results and Discussion

Concentration of the juice extract

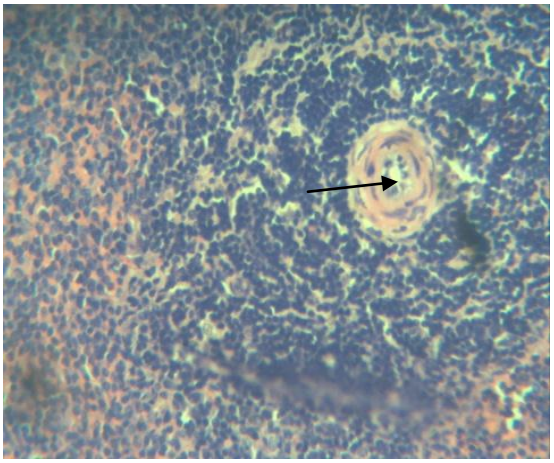
The concentration was calculated to be 70 mg/ml

Effect of sub-acute administration of *Carambola averrhoa* juice extract on the spleen

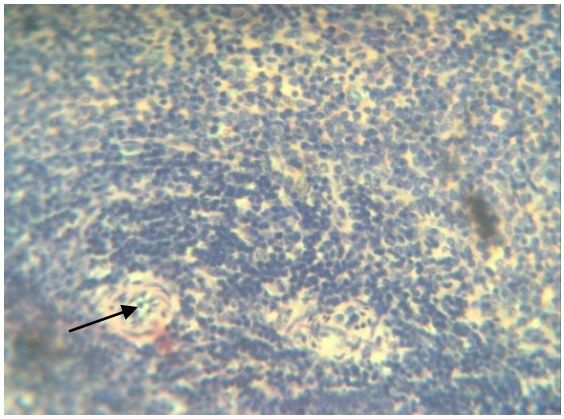
The photomicrographs of the spleen sections indicate that the spleen of all the juice extract-treated groups presented normal histo-architecture comparable to that of the group A rats (normal control)



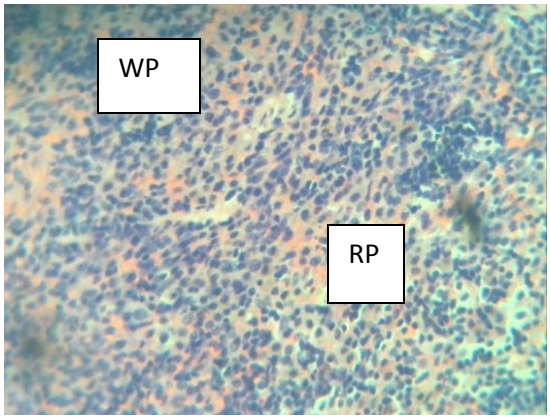
Group A Normal spleen, H&E X400.



Group B Normal Spleen, H&E X400



Group C Normal spleen, H&E X400



Group D Normal spleen, H&E X400

Key:
Group A: Showing splenic sinus (S), white pulp (WP) and red pulp (RP)
Group B: Showing splenic artery (black arrow)
Group C: Showing splenic artery(black arrow)
Group D: Showing white pulp (WP) and red pulp (RP)

This study investigated the effects of sub-acute administration of *A. carambola* juice extract on the spleen histo-architectures of female Albino rats.

The results of the study indicates that the histomorphometry of all the rats that received the juice extract did not vary from that of the normal control rats that received distilled water. This is an indication that the juice extract may not have affected the structure and probably the function of the spleen. Mammalian spleen is a very important organ of reticuloendothelial system. The presence of both the red and white pulp in the spleen equips the organ with both the functions of erythrophagocytosis and immunologic functions (Steinger and, Barth, 2000).

The red pulp splenic macrophages ingest the effete red blood cells in a process called erythrophagocytosis. In this way, senescent red blood cells are removed from the system (Groom *et al*., 1991). The red blood cells are digested in the macrophages and heme is released following proteolytic degradation of haemoglobin. The released heme is further degraded to yield biliverdin, carbon monoxide and ferrous iron which can either be released or stored (Maines, 1997). This process is also important in iron recycling.

On the other hand, the white pulp is the lymphoid region of the spleen which houses the T and B cells compartments. The white pulp has the responsibility of capturing and destroying of pathogens and in induction of adaptive immune responses (Bronte and Pittet, 2013).

Atrophy (reduction in the size of spleen) can affect the white pulp and/or red pulp compartments of the spleen. Lymphocyte atrophy of the white pulp is characterized by a loss of lymphocytes in the T-cell areas (periarteriolar lymphatic sheaths [PALS]) and/or B-cell areas (follicles, germinal centers, marginal zones). Depending on severity, this can result in a decrease in overall PALS cellularity/area or follicle number/size.Red pulp atrophy is characterized by a decrease in the relative amount of red pulp components, including hematopoietic cells. Atrophy can occur as a direct treatment-related effect or can be an indirect effect secondary to weight loss or reduced body weight gain (Ward *et al.,* 1999)

On the other side of the coin, splenomegally (enlargement of spleen) may be caused by neoplasia and some conditions that may lead to overload in splenic functions such as increased haemolysis as may

be occasioned by toxin or haemoparasites-induced haemolysis. Other conditions include inflammatory disorders, viral or bacterial infections (Pozo *et al*., 2009).

In our study, we recorded neither splenic atrophy nor splenomegally, indicating that the juice extract may not have interfered with the splenic functions or cause any form of toxicity to the spleen.

Conclusion

Sub-acute administration of *A. carambola* juice extract to female albino rats did not precipitate any deleterious effects on the histoarchitecture of the spleen.

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EFFECTS OF METHANOLIC LEAF EXTRACT OF *Pterocarpus santalinoides* DC ON BLOOD OXIDATIVE STRESS AND ANTI-OXIDANT PARAMETERS OF ALBINO RATS GIVEN TOXIC DOSES OF CARBON TETRACHLORIDE

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Abstract
This study investigated the effects of methanolic leaf extract of *Pterocarpus santalinoides* DC on blood oxidative stress and anti-oxidant parameters of albino rats given toxic doses of carbon tetrachloride (CCl_4). Thirty male albino rats (*Rattus norvegicus*) of 12 weeks of age were randomly assigned into 6 groups (A – F) of 5 rats each. A mixture of 1 ml/kg CCl_4 in equal volume of olive oil (50% v/v) was injected intraperitoneally to groups A – E at 3 days interval for 12 days (days 0, 3, 6, 9 and 12) to induce sub-acute toxicity. Group A was treated with 10 ml/kg distilled water as placebo and served as negative control (induced untreated), groups B, C and D were treated with 50, 250 and 500 mg/kg of *Pterocarpus santalinoides* methanolic leaf extract (PSMLE) respectively. Group E was treated with 100 mg/kg Silymarin as positive control, while group F was treated with 10 ml/kg distilled water as placebo (normal control not given CCl_4). Treatment was given *per os* twice daily for 15 days. Blood was collected on day 15 post-initiation of treatment for determination of malondialdehyde (MDA), catalase, superoxide dismutase (SOD), glutathione peroxidase (GPx) and total plasma glutathione activity levels. Treatment with PSMLE at 250 and 500 mg/kg especially led to significantly lower ($P < 0.05$) blood MDA levels, and significantly higher ($p < 0.05$) activity concentrations of catalase, SOD, GPx and total glutathione in the treated rats when compared to the untreated negative control. It was concluded that treatment with 250 and 500 mg/kg PSMLE significantly ameliorated CCl_4-induced oxidative stress and enhanced blood levels of antioxidant parameters, which suggests that the extract may be useful in diseases mediated by and associated with oxidative stress.

Key words: Oxidative stress, Anti-oxidants, *Pterocarpus santalinoides,* Methanolic leaf extract, Carbon tetrachloride.

Introduction

Oxidative stress is a state in which oxidation exceeds the anti-oxidant systems in the body leading to imbalance between the generation of reactive oxygen species (ROS) and the level of anti-oxidants in the biological system (Yoshikawa and Naito, 2002). Oxidative stress occurs when free radicals which are not neutralized by antioxidants go on to create more volatile free radicals and damage cell membranes, vessels, proteins, fats and DNA. Biological free radicals are highly unstable reactive molecules that have electrons available to react with various organ substrates such as DNA, proteins and lipids. Oxidative stress is known to be involved in the pathogenesis of lifestyle-related diseases including atherosclerosis, hypertension, diabetes mellitus, ischemic diseases, liver diseases and malignancies (Yoshikawa and Naito, 2002). Carbon tetrachloride (CCl_4) is a commonly used model chemical for the induction of oxidative stress-mediated hepatotoxicity (Boll *et al*., 2001; Weber *et al.,* 2003; Kim *et al*., 2010).

Anti-oxidants are compounds that prevent chemical damage caused by free radicals. Many of the natural antioxidants such as flavonoids and glycosides are very important in the prevention of diseases associated with oxidative stress (Yi-Fang *et al*., 2002; Aruoma, 2003). Plants are rich sources of natural antioxidants that can protect against oxidative stress and thus play important role in the chemoprevention of diseases that have their etiology and pathophysiology in ROS (Ames *et al*., 1993;

Atawodi, 2005). There has been an increase in interest in the therapeutic potential of plants as antioxidants in reducing free radical-induced tissue injury (Schuler, 1990). Many plant species have been investigated in the search for novel antioxidants (Chu, 2000; Mantle *et al*., 2000; Koleva *et al*., 2002; Oke and Hamburger, 2002), but generally there is still a need to investigate the anti-oxidant potential of some other plant species.

Pterocarpus santalinoides DC is an indigenous Nigerian plant in the family *Papilionaceae*. It is commonly known as "red sandal wood" in English and "nturukpa" in Igbo language (Adetunji, 2007; Anowi *et al*., 2012). The leaves are used in folk medicine for the treatment of various ailments such as heart and liver diseases (Adesina, 1982; Okwu and Ekeke, 2003). Phytochemical analysis of the leaf extracts of *P. santalinoides* have shown the presence of tannins, alkaloids, flavonoids, saponins, carbohydrates, glycosides, phenols, terpenes and sterols (Anowi *et al.,* 2012; Eze *et al*., 2012; Ihedioha et al, 2017; Ihedioha *et al.,* 2018). Previous studies have suggested that the hepato-protective effects of methanol leaf extract of *P. santalinoides* in acetaminophen–induced hepatotoxicity may be due to its anti-oxidant phytochemical composition (Ihedioha *et al*., 2017). Also, earlier studies that showed that aqueous leaf infusion of *P. santalinoides* had lipid lowering effects (Ihedioha *et al*., 2018) hinted that this capability may be related to the extract's anti-oxidant capacity. Based on the various medicinal uses of *P. santalinoides* especially in the treatment of diseases in which oxidative stress is known to play a role, the purpose of the present study was to evaluate the effects of methanolic leaf extract of *Pterocarpus santalinoides* DC on blood oxidative stress and anti-oxidant parameters of albino rats given toxic doses of carbon tetrachloride (CCl_4).

Materials and Methods

Fresh leaves of *Pterocarpus santalinoides* used for the study were collected in November 2016, and identified by a plant taxonomist at the Department of Plant Science and Biotechnology, University of Nigeria, Nsukka. The leaves were dried under shade and pulverized. Five hundred grammes (500 g) of the ground leaves were extracted with 80% methanol using the cold maceration extraction technique. The resulting extract was concentrated to dryness with a rotary evaporator (Buchi, Switzerland), and referred to as *Pterocarpus santalinoides* methanol leaf extract (PSMLE).

A total of thirty (30) male albino rats (*Rattus norvegicus*) of 12 weeks of age were used for the study. The rats were randomly assigned to 6 groups A – F of five (5) rats per group. Sub-acute toxicity was induced in rat groups A – E using CCl_4 model (Singh *et al*., 2012). A mixture of 1 ml/kg CCl_4 in equal volume of olive oil (50% v/v) was injected intraperitoneally to groups A – E at 3 days interval (days 0, 3, 6, 9 and 12) for 12 days to induce sub-acute toxicity. Group A served as negative control (induced untreated), groups B, C and D were treated *per os* twice daily with 50, 250 and 500 mg/kg of PSMLE respectively. Group E was treated with 100 mg/kg silymarin (a standard hepatoprotective drug) p*er os* twice daily as positive control, while group F was treated *per os* twice daily with 10 ml/kg distilled water as placebo (normal control not given CCl_4). Treatment was done for 15 days, and the albino rats used for the study were cared for and handled humanely all through the study. Blood was collected on day 15 post-initiation of treatment for evaluation of blood levels of oxidative stress and anti-oxidant parameters, using the following standard methods: malondialdehyde (MDA) – modified thiobarbituric acid method (Draper and Hadley, 1990); total glutathione – modified enzyme recycling method (Tipple and Rogers, 2012); catalase, superoxide dismutase (SOD) and glutathione peroxidase (GPx) activity – methods described by Weydert and Cullen (2010).

Data obtained from the study were subjected to one way analysis of variance (ANOVA). Variant means were separated post-hoc using the least significant difference method. Significance was accepted at $p < 0.05$, and a summary of the results were presented as means with standard error.

Results and Discussion

Results of the MDA assay showed a dose-dependent variation in MDA levels across the groups, with group A being significantly higher ($p < 0.05$) than groups C, D, E and F, but not significantly different ($p > 0.05$) from group B (Table 1). This implied that there was higher free radical production

in groups A and B when compared to other groups, as an increase in free radicals causes increased production of MDA (DelRio *et al*., 2005). MDA is one of the final products of polyunsaturated fatty acids peroxidation in cells and is a known marker of oxidative stress status in several diseases (Gawel *et al*., 2004). Catalase activity concentration of group A rats was significantly lower ($p < 0.05$) than that of groups B, C, D, E and F rats, and there were no significant differences ($p > 0.05$) in catalase activity of groups B, C, D and E (Table 1). This is an indication that group A rats had no protection from oxidative damage as compared to other groups. Catalase is a very important enzyme in protecting the cell from oxidative damage (Chelikani *et al*., 2004). It is the main enzyme that removes hydrogen peroxide a reactive oxygen species and blocks oxidative stress (Gaetani *et al*., 1996). Results of the SOD assay also showed significantly lower ($p < 0.05$) superoxide dismutase (SOD) level of groups A and B rats when compared to other groups (Table 1). This is also an indication that groups A and B rats had no significant protection from oxidative damage as compared to other groups. Superoxide dismutase is an important antioxidant defense in living cells exposed to oxygen. Earlier studies had shown that treatment with SOD decreases reactive oxygen species generation and oxidative stress (Fridovich, 1997; Gongora *et al*., 2006). Glutathione peroxidase (GPx) levels followed the same pattern as catalase and SOD with groups A and B being significantly lower ($p < 0.05$) than groups C, D, E and F (Table 1). The main biological role of GPx is to protect the organism from oxidative damage. Its biochemical function is to reduce lipid hydroperoxides to their corresponding alcohols and to reduce free hydrogen peroxide to water. Blood levels of GPx have been reported to be low in some important diseases, and had significantly improved when anti-oxidants were administered (Lubos *et al*., 2011). Results of the total glutathione assay showed a dose dependent variation in plasma total glutathione level across the groups, with group A rats being significantly lower ($p < 0.05$) than those of other groups, and group F being significantly higher ($p < 0.05$) than other groups (Table 1). Plasma total glutathione is one of the major endogenous antioxidants produced by cells which participates directly in the neutralization of free radicals and reactive oxygen species, as well as maintaining exogenous antioxidants such as vitamins C and E in their reduced (active) forms (Dringen, 2000). The higher total glutathione level recorded in this study for groups B, C, and D implies a dose-dependent increase in anti-oxidant activity in these groups.

Table 1. The blood oxidative stress and anti-oxidant parameters of rat groups* given CCl_4 and treated with varied doses of *Pterocarpus santalinoides* methanolic leaf extract (PSMLE).

Oxidative stress and antioxidant parameters	**Means, with standard deviation in brackets**					
	Group A	**Group B**	**Group C**	**Group D**	**Group E**	**Group F**
Malondialdehyde (µmol/L)	17.61 [a] (3.32)	14.19 [ab] (4.29)	9.65 [bc] (2.87)	7.52 [cd] (3.30)	7.65 [cd] (2.88)	4.05 [d] (1.90)
Catalase (IU/ml)	12.18 [a] (2.36)	21.55 [b] (2.38)	20.92 [b] (3.35)	20.35 [b] (3.49)	23.14 [bc] (4.40)	29.76 [c] (7.99)
Superoxide dismutase (IU/ml)	0.221 [a] (0.020)	0.257 [ab] (0.049)	0.300 [c] (0.024)	0.278 [bc] (0.020)	0.294 [bc] (0.027)	0.299 [c] (0.019)
Glutathione peroxidase (IU/L)	82.50 [a] (10.74)	88.41 [a] (12.89)	119.35 [b] (20.17)	124.29 [b] (23.90)	127.16 [b] (17.27)	190.25 [c] (18.58)
Total Glutathione (µg/µl)	0.016 [a] (0.006)	0.029 [b] (0.004)	0.039 [bc] (0.005)	0.041 [bc] (0.005)	0.046 [c] (0.006)	0.068 [d] (0.015)

[a,b,c] Different alphabetical superscripts in a row indicate significant differences ($p < 0.05$) between the groups.

* Groups: Group A – CCl_4 and no treatment; Group B – CCl_4 + 50 mg/kg bw PSMLE; Group C – CCl_4 + 250 mg/kg bw PSMLE; Group D – CCl_4 + 500 mg/kg bw PSMLE; Group E – CCl_4 + 100 mg/kg bw Silymarin; Group F – No CCl_4 and no treatment.

Conclusion and Recommendations

Based on the results of the study, it was concluded that treatment of oxidative stress mediated CCl_4-induced toxic injury in albino rats with methanolic leaf extract of *P. santalinoides* at the doses of 250 and 500 mg/kg, especially led to significantly lower ($P < 0.05$) blood MDA levels, and significantly higher ($p < 0.05$) activity concentrations of catalase, SOD, GPx and total glutathione of the treated rats when compared to the untreated negative control. The implication of these findings is that extracts of the leaves of *P. santalinoides* may be beneficial in the treatment and management of diseases mediated by or associated with oxidative stress.

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ERYTHROCYTE AND LEUCOCYTE RESPONSES OF GOATS ADMINISTERED MELATONIN TO DIMINAZENE ACETURATE-INDUCED TOXICITY

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Abstract

The experiment was performed with the aim of evaluating erythrocyte and leucocyte responses of goats administered with melatonin to diminazene aceturate-induced toxicity. Simple random sampling was used to assign 20 goats into four groups, comprising five (5) goats each. Group I goats served as untreated control, without melatonin supplementation; Group II melatonin (0.5 mg/kg *per os*); Group III pre-treated with melatonin for three days and administered with diminazene aceturate (7 mg/kg, deep i.m. once), and melatonin administration was continued for additional 10 consecutive days; Group IV goats were administered with diminazene aceturate alone. Two millilitres of blood were collected from the jugular veins of each goat on days 1, 4, 7 and 10 post-diminazene aceturate administration for determination of erythrocyte and leucocyte counts using standard methods. The erythrocyte counts obtained on days 1 and 4 ($6.76 \pm 1.07 \times 10^6$/l and $6.68 \pm 0.86 \times 10^6$/l, respectively) in melatonin-treated groups were the highest ($P > 0.05$). However, on days 7 and 10 post-administration of diminazene aceturate, the highest ($P < 0.05$) leucocyte counts ($13.56 \pm 1.06 \times 10^9$/l and $13.74 \pm 1.80 \times 10^9$/l, respectively) were recorded in goats pre-treated with melatonin and administered diminazene aceturate. The findings demonstrated that, diminazene aceturate intoxication did not exert significant effect on erythrocyte count, but it decreased leucocyte count in goats. Pre-treatment with melatonin reversed the toxicity by increasing the leucocyte count.

Key words: Goats, melatonin, leucocytes, erythrocytes and diminazene aceturate

Introduction

Diminazene was introduced to the market in 1955 as a trypanocide and babesiacide for livestock, including goats (Ge *et al*., 2018). It is normally curative at a dose of 3.5 mg/kg body weight (Da Silva Oliveira and De Freitas, 2015). The use of high doses of diminazene aceturate (Berenil®) may offer some advantages in the treatment of trypanosomosis (Sudan *et al*., 2017), but the merits of this practice should be carefully balanced in view of the adverse effects observed when animals are administered with the trypanocide (Oguejiofor *et al*., 2010). The mechanisms of action of Berenil® have remained poorly understood. While some earlier reports show that Berenil® possesses trypanolytic and trypanostatic properties, some studies have shown that it may also indirectly suppress the host immune system (Kuriakose and Uzonna, 2014). Due to its higher therapeutic index and low incidence of resistance compared to other compounds, it has become the most commonly used therapeutic agent for trypanosomosis in livestock (Peregrine and Mamman, 1993). Melatonin is a neurohormone produced by the pineal gland, possessing antioxidant activity (Maldonado *et al*., 2012). It crosses all cell membranes, including the blood-brain barrier due to its amphiphilicity (Hardeland and Pandi-Perumal, 2005). There is paucity of information in the available literature on mitigating effects of diminazene aceturate-induced toxicity in goats, particularly on haematology.

Effects of melatonin administration in goats subjected to diminazene aceturate treatment are currently lacking in the available literature. The objective of the study was to evaluate erythrocyte and leucocyte responses in goats administered with melatonin to diminazene aceturate-induced toxicity.

Materials and Methods

The experiment was performed in a goat experimental pen in the Department of Physiology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria (11° 10/ N, 07° 38/ E), located in the Northern Guinea Savannah zone of Nigeria. Twenty (20) healthy goats were bought from Tudun Sebu market in Soba Local Government Area of Kaduna State for the study. They were screened for both endo- and ecto-parasites. The goats were fed with hay with zero grazing. They were given access to feeds and water *ad libitum*. By simple random sampling, the 20 goats were assigned into four groups, comprising five (5) goats each. Group I goats served as untreated controls, without melatonin supplementation. Group II goats were treated with melatonin (ISI Brands, Inc. Utah, USA) alone at 0.5 mg/kg *per os*. Melatonin was administered once daily for 13 consecutive days at 17:00 h to goats in groups II and III. Group III goats were pre-treated with melatonin for three days and administered diminazene aceturate (7 mg/kg deep i.m. once). Thereafter, melatonin administration was continued for additional 10 consecutive days. Group IV goats were administered with diminazene aceturate alone. Two (2) millilitres of blood were collected from the jugular vein of each goat on days 1, 4, 7 and 10 post-diminazene aceturate administration into separate sodium ethylenediaminetetraacetic acid bottles. The blood was taken to the Veterinary Clinical Pathology Laboratory, Ahmadu Bello University, Zaria for haematological analysis. Erythrocyte count was determined as described by Dacie and Lewis (1991). Similarly, the total leucocyte count in 1 mm^3 of blood sample was obtained using the method described by Weiss *et al*. (2010). Data were expressed as mean ± standard error of the mean (mean ± SEM). All data obtained were subjected to one-way analysis of variance (ANOVA). Multiple means were compared by Duncan's (1955) multiple range test. Values of $P < 0.05$ were considered significant.

Results and Discussion

The erythrocyte counts obtained in the goats are shown in Table 1. The values of 6.76 ± 1.07 x 10^6/l and 6.68 ± 0.86 x 10^6/l obtained on days 1 and 4, respectively in melatonin-treated groups were the highest. The values were not significantly ($P > 0.05$) different from those recorded in other groups on the same day (Table 1). Similarly, the values of 5.86 ± 0.60 x 10^6/l and 6.30 ± 0.70 x 10^6/l obtained in diminazene aceturate-treated goats recorded on post-diminazene aceturate administration, days 7 and 10, respectively were the highest. However, the values did not differ significantly from those obtained in the other groups of goats (Table 1). The overall erythrocyte counts did not differ significantly ($P > 0.05$) across the groups. The leucocyte counts obtained in the goats are shown in Table 2. The highest ($P > 0.05$) leucocyte count (11.66 ± 1.29 x 10^9/l) was obtained on day 1 post-administration of diminazene aceturate in goats administered with melatonin only (Table 2). On day 4, the lowest leucocyte count (11.00 ± 1.39 x 10^9/l) recorded in the control group did not differ significantly from the counts obtained in other groups. At days 7 and 10 post-administration of diminazene aceturate, the highest ($P < 0.05$) leucocyte counts (13.56 ± 1.06 x 10^9/l and 13.74 ± 1.80 x 10^9/l, respectively) were recorded in goats pre-treated with melatonin and administered with diminazene aceturate (Table 2). Overall, the highest ($P < 0.05$) leucocyte count (13.36 ± 0.94 x 10^9/l)

was recorded in goats pre-treated with melatonin and administered with diminazene aceturate (Table 2). The findings of the study demonstrated, for the first time, that diminazene aceturate intoxication did not affect erythrocyte count. Hence, diminazene aceturate-induced toxicity at 7 mg/kg in goats exerted no adverse effects on the erythrocyte counts. The results showed that diminazene aceturate administration decreased leucocyte counts in goats. Interestingly, pre-treatment of goats with melatonin before diminazene aceturate administration increased the leucocyte counts. The results suggest that diminazene aceturate exerted an undesirable depressant effect on the bone marrow, alleviated by melatonin. The finding is consistent with the report of Anwar

Table 1: Red blood cells count (x 10^6/l) of Kano Brown goats co-administered with diminazene aceturate (DA) and melatonin.

Groups	Day post-administration of diminazene aceturate				
	1	4	7	10	Overall
Control	6.26 ± 0.57	6.38 ± 0.96	4.76 ± 0.46	4.88 ± 0.60	5.57 ± 0.35
Melatonin	6.76 ± 1.03	6.68 ± 0.86	5.70 ± 0.87	5.48 ± 0.87	6.16 ± 0.44
Melatonin + DA	5.44 ± 0.54	5.38 ± 0.64	4.72 ± 0.52	5.26 ± 0.69	5.20 ± 0.28
DA	6.74 ± 0.55	5.90 ± 0.53	5.86 ± 0.60	6.30 ± 0.70	6.20 ± 0.29

Table 2: White blood cells count (x 10^9/l) of Kano Brown goats co-administered with diminazene aceturate (DA) and melatonin.

Groups	Day post-administration of diminazene aceturate			
	1	4	7	10
Control	10.30 ± 0.59	11.00 ± 1.39	11.38 ± 1.35^{ab}	12.90 ± 1.44
Melatonin	11.66 ± 1.29	13.50 ± 1.86	10.66 ± 2.04^{ab}	12.04 ± 1.39
Melatonin + DA	11.02 ± 1.49	15.12 ± 2.82	13.56 ± 1.06^{b}	13.74 ± 1.80
DA	11.24 ± 1.78	11.02 ± 1.43	8.20 ± 0.52^{a}	10.42 ± 1.38

$^{a, b}$: Means within the same column belonging to different groups and having different superscript letters are significantly ($P < 0.05$) different.

et al. (1998) that melatonin exerts protective and stimulatory effects on bone marrow, exposed to damage by chemical substances. The result shows that immunosuppression occurring in trypanosomosis (Bassi *et al*., 2018) may be aggravated in diminazene aceturate-treated goats by reduction in the leucocyte counts. This may be responsible for the death of trypanosomosis-infected animals administered with diminazene aceturate at high dose of 7 mg/kg. However in the present study, melatonin enhanced immune responses by increasing the leucocyte counts in treated goats. The findings agreed with the report of Nickovic *et al*. (2018) that melatonin is an immunostimulant agent, and may be beneficial in developing novel adjuvant therapies against diminazene aceturate-induced toxicity.

Conclusion and Recommendation

Diminazene aceturate decreased total leucocyte count (10.22 ± 0.68 x 10^9/l) in goats, while melatonin increased the count in diminazene aceturate-treated goats (13.36 ± 0.94 x 10^9/l). Clinicians should co-administer melatonin to trypanosomosis-infected goats treated with diminazene aceturate in order to increase their leucocyte counts.

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Effect of Biochemical Constituents of *Detarium senegalensis* root (tallow tree) and *Eucalyptus camaldulensis* leaf (river red gum) mixed Methanolic Extracts on *Trypanosome brucei-brucei* using Mice Model

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Abstract
Medicinal plants are considered to be of great importance to human because they contain active constituents which can be used to treat different diseases. Methanol extracts of *Detarium senegalensis*(root) and *Eucalyptus camaldulensis* (leaf) were screened for trypanocidal activity. Mice infected with *Trypanosoma brucei-brucei* were treated with methanol extracts of root of D. *senegalensis* and leaf of *E. camaldulensis*. The combination of the extracts in different ratios (1:1,2:1,3:1,1:0 and 0:1) were administered intraperitoneally at a combined dose level of 200mg/Kg body weight/day respectively. Parasitemia was found to increase in all animals with a short relapse and an increase that proceeded till death, except for the ones treated with 2:1(group B) and 0:1(group E) which survived for 26days and 30days respectively. In the repeat screening with 2:1 and 0:1 doses, parasites were cleared from the blood but resurfaced two days later while treatment was on. Only animals treated with 0:1 dose survived for 19 days. This study indicates the possibility of exploiting *Eucalyptus camaldulens* for the treatment of Trypanosomosis since its activity was more pronounced.

Key words: Diseases, Medicinal plants, Parasitemia, Relaps

Introduction
Nigeria's biodiversity is rich in medicinal plants. Over 25% of our common medicines contain at least some compounds obtained from plants (Mann and Ogbadoyi, 2012). The World Health Organization reported that 70–90% of the world's population relies chiefly on traditional medicine and a major part of the traditional therapies involve the use of plant extracts or their active constituents (Kumar and Navaratnam, 2013). The local use of natural plants as primary health remedies is due to their pharmacological properties (Robinson *et al.,* 2011). Many plant extracts owe their potency to the presence of metabolites. These metabolites are usually found in various parts of the plants like roots, leaf, shoots and bark. Many plants have therefore become sources of important drugs and as such the pharmaceutical industries have exploited traditional medicine as a source of bioactive agents that can be used in the preparation of synthetic medicine (Kennedy and Wightman, 2011). Natural products play important roles in drug discovery and development process, particularly in the field of infectious diseases, where 75% of these drugs are of natural origin (Song *et al.,* 2014). Trypanosomiasis, a disease of major importance in human and animals has continued to threaten human health and economical development (Grant *et al.,* 2015). T. b. gambiense and T. b. rhodesiense as the etiological agents of trypanosomiasis affect millions of people in sub-Saharan Africa and are responsible for the death of about half a million patients per year (Rodgers *et al.,* 2011)

Therefore, the present study aimed to investigate the *in vivo* antitrypanosomal activity of *Detarium senegalensis* (root) and *Eucalyptus camaldulensis* (leaf) mixed methanolic extracts

MATERIALS AND METHODS
The experimental animals used were healthy adult albino mice. The mice were obtained from VOM, Plateau State. They were kept in safe cages and were adequately fed. The underlying

saw dust in the cage containing the mice were changed regularly and allowed free access to water.

Trypanosome brucei-brucei was obtained from the Biochemistry and Chemotherapy Division, National Institute for Trypanosomiasis Research (NITR) VOM, Plateau State. *Eucalyptus camaldulensis* leaf was obtained from Old Secretariat, Minna, Niger State. The leaf were rinsed, air dried and grounded into powder using pestle and mortar. The *D. senegalensis* root was obtained from Suleja, Niger State. The root was rinsed, air dried and grounded into fine granules using mortar and pestle as well. One hundred (100) g of the dried samples were weighed and 400 mL of methanol was added into distillation flask and extracted at 65 ^{o}C by reflux heating for 2hours. After 2 hours, the solution was transferred into a rotary evaporator flask to evaporation until a considerable amount of methanol was obtained. The filtrate was evaporated to dryness with the aid of steam bath and the extract was obtained. The dried extract was transferred into sample bottles and stored in a refrigerator.

Results and Discussion

The result obtained from the study shows that *E. camaldulensis* methanol leaf extract shows anti-trypanosomal activity. The parasitemic level observed animals receiving different doses of *E. camaldulensis* show suppressive effects as compared with the negative control (infected but not treated) figure 1.

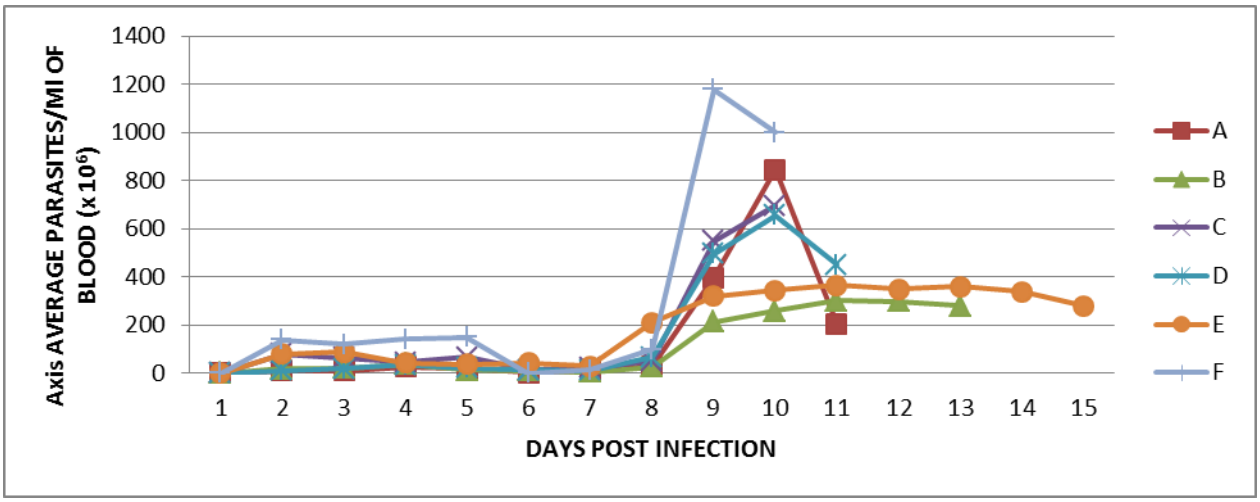

Fig 1: shows the result of antitrypanosomal activity of combined extracts of *D. senegalensis (*root) and *E. camaldulensisi (*leaf*)* in phase one of the experiments. Animals treated with extract ratio of 1:1, 3:1 and 1:0 could not survive post treatment. The animals showed high parasitemia level per microscopic field before death.

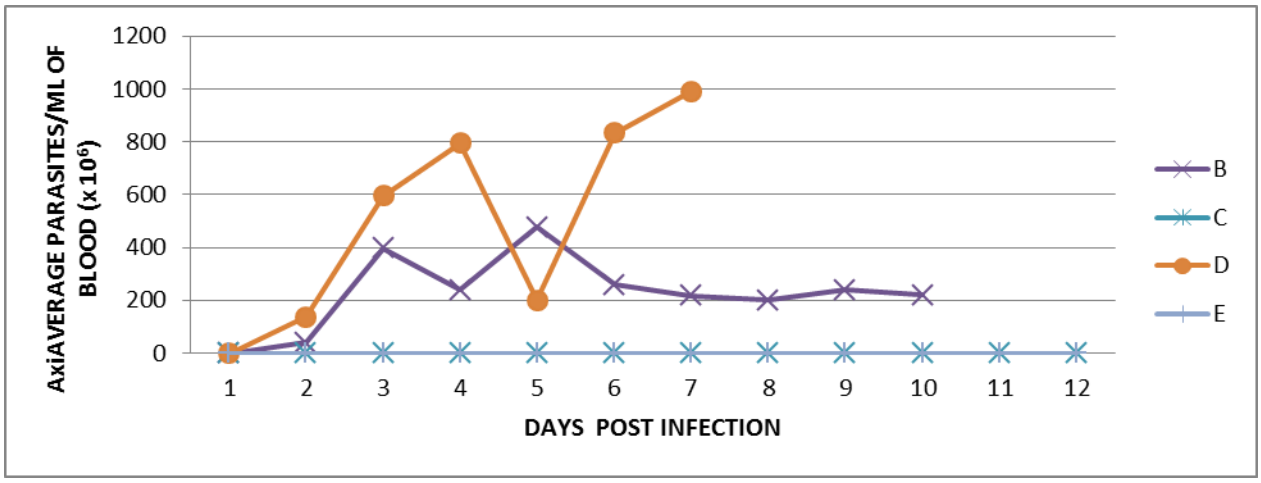

Fig 2: shows the result for the repeat screening for anti trypanosomal activity using effective combinations 2:1 and 0:1. It shows that the methanol extract of *E. camaldulensis* (leaf) is most effective against trypanosomosis. A 2:1, B 0:1, C Berenil (3.5 mg/kgbw), D Infected, not treated (negative control) and E Not infected not treated (positive control).

Plants of different families could possess potent trypanocidal activity. It is therefore, not surprising that the plants tested showed promising trypanocidal effects. Atawodi *et al.,* (2004), reported that these plants drastically reduced motility of *T. b. brucei*, in vitro. This has prompted the in vivo study to verify the efficacy exhibited in vitro. Many researched have been done in anti-trypansomal activity of different medicinal plants such as *Annona* senegalensis, bitter kola, *Azadirchta indica* (Neem), *Adansonia digitata*, and most plant extracts were found to show different level of experimental anti-trypanosomal activities (Rajendran *et al.,* 2014).

The results obtained with methanolic extract of *Eucalyptus camaldulensis* agrees with the previous work done on *Annona senegalensis*. The extract of *Annona senegalensis* was used to treat mice orally and intra peritoneally, the parasites were cleared from circulation after few days of infection (Mustapha, 2013). It was observed that *Eucalyptus* extract to some extent showed same effect of anti-trypanosome activity as most parasites were cleared from circulation and the animal survived longer than the negative control group.

Eucalyptus leaf was reported to contain high level of phenolic and terpenoid (which can be toxic), Oleic acid, ascorbic acid, butilinic acid (Vuong *et al.,* 2015). Natural products such as alkaloids, terpenes, quinones, and polyphenols found in these extracts have been shown to be potent growth inhibition of *T. cruzi* (da Silva, da Silva, & Correia, 2017). Triterpenoids and sterols from the plants are reported to possess anti trypanosomal activity (Ibrahim *et al.,* 2014). The anti trypanosomal activities of alkaloids like actinodaphine, dicentine, cassythine isolated from *Cassytha filiformis* (Andre *et al.,* 2007) are also found in *B. buonopozense* and several other alkaloids displayed significant *in vitro* anti trypanosomal activity (Andre *et al.,* 2007). The DNA intercalation in combination with portion biosynthesis inhibition is reported to be the mechanism of action responsible for the observed anti-trypanosomal effect of the active alkaloids (Merschjohann *et al.,* 2001). The trypanocidal activity of several flavonoids such as quercetagetin (Tasdemir *et al.,* 2006); hispidulin and santin (Muschietti *et al.,* 2013) has been previously reported. An azaanthraquinone early reported in *A. nilotica* was associated with the observed anti trypanosomal effects (Passalacqua *et al.,* 2015). Although it is difficult to speculate the mechanism by which this extract exhibits their trypanocidal actions, however accumulated evidence suggests that many natural products exhibits their trypanocidal activity

by virtue of their interference with the redox balance of the parasites acting on their respiratory chain or their cellular defenses against oxidative stress (Adebayo *et al.,* 2013). This may be so because the natural products possess structures capable of generating radical; this may cause peroxidative damage to trypanothione reductase that is very sensitive to alterations in the redox balance. It is also known that some agent act by binding with the kinetoplast DNA of the parasite (Halici *et al.,* 2011).

Conclusion and Recommendation

In this *in vivo* studies, with mice infected with *T. b. brucei*; the methanol extracts of *E.* camaldulensis and *D. senegalensis* were found to be significantly active. Therefore, the trypanocidal effects of extracts will require further experimentation after fractionation and characterization using chromatographic and spectroscopic techniques, a work that is currently in progress.

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HELMINTH FAUNA OF THE FIVE PHENOTYPES OF THE NIGERIAN LOCAL CHICKEN IN NSUKKA, ENUGU STATE, NIGERIA.

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Abstract

With the rise in the rearing of local chicken in Nigeria, it becomes pertinent to study various aspects of diseases affecting this type of chicken. In this study five phenotypes (normal, frizzle feathered, wild type, naked and crested neck) of the Nigerian local chicken in Nsukka, Enugu State, Nigeria were screened for helminth parasites. An overall prevalence (OP) of 84% (95% CI = 0.6473 to 0.9421) was recorded. The helminth fauna of the five phenotypes were observed to be made up of *Ascaridia galli* (OP 32%), *Raillietina sp.* (OP 64%) and *Tetrameres sp.* (OP 16%). Single and mixed infections were observed in the study; single infections of *Raillietina sp.* was the highest occurring (40%) while a mixed infection of *Ascaridia* galli and *Raillietina sp*. occurred most (20%). Crested neck showed the highest prevalence (100%) of helminth infection (95% CI = 0.5109 to 1.0000) while the other four (4) phenotypes had 80% prevalence of helminth infections (95% CI = 0.3596 to 0.9797) each. The high prevalence reported across all the phenotypes was likely attributed to the poor management and feeding habit of the Nigerian local chicken. It is recommended that farmers adopt the intensive system of management for the rearing of the Nigerian local chicken and regular anthelmintic treatment of their birds.

Keywords: Nigerian local chicken, *Ascaridia galli, Raillietina sp., Tetrameres sp.*, avian helminthosis

Introduction

Poultry is widely distributed across Africa and the world in general. Among members of the poultry family, chicken is the most common and accounts for approximately 98% of the total poultry population in Africa (Solomon and Udoh, 2017). In Nigeria, indigenous/ local birds take up about 80% (120 million) of the 150 million total population of poultry, while the exotic birds make up the remaining 20% or 30 million (RIM, 1992).

Generally, poultry production is hindered by poor management system and diseases (Adang *et al.*, 2014). According to Adang *et al*. (2014), gastrointestinal parasitism constitutes a major threat to poultry production especially in the extensive and semi-extensive systems which are the major systems of production used for the Nigerian local chicken (NLC). Helminthosis has been reported to result to weight loss, depression and reduced egg production in avian species (Yazwinski *et al.*, 2013).

Rearing of indigenous birds serves as a source of protein and income to most inhabitants of rural communities in the tropical and subtropical areas (Odubote, 2015; Padhi, 2016). They are thought to be delicacies as they are considered much tastier, flavourful and lean (Ajayi, 2010). They are also hardy; expressing high level of disease resistance and adaptability to the adverse tropical climatic conditions, and exhibiting slow maturity and growth rate (Padhi, 2016).

Five phenotypes of the Nigerian local chicken has been described based on their feather arrangement, plumage colour, body size, structure and colour variants (Ajayi and Agavieozor, 2009). These phenotypes are divided into three common phenotypes of normal feathered, frizzle feathered and naked neck and two less common phenotypes of crested neck and wild type. The normal feathered is the highest occurring followed by the naked neck and frizzled feathered while the crested neck and wild types are the least occurring (Ajayi and Agavieozor, 2009).

Various researchers have observed variations in the production, maturity, weight gain, haematological parameters, adaptation etc among the five phenotypes (Ajayi, 2010; Ibe, 1993). Frizzle feathered and naked necks were observed to produce bigger and greater number of eggs, greater body weight gain and earlier maturity than the normal feathered (Ajayi, 2010). Frizzle feathered showed superior haematological parameters, indicating greater cell mediated immunological prowess and feed conversion efficiency (Solomon and Udoh, 2017). Thus it can be inferred that the Frizzle feathered will be more resistant to infections than other phenotypes.

The paucity of information on the helminth parasite fauna of the Nigerian local chicken prompted this study.

Materials and method

A total of twenty-five (25) Nigerian local chickens made up of five males from each of the five phenotypes, bought from the local communities in Nsukka, were examined post mortem. The birds were eviscerated and the gastrointestinal tract (GIT) placed in labelled petri dishes containing normal saline. The gastrointestinal tracts were split open using a dissecting knife; the parasites found were viewed under a stereomicroscope and were identified according to Soulsby (1982).

Statistical analysis

The prevalence rates were analyzed using descriptive statistical analysis and presented in tables. The mean intensity and mean abundance were equally calculated.

Results

Three helminth parasites (2 nematodes; *Ascaridia galli* and *Tetrameres sp.* and 1 cestode; *Raillietina sp.*) were observed in the study. The overall prevalence (OP) of helminth infections was 84% (95% CI = 0.6473 to 0.9421). *Raillietina sp.* had the highest OP of 64% followed by *Ascaridia galli* with OP of 32% and *Tetrameres sp.* with OP of 16% (Table 1).

The overall prevalence of helminth infection among the five phenotypes is represented in Table 2. Crested neck had the highest helminth infection prevalence of 100% while the other 4 phenotypes recorded 80% prevalence each.

Table 1: Overall prevalence of helminth infections in the Nigerian local chicken

	Number of NLC infected	Number of NLC screened	Overall prevalence
Raillietina sp.	16	25	64%
Ascaridia galli	8	25	32%
Tetrameres sp.	4	25	16%
Overall prevalence	21	25	84%

Table 2: Overall prevalence of helminth infection in the five phenotypes of the Nigerian local chicken

Phenotype	Overall Prevalence of helminth infection (N = 25)	
Normal feathered	80%	(95% CI = 0.3596 to 0.9797)
Naked neck	80%	(95% CI = 0.3596 to 0.9797)
Frizzle feathered	80%	(95% CI = 0.3596 to 0.9797)
Wild type	80%	(95% CI = 0.3596 to 0.9797)
Crested neck	100%	(95% CI = 0.5109 to 1.0000)

Table 3 shows the prevalence rate, mean intensity and mean abundance of the three helminth parasites recovered from the five phenotypes. *Raillietina sp.* in the crested neck phenotype had the highest prevalence rate of 100% followed by the frizzle feathered with a prevalence of 80% (Table 3).

Table 3: Prevalence of the various helminthes recovered in the five phenotypes of the Nigerian local chicken.

	Phenotype	Helminth parasite	Prevalence	Mean intensity	Mean abundance
1.	Normal feathered	*Raillietina sp.*	60%	5	2
		Ascaridia galli	40%	1	0.4
2.	Naked neck	*Raillietina sp.*	60%	10	6
		Ascaridia galli	20%	30	12
		Tetrameres sp.	40%	NA	NA
3.	Frizzle feathered	*Raillietina sp.*	80%	7.25	5.8
		Ascaridia galli	20%	1	0.20
4.	Wild type	*Raillietina sp.*	40%	16.5	6.6
		Ascaridia galli	20%	2	0.4
		Tetrameres sp.	40%	NA	NA
5.	Crested neck	*Raillietina sp.*	100%	7.2	7.2
		Ascaridia galli	40%	6	2.4

*NA – Not Applicable

Single and mixed infections were observed in this study. Mixed infections with *Ascaridia galli* and *Raillietina sp*. occurred most with a prevalence of 20% (Table 4); while the single infection of *Raillietina sp* was observed to have the highest prevalence of 40% (Table 4).

Table 4: Single and mixed infection rate with two or more parasites in the Nigerian local chicken.

Helminthes	No. Infected	No. examined	Prevalence (N = 25)
Ascaridia galli + Raillietina sp.	5	25	20%
Raillietina sp. + Tetrameres sp.	1	25	4%
Ascaridia galli + Raillietina sp. + Tetramere sp	1	25	4%

Ascaridia galli* + *Tetrameres sp.	0	25	nil
***Ascaridia galli* only**	2	25	8%
***Raillietina sp.* only**	10	25	40%
***Tetrameres sp.* only**	**2**	**25**	8%

Discussion and Conclusion

A very high prevalence for helminth infection (84%) was observed in the NLC in Nsukka and though this could be attributed to the small sample size, it is consistent with the prevalence rates recorded by some other researchers across Nigeria; 81.3% in Gombe State (Adang *et al.*, 2014), 87.8% in Bauchi State (Yoriyo *et al.*, 2008) and 96.8% in Nsukka Enugu State (Idika *et al.*, 2015). But higher than that of Dawet *et al.*, (2012) who reported 37.85% in Jos, Plateau State.

The high prevalence recorded can be related to the fact that the NLC are mostly left to roam and scavenge for food during which they pick up insects which may be intermediate hosts of various parasites such as *Raillietina sp.* and *Tetrameres sp.* These roaming birds are equally exposed to contaminated soil that could contain infective stages of parasites.

Gastrointestinal parasitism interferes with host's metabolism, thus resulting in poor feed utilization, reduced growth and rarely death in severe cases (Dawet *et al.*, 2012). *Raillietina sp*., which causes nutrient depletion, was the highest occurring followed by *Ascaridia galli*, which interferes with the intestinal surface area for absorption of nutrients and also blockage when they occur in large numbers. These two parasites have been reported to be the most common helminthes of birds (Idika *et al.*, 2015).

The massive infection rate of helminth parasites is the most likely reason why the NLC are thought to have slow growth rate and feed conversion. It is possible that under good management system and regular anthelmintic treatments they could perform optimally.

In conclusion, farmers should be enlightened on the need for better management system, such as the intensive system of management, for the rearing of local chickens and the need for an anthelmintic regimen/schedule for their birds.

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PREVALENCE AND HEMATOLOGICAL PARAMETERS OF BOVINE TRYPANOSOMOSIS IN AGUATA AND ORUMBA SOUTH LOCAL GOVERNMENT AREAS OF ANAMBRA STATE

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Abstract

The prevalence and hematological parameters of bovine trypanosomosis were investigated in Aguata and Orumba South Local Government Areas (LGA) of Anambra State. 210 cattle were randomly sampled in Aguata (140) and Orumba South (70) LGAs between February and May, 2017. The blood samples were collected into well labeled bottles containing EDTA. Characteristics of each slaughtered cattle such as sex, breed and body condition scores were noted. The blood samples were screened for trypanosomosis using standard detection techniques. Some hematological parameters of each of the blood samples such as packed cell volume (PCV), red blood cell count (RBC) and white blood cell count (WBC) were also determined using standard techniques. Of the 140 cattle screened at Aguata LGA, 16 (11.43%) were positive for trypanosomosis while 6 (8.57%) were positive out of the 70 cattle screened at Orumba South LGA. The overall prevalence of bovine trypanosomosis was 10.48%. Body condition score significantly influenced ($p<0.05$) the prevalence of bovine trypanosomosis in the study area while sex and breed did not. The PCV, RBC and WBC of the infected cattle differed significantly ($p<0.05$) from those of uninfected cattle. It was therefore concluded that bovine trypanosomosis is endemic in Aguata and Orumba South LGAs and is associated with changes in hematological parameters.

Keywords: Prevalence; hematological parameters; trypanosomes; cattle; Anambra State.

Introduction

African trypanosomosis is caused by one or more of the tsetse fly-borne haemoflagellate protozoan parasites belonging to the genus *Trypanosoma* (Anene *et al.*, 2001). The disease has been continually recognized as a cause of morbidity and mortality since 20th century in humans and animals throughout sub-Saharan Africa (Oyewusi *et al.*, 2010). African trypanosomosis has remained a serious setback to improved and profitable livestock production, crop production and the realization of the millennium development goals (MDGs) in tropical Africa (Oyewusi *et al.*, 2010). Presently, about 55,000 human and 3 million livestock deaths reported annually are attributable to the disease, with over 60 million people and 48 - 55 million livestock at risk (Obi *et al.*, 2013).

Nigeria, the most populated country in Africa and with the highest number of cattle in West Africa (Samdi *et al.*, 2010), is heavily at risk. The socioeconomic effects of the trypanosomosis are still on the increase, thus effective control of the disease is imperative. Despite almost a century of tsetse and trypanosomosis control efforts, the disease still ravages Nigeria and the sub-Saharan Africa, and is still far from been resolved.

The prevalence of trypanosomosis in different parts of Nigeria has been variously reported by several researchers (Odeniran and Ademola, 2018). However, paucity of information exists on the prevalence of bovine trypanosomosis in Anambra State especially in Aguata and Orumba

South Local Government Areas (LGA). Given the zoonotic nature of bovine trypanosomosis, active surveillance is highly essential. Thus, this study seeks to determine the hematological parameters and prevalence of bovine trypanosomosis in Aguata and Orumba South Local Government Areas of Anambra State, Nigeria.

Materials and method

Study area: The study was conducted between February and May, 2017 in Aguata LGA (Uga slaughter slab and Igbo-Ukwu slaughter slab) and Orumba South Local Government Area (Umunze slaughter slab) of Anambra State.

Study population and sampling method: 210 cattle presented for slaughter at these slaughter slabs were randomly sampled. The sex, breed and body condition scores of the cattle were recorded. Breed identification was based on morphology while appearance of external genitals was the basis for sex differentiation. The body condition score of cattle was evaluated on a four point scale based on slight modification of the method described by DEFRA (2001).

Blood sample collection: 3 milliliters of blood samples were collected from the jugular vein of cattle at slaughter into a labeled sample bottle containing EDTA. The blood samples were placed in a flask containing ice packs before being transported to the Animal Science Laboratory of the Department of Agricultural Education, Federal College of Education (Technical), Umunze for analysis.

Trypanosome detection and hematological analysis: The blood samples were screened for trypanosomes using standard detection techniques; wet blood films, buffy coat method and Leishman stained thin smear (Murray *et al.*, 1977). The packed cell volume (PCV), red blood cell count (RBC) and White blood cell count (WBC) were also determined using standard techniques (Coles, 1986).

Data analysis: The data obtained from this study were analyzed using Graphpad® statistical software. Chi-square test was used to determine the possible association between the prevalence rates and sex, breed, and body condition scores. Hematological parameters were compared using students' t-test. Values of $p<0.05$ were considered significant.

Results and Discussion

The prevalence of bovine trypanosomosis were 8.57% and 11.43% for Orumba South and Aguata LGAs respectively while the overall prevalence rate was 10.48% (Table 1). This finding was very high compared to the 2.2% and 3.7% reported by Samdi *et al.* (2011) in Kaduna and Ohaeri (2010) in some parts of Abia State respectively. The 46.8% prevalence recorded by Majekodunmi *et al.* (2013) in Jos was higher than the prevalence rate obtained in the current study. The differences in the prevalence rates of bovine trypanosomosis could be attributed to the climatic conditions of the different locations, season, availability of the vector, diagnostic method utilized, livestock management system, frequency of trypanocidal intervention amongst other factors.

In Aguata LGA, males had a prevalence rate of 7.14% while females had 4.29% prevalence (Table 1). Orumba South LGA recorded 7.14% and 1.42% prevalence rates for male and female cattle respectively. The overall prevalence for both male and female cattle in the study area was 7.14% and 3.33% respectively. Based on the breeds of cattle sampled, White Fulani, Sokoto Gudali and Red Bororo had 8.57%, 2.14% and 0.71% prevalence rates respectively in Aguata LGA while in Orumba South LGA, 1.42%, 5.71% and 1.42% prevalence were obtained for White Fulani, Sokoto Gudali and Red Bororo respectively. The overall prevalence rates were 6.19%, 3.33% and 0.95% for white Fulani, Sokoto Gudali and Red Bororo respectively. Sex and breed were found not to exert any influence on the prevalence of bovine trypanosomosis in the study area although; male cattle and White Fulani breed of cattle were the most infected. This could be attributed to the fact that the White Fulani breed and male

cattle constituted more than half of the cattle sampled. Similar findings have been reported by several authors (Ohaeri, 2010; Samdi *et al.,* 2011).

The prevalence rates of 3.57%, 6.43%, 1.43% and 0% were obtained in cattle with thin, moderate, good and excellent body condition scores in Aguata LGA (Table 1). In Orumba South LGA, thin, moderate, good and excellent body condition scores had prevalence rates of 2.86%, 4.29%, 1.42% and 0% respectively. The overall prevalence rates were 3.3%, 5.71%, 1.42% and 0% for thin, moderate, good and excellent body condition scores. Body condition score significantly influenced ($p<0.05$) the prevalence of bovine trypanosomosis in the study area with thin (emaciated) animals being infected most. This could be attributable to poor nutrition and management as poorly fed and managed animals look emaciated and are prone to various diseases and infections including trypanosomosis.

Some hematological parameters of cattle slaughtered at both Aguata and Orumba South Local Government Areas were presented in Table 2. The mean PCV and RBC values of the cattle were found to be significantly low ($p<0.05$) when compared to the uninfected cattle suggesting anemia. Anemia is the most consistent clinical signs of trypanosomosis (Obi *et al.,* 2013) and its pathogenesis are multifactorial (Taylor and Authie, 2004). However, concurrent gastro-intestinal parasites and poor nutrition could also be attributed to the low PCV observed. The WBC counts of the cattle infected with trypanosomosis was significantly higher ($p<0.05$) than that of the uninfected cattle. This could probably be due to the body's increased production of leucocytes to fight against invading pathogens during infection (Obi *et al.,* 2013). Samdi *et al.* (2011) reported a significant decline in the PCV of the infected cattle compared to the uninfected cattle.

Conclusion

Bovine trypanosomosis is endemic in Aguata and Orumba South Local Government Areas of Anambra State and were associated with some hematological changes. Sex and breed did not influence the prevalence while body condition score influenced the prevalence of bovine trypanosomosis in the study area.

Recommendation: Systematic and radical institution of integrated trypanosomosis control measures involving vector control, chemoprophylaxis and chemotherapy so as to improve production potentials of animals and owners' economic wellbeing.

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	No exam	Infected (%)
Aguata LGA	140	16 (11.43)
Orumba South LGA	70	6 (8.57)
Overall	**210**	**22 (10.48)**

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Sex	Aguata LGA		Orumba South LGA		Overall	
	No exam	Infected (%)	No exam	Infected (%)	No exam	Infected (%)
Male	86	6 (4.29)	61	5 (7.14)	147	15 (7.14)
Female	54	10 (7.14)	9	1 (1.42)	63	7 (3.33)

Breed	Aguata LGA		Orumba South LGA		Overall	
	No exam	Infected (%)	No exam	Infected (%)	No exam	Infected (%)
Sokoto Gudali	43	3 (2.14)	31	4 (5.71)	74	7 (3.33)
Red Bororo	14	1 (0.71)	16	1 (1.42)	30	2 (0.95)
White Fulani	83	12 (8.57)	23	1 (1.42)	106	13 (6.19)

Body Condition Score	Aguata LGA		Orumba South LGA		Overall	
	No exam	Infected (%)	No exam	Infected (%)	No exam	Infected (%)
Thin	5	5 (3.57)	3	2 (2.86)	8	7 (3.33)
Moderate	51	9 (6.43)	23	3 (4.29)	74	12 (5.71)
Good	67	2 (1.43)	40	1 (1.42)	107	3 (1.42)
Excellent	17	0 (0)	4	0 (0)	21	0 (0)

TABLE 1: Prevalence of bovine trypanosomosis in Aguata and Orumba South Local Government Areas of Anambra State

TABLE 2: Hematological parameters (Mean ± SEM) of slaughtered cattle in Aguata and Orumba South Local Government Areas of Anambra State

	Aguata LGA		Orumba South LGA		Overall	
	Uninfected	Infected	Uninfected	Infected	Uninfected	Infected
PCV	34.85±0.48[a]	25.75±1.28[b]	28.5±0.99[a]	36.3±0.43[b]	35.36±0.33[a]	26.50±0.99[b]
RBC	6.32±0.11[a]	3.12±0.35[b]	5.21±0.26[a]	7.07±0.08[b]	6.55±0.08[a]	3.69±0.33[b]
WBC	10.16±0.43[a]	12.85±1.29[b]	8.90±0.16[a]	7.84±0.11[b]	9.37±0.30[a]	11.77±1.01[b]

[ab] *Rows with different superscripts differ significantly at ($p<0.05$).*

SCEPTICAEMIC COLIFORMS IN BROILER CHICKENS ADMINISTERED EXTRACTS OF MANGO (*Magnifera indica)* AND NEEM *(Azadirachta indica)* BARK OBTAINED BY DIFFERENT METHODS

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Abstract

Two hundred and eighty-eight-day old broiler chicks were used in a 56 days trial to investigate the effects of different methods of extraction of *Mangifera indica* (Mango) and *Azadirachta indica* (Neem) bark extracts on scepticaemic coliforms in broiler chickens. The birds were divided into two groups (144 each) and each group was sub divided into four (4) sub groups comprising of 36 birds replicated thrice with 12 birds each. Each sub group was either administered *Mangifera indica* or *Azadirachta indica* extract obtained from different extraction methods; maceration, infusion, decoction and control (antibiotics only). Extracts were administered in water at the rate of 150ml/litre without any antibiotics except the controls. Blood samples were collected at the 4th and 8th weeks to determine the total blood coliform count. Data collected were subjected to one-way Analysis of Variance in a 2 *4 factorial experimental layout. Results obtained showed that the two herbs had similar effects on the total blood coliform counts at starter and finisher phases. Total blood coliform count reduced with respect to different extraction methods as against control at the starter phase, however no significant difference (P>0.05) was observed at the finisher phase. It was concluded that both herbs had similar effects on scepticaemic coliforms. Different methods of extraction reduced coliform counts at starter phase, however, infusion method of extraction was more effective, hence recommended.

Keywords: *Azadirachta indica,* Coliforms, Extraction, *Mangifera indica* and Scepticaemic

Introduction

Coliform infections have been implicated as a major cause of morbidity, mortality, and condemnations in chickens and turkeys in recent years (Joe and Delbert, 2009). In bid to curtail this, antibiotics of different strain have been used which later resulted in the development of resistance in the bird against these allopathic medicines, with the accumulation of residues both in meat and eggs, which could pose threat to human health. Phytobiotics, being immunostimulant (Rangasamy and Kallipan, 2007) is considered one of the desirable alternatives, and if used wisely can reduce chemotherapeutic load in birds. The herbal remedies are cost effective, having minimum toxicity with reduced health hazards (Khandaker *et al*., 2016).

Several studies have reported antibacterial activites (Debashri and Tamals, 2012; Maragathavalli *et al.,* 2012) and antiviral properties of neem (Durrani *et al*., 2008; Sadekar *et al*., 1998). Mango has been reported to show moderate anti-microbial activity against Gram positive bacteria (Islam *et al*., 2010). It has also recently been reported that the extract of *Mango* exerted antifungal activity (Kanwal *et al.,* 2010).

The present study was therefore conducted to determine the effects of different methods of extraction of Mango (*Mangifera indica*) and Neem (*Azadirachta indica*) bark on scepticaemic coliforms in broiler production.

Materials and Methods

Experimental Site

The experiment was carried out at the Directorate of University Farms, (DUFARMS) of the Federal University of Agriculture, Abeokuta, South-west, Ogun State, Nigeria. The farm area lies within latitude 7°10'N. Longitude 3°2'E and Altitude 76mm above the sea level (Google Earth, 2017)

Source of Test Ingredients and Preparation

Fresh neem and mango bark were collected from Neem and mango tree within and outside the university premises. They were air dried until they became dried and cut into smaller pieces. Three methods of extraction namely: Maceration, infusion and Decoction were used to get extracts from neem and mango bark.

Maceration: 100g of air-dried neem and mango bark were soaked inside 1 litre of water for 72 hours in a separate container after which the solution was filtered to obtain the aqueous extract.

Infusion: involves soaking 100g of neem and mango bark separately in 1 litre of hot water each for 12 hours to obtain the extract by filtration.

Decoction**:** this involves cooking 100g of neem and mango bark separately in 1 litre of water for two hours after which it was cooled before the extract was collected for use.

Experimental Birds, Design and Management

A total number of 288 commercial broiler day old chicks were obtained from a reputable hatchery. The experiment was arranged in a 2×4 factorial layout comprising of eight treatment groups. The birds were divided into two groups (144 each). Each group was sub divided into four (4) sub groups comprising of 36 birds replicated thrice with 12 birds each. Each sub group was either administered *Mangifera indica* or *Azadirachta indica* obtained from different extraction methods; maceration, infusion, decoction and control (antibiotics). The birds were brooded for two weeks. Birds administered either of the herbs were equally vaccinated and medicated except that no antibiotics was given but herbs. Herbs were supplied in their water for three consecutive days per week. Birds were fed *ad libitum* with commercial broiler starter (0-4weeks) and finisher (4-8weeks).

Data collection

Total Blood Coliform Count.

At the 28th day and 56th day, one bird from each replicate was selected and 3ml of blood was collected from them via the wing vein into a plain bottle. The blood samples were taken to the

laboratory for determination of total bacteria count and coliform count according to Kinley (2009).

Statistical Analysis

Data collected were arranged in a 2×4 factorial layout and subjected to Analysis of Variance in a Completely Randomized Design using SAS (1999). Significant (P<0.05) differences among means were separated using Duncan Multiple Range Test as contained in the software

RESULTS

The effect of herbs and extraction methods of herbs on total blood coliform bacteria count in broiler chickens at starter and finisher phases is presented in Table 1. Coliform count was similar (p>0.05) between birds administered extract of *Mangifera indica and Azadirachta indica* at both starter and finisher phase. Extraction methods (maceration, infusion and decoction) of herbs reduced (p<0.05) coliform count at starter phase as against the control groups (antibiotics). However, coliform count was not affected by extraction methods at the finisher phase and the values ranged from (0.00 -267.50 cfu).

The result revealed that interaction of herbs and the different methods of extraction significantly (p<0.05) affected the total blood coliform count of the broiler birds at starter phase but had no effect (P>0.05) at the finisher phase. The control birds of the *Azadirachta indica* group had the highest coliform count (530.67cfu) while values were similar among other groups.

Table 1: Effect of herbs and different extraction methods on total blood coliform count in broiler chickens at starter and finisher phases

			Starter phase Coliform count(cfu)	Finisher phase Coliform count (cfu)
Herbs		Mango	125.67±36.13	260.63±98.53
		Neem	183.17±75.58	134.38±88.00
Extraction Methods		Control	357.33±88.04[a]	258.75±149.42
		Maceration	144.67±95.12[b]	263.75±152.28
		Infusion	27.67±26.10[b]	0.00±0.00
		Decoction	88±41.37[b]	267.5±154.56
Herbs * Extraction Methods	*Mangifera indica*	Control	184.00±92.53[b]	255.00±255.00
		Maceration	104.00±96.11[b]	527.50±2.50
		Infusion	52.67±52.67[b]	0.00±0.00
		Decoction	162.00±53.70[b]	260.00±260.00

	Azadirachta indica	Control	530.67±12.1[a]	262.25±262.25
		Maceration	185.33±185.33[b]	0.00±0.00
		Infusion	2.67±2.67[b]	0.00±0.00
		Decoction	14.00±14.00[b]	275.00±275.00

[a,b] Means on the same column are significantly different ($p<0.05$)

DISCUSSION

In this study, reduced total coliform count by different extraction methods of herbs corroborate the study of (Cross *et al*., 2007) who stated that some plant extracts exhibit antibacterial, antiviral and antioxidant properties. The antibacterial effect of neem in this study can be attributed to the presence of nimbidin, the main active antibacterial agent in the neem bark as reported by Biswas *et al.* (2002).

The antibacterial activity of mango in this present study is in accordance with Savikin *et al*. (2009) who demonstrated the antibacterial activity of mango extract upon gram-positive and gram-negative bacteria in his research which he attributed to the presence of tannin and mangiferin. The result of this study is also in agreement with Vega-Vega *et al*. (2013) who found the anti-bacterial ability of mango extract against *Salmonella and E. coli.*

In this study, infusion method of herb preparation or extraction was more effective, and this may be because large quantity of inert materials (ballast) that has no therapeutic value is extracted when maceration and decoction method were used (Azwanida, 2015).

Conclusion

It can be concluded that both herbs had similar effects on scepticaemic coliforms. Different methods of extraction reduced coliform counts at starter phase, however, infusion method of extraction was more effective.

Recommendation

Both herbs and any other of the extraction methods can be used to reduce coliform load in the blood of chicken especially at the starter phase.

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LIVESTOCK VACCINATION: A VERITABLE TOOL IN THE CAMPAIGN FOR FOOD SECURITY IN NIGERIA- A REVIEW

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Abstract

The impact of disease and its outbreak on livestock production has necessitated the need for vaccination. Livestock farmers worldwide are embracing the use of vaccines to improve health of animals and reduce losses resulting from diseases. This is crucial so as to ensure food security and meet the demand of the growing global population for livestock products. Livestock accounts for one third of Nigeria's agricultural GDP. Animal vaccination continues to play a key role in disease control programmes in livestock production and may also aid in the responsible use of antibiotics. Investment in making vaccines available to farmers and innovative research into development of effective and safe veterinary vaccines is highly recommended for continued benefit to livestock producers. This help to increase the production of safe and affordable livestock products in Nigeria. Recent studies have recommended continued research, awareness, development and availability of vaccines in the rabbit, pig, cattle and poultry industries in Nigeria. These can be achieved through collaborative efforts of stakeholders of veterinary health in Nigeria.

Keywords: Vaccination, Livestock, Veritable, Tool, Food Security.

Introduction

Livestock account for one third of Nigeria's agricultural GDP. It provides income, employment, food, farm energy, manure, fuel and transport. Livestock is also a major source of government revenue. From the year 1961 to 2011, average meat consumption in the world increased from 23 to 43kg per capita/year, while milk consumption increased from 75 to 87 kg per capita/year (FAOSTAT, 2013). Meat and milk production is also consistently increasing at approximately 2.2% per year. Several studies have demonstrated the importance of inherent losses from infectious animal diseases and emerging zoonotic risks threatening humanity. The death of a single animal can have dire consequences on vulnerable households by reducing their ability to withstand food crises and to emerge from poverty. (Comfort *et al*., 2018; FAO, 2016). This can cumulatively affect the gross economy of a nation, most importantly, developing countries like Nigeria still grappling with high poverty level.

According to Fadiga *et al*. (2013), Newcastle disease (NCD) in unvaccinated village poultry has 45% background mortality. Peste des petits ruminants (PPR) in sheep and goats, Contagious Bovine pleuropneumonia (CBPP) in cattle and African swine fever (ASF) in pigs have background morbidity rates of up to 50%, with mortality rates of about 50% for PPR, 25% for CBPP and 100% for ASF. The report indicated that, livestock lost in Nigeria resulted from vaccinable diseases such as Newcastle

disease, Peste des petits ruminants, contagious bovine pleuropneumonia, African swine fever and Trypanosomiasis.

The overall financial burden of the five diseases on the national economy in 2009 was N29.2 billion, while the model outputs indicated that the cost of targeted intervention was N15.5 billion with 28.4% devoted to vaccination. The report stated that, the loss analyses include: 50% Newcastle disease in chickens and 80% in small ruminants, which led to decreased

productivity in regards to quantity and quality of eggs, milk yield, poor growth rate and increased calf mortality among others.

Proper vaccination of livestock could have prevented this colossal economic loss credited to only five animal diseases. The loss was not only limited to financial terms but also loss in food and nutrition which could have been available to feed the human population.

Among all the animal species that made up the bulk of livestock kept by farm families in the country's agricultural system in Nigeria, include cattle, sheep and goats. Nigeria's livestock population comprises of 13.9million cattle, 22.1million sheep and 34.5million goats (Lawal-Adebowale, 2011). These agricultural resources possess great economic values which must be protected in order to sustain steady growth in the agricultural sector of the economy and avert losses that can lead to huge deficits in animal-based food.

Vaccination practice is a tool that can be employed in preventing such losses. Vaccinating 70% of livestock population against these diseases will ensure herd immunity and subsequent protection of the animal and human population. Nigeria produces only a few veterinary vaccines which is not sufficient to address animal health issues in our country. For example, vaccines are yet to be produced to face certain challenges in the rabbit production industry which is in its infancy (Ume *et al*., 2016) as shown in Table 1. There is therefore the need for continued investment in animal vaccine research; improved image of veterinary vaccine and its use through campaigns, legislation and policies that support its coverage (Musa *et al*., 2013).

The objective of the study was to review the effect of livestock diseases on the economy of Nigeria and the potentials of vaccination to ensure food security in the country.

Table 1: Information on Emerging Diseases in Nigeria and Availability of their Vaccines in Nigeria.

Animal	Disease	Vaccine developed	Developed in Nigeria	Accessibility to village farmers in Nigeria
Cattle	Lumpy Skin Disease	Yes	No	No
Rabbit	Hemorrhagic disease	Yes	No	No
Pig	African Swine fever(ASF)	No	No	No
Chicken	Avian influenza(HPA1)	Yes	No	No

Source: (Agnes *et al*., 2018; Lawal-Adebowale, 2011 and Oluwole *et al*., 2012).

Vaccination in Nigeria and Focus for Future Research

In recent times, rabbit farming has been encouraged as its meat is a rich source of protein, low in cholesterol, have rapid growth rate as in broiler chicken and therefore can be a fast source of income to farmers and improve food security in Nigeria. However, Nigerian farmers are faced with challenges of untimely death of fryers from infectious diseases and parasites of rabbits not known to the extension agents who could enlighten them since rabbit farming is in its infancy in Nigeria (Baruwa, 2014).

Vaccines have been developed to protect poultry from fowl typhoid and cholera diseases (NVRI, 2016). However, continued research can be carried out on brucellosis. The research carried out by Joseph *et al*. (2018) in Anambra State revealed that, there is an urgent need for control programme against avian brucellosis which frequently cause enormous loss in animal agriculture in Nigeria. Also, development of thermostable Newcastle disease vaccine to support

poultry industry in Nigeria, where there is no stable electricity supply to keep the cold chain of vaccines (Shahid Mahmood *et al.,* 2014). Although in 2008, a field trial of Malaysian thermostable Newcastle disease vaccine was carried out in village chickens in Kaduna State, Nigeria (Nwanta *et al*., 2008).

More vaccination research on bovine brucellosis is required in Nigeria. The study carried out in Adamawa, Kaduna and Kano States, northern Nigeria and Enugu State, South -East Nigeria revealed a high prevalence of brucellosis in cattle herds (Hassan *et al*., 2012; Samuel *et.al*. (2018). Also, a recent research on *Mycobacterium bovis* in cattle by abbatior surveillance in Bauchi and Gombe States revealed its high prevalence. Urgent and intensive investment in Mycobacterium vaccination is important; especially because of its zoonotic potential (Ibrahim *et al*., 2018). According to Adedeji *et al*. (2017), twenty-three (23) Holstein Friesan calves died during repeated outbreaks of lumpy skin disease(LSD) with estimated value of N3, 180, 000 ($17,377.05) in the year 2010, 2013 – 2014 on a dairy farm in Jos, Plateau State, Nigeria. The outbreak of lumpy skin disease was also recorded in 2016 in Sokoto Gudali and Holstein Friesan crossed in a dairy farm in Nasarawa State. These were caused by Lumpy skin disease virus (LSDV) of the genus capripoxvirus; which requires animal health workers attention as reported by Adedeji *et al*. (2018).

Worldwide Porcine Reproductive and Respiratory Syndrome virus (PRRSV) and porcine parvovirus (PPV) are known to infect and cause economic loss in the pig industry (Comfort *et al*., 2018).Vaccination against these viruses are not yet available in Nigeria. However, the study conducted on the prevalence of PRRSV and PPV antibodies in 368 commercial pigs in Southwest, Nigeria revealed 53.8% and 36.1% antibody prevalence of PRRSV and PPV respectively(Comfort *et al.*, 2018) Therefore, there should be continuous monitoring of this virus in pigs in Nigeria for early detection, awareness and control measures. A study conducted by Aiki-Raji *et al*. (2018) revealed that, pigs in Ibadan, South-West Nigeria showed infection from porcine circovirus type 2(PCV2) which is one of the major agents of mortality in the swine industry. This indicates that the pigs are carriers of the virus, and there is no routine vaccination against it. It is therefore recommended that Nigeria conduct continuous surveillance of the PCV2 in pigs for control measures. Porcine pneumonia is also of economic importance in pig industry in Nigeria, the study conducted on pigs from farms in Lagos, Osun, Oyo and Ogun revealed high prevalence of bronchointestitial pneumonia. Knowledge of the causative agents and production of vaccines to protect pigs should be considered in Nigeria (Emikpe *et al*., 2018).

Conclusion

The availability of veterinary vaccines in Nigeria should be a key priority for the Veterinary Medicines and Allied Product and the National Veterinary Research Institute, VOM in charge of veterinary vaccines with the continued support of government; in order to prevent animal diseases, protect public health and also provide healthful and affordable food.

Recommendation

With the consistently growing human population in Nigeria, food security is seriously challenged and must be addressed quickly. All stakeholders must promote livestock vaccination to improve herd immunity against diseases, promote livestock health, thereby increasing animal-food production and by extension, human health.

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PERFORMANCE OF GROWING COTURNIX QUAILS (*Coturnix coturnix Japonica*) FED ENZYME SUPPLEMENTED RICE OFFAL DIETS

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Abstract

A feeding trial of 6 weeks was conducted to determine the effect of including rice offal supplemented with natuzyme on the performance of growing Japanese quails. One hundred and eighty 2 –week old quails of mixed sexes were randomly allocated to four diets in a completely randomized design. The quail chicks were allocated one of four diets containing either 0 (Control), 5, 10, and 15% of rice offal. The diets were isonitrogenous (25% CP) but decreased in energy levels from 2,779.32 (Diet A), 2,747.73 (Diet B), 2,715.54 (Diet C) to 2,683.54kcal/kg ME (Diet D). Each diet was replicated thrice with feed and water given *ad libitum*. Feed intake was significantly lower ($p<0.05$) on diet A (20.64g/bird) than on diets C (23.48) and D (24.08g/bird/day). Feed conversion ratio was significantly better ($p<0.05$) on diet A (5.87) than on diets B (7.70), C (8.36) and D (7.95) respectively. Feed cost/kg gain was significantly ($p<0.05$) better on diet A (N532.65) than on diets B (N666.75) and C (N688.92) only. Water intake (34.24, 34.93, 34.77 and 37.71ml/bird/day) and weight gain (3.53, 2.93, 2.83 and 3.05g/bird/day) did not differ significantly ($p>0.05$) across the diets. The diet with 5% rice offal was similar in feed intake and weight gain to the control and is recommended.

Key words: Rice offal, natuzyme, water intake, weight gain, Japanese quails

Introduction

Erratic changes in price of feed materials constantly force feed manufacturers to change formula used to produce feed in order to maintain reasonable gross margin. Rice is a major staple food in most developing countries. According to FAO (2017), preliminary forecast of global paddy production in 2017 is set at 758.9 million tonnes. The husk (the outer rough covering) produced from this rice is either burnt off or heaped as wastes but more recently is being used sparingly in poultry diets due to the high fibre content. These agro industrial by products ((rice offal, maize offal, wheat offal, brewer's dried grain) have elicited some levels of improvement when fed to broiler chickens at lower levels (Makinde *et al*., 2014). Rice milling waste has been reported to reduce production cost, produce lean meat and supply nutrients like vitamins and minerals and other unidentified factors which improve growth (Ojewola and Ewa, 2005). However, as high as 80% inclusion of these by products may result in low calcification, decreased feed intake, poor digestibility and even mortality (Aruna and Singh, 1999). Therefore, it is necessary to incorporate exogenous enzymes in monogastric animal diets to enhance the breakdown of non-starch polysaccharides (NSP) in rice offal. Allen *et al*. (1997) reported that inclusion of enzyme in monogastric animal diets reduces viscosity of the intestinal ingesta and shows a marked improvement on the various morphological effects of feeding fibrous materials.

The objective of this study is to determine the effect of replacing maize with rice offal supplemented with natuzyme on the performance of growing Japanese quails owing to the paucity of information regarding the use of this feed resource in quail nutrition.

Materials and Methods

Birds, housing and management: 180 two-week old Japanese quail birds of mixed sexes obtained from the National Veterinary Research Institute poultry farm were used in this study. They were uniform in size and housed in deep litter house partitioned into several pens with wire mesh to allow for adequate ventilation. The birds occupied 12 pens with 15 birds per pen. The birds were offered one of four diets containing either 0 (control), 5, 10 or 15% of rice offal at forty-five birds per diets in a completely randomized design. The experimental diets were designated A, B, C and D respectively. All birds from each unit were weighed at the beginning and weighed weekly for six weeks. Feed and water were given *ad libitum*.

Rice offal: Rice offal was purchased from feed material shops or sales points in Bukuru, Jos South LGA of Plateau State. They were obtained dry and incorporated into the diets free from mould and weevils.

Experimental diets: Four isonitrogenous (25%CP) diets containing graded levels (0, (control), 5, 10, and 15%) of rice offal (Table 1) were used in this study. The diets containing rice offal were treated with Natuzyme ™ at the rate of 100grams per 100 kilogram of the diet and were mixed homogenously to achieve a complete blend. Natuzyme contains phytase, β-glucanase, α-amylase, cellulase, pectinase, amyloglycosidase, xylanase and protease. The diets were designated A, B, C and D and contained metabolizable energy (ME) levels; 2,779.32, 2,747.73, 2,715.54 and 2,683.54 kcal/kg ME respectively.

Table 1. Composition of experimental diets (%)

	Diets			
Ingredients	A	B	C	D
Maize	39.81	34.40	28.98	23.55
Rice offal	0.00	5.00	10.00	15.00
Ground nut cake	41.99	42.40	42.82	43.25
Natuzyme	-	+	+	+
**Others				
Calculated composition%				
CP	24.99	25.00	25.00	25.00
ME (Kcal/kg)	2779.32	2747.73	2715.54	2683.50
Ca	1.38	1.38	1.39	1.40

P	0.44	0.45	0.49	0.50
CF	4.58	5.12	5.65	6.19
Feed cost/kg(₦)	90.74	86.60	82.44	78.29

**Others: palm kernel cake (13.50%), fish meal (0.50%), bone meal (2.00%), lime stone (1.50%), *premix (0.25%), salt (0.25%), methionine (0.10%), lysine (0.10%).

CP, crude protein; ME, metabolizable energy; CF, crude fibre

Data Collection and analysis: The mean weekly body weights, water intake and feed intake were recorded throughout the experimental period. From the mean body weight and feed intake, feed conversion ratio was calculated. Feed cost/kg gain and feed cost/kg diet were calculated from prevailing local market price of feed materials. Data collection was subjected to analysis of variance; ANOVA (Steel and Torrie, 1980) and where significant differences occurred, means were separated by Duncan's new multiple range test (Obi, 1990). The analysis was carried out using Minitab version 14 (Minitab, 1991).

Results and Discussion

Data on feed intake, weight gain and feed conversion ratio are presented in Table 2. Feed intake increased significantly as the level of rice offal increased in the diet. It was higher on diets C and D than on diet A. This is contrary to the similarity in feed intake reported by Fafiolu *et al*. (2010) for meat-type chicken fed rice offal based diets. However, the significant effect of rice offal diet on feed intake of grower turkeys has been reported by Makinde *et al*. (2015). They reported significant decrease in feed intake with increasing rice offal content in the diet. The significant increase in feed intake noted in this work may be as a result of solubilizing of cell wall of high fibre rice offal (IFRU, 2003) and also because birds eat to satisfy energy requirement more so the energy level of the diet was decreasing with increased content of rice offal. Feed conversion ratio was significantly better for birds on the control than for those on the rice offal diets. Result similar to this has been reported by Makinde *et al*. (2015). The poorer ability of birds on the rice offal diets to convert the diets to flesh compared to the control maybe due to incomplete break down of non-starch polysaccharides (NSP) in the fibre contained in rice offal.by exogenous enzymes. Timbrell (1992) had observed that there could be instances where enzyme additions or supplementation add little value to particular ingredients or fail to result in improved performance. Feed cost/gain was significantly better on the control than on the rice offal diets following a similar trend to feed conversion ratio and feed intake and it's due to the higher level of intake per unit of gain which understandably translates to higher cost as compared to the control. However, Makinde *et al*. (2015) reported similarity in feed cost/gain between birds on the control and those on the rice offal diet which is different from the result of this study. This difference may be due to different species of birds used. Body weight gain was similar across the diets. The exogenous enzyme might have enhanced a less viscous digesta leading to improved digestion resulting in the similarity in weight gain. Weight gain and water intake did not differ significantly across the diet from the control. This is contrary to increasing weight gain and water intake reported by Abeke *et al*. (2011) with increasing content of ground rice offal. Increased bulk in the feed has been

reported to support higher water consumption. However, quails have been reported to adjust feed intake across a wide range of energy levels Weber and Reid (1967) probably due to intrinsic habit developed in the wild. This adjustment may also include water intake. However, values of water intake reported here are close to values reported by Edache *et al*. (2018).

Table 2. Effects of different rice offal levels on parameters measured

Parameters	A	B	C	D	SEM
Feed intake (g/b/d)	20.64[a]	22.45[ab]	23.48[b]	24.08[b]	1.00*
Water intake (ml/b/d)	34.24	34.93	34.77	37.71	1.84NS
Weight gain (g/b/d)	3.53	2.93	2.83	3.05	0.28NS
Feed/gain ratio	5.87[a]	7.70[b]	8.36[b]	7.95[b]	0.69*
Feed cost/kg gain (N)	532.65[a]	666.75[b]	688.92[b]	622.41[ab]	55.77*
Initial weight (g/b)	32.00	35.78	35.33	36.78	2.57NS
Final weight (g/b)	156.33	143.00	145.00	153.00	7.37NS

a,b, means with different superscript letters within rows are significantly different ($p<0.05$)

Conclusion

Rice offal, a byproduct of rice processing factory is obtainable from several rice mills in rice producing communities and at times constitutes a waste disposal burden. The escalating cost of poultry feed could effectively be alleviated by use of cheaper feed resources like this. While feed intake was significantly higher on the rice offal diets, feed conversion ratio and feed cost per gain were better on the control than on the rice offal diets. Therefore, rice offal is recommended for inclusion at 5% in the diet of quail chicks for profitable performance provided the diet is adequately supplemented with exogenous enzyme and the diet with 5% rice offal has a cost saving of 4.60% over the control.

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PERFORMANCE OF RATS FED PROCESSED MATURED AND IMMATURED NYPA PALM *(Nypa fruiticans)* FRUIT NUT MEAL

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Abstract

Forty two male weanling albino rats of Wistar strain of six rats per group were randomly allotted to seven experimental diets, consisting of a control diet and six other diets of same combinations of nypa palm fruit nut meal. Nypa palm fruit nut meal at two maturity stages and three processing methods provides energy in the formulation to maize in a 2x3 Factorial experiment in a Completely Randomized Design at 100% level of inclusion per diet. The diets were fed to the animals for 3 weeks with feed and water given *ad libitum*. The result showed that feed intake and feed conversion ratio were significantly different ($P<0.05$) among treatment diets, and rats fed the matured sun-dried treatment recorded the highest feed intake of 11.86g. There was no significant difference ($P>0.05$) in weight gain among sample diets. However, rats fed the matured sun-dried sample recorded the highest weight gain of 1.97g and was numerically better compared to the control diet. No mortality was recorded throughout the entire study and this justifies the practical possibility of utilizing nypa palm fruit nut meal as an energy source replacement in diets for monogastric animals.

Key words: Performance, rats, processed immature, processed matured, Nypa palm fruit nut meal.

Introduction

The use of non-conventional feedstuff in the formulation of livestock ration has become very necessary due to the comparative soaring cost of conventional energy sources. Maize and sorghum which forms bulk in livestock rations are becoming scarce due to its use by man for diversified products, effects of climate change, draught, insurgency in major grain growing regions of Benue State and North Eastern parts of Nigeria. As an alternative to the scarcity of cereal grain and availability, there is an abundance of Nypa palm growing wild and bearing bunches of fruits along the coastal fringes of the Qua River in Akpabuyo Local Government Area of Cross River State (Ukam *et al.,* 2012). Also, large expanse of these plants are seen along the coastal fringes of Bayelsa, Rivers, Akwa Ibom, Cross River and has covered an estimated area of 821km^2 in four states in Nigeria (Isebor *et al.,* 2003).

Nypa fruiticans is abundant in regions where they grow but their fruits are under-utilized and lacks scientific attention (Prasad *et al.,* 2013), Chemical evaluation of nypa palm fruit nut meal revealed the seed is rich in Carbohydrate high in fibre, low in ether extract,

mineral elements, protein and anti-nutritional factors (Osabor *et al.,* 2008; Ukam *et al.,* 2012; Ukam *et al.,* 2013). Being high in Carbohydrate, the nypa fruit nut meal is comparable of providing a good energy replacement for conventional feeds in livestock feeding. Thus, this study was carried out to evaluate the performance of rats fed processed immature and matured nypa palm fruit nut meal in order to determine a better maturity stage, processing method and its use in ration formulation for monogastric animals.

MATERIALS AND METHODS

Location of the study

The research study was conducted in the Animal House of the Department of Biological Sciences, University of Calabar. The research unit is located at latitude $4^{o}58$" N of the Equator and longitude $8^{o}17$" E of the Greenwich Meridian. It has an annual temperature range of 25-30^{o}C, rainfall range of 1260-1280mm and a relative humidity of 53-93 perce-nt respectively (Okon *et al.,* 2009).

Experimental materials

The test materials (Nypa palm fruits) were harvested from the mangrove swamp forest of the Cross River Estuary at Esuk Mba village in Akpabuyo Local Government of Cross River State, Nigeria. Two stages of maturity (matured and immatured nypa fruits) were used for the preliminary study. The fruits were dehusked and sliced into halves using a cutlass and the nuts removed from the fruit using kitchen knife. The nuts were cracked roughly using kernel cracker and the products milled using hammer mill to give a fine texture. Each of the matured and immatured nypa fruits were divided and processed as sun-dried, toasted and autoclave to six different treatments as follows:

Matured sun-dried nypa palm fruit nut meal (MSNPFM).
Matured toasted nypa palm fruit nut meal (MTNPFM).
Matured autoclaved nypa palm fruit nut meal (MANPFM).
Immatured sun-dried nypa palm fruit meal (ISNPFM).
Immatured toasted nypa palm fruit nut meal (ITNPFM).
Immatured autoclaved nypa palm fruit nut meal (IANPFM).

The various processed meals were stored in juts bags in a cool and dry place till their use.

Formulation of experimental diets

Seven (7) experimental diets were formulated such that diet one (1) served as control with maize (100 percent), while the other six (6) consisting of two maturity stages and three processing methods replaced with maize at 100 percent inclusion levels (Table 1)

Table 1: Composition of experimental diets for rats

Ingredients	Treatments/level of inclusion						
	Control diet (Diet 1)	Matured sun – dried nypa palm fruit nut meal (MSNPFM)	Matured toasted nypa palm fruit nut meal (MTNPFM)	Matured autoclaved nypa palm fruit nut meal (MANPFM)	Immatured sun- dried nypa palm fruit nut meal (ISNPFM)	Immatured toasted nypa fruit nut meal (ITNPFM)	Immatured autoclaved nypa palm fruit nut meal (IANPFM)
	100%	100%		100%	100%	100%	100%

			100%				
Maize	76.44	-	-	-	-	-	-
Nypa	-	70.50	70.50	70.50	70.50	70.50	70.50
Soya bean meal	6.04	10.78	10.78	10.78	10.78	10.78	10.78
Crayfish dust	4.02	5.22	5.22	5.22	5.22	5.22	5.22
Rice bran	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Groundnut oil	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Periwinkle meal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Vit/Min. Premixes	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Common salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Cal values							
C.P(%)	12.00	11.90	11.90	11.90	11.90	11.90	11.90
M.E (Kca/kg)	3354.44	3285.00	3285,00	3285.00	3285.00	3285.00	3285.00

*Premix contains the following: Vit=A 8,800,000 i.ur, Vit.=D_3 1,600,000 i.u; Vit. E=500,000 i.u; Vit. K=200mgr; Vit, B_1= 1,500 mgr; Vit. B_2=4,000mgr; Vit. B_6 = 1,5000mgr Vit. B_3=15,000mgr; Vit. B_{12}=10mgr; panthothenic acid =5,000mgr; folic acid=500mgr ; biotin =20mgr ; choline chlorine =200gr; antioxidant=125gr; Mn=80gr; Zn= 50gr; Fe =20gr; Cu=5gr; I =12gr; Se=200mgr; Co =200mgr.

Management of experimental rats

A total of 42 male Albino rats consisting of six (6) rats per treatment were selected based on body weight at the age of 21±2 days, for the 21 days study in a 2x3 factorial experiment in a completely randomized design at 100% level of inclusion per diet. Each treatment was replicated twice with three rats per replicate and the rats were housed individually in metabolic cages. Water and feed were given *ad libitum*.

Data collection and analysis

Body weight was taken weekly, while feed intake was recorded daily by weighing the feed served and the left over with the quantity spilled over after 24 hours and the difference calculated.

Data generated were analyzed using Analysis of Variance (ANOVA) in a Completely Randomized Design. Significant differences between means were separated using Least Significant Difference (Steel and Torrie, 1980).

Results and discussion

Table 2 shows the performance of rats fed processed matured and immatured nypa palm fruit nut meal. There was a significant (P<0.05) difference in feed intake among the treatment diets. The lowest feed intake of 10.02g was obtained from rats fed the immatured autoclaved sample while the highest feed intake of 11.86g was recorded for rats fed the matured sun-dried sample. Generally, mean daily feed intake obtained in the study was lower than the 15g per rat for a day of dietary intake for Sprague-Dewleg and Fisher male rats (NRC, 1995). The lower feed intake might be due to the coarse and high fibre content of the diets which depressed feed intake by the rats.

Weight gain of rat were not significantly (P>0.05) different among sample diets. Rats fed on the matured toasted sample recorded the lowest weight gain of 1.46g, while rats fed matured sun-dried sample recorded the highest weight gain of 1.97g. In the matured sample (MSNPFM, MTNPFM, MANPFM) a gradual decrease in weight gain was observed from the matured sun-dried to the matured autoclaved nypa palm fruit nut meal while an increased in weight gain was observed in the immatured sample (ISNPFM, ITNPFM, IANPFM). The better weight gain recorded in the matured sun-dried processed method (MSNPFM) compared to the control might be due to a higher efficiency of utilization of the sample diets.

The feed conversion ratio was significantly (P<0.05) different among the dietary treatments. The lowest feed conversion ratio of 5.44 was obtained for rats fed the control diet while the highest value of 7.33 was recorded for rats fed the matured toasted sample. The higher feed conversion ratio obtained in the test diets compared to the control might be due to the high fibre content in nypa palm fruit nut meal which affected the breakdown of edible proteins in the various diets (Osabor *et al* ., 2008; Ukam *et al*., 2012; Ukam *et al*., 2003).

No mortality was recorded throughout the trial period thereby showing the various processed samples of nypa palm fruit nut meals do not contain harmful factors which might affect the performance of the rats.

Table 2: Performance characteristic of rats fed processed matured and immature nypa palm fruit nut meal with maize as reference diet.

Parameters	Treatments							LSD
	Control	MSNPFM	MTNPFM	MANPFM	ISNPFM	ITNPFM	IANPFM	
Initial weight/rat/g	23.60	21.61	26.04	24.47	23.13	25.83	24.53	N.S
Final weight/rat/g	60.39	63.05	59.31	55.45	57.57	60.54	59.53	N.S
Daily weight gain/rat/g	1.70	1.97	1.58	1.48	1.64	1.65	1.67	N.S
Daily feed intake /rat/g	9.52^{c}	11.86^{a}	11.67^{ab}	10.70^{abc}	10.24^{abc}	10.57^{abc}	10.02^{be}	1.80
FCR/rat/g	5.44^{d}	6.02^{cd}	7.33^{a}	7.13^{a}	5.85^{d}	6.44^{c}	6.07^{cd}	0.43
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N.D

$^{abc...}$Means on the same row with different superscripts are significantly different (P<0.05); LSD: Least Significant Difference, FCR: Feed Conversion Ratio

Conclusion

From the feeding trial using laboratory rats on two stages of maturity and three processing methods each on nypa palm fruit meal, it was observed that rats fed the matured

sun-dried diets was the most preferred in the study. This is because the daily weight gain was numerically better compared to the control diet. It therefore stands a better chance to be utilized in diets for monogastric animals.

Recommendation

Based on the findings of the study, it was recommended that:

Modern technology should be employed in the fabrication of equipment to harness the processing of nypa fruit nuts. This will help to reduce the human labour involved in slicing and removal of the nuts which is very difficult and tedious. The government and non-governmental organizations (NGOs) can assist in this direction.

Workshops and seminars should be organized for the local communities within the nypa fruit established communities on techniques of processing the fruit into meals for farm animals. This would help the local communities manage sizeable number of farm animals at reduce cost to raise their income level thereby improving their standard of living.

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RESPONSE OF JAPANESE QUAILS (*Coturnix coturnix Japonica*) FED DIETS CONTAINING VARYING LEVELS OF SWEET POTATO PEEL (*Ipomoea batatas)* MEAL

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Abstract

The response of Japanese quail chicks (*Coturnix coturnix japonica*) fed diets containing varying levels of Sweet potato peel (*ipomoea batatas*) meal as dietary energy was studied. Three hundred unsexed 2 weeks old Japanese quails (mean weight 32.00g) were fed the different diets for a period of 28 days during which data were collected. The birds were randomly assigned to four dietary treatments each (0, 10, 20, 30% sweet potato peel meal) consisting of 75 grower quails per treatment with three replicates of 25 birds in a completely randomized designed (CRD). Water and feed were supplied ad libitum. Result showed that inclusion of sweet potato peel meal in diets of grower quails significantly improved ($P<0.05$) their final live weights, weight gain, cost per gain and age at 1st egg across dietary treatments. Feed intake decreased significantly ($P < 0.05$) as the levels of sweet potato increased in diets. Quail birds fed 10% sweet potato peel meal performed significantly ($P < 0.05$) better in feed conversion ratio. It was concluded that sweet potato peel inclusion at 10% enhanced growth performance of Japanese quails up to 6 weeks of age compared to other dietary treatments.

Keywords: Dietary treatments; Japanese quails; performance; sweet potato peel; varying levels.

INTRODUCTION

The Nigerian poultry industry is faced with a lot of problems that have resulted to a gross shortage of meat to meet the population challenge in the country and there is acute shortage of animal protein in the diet of an average Nigerian (FAO, 2006). This is due to the high cost of conventional protein and energy concentrates, increasing competition between man, industries and livestock for the available grains, price fluctuations and unavailability of the feed ingredients for the formulation of animal feeds (Duru and Dafwang, 2010). Profit maximization cannot be attained unless the birds are fed diets at lowest costs. There is need to search for non-conventional feed resources that are cost-effective, non-toxic and readily available and alternative sources of energy concentrate. Sweet potato peel can be a good alternative source of energy in poultry ration.

Japanese quails (*Coturnix coturnix japonica*) are beginning to make useful contribution to meat supply in Nigeria where there is shortage of animal protein. They have unique characteristic of fast growth, early sexual maturity, short generation interval that make them suitable for diversified animal agriculture (Oluyemi and Roberts, 2007). They are fairly resistant to disease and required little demand for vaccination (Jadhav and Saddiqui, 2010). This study was designed to evaluate the effect of varying dietary sweet potato peel levels on growth performance of Japanese quails and compared cost benefit effect of experimental diets.

MATERIALS AND METHODS

The study was conducted at the Quail Unit, Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria. Zaria is located within the Northern Guinea Savanna Zone on latitude 11^0 11' 06" N and longitude 7^0 38' 55' E, at an altitude of 706m above sea level. A total of three hundred (300) quail birds were purchased from Maizuma farm at Galma New Jos Road, Along Dakace Zaria, Kaduna State. Sweet Potato Peel was sourced from Local Sweet potato fryers within Samaru and Samaru market in Zaria, Kaduna State (during dry season). The sweet potato Peel was washed and sun-dried on concrete floor (under hygienic condition), after which they were winnowed to get rid of any foreign materials. Sample of the winnowed sweet potato peel were oven dried, milled and used for chemical analysis. The other ingredients were sourced from Rebson Feed Mill, Samaru Zaria, Kaduna State. A total of three hundred (300) 2 weeks old quail birds were used for the study. On arrival, the quails were weighed and randomly assigned into four groups of 75 birds each. Each of the groups was subdivided into 3 replicates of 25 birds per replicate in a completely randomized design (CRD). Common diet was given for a day and all necessary routine management practices were adhered to throughout the study period. Four Experimental diets were formulated for the trial. The quail birds were given their respective diets and water *ad-libitum* throughout the trial period. The birds were weighed at the beginning of the trial and weekly thereafter. Performance parameters were monitored. Feed intake and body weight gain were taken weekly. These were used to calculate average or daily feed intake and weight gain. Feed conversion ratio was calculated on the basis of unit of feed consumed to unit of body weight gain. Samples of the Sweet Potato peel were taken to the Animal Science Biochemical Laboratory for proximate analysis using the methods described by A.O.A.C. (2005). Metabolizable energy (ME) was computed using the method described by Pauzenga, (1985). Data generated were statistically analyzed using the General Linear Model Procedure of Statistical Analysis System (SAS, 2002). Significant means were separated using Dunnett's Test in the SAS package.

Table 1: Proximate composition of sweet potato peel meal and experimental diets containing varying levels of sweet potato peel meal for grower Japanese quails (2 – 6 weeks)

		Inclusion levels of Sweet Potato Peel (%)			
Parameters (%)	Sppm	0	10	20	30
Dry matter	92.86	93.50	93.07	92.75	93.45
Crude protein	3.88	21.44	25.31	23.75	25.19
Ash	11.38	8.74	9.24	8.08	9.02
Crude fibre	7.70	6.33	6.19	6.08	6.80
Ether Extract	5.10	4.48	4.56	4.84	4.75
Nitrogen free Extract	70.99	59.01	54.70	57.25	54.25
ME (Kcal/ Kg)	3073.07				

Spm=Sweet potato meal. ME=metabolisable energy. ME (Kcal/Kg) = (35.0x%CP)+(81.8xEE)+(35.5xNFE),Pauzenga, 1985

RESULTS AND DISCUSSION

The result of proximate composition of sweet potato peel meal and experimental diets is shown in table 1. The effect of diets containing varying levels of sweet potato peel meal on the growth performance of grower Japanese quails is presented in Table 2. The final weight (141.33g) and weight gain (109.33g) were significantly ($P < 0.05$) higher in birds fed 10% sweet potato peel based diets. The feed intake was significantly ($P < 0.05$) higher in birds fed 10% sweet potato peel based diets (128.33g).The feed conversion ratio (1.00g) was significantly ($P < 0.05$) higher in birds fed 10% sweet potato peel based diets. The average age at first egg (AAFL) was significantly ($P < 0.05$) higher in birds fed 10% sweet potato peel based diets (39.67g). The weight of first egg was significantly ($P < 0.05$) higher in birds fed 10% sweet potato peel diets. Feed cost per kg gain (10.50) was significantly ($P < 0.05$) better in birds fed 30% sweet potato peel based diets. The cost of daily feed intake (₦8.82) and cost of total feed intake (₦247.08) were significantly better in birds fed 30% sweet potato peel based diets. The proximate composition of the sweet potato peel meal was similar to values reported by Agbai *et al*, 2017 that sweet potato meal contained 92.95% DM, 5.25%CP and 76.85% NFE and also similar to values reported by Afolayan (2010) that sweet potato meal contained 92.76% DM, 5.36%CP and 81.78% NFE. Birds on 10% sweet potato meal performed better on the basis of feed intake, weight gain, feed conversion ratio and dressing percentage compared to the control diet and other treatments. This may be due to the increased level of digestibility of the diets. Yoshida and Morimoto (1958) and Ravindran (1995) reported the carbohydrate fraction in sweet potato to be about 90% digestible in grower birds. The result showed significant difference between the weight gained and the level of dietary Sweet potato. The 10% sweet potato diets appeared to be the most efficiently utilized compared to the other diets. The 30% diets were the most poorly utilized. The increase in the inclusion levels of sweet potato resulted in decline in feed intake and growth. This agreed with the report of Maphosa *et al.* (2003) who reported that a significant decline in weight gain was noticed with increase in the inclusion of sweet potato during the starter and finisher phases. The significantly reduced weights of birds on diets containing 30% sweet potato meal could be as a result of increased fibre in the sweet potato meal which also increases the fibre content and anti-nutrients factor (Oladunjoye and Ojebiyi, 2012). Bach, (2001) reported that the main physiochemical characteristics of dietary fibre with nutritional significance was hydration properties, which influence solubility, water holding capacity (WHC), and swelling capacity.

Table 2: Effect of varying levels of sweet potato meal on growth performance of grower Japanese quails

(2 – 6 weeks)

	Inclusion levels of sweet potato (%)				
Parameters	0	10	20	30	SEM
Initial weight (g/b)	32.00	32.00	32.00	32.00	0.00
Final weight (g/b)	141.28^{a}	141.33^{a}	132.70^{b}	132.32^{c}	0.11
WG (g/b)	109.28^{a}	109.33^{a}	100.70^{b}	100.32^{c}	0.10
Total Feed intake (g/b)	128.37^{ab}	128.33^{b}	155.62^{a}	119.77^{c}	10.30
DFI (g/b/d)	4.59^{ab}	4.58^{b}	5.56^{a}	4.28^{c}	0.37
FCR	1.18	1.00^{a}	1.55^{c}	1.19^{ab}	0.10
AAFL (d)	36.67	39.67^{a}	35.50^{c}	39.33^{ab}	0.77
AWFE (g)	8.87	9.78^{a}	8.49^{bc}	9.72^{a}	0.19

Cost/kg WG (₦/kg)	31.42[b]	12.87[b]	15.13[c]	10.50[a]	2.32
Cost of feed (₦/kg)	26.63[d]	24.64[c]	22.63[b]	20.63[a]	0.00

[abcd] Means with different superscript on the same row are significantly different (P < 0.05) SEM: Standard Error of Means. WG: weight gain. DFI: daily feed intake. FCR: feed conversion ratio. AAFL: average age at first lay. AWFE: Average weight of first egg. (g/b): gram/bird. (g/b/d): gram/bird/day.

Birds on 10% sweet potato inclusion in their diets had better feed conversion ratio compared to those on 0% sweet potato inclusion in their diets. This agreed with the observation of Gerpacio *et al.* (1978) who reported that the performance of birds fed diets containing sweet potato especially at the higher levels was less satisfactory compared to corn. The significant difference in feed conversion ratio observed across the dietary treatments is in agreement with the observation of Afolayan *et al.* (2012) who reported that birds fed diets containing 10% to 20% sweet potato meal performed better than those on 30 and 40% inclusion levels. The significant difference among dietary treatments may be as a result of the presence of anti-nutritional factors which affected nutrient utilization. Elkin *et al.* (1995) reported that the growth of poultry birds has been known to reduce due to the presence of anti-nutritional factors in the diet which reduced the utilization of energy, protein and specific amino acids. No mortality was observed across the treatments. This is in agreement with earlier reports that though sweet potato may contain unidentified growth inhibitors, the level in sweet potato definitely posed no danger of death to birds. Many researchers (Tewe, 1994; Ravindran and Sivakanesan, 1996) have attested to the claim that sweet potato in broiler chickens diets does not result in mortality. Observation by Maphosa *et al* (2003) however differed and the authors attributed the high mortality recorded in their experiment to sweet potato inclusion in the diets. The difference in the present result and that of Maphosa *et al* (2003) may be due to the difference in the type of sweet potato cultivars used. Diets containing 10 and 30% sweet potato peel meal reduced cost of production by 59.04% (₦ 18.55) and 20.92% (₦ 66.58%) respectively. Increase in inclusion of sweet potato peel meal, decreases cost of feed.

CONCLUSION AND RECOMMENDATION

It was concluded that sweet potato peel meal inclusion at 10% enhanced growth performance of quails at least cost of production compared to those on the control diets.

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PERFORMANCE OF WEANER RABBITS FED ENSILED CASSAVA PEEL, BOVINE BLOOD AND RUMEN CONTENT MIXTURES

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ABSTRACT

The performance of weaner rabbits fed ensiled cassava peel, bovine blood and rumen content mixtures (CABLORUM) were investigated. CABLORUM were ensiled for 14days at different ratios (1:1:1, 2:1:1, 1:2:1 and 1:1:2). The silage was added to formulate diets designated as diet 1 (0% CABLORUM), diet 2(1:1:1), diet 3(2:1:1), diet 4(1:2:1), diet 5(1:1:2). Thirty weaner rabbits of about 5-6weeks of age with average weight of 504g were randomly allocated to the five dietary treatments and fed for 70days. The parameters evaluated were weight gain, length gain, chest girth gain, feed intake, feed conversion ratio. The results showed that average final body weight, average daily weight gain, total length gain and total chest girth gain were not significant among the dietary treatments ($p>0.05$). However, average daily feed intake (ADFI) of rabbits fed diets 1, 3 and 4 were similar but lower than those fed diets 2 and 5 ($p<0.05$). The FCR of rabbits fed diet 1 was similar to Diets 2, 3 and 4 but lower than Diet 5 ($p<0.05$). The cost analysis showed that feed cost per kg and feed cost per kg weight gain was lower in CABLORUM based diets ($p<0.05$), particularly when mixed in a ratio of 2:1:1. It was concluded that ensiled CABLORUM could be included in diets of weaner rabbits without adverse effects, while CABLORUM at 2:1:1 ratio gave the least cost per kg weight gain. It was therefore recommended for adoption by rabbit farmers to reduce cost.

Keywords: CABLORUM, Cassava peel, Bovine blood, Rumen content, Weaner rabbits.

INTRODUCTION

The greatest proportional cost in livestock production is expended on feeding, with the exception of ruminants whose feed is based on pasture. In non-ruminant animals such as pigs, rabbits and poultry, feed ingredients represent 65 to 70% of the total cost in an intensive production system in Nigeria as in many developing countries (Esonu *et al.,* 2006). Rabbit has long been known to thrive on farm and kitchen wastes of high fibre content. However, fibre digestion in the caecum is often limited but enhanced by caecotrophy (Esonu *et al.,* 2006). Fermentation procedures have been employed to improve the nutritive quality of many farm wastes by reducing fibre proportion while increasing protein content; therefore making raw materials rich in non-digestible carbohydrates a functional livestock feed (Dairo *et al.,* 2005).

Cassava peel is an agricultural by-product. It offers a tremendous potential as a cheap and alternative feedstuff for conventional feedstuffs. It however contains hydrogen cyanide that has been shown to be toxic to livestock and could limit its usage in raw state as feed for livestock (Ewane, 1996). Detoxification of cassava peels has been made possible by several

methods including sun drying and ensiling (Adegbola and Okonkwo, 2002). Bovine blood and rumen content are some of the by-products of abattoirs. Rumen content is the partially digested forage mainly found in the rumen of ruminant animals. It is fairly rich in crude protein (18.52%) and other micro flora such as fungi, protozoa and bacteria (Dairo *et al.,* 2005). The utilization of bovine blood and rumen content as animal feed also alleviate and maximize the economic and environmentally benign disposal of slaughter house by-products (Esonu *et al.,* 2006) while reducing cost of production. Therefore this study was conducted with the objective to investigate the performance of weaner rabbits fed different mixtures of ensiled cassava peel, bovine blood and rumen content (CABLORUM).

MATERIALS AND METHODS

The study was carried out at the rabbit unit of the Department of Animal Science farm, University of Nigeria, Nsukka, located on latitude 05^{o} 22' North and longitude 07^{o} 24' East (Asadu, 2002).

Preparation of Test Ingredients.

Cassava peels were obtained at Obukpa market in Nsukka Local Government Area of Enugu State. Bovine blood and rumen contents were collected from the Ikpa abattoir in Nsukka Local Government Area of Enugu State. The rumen content was collected directly from animals freshly slaughtered and air dried for two days to reduce the moisture content.Four (4) different silage based diets were prepared. The first using the cassava peel, bovine blood and rumen content in a ratio of 1:1:1 (one unit representing 5kg), the second was in a ratio of 1:1:2, then 1:2:1 and 2:1:1 for third and fourth silage based diets respectively. The ensiled materials were compressed tightly using blocks; sand was used to fill up the gaps in the silage pit and then allowed for two weeks to ferment. After two weeks the fermented products were sun-dried on a concrete floor to about 12% moisture content and all foreign objects were removed. After sun-drying, the mixtures were milled and stored for mixing with other ingredients. Five (5) experimental diets were formulated as shown in. Table 1. Diet 1 was the control diet without CABLORUM content. Diet two had 20% mixture of CABLORUM at a ratio of 1:1:1, while diet 3, 4 and 5 had 20% mixture of CABLORUM at a ratio of 2:1:1, 1:2:1 and 1:1:2 respectively. The experimental diets were fed in mash form for 70days. Representative samples of CABLORUM and of the five diets were analyzed for their chemical constituents using the method of the Association of Analytical Chemists (AOAC, 1990). The results are presented in Table 2.

Table 1: Percentage Composition of Experimental Diets.

Ingredients	Diet 1 Control	Diet 2 1:1:1	Diet 3 2:1:1	Diet 4 1:2:1	Diet 5 1:1:2
Maize	41	31	31	31	31
Soybean meal	20	10	10	10	10
CABLORUM	0	20	20	20	20
Palm kernel cake	19	19	19	19	19
Wheat offal	15	15	15	15	15

Bone meal	3	3	3	3	3
Limestone	1.5	1.5	1.5	1.5	1.5
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100

Table 2: Proximate Composition of the Experimental Diets and Test Ingredients

Test Ingredients	CP (%)	CF (%)	DM (%)	E.E (%)	Ash (%)	N.F.E (%)
CABLORUM 1:1:1	19.70	10.31	81.12	1.50	10.83	38.78
CABLORUM 2:1:1	14.45	19.41	80.92	1.03	16.38	29.64
CABLORUM 1:2:1	21.64	11.82	78.33	1.22	12.29	31.36
CABLORUM 1:1:2	11.38	20.23	76.91	1.12	14.54	29.64
Diet 1: Control	17.34	11.93	89.55	4.90	8.11	47.26
Diet 2: 1:1:1	18.34	11.81	88.14	4.32	11.10	42.57
Diet 3: 2:1:1	17.09	14.12	88.32	3.89	12.89	40.33
Diet 4: 1:2:1	19.26	11.31	88.08	4.23	12.11	41.17
Diet 5: 1:1:2	16.29	15.75	87.18	4.02	12.68	38.34

CP-crude protein, CF-Crude fibre, DM-Dry matter, E.E – Ether extract, NFE-Nitrogen free extract.

Management of Experimental Animals and Experimental design

A total of thirty (30) weaner rabbits of about 5-6 weeks of age, with an initial average weight of 504g were used for the study. The rabbits were allowed a two-week adjustment period during which they were treated against some common diseases by administering prophylactic drugs. The animals were randomly divided into five (5) treatments with three (3) replicates (2 animals per replicate). The animals were intensively managed and housed in wire cages and provided with drinking and feeding facilities. A total of 200g of feed was supplied to each replicate per day at a rate of 100g in the morning and 100g in the evening to reduce wastage. Orts (left over) was collected and weighed the following morning in order to determine feed intake. Water was provided *ad libitum*. Parameters measured were; Daily feed intake, Weekly body weight, Weekly body length and Weekly chest girth.

The experimental design used was the completely randomized design (CRD) with the model

$X_{ij} = U + T_i + E_{ij}$

X_{ij} = individual observation, U = population mean, T_i =CABLORUM effect, E_{ij} = experimental error

Economic and Statistical analysis

The variable cost of feeding the rabbits was considered as the cost of the feeds as all other costs (i.e. labour, capital investment, housing) were the same for all the treatments. The cost of processing the CABLORUM was included as the feed cost. All data collected were analysed using SPSS version 20.0 statistical software such that data were subjected to analysis of variance (ANOVA) and significantly different means were separated using Duncan New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

The results of the performance of weaner rabbits fed ensiled cassava peel, bovine blood and rumen content (CABLORUM) mixtures are presented in Table 3.

Table 3: Performance of Weaner Rabbits Fed Ensiled Cassava Peel, Bovine and Rumen Content (CABLORUM) Mixtures.

Parameter	Diet 1 Control	Diet 2 1:1:1	Diet 3 2:1:1	Diet 4 1:2:1	Diet 5 1:1:2	Mean	SEM
AIBW (g)	508.33	515.00	516.67	488.33	491.67	504.00	12.866
AFBW (g)	1521.67	1515.00	1485.00	1398.33	1405.00	1465.00	19.279
ADWG (g)	14.47	14.29	13.83	13.00	13.05	13.73	0.227
TLG (cm)	11.17	12.00	10.67	11.25	10.92	11.20	0.239
TCGG (cm)	9.92	10.00	9.00	8.92	8.92	9.35	0.232
ADFI (g)	63.22^{b}	66.69^{a}	61.74^{b}	61.43^{b}	66.79^{a}	63.97	0.745*
FC (₦)	326.02^{a}	283.37^{b}	258.31^{d}	263.04^{c}	285.60^{b}	283.27	6.415**
FC/WG (₦/kg)	321.84^{a}	283.37^{c}	266.85^{e}	271.74^{d}	312.84^{b}	291.32	5.925**
FCR	4.37^{a}	4.68^{ab}	4.47^{a}	4.73^{ab}	5.13^{b}	4.68	0.089*

AIBW- Average Initial Body Weight, AFBW- Average Final Body Weight, ADWG- Average Daily Weight Gain, TLG – Total Length Gain, TCGG- Total chest girth gain, ADFI – Average Daily feed intake, FC-feed cost, WG-Weight gain, FCR-Feed conversion ratio, SEM-Standard error of means, * significant ($p<0.05$), ** significant ($P<0.01$), $^{a-d}$Means with different superscript on the same row differ.

The average final body weight was not significantly ($p>0.05$) different among treatments. However the values obtained in this study are similar to the values reported by Ajayi *et al*., (2007) and Mohammed *et al*., (2011) but higher than the values reported by Dairo *et al.,* (2005). This is an indication that the ensiled CABLORUM based diets provided the required nutrients for good growth of the rabbits and therefore can replace maize and soybean meal in the diets of rabbits. The average daily weight gain were not significantly ($p>0.05$) different among treatments. The values recorded in this study are however similar to the values reported by Ojebiyi *et al*., (2006) who used cassava peel/blood meal based diet to feed weaner rabbits but lower than values of Ajayi *et al*., (2007) who used blood-wild sunflower leaf based diets to feed weaner rabbits. This is also an indication that ensiled CABLORUM can be included into the diets of rabbits without any adverse effects. The total length gain and total chest girth gain were not significantly ($p>0.05$) influenced by the dietary treatments. In this

study the experimental ingredients were prepared by ensilage thereby producing a combination that was less powdery, denser and having a good nutritional profile. These suggest that the experimental diets sufficiently satisfied the nutrient requirements of rabbits. Thus it supported the growth of the rabbits as the control diets. Table 3 showed that the effect of the treatments on average daily feed intake (ADFI) were significant ($p<0.05$). Feed consumption of rabbits fed diets 1, 3 and 4 were similar but lower than Diets 2 and 5 which were also similar. The ADFI values obtained were similar to the values reported by Ajayi *et al*., (2007) but lower than the reported values of Dairo *et al*., (2005). The differences observed may be due to different fibre levels, palatability and acceptability of the diets. Chaudhury *et al*., (1995) noted that rabbits given higher fibre diets ate more feed daily and gained more weight than rabbits on low fibre diets. In a study using pelleted feed, Ojebiyi and Saliu (2014), reported that rabbits fed blood/rumen content based diets in mash form had reduced feed intake probably due to unattractive odour of the blood/rumen content diets.

The feed conversion ratio differed significantly ($p<0.05$). The results indicated that those with lower FCR values utilized less feed to gain more weight as Diet 5 had higher fibre content. The results agreed with the findings of Mohammed *et al*. (2011) and Ojebiyi and Saliu (2014) but was contrary to the results of Dairo *et al*. (2005) and Ajayi *et al*. (2007) who reported no significant ($P>0.05$) difference in feed conversion ratio.

Inclusion of ensiled CABLORUM led to reduction in feed cost. There were highly significant ($p<0.01$) differences among treatments. It follows that feeding rabbits diets based on ensiled CABLORUM improved cost savings. Cassava peel, bovine blood and rumen content are cheaper feedstuffs than maize and soybean meal. This explains the reduction in cost and subsequent higher revenue from the rabbits fed ensiled CABLORUM diets. Ewane (1996), observed that cassava peel mixed with appropriate high protein feedstuffs produces cheaper feedstuffs than when cereal alone was used. Highly significant ($p<0.01$) differences among treatments on cost per kg weight gain were also observed. The highest cost per kg gain of ₦321.84 was recorded in Diet 1 (control) while the least cost of ₦266.85 was recorded in Diet 3 (2:1:1). The results obtained in this study are consistent with the findings of Onyimonyi and Ugwu (2007) who fed cassava peel/bovine blood based diets to broilers and noted a reduction in feed cost.

Conclusion and Recommendation

We concluded that since there is abundant availability of cassava peel, bovine blood and rumen content, a farmer can reduce cost by incorporating these unconventional feedstuffs in livestock feeding. It is recommended that cassava peel, bovine blood and rumen content should be ensiled at 2:1:1 ratio as this combination supported the performance of rabbits as the control diet and had the least cost per kg gain.

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PERFORMANCE AND COST BENEFITS OF SNAILS (*Archachatina marginata*) FED DIETS CONTAINING NOODLE WASTE AS REPLACEMENT FOR MAIZE

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Abstract

Noodle waste (NW) (a by-product from wheat noodle processing industry) which attract little cost was used to replace maize fraction of the diet of snail in order to reduce feed cost. A total of 120 adult snails (*Archachatina margi*nata) of mean weight 173.42 ± 3.5g of about 9 months of age were used for the feeding trial. Four diets were formulated to contain NW at 0% (A_1) Control, 50% (A_2), 75% (A_3) and 100% (A_4) as replacement for maize fraction in the diet of adult snails. Completely randomized design was used for the trial and each treatment was replicated thrice with 10 snails per replicate. The diets were formulated to contain about 24% crude protein and energy of 2400 kcal/kgME. Data were collected on intake, weight gain, shell length, thickness and width, feed efficiency, feed conversion ratio, dressing percentage, feed cost and cost per weight gain. Results showed that no significant differences were observed in the mean feed intake, weight gain and feed conversion ratio (P>0.05). The dressing percent of the snails was relatively the same in all the treatments (P>0.05). The results of cost analysis showed that cost /kg feed and total feed cost reduced as the level of NW in the diet increased. It was concluded that NW could replace maize fraction of the diet at reduced cost

Key words: *Dressing* Cost/weight gain, dressing percentage, feed efficiency, rice noodle waste, snails.

Introduction

Maize, soybean meal, groundnut cake meal etc constitutes major feed ingredients commonly used Nigeria and Africa in general. The cost of aforementioned feed ingredients are high, hence there is need to look for alternative sources that can be used as substitute without affecting performance of the animal adversely. A lot of studies have been conducted in the use of alternative feed ingredients such as biscuit waste, bakery waste and cassava by-products as partial or total replacement for maize with a desirable results without affecting the carcass, growth and health status of livestock adversely (Longe, 1987; Eniolorunda *et al.,* 2008; Kehinde, 2009; Omole*,et.al.*,2012). There are lots of food processing industries in South Western Nigeria with different by-products. Noodle waste is a by-product from wheat noodle processing industry and it readily available where feed ingredients are sold in Nigeria. The protein content is high and relatively similar to that of maize (Eniolorunda *et al.,* 2008). The cost of noodle waste is relatively low compared to that of maize and it is considered as a waste product, a kilogramme of maize during the course of the feeding trial was ₦120.00 while the same quantity of NW was sold for ₦85.00/kg. Noodle waste has been included in the diet of laying chicken which has resulted in increased hen day production and reduction in the cost of feed without any adverse effect on health status of the birds (Eniolorunda *et al.,* 2008). There is paucity of information on the use of NW in the diet of snails, hence this study was conducted to determine the effect of feeding growing snail with noodle waste as partial

or total replacement for maize fraction of the diet on feed intake, weight gain, feed efficiency, dressing percentage and cost benefits.

MATERIALS AND METHODS

The experiment was carried out at the Snailery Unit of the Institute of Agricultural Research and Training (I.A.R.& T.), Moor Plantation, Ibadan, Oyo State. Noodle waste (NW) was purchased from a feed mill in Ibadan, Oyo state, Nigeria. It was ground before incorporated with other feedstuffs. A total of 120 adults snails (*Archachatina margi*nata) of mean weight 173.42 ± 2.5g of about 3 months of age were used for the feeding trial. Four diets were formulated to contain NW at 0% (N_1) Control, 50% (N_2), 75% (N_3) and 100% (N_4) as replacement for maize fraction in the diet of growing snails. Completely randomized design was used for the trial and each treatment was replicated thrice with 10 snails per replicate. The diets were formulated to contain about 24% crude protein and energy of 2400 kcal/kgME. (Table 1)

The snails were reared in a cage of 12 compartments and each compartment had a dimension of 0.5x 0.5m^2. All management practices were adhered to as suggested by Bright,1996. Feed intake and weight gain were measured on daily and weekly basis with the use of sensitive weighing balance. Feed intake was calculated by subtracting the left-over feed from the feed given while the weight gain was calculated by deducting the initial weight from the final weight.

Table 1: Gross composition of the experimental Diets.

Ingredient (%)	**Cost (₦ /kg)**	**N_1 (0%)**	**N_2 (50%)**	**N_3 (75%)**	**N_4 (100%)**
Maize	67	22.00	11.00	5.5	0.0
Noodle waste	60	0.0	11.00	16.5	22.0
*Othersfeed ingredients		78.0	78.0	78.0	78.0
Total		**100.0**	**100.0**	**100.0**	**100.0**
Cost/kg (N)		59.89	58.79	56.23	55.34
Calculated					
Composition					
Crude protein (%)		24.02	24.39	24.48	24.08
Metabolizable energy (kcal/KgME)		2405.2	2398.7	2389.23	2378.34

**Others fixed ingredients: G.N.C. – 10.0; Soybean meal -24; rice-bran -14.75; Fish meal -4; Bone meal -2.15;Brewer dry grain-12.8 , Oyster shell – 9.70; Methionine - 0.1; Lysine - 0.1; Premix 0.25; Salt-0.1.*

Shell length and width were measured on weekly basis with vernier caliper. Micrometer screw gauge was used to measure the shell thickness on weekly basis. Feed conversion ratio and cost per weight gain was calculated. Carcass analysis was carried out at the end of the feeding trial. All data were subjected to analysis of variance and where differences were observed, means were further separated by the Duncan's Multiple Range Test (SAS, 1999).

Results and Discussion

The results of chemical composition of the test ingredient and experimental diets are shown in Table 2. The protein content of NW was 10.02% which was relatively similar to

Table 2 : Proximate composition of the maize, noodle waste and experimental **diets**

Parameters	Maize	Noodle waste	N_1 (0%)	N_2 (50%)	N_3 (75%)	N_4 (100%)
Dry Matter	93.78	92.74	94.92	93.45	94.78	93.62
Crude Protein	9.89	10.02	23.47	23.56	23.87	24.22
Crude Fibre	5.76	4.58	4.87	4.82	4.41	4.39
Ether Extract	6.78	8.34	4.95	4.98	5.01	5.32
Ash	11.89	12.24	10.67	10.98	11.07	11.43
Nitrogen Free Extract	65.68	64.82	56.04	55.66	55.64	54.64

the report of Eniolorunda *et al.,* (2008) while the protein content of the maize was 9.89. The protein content of the two ingredients were relatively the same hence the two ingredients could be used as substitute for each other. The fibre content of NW was a bit lower than that of maize. The ether extract of NW was higher than that of maize. The protein content of the experimental diets fell within recommended values of protein requirements for growing snails as reported by Hamzat,(2004) and Omole *et al.,* (2012). No Significant difference was observed in the mean total feed intake of the snails fed diet containing varied levels of NW (P>0.05).

The mean total weight gain was not significantly different across the treatments (P>0.05) (Table3) (P>0.05).The mean shell length, width and thickness were not significantly different from one another as the level of NW in the diet increased (P>0.05). The feed conversion ratio was not significantly different from one another (P>0.05) across the treatments. The results of

carcass composition (Table 3) revealed that the dressing percentage across the treatments were relatively the same (P>0.05) and it ranged between 43.56 and 44.23%, this implies that NW could be used as substitute for maize in the diet of snail. The results of the dressing percentage compared favourably with the reports of Hamzat (20040, Adikwu, (2012), and Omole *et al.,* (2012). The results of cost analysis showed that cost /kg feed and total feed cost reduced as the level of NW in the diet increased (Table 3).

Table 3 Performance of snail fed noodle waste as replacement for maize

Parameters	N_1 (0%)	N_2 (50%)	N_3 (75%)	N_4 (100%)	± SEM
Initial weight (g)	173.78	172.23	172.03	174.21	3.26
Final weight (g)	359.02	359.71	358.87	358.02	5.68
Total weight gain (g)	185.24	187.48	186.04	183.81	4.68
Total feed intake (g)	627.96	633.68	628.82	623.11	10.13
Feed conversion ratio (g)	3.39	3.38	3.38	3.39	0.26
Shell length increment (g)	10.34	10.27	10.33	10.23	0.31
Shell width increment	8.75	8.56	8.47	8.45	0.21
Shell thickness increment	0.12	0.12	0.13	0.12	0.03
Dressing percent (%)	43.89	43.78	43.58	43.65	1.98
Total feed cost (₦)	54.50 [a]	53.32 [a]	50.21 [b]	50.02 [b]	1.78
Total weight gain (g)	0.19	0.19	0.19	0.19	
Cost/weight gain (₦ /kg)	286.84 [a]	280.63 [a]	264.26 [b]	263.26 [c]	3.89

Means along rows with different superscript are significantly different from each other (P<0.05)

The lowest cost/weight gain was recorded in the diet containing 100% NW as replacement for maize while the highest cost/weight gain was recorded in the diet containing 0%NW. The reduction in feed cost was due to low cost of NW compared to maize. Based on weight gain, feed intake, feed conversion ratio, cost per weight gain and dressing percentages which was relatively the same, it could be concluded that NW could replace maize fraction of the diet of snails up to 100% without any adverse effect on performance but at reduced cost.

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GROWTH PERFORMANCE AND MEAT QUALITIES OF WEANER RABBITS FED GRADED LEVELS OF BOILED NEGRO COFFEE (*Senna occidentalis*) SEED MEAL

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ABSTRACT

A twelve (12) weeks feeding trial was carried out to determine the growth performance and meat qualities of weaner rabbits fed graded levels of boiled Senna occidentalis seed meal(BSOM). A total of five (5) experimental diets were formulated to include BSOM at inclusion levels of 0, 2.5, 5, 7.5 and 10% respectively. Forty five (45) weaner rabbits of mixed breeds and sexes were randomly apportioned to five (5) dietary treatments in a completely randomized design (CRD. The result obtained for average weekly feed intake showed significant difference ($P<0.05$) between treatments with reduced feed intake as levels of BSOM increases across all the groups. The average weekly weight gain indicated significant difference ($P<0.05$) among treatments and increases as inclusions of BSOM increases up to 7.50 % inclusion level and decreases at 10.00 % inclusion level. Feed conversion ratio (FCR) didn't follow any regular as inclusion levels of BSOM increase. Significant difference ($P<0.05$) were also observed in the protein efficiency ratio (PER) and Energy efficiency ratio (EER). All parameters evaluated for meat quality; water holding capacity (WHC), meat pH, cooking yield (Cy) and cooking loss (Cl), indicated significant difference. The best result in terms of weight gain, FCR and meat qualities were obtained in diet 4 containing 7.50 % BSOM. As regards to these findings, it was concluded that 7.50 % BSOM can be included in the diets of growing rabbits without any deleterious effect.

Key words: rabbits, *Senna occidentalis*, boiling, growth performance, meat qualities.

INTRODUCTION

The search for novel high quality but cheap sources of protein and energy has continued to be major point of concern for scientists and organization charged with the responsibility for food production in many parts of the world (Kudu *et al*., 2010). The high cost of conventional feedstuffs like soybean meal(SBM), groundnut cake (GNC), fish meal, maize, etc has prompted researches on the possible use of non-conventional feedstuffs of high nutritive value, cheaper and readily availble like Negro coffee (*Senna occidentalis*) seeds in livestock feeds formulations. *Senna* species have been widely used by American, African and Indian ethnic groups mainly in the treatment of feebleness, constipation, liver disorders and skin infections (Jesus *et al*., 2015) . However, because of inadequate information about its nutritional qualities and the presence of anti-nutritional factors (ANFs) like; cyanide, phytate, tanins has limited it's utilization (Abdullahi *et al.,* 2003). This study was carried out to determine the effects of boiled *Senna occidentalis* seed meal (BSOM) on the growth performance and some meat quality parameters.

MATERIALS AND METHODS

Experimental site

The experiment was carried out in the Rabbit unit at the Federal University of Technology Minna, Gidan Kwano Campus, Minna, Niger State, Nigeria. Minna is located within latitude 09° 36' 50" N and longitude 06° 33' 25" E, degrees minutes' seconds respectively (MINNA NIGER GEOGRAPHY, 2004 - 2017).

Sample collection and processing

Dried pods of Negro coffee were harvested from mature stands of Negro coffee herb along Minna- Bida road, Niger State, Nigeria. The pods were threshed to obtain the raw Negro coffee seeds (RSOS). The seeds were cleaned of undesirable materials like husks, sand, leaves and underdeveloped seeds. All selected seeds were boiled using the method described by Omoikhoje *et al*. (2009) by subjecting seeds to boiling at temperatue of 100^{o}C for 60 minutes. The boiled seeds were poured into a sieve and allowed to drain and later sun dried. After drying, the seeds were milled using milling machine into coarse sized particles and stored in an air tight container and labelled boiled *Senna occidentalis* seed meal (BSOM). Forty five (45) weaner rabbits were purchased from the Ministry of Livestock and Fisheries, Minna, Niger State, Nigeria.

Anti-nutritional factors (ANFs) analysis of RSOS and BSOM: ANFs of the raw Negro coffee seeds (RSOS) and the boiled *Senna occidentalis* seeds (BSOS) were determined at National Cereal Research Institute (NCRI), Badeggi, Niger State, Nigeria. The parameters mesured were: tannin content, phytate content, cynide content, saponin content and trypsin inhibitor.

Experimental diet and management of experimental animal: The experimental diets were formulated in line with Aduku (1993) for weaner rabbits. The ground BSOS was mixed into rations at inclusion levels of 0.00, 2.50, 5.00, 7.50 and 10.00% designated as $T_{1,}$ $T_{,2}T_3$,T_4 and T_5 respectively. Diet which contained 0.00% BSOM was served as the control diet. Everyday, the remaining feed in the feeders were collected and weighed in order to obtain their daily feed intake and the average of these over a period of sven days was taken as the avarage daily feed intake. Water was made available to all rabbits *ad-libitum*.

Experimental design: The Completely randomized design (CRD) was used. The hutches were ramdomly labelled with each hutch representing a replicate of a treatment and a total of fifteen (15) hutches.

RESULT AND DISCUSSION

Table 1 shows the result for anti-nutritional factors (ANFs) analysis of RSOS and BSOM, it indicated percentage reduction in the levels of ANFs after boiling, the result indicated 24.74 % reduction for saponin which is the lowest reduction, while phytate, trypsin inhibitor, cyanide and tannin has percentage reductions of 35.90 %, 56.86 %, 61.41 % and 78.38 %, respectively. Kudu (2014) reported similar findings. The proximate composition and calculated energy content of RSOM and BSOM is presented in Table 2, however, only the boiled seeds were used for the experiment. The result showed that crude protein, crude fibre, ether extract and ash content of the raw seeds were increased when seeds were boiled, and only nitrogen free extract (NFE), calculated energy (kcal/kg) and moisture content of the raw seeds were reduced after

been boiled. The feed composition of the experimental diets and calculated energy are show in Table 3.The crude protein ranges from 17.99% in T2 to 18.09% in T4.

The growth performance records are shown in Table 4, average feed intake indicated significant differences ($p<0.05$) between treatments for all the weeks with the values decreasing with increasing level of BSOM in the diets. The feed conversion ratio also followed similar trend with significant differences observed among all the treatments throughout the experiment except for weeks 4, 5 and 8. Midala *et al*. (2013) reported decrease in feed intake and feed conversion ratio (FCR) with higher levels of *senna* in the diets. This could be as a result of higher residual effects of anti-nutritional factors.

Table 5 shows the analysed result of meat quality parameters. All parameters for meat quality showed significant difference ($P<0.05$). The highest values for WHC (41.22), meat pH (5.53) and Cy (68.46) were recorded at T5 while, for Cl (43.76) was recorded for T2. The values recorded at T5 for WHC indicated the meats of rabbits in the group are juicier.

CONCLUSION

From the result of this experiment, it was concluded that for most of the parameters measured; feed intake, body weight gain, feed conversion ratio on weekly basis, on the performance of rabbits, T4 which has an inclusion level of 7.50 % BSOM performed best in average weekly weight gain while, T5 which has an inclusion level of 10.00 % BSOM performed poorest. For parameters considered for meat quality, T5 with 10.00 % inclusion of BSOM performed best in WHC considered while T2 with 2.50 % inclusion of BSOM has the highest value in Cl.

Table 1: Anti-nutritional factors (ANFs) of raw and boiled *Senna occidentalis* seeds

Anti-nutritional factors	Raw	Boiled	% Reduction
Cyanide (mg/100g)	18.30	7.06	61.42
Phytate (mg/100g)	518.25	332.18	35.90
Tannin (g/kg)	25.86	5.59	78.38
Saponin (mg/100g)	32.10	24.16	24.74
Trypsin inhibitor (g/kg)	35.72	15.41	56.86

Table 2: Proximate composition and calculated energy contents of RSOS and boiled *Senna occidentalis* seeds (BSOM)

Parameters (%)	Raw	Boiled
Dry matter	90.80	92.55
Crude protein	20.31	21.72
Crude fibre	13.74	13.88
Ether extract	7.46	7.48
Ash	3.74	4.32

NFE*	45.55	44.65
Moisture	9.20	7.45
ME (kcal/kg)*	2972.76	2994.60

*NFE: Nitrogen Free Extract

*ME=Metabolizable Energy calculated according to the formula of Pauzenga (1985):

ME= 37 × %CP + 81 × %EE + 35.5 × %NFE

Table 4: Growth performance of weaner rabbits fed graded levels of pelleted boiled *Senna occidentalis* seed meal

Parameters	T1 0.00	T2 2.50	T3 5.00	T4 7.50	T5 10.00	SEM	LS
Init. body weight (g)	546.67^{a}	548.33^{a}	548.33^{a}	548.33^{a}	546.67^{a}	20.35	NS
Final body weight (g)	1175.00^{bc}	1200.00^{bc}	1410.00^{ab}	1550.00^{a}	1053.30^{c}	119.42	**
Av.d.body wt gain (g)	7.48^{bc}	7.66^{bc}	10.26^{ab}	11.94^{a}	6.03^{c}	1.40	**
Av.d. feed intake (g)	56.50^{a}	53.34^{b}	45.51^{c}	43.93^{c}	40.48^{d}	0.97	**
FCR	7.88^{c}	6.96^{bc}	4.47^{ab}	3.78^{a}	7.20^{c}	1.16	**

Av.d =Average daily, FCR=Feed conversion ratio, Init = Initial weight, abc = means with different letters show significant difference ($p<0.05$)

Table 5: Meat quality parameters

Parameters	T1	T2	T3	T4	T5	SEM	LS
WHC	32.65^{c}	37.55^{b}	30.12^{c}	24.35^{d}	41.22^{a}	1.16	*
Meat pH	5.49^{a}	5.02^{b}	5.13^{b}	5.11^{b}	5.53^{a}	0.14	*
Cy	59.90^{b}	56.24^{c}	62.16^{b}	60.85^{b}	68.46^{a}	1.38	*
Cl	40.08^{b}	43.76^{a}	36.84^{c}	39.15^{bc}	31.54^{d}	1.25	*

a, b, c, d = Means with the same letter are not significantly different (P>0.05), Means with different letters (a, b, c, d) differ significantly (P<0.05), SEM: Standard error mean, LS: level of significance, *: Significant difference, BSOM: Boiled *Senna occidentalis* seed meal, T1: 00.00% BSOM, T2: 02.50% BSOM, T3: 05.00% BSOM, T4: 07.50% BSOM, T5: 10.00% BSOM, WHC: Water holding capacity, pH: Meat pH, Cy: Cooking yield, Cl: Cooking loss.

Table 3: Percentage composition of experimental diets

Ingredients	T1	T2	T3	T4	T5
Maize	36.00	36.50	37.00	37.00	37.50
Soyabean	27.00	25.00	24.00	24.00	20.00
Blood meal	2.45	2.45	2.45	2.50	2.00
BSOM	0.00	2.50	5.00	7.50	10.00
Rice offal	18.00	17.00	18.00	16.45	17.95

Maize offal	13.00	13.00	10.00	9.00	9.00
Bone meal	2.50	2.50	2.50	2.50	2.50
*Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.40	0.40	0.40	0.40	0.40
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20
Total	100	100	100	100	100
Calculated analysis					
Crude protein (%)	18.05	17.99	18.08	18.09	18.00
Calculated energy (kcal/kg)	2992.17	3000.05	3002.63	3002.78	3017.26
Crude fibre	12.23	12.21	11.74	10.87	11.32
Calcium	1.16	0.98	1.13	1.02	0.94
Phosphorus	0.62	0.57	0.61	0.58	0.53

*To provide the following per 100 kg of the diet: 440 mg riboflavin, 720 mg calcium, 2 g pantothenate, 2 g niacin, 2.2 g chloride, 15 mg folic acid, 1mg vitamin B12, 15 mg retinol, 165 g vitamin D2, 1,000 mg DL-tocopherol acetate, 1,700 mg copper, 200 mg iodide, 3,000 mg manganese, 5,000 mg zinc, 10, 000mg iron.

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Moringa oleifera: A MULTIPURPOSE BROWSE PLANT FOR FEEDING RABBITS

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Abstract

This paper provides an overview of the role of dietary *Moringa oleifera* in rabbit production. The high cost of conventional feedstuffs presents a major challenge to agriculturalists, animal scientists and livestock farmers, particularly in developing countries. There are many browse plants of tropical origin that have great potential for use in the livestock feed industry. The utilization of the leaf meal from browse plants as a good source of cheap protein for feeding animals has been generating research interest. One of such browse plants is *Moringa oleifera*, which belongs to the family *Moringaceae*. It is the most popularly grown species in the genus *Moringa*. It is a multipurpose plant with high nutritive quality that has been recommended by many researchers for feeding farm animals. It can serve as a feed additive/supplement or feedstuff in the diet of rabbits. Generally, *Moringa oleifera* has been reported to support the growth, reproductive performance, normal haematological profile and physiology of rabbits. *Moringa oleifera* is a promising browse plant with exceptional qualities for future use in the production of commercial rabbit feeds.

Keywords: Rabbit, *Moringa oleifera*, performance, multipurpose

Introduction

Moringa oleifera is a unique browse plant with multiple benefits and uses. It is a fast-growing perennial tree that has high adaptability to different environmental conditions. *Moringa oleifera* is a non-legume tree commonly referred to as horseradish tree, drumstick tree and ben oil tree with every part being useful. Okiki *et al.* (2015) described *Moringa oleifera* as a multipurpose plant that is capable of contributing significantly to the nutritional needs of both livestock and humans. It has been successfully used for compounding livestock feeds. Livestock farmers are encouraged to incorporate *Moringa oleifera* in the diets of their animals. *Moringa oleifera* is a cheap plant protein source which can be utilized to improve feed nutritive quality as well as enhance the digestibility (Moreki and Gabanakgosi, 2014). The rich nutrient content of the dried leaves of *Moringa oleifera* suggests its crucial role as a potential feed resource in the near future (Moyo *et al*., 2011). The inclusion of *Moringa oleifera* in animal diets has resulted in improved feed efficiency (Mahmoud, 2013; Briones *et al*., 2017). The aim of this review is to present a summary of the information and findings on the use of *Moringa oleifera* in rabbit production.

Discussion

Fresh leaves of *Moringa oleifera* are readily consumed by rabbits and other farm animals. Researchers have recommended the use of *Moringa oleifera* for feeding rabbits and other livestock. Okeke *et al*. (2009) posited that *Moringa oleifera* leaf meal is a nutritive protein source that can be utilized as a supplement in feeding adult rabbits, without negatively affecting performance characteristics of the animals. Ahemen *et al*. (2015) in their experiment included up to 15% of *Moringa oleifera* leaf meal in the diets of weaner rabbits and did not record any adverse effect on their blood profile. Ewuola *et al*. (2012) substituted soybean meal with 15% *Moringa* leaf meal in the diets of growing rabbits and achieved significant increase ($P<0.05$) in apparent nutrient digestibility. The dietary replacement of *Centrosema pubescens* with *Moringa oleifera* had no negative effect on the reproductive performance of rabbits (Odeyinka *et al*., 2008). According to Nuhu (2010), *Moringa oleifera* leaf meal is naturally very nutritive and can efficiently serve as a replacement for soybean meal in the diet of weaner rabbits with no detrimental effect on blood indices and productive performance. This author also suggested that *Moringa* leaf meal can be incorporated up to 20% in the diets of weaner rabbits. It is worth noting from all these aforementioned research reports that *Moringa oleifera* can be successfully incorporated in diets of rabbits at different growth stages (weaners, growers and adults).

Conclusion and Recommendations

Moringa oleifera is an excellent source of many nutrients and antioxidants, and has been shown to support reproductive performance, growth, physiology and normal haematological profile of rabbits. The feeding of *Moringa oleifera* to rabbits is less popular when compared with feeding it to other livestock. Rabbit producers and farmers should be encouraged to include *Moringa oleifera* leaf meal in rabbit feeds. Also, available literature is scanty on the utilization of *Moringa oleifera* in rabbit production. It is, therefore, necessary for research efforts to be geared towards exploring the great potentials of the use of *Moringa oleifera* in rabbit nutrition and welfare.

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HEAMOLYMPH MINERAL COMPOSITION OF TWO SPECIES OF LAND SNAIL FED WITH *Moringa oleifera* LEAF MEAL

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ABSTRACT

This study evaluated the effects of *Moringa oleifera* Leaf meal on haemolymph mineral composition of Giant land snail (*Archachatina marginata) and the* Garden snail *(Achatina fulica).* The experiment was designed on a 4×3 completely randomized design (CRD) with four dietary treatments of 0%, 10%, 15% and 20% levels of *M. oleifera* inclusion over a period of 16weeks. A total of one hundred and forty four (144) snails, 72 of each species were used for the investigation. Each treatment had three replicates with 6 snails per replicate and 18 snails per treatment for each species of snail. Results obtained showed that the haemolymph mineral composition (Magnesium, Calcium, Potassium, Iron, Phosphorus and Chlorine) of the two species (*A. marginata* and *A. fulica*) were highest in both species subjected to treatment with 20% *M. oleifera* while the least was recorded in the control. However, Copper and Sodium were recorded highest in the control while the least was recorded in treatment with 20% *M. oleifera* inclusion. This study showed that haemolymph mineral composition indices are the reflections of the effect of dietary treatment on the animals in terms of the type and amount of feed ingested.

Keywords: Mineral composition, *Moringa oleifera*, Leaf meal, Haemolymph, *Achatina fulica, Archachatina marginata*

INTRODUCTION

Haemolymph is a fluid in the circulatory system of the arthropods such as spiders, crabs, stoneflies and snails and is analogous to the fluids and cells making up both blood and interstitial fluid in vertebrates such as birds and mammals (Wyatt, 1998). Haemolymph fills the entire interior (the hemocoel) of the animal's body and surrounds all cells. It contains haemocyanin, a copper based protein that turns blue in colour when oxygenated, instead of the iron based hemoglobin in red blood cells found in vertebrates, thus giving haemolymph a blue–green colour rather than the red colour of vertebrate blood (Wyatt, 1998; Bateman and Fleming, 2009).

Haemolymph is composed of water, inorganic salts (mostly Na^+, Cl^-, K^+, Mg^{2+} and Ca^{2+}), and organic compounds (mostly carbohydrates, proteins and lipids) which provide a valuable medium for clinical investigation and nutritional status of human beings and animals (Church *et al*., 1994). Hence, World Health Organization recommended the use of blood and biochemical parameters in medical nutritional assessment (Church *et al*., 1994). The various blood functions are made possible by the individual and/ or collective actions of its constituents

(Aletor and Egberongbe, 1992). Dietary components have measurable effect on blood components hence blood constituents are widely used in nutritional evaluation and survey of animals (Babalola and Akinsoyinu, 2011). In folk medicine, the bluish liquid (haemolymph) obtained from the shell when the meat has been removed is believed to be good for infant development (Ademosun and Omidiji, 1999). According to Osemeobo (1992), fluids from snail can be used to stop bleeding from cuts, healing of amputed fingers, and circumcision of male children and suppression of small pox.

MATERIALS AND METHODS

The snail pens were placed in roofed enclosure and protected from direct rain and sunlight. There were plantain trees and rich vegetation around the farm to minimize wind and temperature effects. One hundred and forty-four snails of 72 *Archachatina marginata* and 72 *Achatina fulica* species were used for this study.

Fresh *M. oleifera* leaves were collected from Amansea in Awka Metropolis and were dried under shade until they became crispy. The drying lasted for two weeks before it was milled using local milling machine and then incorporated into the feed at 0%, 10%, 15% and 20% levels of inclusion. Other feed ingredients that includes maize, wheat offals, groundnut cake, blood meal, bone meal, palm kernel cake, limestone and vitamin premix were used to formulate the experimental diet at equicalorie and equiprotein levels. The gross composition for each of the four diets is shown in Table1.

The experimental design was CRD with four dietary treatments having 0%, 10%, 15% and 20% inclusion of Moringa. Eighteen snails (18) were assigned to each of the dietary treatments and each replicated three times such that each replicate has six snails each. The diet with 0% *M. oleifera* served as the control. Each replicate was housed in a mini paddock pens with dimensions 120cm × 60cm × 30cm in accordance with the stocking density recommended by Cobbinah *et al*. (2008). The snails in all the treatments were subjected to the same management conditions: they were fed daily, they were provided with humus soil to a depth of 20cm and were fed 50g of ground egg shell to ensure adequate calcium supply and same amount of water (0.75 liter) was sprinkled daily to increase humidity and prevent hibernation (Ademola, 2008). Haemolymph for analysis from the snails in their groups were collected as described by Babalola and Akinsoyinu (2011).

Analysis

The haemolymph collected was analyzed for minerals using atomic absorption spectrophotometry (AAS). Calcium was analysed by flame photometry using Jenway digital flame photometer. The data obtained were subjected to t-test.

RESULTS AND DISCUSSION

Results obtained showed that the haemolymph mineral composition (magnesium, calcium, potassium, Iron, phosphorus and chlorine) of the two species (*A. marginata* and *A. fulica*) were highest in both species subjected to treatment with 20% *M. oleifera* while the least was recorded in the control. However, Copper and Sodium were highest in the control while the

least was recorded in treatment with 20% *M. oleifera* inclusion. This study shows that haemolymph mineral composition indices are the reflections of the effect of dietary treatment on the animals in terms of the type and amount of feed ingested.

The haemolymph of snails have been known to be fried and eaten like chicken eggs in some parts of Southwest Nigeria and also pregnant women drinks it as reported by Ademolu *et al*. (2004). This could be due to high contents of protein and minerals and also where snails are processed in a large scale; the haemolymph could be coagulated and used as animal feed. This study has showed that increased level of *M. oleifera* leaf meal inclusion in the diet of snails have appreciable effect on the haemolymph constituent of the snails.

Table 1: Gross composition of the experimental diets (%)

Ingredients	0%	10%	15%	20%
Yellow maize	40	40	40	40
Groundnut cake	15	10	12	10
Brewers grain	10	10	7.5	7
Palm kernel cake	12	10	7.5	5
Moringa	0	10	15	20
Blood meal	15	12	10	10
Oyster shell	1.5	1.5	1.5	1.5
Bone meal	1.5	1.5	1.5	1.5
Vitamin premix	5.0	5.0	5.0	5.0
Total	100	100	100	100

Table 2: Proximate composition of the experimental diets (%)

Parameters	0%	10%	15%	20%
Dry matter	57.17	61.86	61.97	62.23
Crude protein	10.90	24.53	24.96	25.89
Ash	6.30	6.50	6.60	6.80
Crude fat	7.00	7.29	7.30	7.32

Table 3: Summary of Haemolymph mineral composition (ppm) of the snails

	Feeding treatment									
	AM					**AF**				
Minerals	**Initial value b4 feeding**	**0%**	**10%**	**15%**	**20%**	**Initial value b4 feeding**	**0%**	**10%**	**15%**	**20%**
Mg	9.88	20.23	20.24	20.25	20.25	7.56	16.32	16.56	16.60	16.82
Ca	24.15	42.63	43.08	44.62	46.46	18.34	33.19	34.09	34.44	37.28
Cu	0.28	0.48	0.46	0,46	0.44	0.21	0.57	0.55	0.54	0.53
K	246.10	640.20	652.20	661.30	675.10	139.66	519.10	524.20	525.30	571.10
Fe	1.06	2.74	2.82	2.91	3.05	0.17	2.64	2.85	2.86	3.00
P	4.86	10.22	11.31	11.78	12.37	4.38	8.56	9.89	10.03	10.79
Cl	2.67	8.43	8.82	9.37	10.23	2.86	7.26	8.11	8.29	8.54
Na	2.24	11.48	10.97	10.65	9.44	63.12	9.21	88.81	88.79	88.77

* AF = *Achatina fulica;* AM = *Archachatina marginata*

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EVALUATION OF TRADITIONAL AND MODIFIED MALIAN TRAPS IN TAGWAI DAM OF NIGER STATE

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ABSTRACT

The evaluation to comparatively determine the efficiency of a traditional and modified Malian traps in capture fishery was conducted in Tagwai Dam, Niger State to ascertain the productivity of the dam and also find out the possibility of adapting the Modified Malian trap by fisherfolk as one of the conservation tools in fishery management. The outcome of the catches revealed that traditionalMalian trap caught 131 fishes, comprising of *Sarotherodon galileus. Tilapia zillii, Clarias gariepinus, Oreochromis niloticus* and *Synodontis membraneceous*. While modified semi-circular trap caught 58 fishes of same species and modified rectangular Malian traps also caught similar species excluding *Hydrocynus forskalii*. The species diversity index calculated for the traditional and modified Malian traps were 0.47 0.41 and 0.39 respectively. Based on the results, it was concluded that the traditional traps had higher catches than modified traps due to the smaller mesh size of the net used with no significant difference (P>0.05) between their biomass. Hence in terms of catch efficiency, the modified trap, proofed to have the potential in competing for species selectivity and biomass with its traditional counterpart and also efficient in trapping mostly large bodied size fish and allowed the escape of juvenile fishes. Modified Malian trap of this nature is recommended as one of the potential fishing gears in conserving aquatic resources.

Key words: Traditional Malian Trap, Tagwai Dam, Modified Semi-circular Malian Trap, Modified Rectangular Malian trap, Mesh size.

Introduction

Fishing gear can be defined as any type of equipment used in capturing, harvesting or cropping fish from any water body Nuhu and Yaro (2005). According to Moses (1992) Fishing gears have generally passed through many improvement and modifications in line with advances in modern technology. Although, the fundamental principle of hooking, trapping, wounding, encircling, filtering and scooping can still be found in existence. (Abiodun and Niworu 2004). There have been several efforts in recent years to modify fishing gears and practices in order to target particular sizes and species of fish and other marine life more efficiently, and to also reduce impact on both surface and bottom habitats of the aquatic system. Furthermore, the development of gear and techniques is still very much in its infancy from the perspective of reducing capture of small size fish and benthic disturbances. The capture process of fishing gear in various environments is the key element in developing modifications and practices that can reduce ecosystem impacts (John and Petri 2000) Malian trap is one of the most widely used gear in combination with other traditional and modern fishing gears. Agbelege and lpinjolu (2001).

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METHODOLOGY

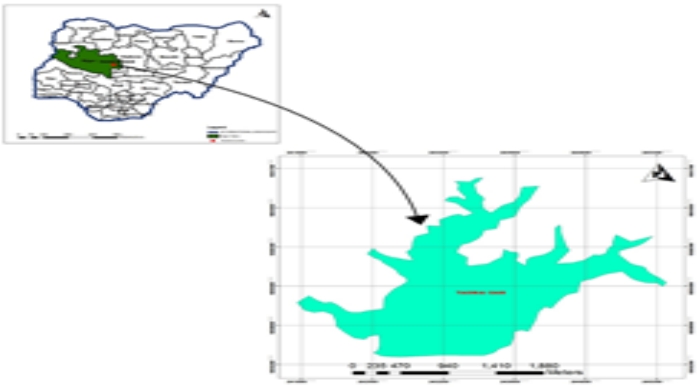

Figure1: Map of Nigeria and Niger State inset Tagwai Dam.

Tagwai Dam is located in Minna, Niger State. Within Latitude 6°33' E and Longitude 9°33' N, covering a land area of 88km^2.

Traps Construction Process, Setting, Monitoring and Data Collection of Trapped Fish

The traps were designed and constructed with the following wooden frame dimensions: - the traditional trap which was cone shaped, had a diameter of 130cm, 100 cm and 70cm while that of the modified semi-circular Malian trap had 100cm length, and 50cm width. Also modified rectangular-shaped, Malian trap had a base length of 100cm, width of 50cm and height of 40cm. The Traditional Malian traps was enclosed in 3.75cm mesh size while the modified Malian trap were both enclosed in a netting material of 5cm mesh size. The traps were set alternately according to their shape with 30m distance apart. Sticks pegged closed to them for easy identification during monitoring visits. Collection of catch was done twice weekly for a period of six months (July to December). The catches were brought into the laboratory for analysis.

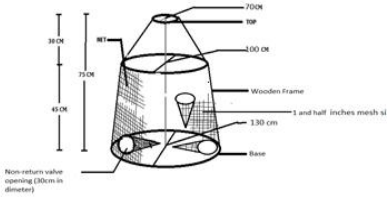

Fig:2 Sketch of a Traditional Malian Trap

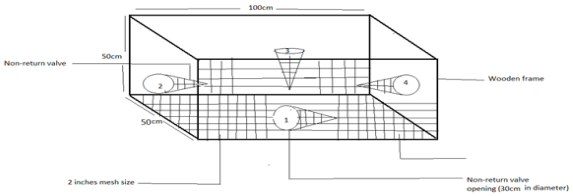

Fig 4: Sketch of Modified Rectangular Malian Trap

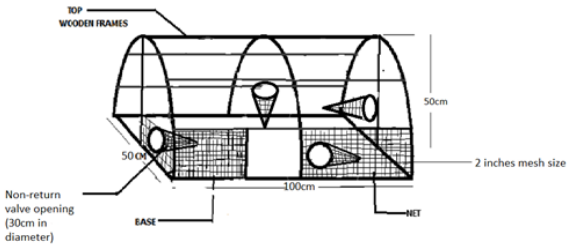

Fig 3: Sketch of Modified Semi-circular Malian Trap

Results

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Where: ± SDM= standard deviation of the mean; TMT= traditional malian trap; MSCMT= modified semi-circular malian trap; MRMT= modified rectangular malian trap

Discussions

There was variation in the rate, weight and species of fish caught. This gave efficient information on the traps employed throughout the study and the productivity of fish in the Dam as well.

A total of 236 fish weighing 15, 611.18g of different size, species occupying different feeding niches were caught in this study. Ayanwale *et al.* (2013) reported that variation in mesh size of gears influenced number of catch and that low catches are mostly recorded during the raining season and daytime. This conform partly with the result of this study in which there was a variation in mesh size used for Traditional and Modified Malian traps and the study was also conducted from July to December. The result of the catch also agreed with Ogunfowora *et al.* (2011) who discovered in their finding that seasonal variation influence catch efficiency with a catch of 1,373 recorded during dry season as compare with 1,198 recorded during the wet season.

The result of this study does not correspond with the report of Ayanwale *et al.* (2013) who study the fish fauna of Tagwai Dam in relation to gear selectivity from July to September, 2010 using cast and gill net and discovered a total of 1,669 specimens. The reason for the variation could be as a result of the differences in year the two study were conducted as fish productivity of the Dam declined with time due to over exploitation.

The finding on dominant species in this study, is in line with Ayanwale *et al*. (2013) who reported *Cichlidae* as the most abundant fish family in the Dam. The species diversity index computed for the traps were close in value. They include TMT 0.47 followed by MSCMT with 0.41 and 0.39 for MRMT. The reason for low species diversity index of the traps employed could also be linked to low productivity of fish in the Dam, season, overexploitation, type of the gear used and migration of certain species which were hitherto known from the Dam. Ago *et al.* (2012) reported species density index of 0.93 recorded for the Polyiniyl chloride (PVC) pot as against 0.79 for the Malian trap. Ipinjolu *et al.* (2004) also reported different species diversity index of 0.86 for 6-V, 0.80 for 8-V and 0.60 for 4-V Lege traps respectively.

Conclusions

This study revealed that modified malian traps can compete favourably with its traditional counterpart in terms of trapping different species of fish available in Tagwai Dam. The study further unfolds the present unproductive nature of fish in the Dam due to overexploitation, lack of regulation, and effective monitoring. The species of fish caught with the traps shows an extinction of few valuable species such as *Mormyrus* species *Alestes* which were hitherto reported to be one of the dominant species in the Dam (Ayanwale *et al.,* 2013). Also, the low value of species diversity index computed further corroborated the low productivity of fish in the Dam.

Recommendations

Base on the finding of this study, Niger State Government, should as matter of urgency regulate the activities of indiscriminate fishing in Tagwai Dam and also restock some valuable species in the Dam which were hitherto reported to be present in the Dam. Also, based on the efficiency of Modified Malian traps, the traps are recommended to the government and fisherfolk as one of the conservation tools in effective fisheries management.

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EFFECT OF HEAT-TREATED SOYBEAN MEAL ON GROWTH PERFORMANCE AND NUTRIENT UTILISATION OF AFRICAN CATFISH (*CLARIAS GARIEPINUS*) FINGERLINGS

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Abstract
This study evaluated the effect of heat treatments of raw soybean seed meals (RSBM) on the growth performance and nutrient utilisation of African catfish *Claras gariepinus*. Six isonitrogenous (35% crude protein) diets were formulated. A diet containing fish meal and non -heated soybean as served as control diet. Raw Soybean seeds were heated in an auto seed dryer machine at 130^0 C for 10-50 minutes represented by RSBM10, RSBM20, RSBM30, RSBM40 and RSBM50 respectively. These were used to partially replace fish meal at 18.85%. Each diet was fed to fingerlings with mean weight of 1.70g stocked 10 fingerlings/treatment in triplicate, fed twice daily for 56 days at 5% body weight. The Mean Weight Gain (MWG), Total Weight Gained (TWG), Total Feed Intake (TFI) and Protein Efficiency Ratio (PER) were determined. Data were analysed using one-way ANOVA at (α 0.05). The highest TWG, MWG of 21.79±2.00g; 2.66g were from the fish fed RSBM40 diet and the least values were from the fish fed the control diet (15.63±2.00g; 1.43g) respectively. However, the fish fed RSBM50 diet recorded the lowest TWG and MWG (16.55±20g; 1.61±006g) among the fish fed diets subjected to heat treatments. The same trends were observed in TFI and PER, where the highest value was from the fish fed RSBM40 diet (308.70±00g; 2.26±00) and the lowest value (233.10±00g; 2.14±00) was from fish fed control diet. The improved performance of fish fed RSBM40 diet, revealed that the anti -nutritional factors were denatured at the optimum temperature for effective utilisation by the fish and decreased performance of the fish fed RSBM50 diet, showed that the nutrients were denatured at higher exposure time. Therefore, it's recommended that soybeans be processed at optimum temperature for 40 minutes by farmers for the best result in culturing *C. gariepinus*.
Keywords: Heat treatment, processing, anti-nutritional factors, *Clarias gariepinus*, fish nutrition, Aquaculture

Introduction:

The world demand for sea food is increasing dramatically year by year and it is for this reason that there is a considerable move towards modernizing and intensifying fish farming. To be economically viable, fish farming must be competitive, which mean that feed cost amongst others must be carefully monitored as the fish feed constitute 60% of production cost. (Akintomide *et al.*, 2005). Due its nutritional value and palatability, fish meal still constitutes a substantial portion of fish feed formulation. However, the scarcity and consequent rising cost of fish meal has put the cost of quality feed out of the reach of the average farmers. Soybean meal has been found to be a good substitute. However, due to presence of anti-nutritional factors in soybean, it is justifiable therefore to evaluate the adequacy of heat treatment that will effectively destroy the anti-nutritional factors without affecting the nutritional quality of soybean. Studies have showed that plant protein particularly Soybean meal (SBM) is a good replacement and is the most commonly used plant protein in feed formulation for aquaculture species (Lim and Akiyama, 1991, Adewole and Owolabi, 2006). The effect of the partial or total replacement of fish meal by soybean meal (SBM) in fish diets which frequently lead to reduced growth performance and poor feed utilization efficiency (Beckmann and Pfeffer, 1989) could be attributed to a number of factors such as improper

balance of essential nutrients, lower digestibility, reduced diet palatability and most importantly the presence of anti-nutritional factors such as trypsin inhibitors (TIs) and lectins (Tacon 1994).

The heat treatment applied during commercial processing of soybean meal (SBM) has been found to inactivate most of the TIs and other heat-sensitive anti-nutritional factors (Liener, 1980). However, it is suggested that this heat treatment should be kept to a minimum due to its cost and the possibility of destroying essential amino acids, such as lysine and methionine, reducing the availability of other nutrients (Qin *et al.*, 1998). Therefore, soybean meal (SBM) heat processing must be a compromise between inactivation factors and destruction/denaturation of essential nutrients. There is need to ascertain the optimum length of period at which soybean will be heated in order to inactivate the TIs in raw soybean meal without compromising its protein nutritional value. Therefore, the effect of heat-treated soybean meal diets on the growth performance and nutrient utilisation of *Clarias gariepinus* fingerlings was investigated.

Materials and Methods

Experimental location: The experiment was carried out in the Fisheries Laboratory of the Department of Animal/Fisheries Science and Management. Enugu State University of Science and Technology (ESUT), Nigeria.

Processing, formulation, preparation of the experimental diets: Raw soybean seeds were procured from Eke Market, Agbani, Enugu State. The seeds were sorted, sun dried for five days and subjected to heating processing in an automatic seed dryer **at temperature** of 130^{o}C, but for different length of time:10,20,30,40 and 50minutes respectively. After heating the content of each of the containers was crushed into dried powder with a clean, dry hammer mill and labelled (RSBM10), (RSBM20), (RSBM30), (RSBM40), (RSBM50) and the control (CONT) meals (without heat treated soybean meal). These were later used in the formulation and preparation of six experimental diets for *C. gariepinus* fingerlings containing iso-nitrogenous crude protein of 35% (Table 1) as reported by (Adewole and Owolabi, 2006).

Table 1: Composition of the Experimental Diets (in 100g) fed to *Clarias gariepinus* in plastic tanks for 56 days

Treatments						
Ingredients	**CONT**	**RSBM10**	**RSBM20**	**RSBM30**	**RSBM40**	**RSBM50**
Fishmeal	**27.73**	**27.73**	**27.73**	**27.73**	**27.73**	**27.73**
Non heated RSBM	**18.85**	**-**	**-**	**-**	**-**	**-**
RSBM heated for 10 min	**-**	**18.85**	**-**			
RSBM heated for 20 min	**-**	**-**	**18.85**	**-**		
RSBM heated for 30 min	**-**	**-**		**18.85**	**-**	
RSBM heated for 40 min	**-**	**-**			**18.85**	**-**
RSBM heated for 50 min	**-**	**-**				**18.85**

Yellow maize	**42.92**	**42.92**	**42.92**	**42.92**	**42.92**	**42.92**
Bone meal	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**
Premix	**4.00**	**4.00**	**4.00**	**4.00**	**4.00**	**4.00**
Oil	**5.00**	**5.00**	**5.00**	**5.00**	**5.00**	**5.00**
Salt	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Fish stocking acclimatization and experimental design: One hundred and eighty (180) of catfish fingerlings were bought from a private hatchery, Epkan Farm, Delta State, Nigeria, and acclimatized for one week. Eighteen (18) plastic bowls with diameter of 48cm and depth of 30cm as rearing tanks were used to stock the fish in a complete randomised experimental design with 10 fish per tank in triplicates, i.e. (30 fish/treatment).

Feeding Management: The fingerling fish were fed at 5% body weight twice daily between 6.30am and 6.30pm daily for 56 days (Adewole and Owolabi, 2006).

Growth measurements: Total length (cm) and total weight (g) of the fish were determined biweekly using metre rule and electronic weighing scale. The growth data obtained were used to compare the growth performance, nutrient utilisation indices and survival of *C. gariepinus* fingerlings fed the various diets as reported by (Adewole,2016). Data were analysed statistically using one-way analysis of variance (ANOVA) at (α0.05).

Results and Discussion

The result showed that all the fish used in the experiment survived, without any mortality (Table 2). This agreed with the result obtained by Helena *et al., (*2003) which reported an average survival rate of 99 percent in their work. The high survival rate obtained in this work could be as a result of good and efficient water quality management technique and reduction of stress to the fish during the feeding trials. The results at the end of the feeding trials showed that the fish responded well to the experimental diets (Table 2),there were increases in the lengths and weights of the fish from the initial total length of 3.57±9cm to 7.41±9cm from the fish fed RSBM40, while the highest Total Weight Gained (TWG) and Mean Weight Gain (MWG) of 21.79±2.00g; 2.66g were from the fish fed RSBM40, closely followed by fish fed RSMB30 (17.43±2.00g; 1.77g) and the least values were obtained from the fish fed the control diet (15.63±2.00g;1.43g) respectively. However, there was reduction in the final weight as the fish fed RSBM50 recorded the lowest weight among the diets subjected to heat treatments. The same trends were observed in the Total Feed Intake (TFI), which revealed that the highest value was from the fish fed RSBM40 (308.70±00g) and the lowest value (233.10±00g) was from the fish fed the control diet. The final condition factor (K2) showed that the highest value (6.91) was from the fish fed RSBM10 and the lowest value (1.72) was from the fish fed RSBM40.

The result obtained indicated that there was a significant reduction in both the total length, weight and feed intake of the fingerlings fed the (Control diet and RSBM10) as result of anti-nutritional factors present in the soybean which have not be inactivated to a level, that could have been utilized by fish with the heat treatment applied during the processing of soybean meal (SBM) which has led to decrease in growth performance of the fish fed with soybean based diet heated for 10minutes. This was in agreement with (Wilson and Poe, 1985; Balogun and Ologhobo, 1989) which as earlier reported that Trypsin inhibitors in soybean cause growth depression reduced feed efficiency and survival of some fish species.

Furthermore, it was observed that the fish fed RSBM20- RSBM40 diets had appreciable increased length, weight and feed intake when compared with the fish fed (Control diet, RSBM10 and RSBM50) respectively. The weight gains of fish fed heated soybean based diets increased from RSBM10 –RSBM40 and then decreased in fish fed RSBM50 as heating process progressed. This could be as a result of the

gradual inactivation of anti-nutritional factors present in soybean as heating process progressed from RSBM10to RSBM30and totally destroyed at RSBM40 (40minutes of heating) to fully release the available essential nutrients for better utilization by the fish. The observed decreased after RSBM40 could be as a result of prolonged/excessive heating which Lim and Akiyama, (1991) reported can lead to destruction of these essential nutrients of the soybean, primarily lysine in non-enzymatic browning reaction and sulphur amino acid. These observations invariably agreed with Wilson and Poe, (1985) and Fowler, (1980) who had earlier reported the deleterious effect of overheating soybean on its nutritional values. This also agreed with the previous study on channel catfish that fish fed with soybean based diets heated for 40min at 130^0C increases whole body and better protein utilization (Castell and Cliplef, 1988).

Conclusion and Recommendation: It can be concluded that by heating soybean at 130^0C for 40minutes improved the growth performance and feed utilization efficiency of *C. gariepinus* fingerlings due to lowered trypsin inhibitor and other anti-nutritional factors and bioavailability of other nutrients to the fish. Therefore, processed and heat treated soybean meal is recommended as a replacement for fishmeal in the culturing of catfish in Nigeria.

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Table 2. Growth performance and nutrient utilisation of C. g*ariepinus* fed with heat treated Soybean meal as a partial replacement for fish meal

Treatments **Parameters**	**CONT**	**RSBM10**	**RSBM20**	**RSBM30**	**RSBM40**	**RSBM50**

Experimental period(days)	**56**	**56**	**56**	**56**	**56**	**56**
No. of fish stocked/replicate	**10**	**10**	**10**	**10**	**10**	**10**
Mean Initial Total Length(cm)	**3.57±90**	**3.57±90**	**3.57±90**	**3.57±90**	**3.57±90**	**3.57±90**
Mean Final Total Length (cm)	**5.69 ±90**	**5.34±90**	**6.47±90**	**6.74±90**	**7.41±90**	**6.81±90**
Mean Initial Weight (g)	**1.70±00**	**1.70±00**	**1.70±00**	**1.70±00**	**1.70±00**	**1.70±00**
Mean Final Weight (g)	**3.13±00**	**2.97±00**	**3.44±00**	**3.47±00**	**4.36±00**	**3.31±00**
Mean Weight Gained (g)	**1.43±00**	**1.27±00**	**1.74±00**	**1.77±00**	**2.66±00**	**1.61±00**
Mean Weight Gained/day	**0.026±10**	**0.022±10**	**0.031±10**	**0.027±10**	**0.048±10**	**0.029±10**
Total Weight (g) (TW)	**15.63±20**	**14.86±20**	**17.10±20**	**17.34±20**	**21.79±20**	**16.55±20**
Feed Conversion Ratio (FCR)	**14.91±00**	**15.12±00**	**14.77±00**	**15.74±00**	**14.17±00**	**14.86±00**
Total Feed Intake (g)	**233.10±00**	**224.90±00**	**254.10±00**	**260.40±00**	**308.70±00**	**245.90±00**
Total Protein Intake (TPI) (g)	**1.46±02**	**1.41±03**	**1.59±00**	**1.59±01**	**1.93±00**	**1.54±00**
Protein Efficiency Ratio (PER)	**2.14±00**	**2.11±00**	**2.16±00**	**2.03±00**	**2.26±00**	**2.16±00**
Initial Condition factor (K1)	**3.74±01**	**3.74±02**	**3.74±02**	**3.74±02**	**3.74±02**	**3.74±02**
Final Conditional factor (K2)	**6.04±00**	**6.91±00**	**1.91±00**	**1.72±00**	**1.73±00**	**1.55±00**
Difference	**-2.3**	**-3.71**	**1.83**	**2.02**	**2.01**	**2.19**
Survival (%)	**100**	**100**	**100**	**100**	**100**	**100**

Data are mean values of three replicates

DIETARY ADMINISTRATION OF MALABAR SPINACH (*Basella alba*) LEAVES EXTRACTS ON GROWTH PERFORMANCE, SURVIVAL AND CONDITION FACTOR OF JUVENILES *Clarias gariepinus*

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ABSTRACT
A 56 day experiment was aimed to determine the dietary supplementation of Malabar spinach leaves (*Basella alba*) (BA) extracts and Chloramphenicol (CHRL) on growth, survival and condition factor of juveniles *Clarias gariepinus*. Fish with average weight of 4.11±0.01g were distributed into five treatments, replicated twice with 20 fish per replicate. Experimental diets consist of control (0%), BA_2 (1%), BA_3 (2%), $CHRL_4$ (30mg/kg), and $(BA+CHRL)_5$ (2%) were fed twice daily to the experimental fish at 3% body weight of 45% crude protein. Biological indices (Mean weight gain, Specific growth rate, Survival rate, Nitrogen metabolism, Protein efficiency ratio and Protein intake) were determined. Data were analyzed using descriptive statistics and ANOVA at P=0.05. The result indicated that, fish fed the diets supplemented with BA and CHRL enhanced weight gain, specific growth rate, survival rate, Nitrogen metabolism, protein efficiency ratio and protein intake when compared to the control diets ($P<0.05$). The result suggested that BA extracts, and combination of the plant with chloramphenicol would positively enhance growth, survival and health status of *C. gariepinus* juveniles

Keywords: *Clarias gariepinus*, Spinach leaves, Chloramphenicol, Growth, Survival.

INTRODUCTION
Fish is a vital source of high-quality protein, providing approximately 16% of the animal protein consumed by the world's population (Food and Agricultural Organisation, FAO, 1997). It is a particularly important and cheap protein source in regions where livestock is relatively scarce and expensive. It is estimated by the FAO that about one billion people worldwide rely on fish as their primary source of animal protein (FAO, 2000). The global aquaculture production has quadrupled over the past twenty years and that aquaculture production is likely to double in the next fifteen years, as a result of wild fisheries approaching their biological limits and the world demand for cultured fish continuing to increase (Ayinla 2012). The aquaculture sub-sector is considered a very viable alternative to meet in the nation's need for self-sufficiency in fish production.

Malabar spinach (*B. alba*) leaves as plant immunostimulants can be used as a growth promoter and for health management in African catfish (*Clarias gariepinus*) in which it could increase body weight gain, feed intake and feed efficiency. However, scientists have worked on different natural products such as onion bulb (Bello *et al* 2012), garlic (Nya and Austin, 2009) microalgae (Cerezuela *et al*, 2012), and mistletoe (Park and Choi, 2012), but there is a dearth of information and research on the utilization of Malabar spinach leaves by *C. gariepinus.* The aim of this study was therefore to evaluate the growth performance, survival and health status in *C. gariepinus* juveniles.

MATERIALS AND METHODS
Malabar spinach leaves were plucked and air dried at an ambient temperature (25^{o}C) for three weeks. After which it was grinded to fine powder and soaked in 2500ml of 95% ethanol for 48 hours. The plant was stirred every three hours for proper extraction and filtered using sterile muslin cloth, after which the extract was obtained, air dried and stored until required. The experiment was carried out in ten aquaria for 8 weeks in the Fisheries and Aquaculture Laboratory, Ondo State University of Science and Technology, Okitipupa. The water level in each aquarium was maintained at volume of 35 litres throughout the experimental period. Water in each bowl was replaced every three (3) days throughout the

period of the experiment to maintain relatively uniform physiochemical parameters and also to prevent fouling that may result from food residues.

Each treatment have two replicates, 20 fish per replicate with mean initial body weight of 4.11±0.01g and uniform- sized fish was selected from 450 juveniles, weighed and distributed in the experimental bowls. The fish was acclimatized for fourteen days before the experiment. The experiment lasted for 8 weeks during which the fish was fed at 3% body weight daily. The diet per day was divided into two; 1.5% was given in the morning by 9.00-10.00 am and 1.5% in the evening by 5.00 pm. Measurement of the weight changes was performed weekly and the feeding rate adjusted every week according to the new body weight. After preparation, feed ingredients were mixed together to formulate 45% crude protein diet. The pelleted diets were sun dried, packed in labeled polythene bags and stored in a cool dry place to prevent mycotoxin formation (Table 1).

Table 1: Gross and proximate composition of experimental diets (g/100g)

Ingredients/Parameters	Control (0%)	BA2 (1%)	BA3 (2%)	CHRL (30mg/kg)	CHRL + BA (2%)
Fish meal	21.25	21.25	21.25	21.25	21.25
Soy bean	42.49	42.49	42.49	42.49	42.49
Yellow maize	28.26	27.26	26.26	26.26	26.26
Starch	1.00	1.00	1.00	1.00	1.00
Vegetable oil	2.00	2.00	2.00	2.00	2.00
DCP	2.00	2.00	2.00	2.00	2.00
Vitamin premix*	2.00	2.00	2.00	2.00	2.00
Salt	1.00	1.00	1.00	1.00	1.00
Basella alba	-	1.00	2.00	-	1.00
Chloramphenicol	-	-	-	2.00	1.00
Total	100.01	100.01	100.01	100.01	100.01
Moisture (%)	6.61±0.01^{c}	6.75±0.01^{d}	6.57±0.01^{c}	6.35±0.01^{a}	6.54±0.01^{b}
Crude protein (%)	43.63±0.02^{a}	45.84±0.01^{a}	45.49±0.01^{b}	45.40±0.29^{a}	45.31±0.01^{a}
Ether extract (%)	6.38±0.01^{b}	6.73±0.01^{c}	6.00±0.04^{a}	6.32±0.02^{b}	6.03±0.02^{a}
Ash (%)	8.55±0.01^{c}	6.09±0.02^{a}	7.56±0.01^{b}	10.35±0.01^{e}	9.34±0.01^{d}
NFE (%)	37.07±0.40^{b}	36.90±0.02^{c}	36.57±0.05^{a}	33.93±0.23^{d}	36.22±0.02^{b}

BA = *Basella alba*, DCP = Dicalcium phosphate, CHRL = Chloramphenicol, the mean values in each rows with similar superscript are not significantly different (P> 0.05)

Fish were evaluated as follows: weight gain = final body weight - initial body weight; weight gain (%) = 100 (final body weight - initial body weight)/initial body weight; specific growth rate (SGR) = 100 (loge final body weight - loge initial body weight)/time (days); feed conversion ratio (FCR) = dry weight of feed fed (g)/fish weight gain (g); protein efficiency ratio (PER) = wet body weight gain (g)/crude protein fed; protein productive value (PPV) = 100(final fish body protein - initial body protein)/crude protein intake; survival (%) = 100 (initial number of fish stocked - mortality)/initial number of fish stocked, protein intake = (feed intake × percent protein in diet)/100, and condition factor (K) = $100W/L^3$ where: W =Weight of fish (g), L = Standard length (cm)

Experimental diets and fish carcasses were analyzed for proximate composition before and after the experiment according to the methods of Association of Official Analytical Chemists [A.O.A.C] (2005). Growth performance and nutrient utilization indices resulting from the experiment were subjected to one- way analysis of variance (ANOVA) and Duncan multiple range test was used to compare differences among individual means at P = 0.05

RESULTS

Proximate composition of experimental diets

The proximate composition of experimental diets showed significant differences ($p< 0.05$) among the dietary groups in the moisture, crude protein, ether extract, ash and Nitrogen Free Extract (NFE) (Table 1).

Proximate composition of experimental fish before and after the experiment

The proximate composition of experimental fish after the experiment were better in the treated groups ($P< 0.05$) compared to the control and value obtained before experiments in terms of moisture, crude protein, ash and Nitrogen Free Extract (NFE) (see Table 2).

Table 2: Proximate composition of fish before and after experiment (DM %)

	BEFORE	CONTROL	BA2	BA3	CHRL4	(CHRL+BA)5
Moisture	4.59±0.02^{a}	5.90±0.01^{b}	6.25±0.02^{c}	9.17±0.02^{f}	6.82±0.02^{e}	6.62±0.04^{d}
Crude protein	47.00±0.02^{a}	65.24±0.02^{c}	69.33±0.01^{b}	68.35±0.03^{d}	67.50±0.02^{cd}	67.76±0.01^{cd}
Ether extract	4.07±0.02^{b}	4.39±0.01^{d}	4.14±0.01^{a}	4.04±0.07^{b}	4.22±0.01^{c}	4.56±0.01^{e}
Ash	4.02±0.02^{a}	4.12±0.01^{b}	6.83±0.01^{e}	5.64±0.02^{c}	6.68±0.01^{d}	7.25±0.01^{f}
NFE	42.35±0.02^{f}	26.26±0.01^{d}	19.72±0.01^{e}	21.98±0.10^{c}	21.61±0.01^{b}	20.28±0.02^{a}

Key: Mean followed by the same letter in the row was not significantly different ($p > 0.05$). NFE = Nitrogen Free Extract, BA= *Basella alba*, CHRL= Chloramphenicol

Growth performance of *Clarias gariepinus* juveniles fed with spinach leaves enriched diet for 56 days

The result of the experiment revealed general increase in the values of treated groups when compared with the control in terms of weight gain, SGR, NM, PPV, PER and SR and there were significant differences ($P > 0.05$) within the treatments (see Table 3).

Table 3: Growth response, nutrient utilization and survival parameters of *Clarias gariepinus* fed with experimental diet

Parameters	Control (0%)	BA2 (1%)	BA3 (2%)	CHRL (30mg/kg)	CHRL + BA (2%)
Initial Body Weight	4.11±0.00^{a}	4.11±0.00^{a}	4.12±0.50^{a}	4.11±0.00^{a}	4.12±0.50^{a}
Final body weight	8.44±0.65^{a}	10.26±1.56^{a}	15.93±0.37^{b}	11.11±1.15^{a}	12.22±1.60^{b}
Mean Weight gain	4.33±0.65^{a}	6.15±1.56^{a}	11.82±0.38^{b}	7.00±1.15^{a}	8.10±1.60^{ab}
Body weight gain (%)	105.35±5.82^{a}	149.64±7.96^{b}	286.65±9.95^{d}	170.20±7.86^{bc}	196.89±9.12^{c}
Specific growth rate	0.64±0.07^{a}	0.81±0.04^{b}	1.20±0.02^{b}	0.89±0.03^{c}	0.97±0.05^{b}
Nitrogen metabolism	168.81±8.75^{a}	193.29±5.99^{b}	269.62±4.91^{d}	299.28±9.23^{e}	219.65±1.39^{c}
Survival Rate (%)	75.0±0.00^{a}	77.5±2.50^{a}	82.5±7.50^{a}	85.0±5.00^{a}	85.0±5.00^{a}
Feed Conversion Ratio	3.76±0.57^{a}	4.24±1.08^{a}	2.39±0.08^{a}	4.07±0.67^{a}	3.17±0.63^{a}
Protein Efficiency ratio	0.10±0.02^{a}	0.14±0.04^{a}	0.26±0.01^{b}	0.16±0.03^{a}	0.18±0.04^{ab}
Protein Production value	39.97±0.05^{a}	48.70±0.00^{e}	46.93±0.07^{d}	45.15±0.32^{b}	45.82±0.03^{c}
Protein Intake	7.25±0.01^{a}	11.18±0.01^{b}	12.80±0.01^{d}	12.60±0.08^{c}	11.16±0.00^{b}
Condition factor (K)	1.53±0.19^{a}	0.97±0.23^{a}	1.05±0.03^{a}	1.09±0.37^{a}	1.18±0.21^{a}

Key: Mean followed by the same letter in the row was not significantly different ($p > 0.05$). BA= *Basella alba*, CHRL= Chloramphenicol

DISCUSSION

The results of proximate composition of experimental diets obtained in this study corroborates with the findings of Bello *et al*., (2012) who reported 45% crude protein for *C. gariepinus* juveniles fed graded levels of onion bulb and walnut leaves supplemented diet. The result of proximate composition of the experimental fish after the experiment showed a general increase in crude protein, ether extract, moisture, and ash contents when compared to the values obtained in the control and before the experiment. The result of this study agree with those obtained by Dienye and Olumuji (2014) and Obe (2014) who reported higher values of crude protein, ether extract and moisture content of *C. gariepinus* juveniles fed graded levels of *Moringa oleifera* and sorghum supplemented diet respectively.

The result of experimental fish obtained in this study showed an increased in weight gain, percentage weight gain, specific growth rate, nitrogen metabolism, protein efficiency ratio, protein productive value, protein intake and survival rate in the treated groups when compared to the control and they were significant difference ($P< 0.05$) within the treatments. Fish fed with BA_3 (2%) had the best

performance. This suggest the potential of Malabar spinach leaves as feed additive and agree with the report of Sotolu, (2010) who observed better performance in *Leucaena leucocephala* when compared to the control. Also, the results of the condition factor of this study support the report of Bello *et al*., (2012) who recorded better condition factor in treated groups when compared to the control.

Conclusion

It can be inferred from this study that diets with *B. alba* leaves extracts had nutritional beneficial use in fish farming and an inclusion of 2% *B. alba* leaves extracts in fish feed will positively enhanced the growth performance, survival and health status of *C. gariepinus* juveniles

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AWARENESS AND ADOPTION OF IMPROVED FISH PROCESSING TECHNOLOGIES AMONG FISH FARMERS IN OBIO/AKPOR LOCAL GOVERNMENT AREA OF RIVERS STATE

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Abstract
The study investigated the adoption of improved fish processing technologies in Obio/Akpor Local Government Area of Rivers State. Multistage sampling technique was used. The first stage was purposive selection of seven (7) communities, while the next stage was snowball sampling technique used to select 10 fish farmers' from each community to give 70 sample size. Data were collected through structured questionnaire and descriptive statistics such as frequency and percentage were used for the analysis. The results revealed that 84.3% of the fish farmers were aware of information on fish processing technologies, and 18.6% of respondents got information on improved fish processing technologies from friends and family members and other fish farmers, respectively. The level of awareness on using charcoal smoking kiln, as improved fish processing, was 42.6%, and the adoption level was 51.5%. The study recommends that extension agents should be consistently trained on fish processing technologies by the subject matter specialists, through the government, and be readily available to disseminate the acquired skill and information to the fish farmers. Available channels of information should be adequately utilized in disseminating fish processing technologies to fish farmers.
Keywords: Adoption, awareness, fish farmers, fish, fish processing.

Introduction

Fish is one of the cheapest sources of dietary protein especially in isolated fishing communities (FAO, 2010) and its production a; source of employment as the fishery sector generates employment to over 70% of persons living in rural areas. It is also of medicinal value and further useful for industrial purposes such as in the production of fish meal (Odediran and Ojebiyi, 2017). Fish is a major source of protein and its harvesting, handling, processing and distribution provide livelihood for millions of people in Nigeria. Fish is highly susceptible to deterioration without any preservative or processing measures, immediately the fish dies, a number of physiological and microbial deterioration set in and thereby degrade the fish. (Davies and Davies, 2009) resulting in economic losses. Fish spoilage occurs mainly as a result of bacterial metabolism of the fish muscle producing metabolites that decrease the quality of fish (Onyango *et al.*, 2017). The most common spoilage reaction is the production of biogenic amino of which trimethylamine is the most important (Kyrana and Vladimiros, 2002).
Opara and Al Jufaili (2006) reported high incidence of fish losses as a major impediment to the realization of government goal towards increasing the contribution of the sector to the overall national economy. The use of appropriate technology which is a radical approach to stem up production and processing technique, has become subordinate to social need, and is of paramount importance.
Freshwater fish processing should assure best market quality, assure health safety of products, apply the most appropriate processing method and reduce wastes to the barest possible extent (Gani and Sogbesan, 2017). It is imperative to process and preserve some of the fish farmers harvested in the period of abundance, so as to ensure an all year round supply which will automatically reduce post-harvest losses,

increase the shelf-life of fish, and guarantee a sustainable supply of fish during off season with reasonable increase in the profit of the fish farmers.
Currently, less effort is put into the mechanization of fish processing as traditional methods are commonly used and some of these traditional fish processing methods are associated with contaminations which are mainly injurious to consumers (George et al., 2014).The study therefore aimed at examining awareness and adoption of fish processing technologies among fish farmers in Obio/Akpor of Rivers State, Nigeria.

Materials and Methods

Area of study

The study was carried out in Obio/Akpor Local Government Area in the metropolis of Port Harcourt, one of the major cities of Niger Delta, located in Rivers State. The Local Government Area covers 260 km^2 and had a population of 464,789 people at the 2006 census. Obio/Akpor is bounded by Port Harcourt (Local Government Area) to the south, Oyigbo to the east, Ikwerre to the North and Emuoha to the west. It is located between the latitude 4^o, 45'N and 4^o 60'N and longitude 6^o 50'E and 8^o 00'E. It is mainly made up by people of Ikwerre ethnic nationality. The major occupations of the people are arable crop farming, trading and fishing. Obio/Akpor has a total number of three kingdoms which are Apara, Evo and Akpor Kingdoms from which 54 communities are found (Obio/Akpor geographical location, 2017)

Sampling procedure

Multistage sampling technique was used to select respondents for the study. The first stage was a purposive sampling of seven (7) communities that have more fish farmers than the others. The next stage involves the use of snowball sampling technique to select (10) fish farmers in each of the seven selected communities. Thus the total population size was 70 fish farmers.

Data collection and method of analysis

Questionnaire were used for data collection and supplemented with scheduled interview where respondents were illiterates. Data collected were analyzed using descriptive statistics such as frequency and percentage.

Results and Discussion

Table 1 show that 84.3% of the fish farmers were aware of improved fish processing technologies, while 11.4% were not aware. This is an indication that improved fish processing technologies have been disseminated to the fish farmers through various channels which is a good development towards reducing fish spoilage as advocated by researchers.

Table 1: Awareness of fish processing techniques

Variables	Frequency	Percentage (%)
Yes	**59**	**84.3**
No	**8**	**11.4**
No response	**3**	**4.3**
TOTAL	**70**	**100**

Source: field survey 2017

The result in Table 2 indicated that, 18.6% of respondents got their information on improved fish processing technologies from friends and family members, 18.6% from other farmers,; extension agents, 14.4% (the least) from radio, while 20% did not specify the source of their information. However, Ifejika *et al.,* (2008) reported extension agents as the major source of information on fish technologies. Adesehinwa (2007) reported that development of improved technologies must be backed up with efficient dissemination to enhance their adoption.

Table 2: Sources of information on fish processing technologies

Variables	Frequency*	Percentage (%)

Extension agent	**10**	**14.4**
Friends and family members	**13**	**18.6**
Other farmers	**13**	**18.6**
Private consultants	**10**	**14.4**
Television	**3**	**4.3**
Internet	**11**	**11.4**
No response	**14**	**20.0**
Radio	**1**	**1.4**
Television	**3**	**4.3**
Fish buyers	**6**	**8.6**

Source: Field survey 2017
* Are multiple responses.

The result in Table 3 shows that 42.6% of respondents were aware of charcoal smoking kiln, 12.8% were aware of refrigeration of fish, 11.4% were aware of gas fish dryer technology while 15.7% did not specify the improved technologies which they were aware of. High level of awareness of charcoal smoking kiln can be attributed to the fact that it is an indigenous technology compared to all others that are imported fish processing technologies. Nkeme *et al.* (2013) and, Odediran and Ojebiyi (2017) also reported high level of awareness of charcoal smoking kiln among fish processors.

Table 3: Awareness of fish processing technologies by farmers in the study area

Variables	Frequency*	Percentage (%)
Charcoal smoking kiln	**30**	**42.6**
Gas fish dryer	**13**	**11.4**
Refrigeration of fish	**9**	**12.8**
Electric fish dryers	**5**	**7.1**
Solar fish dryer	**3**	**4.3**
Kerosene fish dryer	**3**	**4.3**
No response	**11**	**15.7**

Source: field survey 2017
* Are multiple responses

Table 4 shows that 51.5% of the respondents adopted the charcoal smoking kiln, 10.0% adopted the refrigeration of fish while solar dryer and kerosene fish dryer were the least adopted processing technologies with 1.4%. Awareness is a major factor that usually determines adoption of technologies. Rogers (2003) added that the adoption of a technology can be affected by the way it is named and positioned.

Table 4: Adopted fish processing technologies in the study area

Variables	Frequency*	Percentage (%)
Charcoal smoking kiln	**34**	**51.5**
Refrigeration of fish	**7**	**10.0**
Gas fish dryer	**2**	**2.9**
Electric fish dryers	**1**	**1.4**
Solar fish dryer	**3**	**4.3**
Kerosene fish dryer	**1**	**1.4**
No response	**22**	**31.4**

Source: Field survey 2017
* Are multiple responses

Conclusion and Recommendations

Fish farmers were aware of fish processing technologies through friends, family members and other fish farmers. The levels of awareness and adoption of charcoal smoking kiln for fish processing were high among the respondents. Extension agents should be consistently trained on fish processing technologies by subject matter specialists who should be readily available to disseminate necessary information to the fish farmers. Available channels of information should be adequately utilized in disseminating fish processing technologies to fish farmers.

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COMPARATIVE FLOATABILITY RATE OF EXTRUDED AND ON-FARM FLOATING FEEDS

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ABSTRACT
The comparative floatability rate of extruded and on-farm feeds was evaluated in order to produce a higher quality nutritious locally made feed that can compete favourably with the imported extruded feeds at low cost. The on-farm floating feeds were formulated, to contain 35 and 42% crude protein. The feeds were then subjected to floatation test. The results of the test revealed no significant ($p>0.05$) differences in the ability of the formulated diets to float up to 90 minutes. However, significant ($p<0.05$) differences were observed in their floatation rates as from 120-270 minutes post soaking. Among the feeds, Eco float and Aqualis had similar ($p>0.05$) mean floatability rate which was found to be better than the rest of the feeds. The on-farm formulated feeds had similar ($p>0.05$) mean floatation rate compared to Skretting which is an imported extruded feed. Amongst the imported feed, Skretting had the least floatability rate (70%). Based on the findings of this study, it was concluded that the floatability of fish feed is influence by particle size of the ingredients used, inclusion of a floating catalyst such as yeast, oil, binders and other plant materials.

KEYWORDS: On-farm, feed, floatability, catalyst, extruded.

INTRODUCTION
Fish is very important to humans because it contain protein of very high quality and sufficient amounts of all the essential amino acids required by the human body for growth and development, as well as efficient and effective functioning of the muscular tissues (Ayoola, 2011). However, Fish feed production is an important factor to be considered in both subsistence and commercial fish farming as it has direct effect on the growth potential of the sector (Tsevis and Azzaydi, 2000). Fish feed have significant effect on the cost of production as its account for 60-80% of management costs Olomola (1990) while Ali and Jauncey (2004) stated that the critical challenge faced by aquaculture is the high cost of fish feeds and that more than 50% of the total cost of production is intensified in culture system. Fish farmers are delighted in feeding their fishes with floating feed as it enables them observe fish; feeding condition and response to feeding. Floating feed also reduces wastages during feeding. However, its high cost takes significant part of the profit from the production (Olomola, 1990). In addition, the imported floating feed takes a significant toll on the nation's foreign exchange that would have been spent on other critical area of developments.

In an attempt to reduce cost of feeding fish, farmers produce on-farm feed which always sink and pollute water thereby, leading to disease outbreak and eventual losses (Lopez-Alverado *et al.*, 1994; Falayi *et al.*, 2003). However, researchers have developed floating fish feed using thermal method (Suleiman *et al.*, 2008), Mellon shell (Obi *et al.*, 2011), inclusion of Bakers' yeast and Baking powder (Adekunle *et al.*, 2012). Orire *et al.* (2015) reported 85% floating rate in on-farm pelleted feed using locally sourced floating catalysts; the feed floated for about 35 minutes. This however, is not good enough for aquaculture feed industry as it cannot compete efficiently with the extruded imported feed that floats for 100% and for more than 60 minutes (Obi *et al.*, 2011). The on-farm production of fish feeds of same or better quality from locally available sources and that can float for at least 1 hour and at the least competitive price and of international standard would help to boost our foreign exchange and help to conserve the excessive

money that would have been spent by farmers who would now patronize the locally produced feeds within Nigeria.

MATERIALS AND METHODS

The study was carried at the laboratory of the Department of Water Resources, Aquaculture and Fisheries Technology of the Federal University of Technology, Gidan Kwanu campus, Niger State. Gidan Kwanu is located between latitude 9^0 32' N and longitude 6^0 27' E. Based on the nutritional requirements of catfish fingerlings (NRC, 1993), the on-farm floating feeds were formulated using Pearson Square to contain 35 and 42% CP (crude protein), respectively. The major ingredients used in compounding the on-farm feeds were fish meal and flour meal while the floating catalyst and premix used were kept constant at 5 and 3% in both on-farm feeds. The feeds were mixed with 62 and 78mls of water to form good homogenous gelatinized doughs. Thereafter, the doughs were pelletized with an on-farm pelletizing machine of 4mm die and sundried. The pelletized on-farm feeds and the imported extruded feeds (Aqualis, Skretting and Eco float) were then subjected to buoyancy test carried out on 10 pellets/feed. The pellets were each placed in water contained in five 500ml beakers. Readings on the floating ability of the pellets were taken at 30 minutes interval. Data collected and expressed in percentages were subjected to analysis of variance using SPSS software.

RESULTS

Table 1 depict the results of the comparative floatability test of extruded and on-farm feed at various durations. No significant ($p>0.05$) difference was observed between the imported extruded feed, and the on-farm feeds. Both of the on-farm feed floated 100% for one hour while the 35% CP floated for up to 90 minutes. From 120 minutes up to 270 minutes however, differences ($p<0.05$) were observed in the floatability of the feeds; the on-farm feeds were observed to be consistently poor up to 240 minutes. By 270 minutes however, Skretting and the on-farm feed with 42% CP were similar in their poorness. Among the feed, Eco float gave the best mean floatability rate of 100% after 270 minutes; this was followed by Aqualis (94%). Skretting and the on-farm feeds showed similar mean floatability.

Table 1: Comparative floatability of extruded feed and on farm formulated feed (%)

Time	Aqualis	Skretting	Eco float	On-farm Feed			
	4mm	4mm	4mm	4mm	4mm		
(min)	(45% CP)	(45% CP)	(38% CP)	(42% CP)	(35% CP)	SE	LS
0	100	100	100	100	100	4.65	ns
30	100	80	100	100	100	4.65	ns
60	100	80	100	100	100	4.64	ns
90	100	80	100	80	100	4.32	ns
120	100^a	80^c	100^a	60^d	90^b	4.12	*
150	100^a	80^b	100^a	50^c	60^c	5.32	*
180	100^a	80^b	100^a	50^c	60^c	5.79	*
210	100^a	60^b	100^a	20^d	50^c	8.26	*
240	70^b	50^c	100^a	20^d	30^d	7.79	*
270	70^b	10^d	100^a	10^d	30^c	9.57	*
Mean	94^a	70^b	100^a	59^b	72^b	3.93	*

LS = level of significance, ns = not significant ($p>0.05$), * = significant at $p<0.05$.

DISCUSSION

The bulk density of the on-farm feed formulated must have been less than 640g/cm^3 at least for the first 90 minutes where no significant difference was observed between the extruded imported and on-farm formulated diets. This tally with the findings of Hardy (1989) that diets containing wheat and yeast had the best floatation than diets devoid of them, and that floatability of fish diets is greatly influenced by the bulk density of their pellets. It seems diets with the least bulk density had the best floatation and vice versa. The findings of this study agrees with the report of Riaz (2009) who claim that objects must have bulk densities less than that of water (1g/cm3) in order to float. Rokey and Plattner (2006) also suggests that pellets will sink very fast when immersed in water if their bulk density is greater than 640g/cm^3. In this study, floating catalyst was used to produce 35 and 42% crude protein diets in which 100% floatability rate was achieved at one hour for the 42% CP diet, and 90 minutes for the 35% CP diet. The percentage obtained is greater than the 85% floatation rate reported by Orire *et al.* (2015) in on-farm pelleted feed produced using locally sourced floating catalysts. The on-farm feeds floated probably due to the addition of yeast in them. Falayi and Sadiku (2013) revealed in their research that when yeast is included as a floating additive to wheat in the production of 30% CP diet, variation was observed in the floatability rate of the diets. They attributed the subsequent differences in floatation rate to the high inclusion of heavy plant protein ingredients in the diets. The result of this study revealed that the inclusion of 5% floating catalyst to 35 and 42% CP on-farm diets led to 100% floatation rate being achieved for one hour (42% CP diet) and 90 minutes (35% CP diet), respectively. This is in conformity with the findings of Momoh *et al.* (2016) who reported that when 40% CP diets were produced with the inclusion of yeast as a floating catalyst in them, the yeast influenced the diets to float for 6-10 minutes; achieving 76.76% floatation in the first 5 minutes of their test. The floatability of the on-farm formulated diets could also be attributed to the uniform particle size of the feedstuff used in the study. Momoh *et al.* (2016) had earlier also attributed the floatability rate they observed in their study to the uniform particle size (<0.5mm) of ingredients used.

CONCLUSION

Based on the finding of this study, it can be concluded that the floatability of fish feed is influence by the uniform particle size of the ingredients used, inclusion of floating catalyst such as bee wax, yeast, oil, binders and others plant materials.

RECOMMENDATIONS

To achieve floatability of fish feed, aqua culturists should endeavour to use feedstuff with uniform particle size, include floating catalyst such as bee wax, yeast, oil of low viscousity, binder and other plant materials in formulating fish feed.

The fish farmers should ensure that their formulated on-farm feed does not have high bulk density >640g/cm^3 in order to achieve desirable floatability.

Only 5% inclusion level of floating catalysts was used in this study; more research should be done using higher inclusion levels of floating catalyst; more study should also be conducted on the use of other plant and synthetic materials that can aid floatability of fish feed.

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HAEMATOLOGY AND HISTOPATHOLOGY OF *CLARIAS GARIEPINUS* FED *ASPERGILLUS BRASILIENSIS* FERMENTED PALM KERNEL SLUDGE IN REPLACEMENT OF MAIZE

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Abstract

This study assessed the haematology and histopathology of *Clarias gariepinus* fed *Aspergillus brasiliensis* fermented Palm Kernel Sludge (AbfPKS) in replacement of maize. The AbfPKS was used to replace maize at 0%, 25%, 50%, 75% and 100%. Polyzyme (commercial enzyme) was added to the sixth treatment containing unfermented PKS. The experiment was a completely randomised design and data obtained was analysed using ANOVA at $\alpha_{0.05}$. Means observed were separated using Duncan's Multiple Range Test (DMRT). The packed cell volume (PCV) of fish fed AbfPKS ranged between 16.33±0.58% and 29.00±1.00%. Highest haemoglobin (Hb) was recorded in fish fed diet 5Ab (9.63±0.23gm%) while least Hb was recorded in fish fed diet 2Ab (5.30±0.17gm%). The WBC varied from 6.27±1.40 (x $10^{9/L}$) to 10.53±0.83 (x $10^{9/L}$). Platelets ranged between 4.00±0.00 (x $10^{9/L}$) to 8.67±1.15 (x $10^{9/L}$). The ESR significantly ($p<0.05$) increased as inclusion of AbfPKS increased in the diet of fish. Histopathological observations on liver, kidney and intestine of fish fed AbfPKS showed that livers of experimental fish had hepatocellular degeneration and necrosis of hepatocytes. Fish fed dietary treatments did not have any observable lesion in their intestines. Fish fed dietary treatments had necrosis, tubular epithelial degeneration with atrophy of tubules present in their kidneys. Pathological signs observed in liver of experimental fish were not as a result of feeding on AbfPKS because these signs were also observed in fish not fed AbfPKS. Feeding on AbfPKS did not cause any observable lesion in the intestine of all experimental fish.

Keywords: *Aspergillus***,** ferment, signs, maize

Introduction

The competition by Nigerian livestock feed industry with humans for energy feed resources such as maize, wheat and sorghum has necessitated the search for alternatives through the improvement of non-conventional feed ingredients and agro-wastes (Iyayi, 2004; Tarhazadesh, 2010). One of such improvement efforts is the solid state fermentation of oil palm by-products by Omoikhoje, *et al.,* (2014) and Folorunso, (2018) to compound livestock feeds. The abundance of palm products was a major reason that stimulated interest in exploring its usage in fish diets (Ng, 2003). But it is noteworthy that feed of plant origin have a great influence on histological changes in liver and intestine of fish (Rašković *et al*., 2011). Thus, this study was aimed at assessing the haematology and histopathology of *Clarias gariepinus* fed *Aspergillus brasiliensis* fermented Palm Kernel Sludge (AbfPKS) in replacement of maize.

Materials and Methods

The average weight, Standard Length (SL) and Total Length (TL) of fish used was (6.03±0.65g), (8.26±0.26cm) and (9.60±0.35cm) respectively. Each treatment contained 60 pieces of fish while 20 were per replicate. The fish were fed at 5% body weight per day with their feeding rate adjusted every forthnight according to the new body weight. They were reared for a period of 16 weeks. Six (6) isonitrogenous and isocalorific diets were formulated to contain 40% crude protein as recommended by Faturoti (2000). Production of AbfPKS was as described by Folorunso *et al.,* (2018). Gross composition of diets used contained Maize**:**AbfPKS combination (18.49%), wheat offal (4.1%), Soy cake (48.22%), fishmeal

(25.11%), DCP (2%), salt (0.3%), vitamin premix (0.25%), lysine (0.1%), methionine (0.1%) and starch (1.5%). Diet 1Ab contained 100% maize. Diet 2Ab contained 75% maize and 25% AbfPKS. Diet 3Ab contained 50% maize and 50% AbfPKS. Diet 4Ab had 25% maize and 75% AbfPKS. Diet 5Ab did not contain maize and maize was replaced with 100% AbfPKS. Diet 6Ab contained unfermented PKS plus Polyzyme. The diets were pelletised through a 2mm die, dried, kept in polythene bags and stored in a cool dry place before use. At the end of the feeding trial, fish were fasted for 24 hours prior to the collection of blood samples from the caudal peduncle. Blood from two (2) pieces of fish from each replicate was pooled to get enough blood for analysis. Haematocrit (PCV %), Haemoglobin concentration (Hb g dL^{-1}), Red Blood Cells count (RBCs) and white blood cells (WBC) were determined using standard formulae while erythrocyte sedimentation rate (ESR mm h^{-1}) was determined as described by WHO (2003). Also, a fish was selected from each replicate. The head kidney, liver and intestine were harvested and processed using standard laboratory methods. The experiment was a completely randomised design and data obtained was analysed using ANOVA at $\alpha_{0.05}$. Means observed were separated using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Haematological parameters of fish fed AbfPKS are presented in Table 1. The PCV of fish fed AbfPKS ranged between 16.33±0.58% (diet 2Ab) and 29.00±1.00% (diet 5Ab). Highest Hb was recorded in fish fed diet 5Ab (9.63±0.23gm%) while least Hb was recorded in fish fed diet 2Ab (5.30±0.17gm%). Fish fed diet 3Ab had highest RBC (5.22±0.94) x $10^{12/L}$ which was similar to RBC of fish fed diet 6Ab (4.37±0.39) x $10^{12/L}$ but was significantly different ($p<0.05$) to RBC of fish fed diets 1Ab, 2Ab, 4Ab and 5Ab. The WBC varied from 6.27±1.40 (x $10^{9/L}$) (diet 6Ab) to 10.53±0.83 (x $10^{9/L}$) (diet 2Ab). Platelets ranged between 4.00±0.00 (x $10^{9/L}$) diet 2Ab to 8.67±1.15 (x $10^{9/L}$) in diet 5Ab while Lymphocytes varied from 22.33±0.58% (diet 6Ab) to 45.67±0.58% (diet 4Ab). Neutrophils ranged from 53.33±0.58% (diet 4Ab) to 76.67±0.58% (diet 6Ab). The ESR significantly ($p<0.05$) increased as inclusion of AbfPKS increased in the diet of fish. In this study, fish fed diet 2Ab containing the least amount of AbfPKS had lower PCV than fish fed the control and other diets containing higher amount of AbfPKS. The non reduction in PCV and RBC of fish fed high replacement levels of maize with AbfPKS shows that the experimental fish did not experience anaemia and are of good health status and that the anaemic condition observed in diet 2Ab may not necessarily be as a result of feeding on AbfPKS. Also, inclusion of AbfPKS in fish diets enhanced RBC and haemoglobin values of the experimental fish. This may be due to more minerals and vitamins (Lawal *et al.*, 2015) made available by inclusion of AbfPKS. The non significant difference in WBC of fish fed AbfPKS is an indication that immunity was not compromised. Because, when WBC is elevated, this indicates immune system of animals is responding to a factor which can be a disease or environmental challenge (Ahamefule *et al*., 2008). The ESR of experimental fish significantly increased ($p<0.05$) with replacement of maize with AbfPKS while the fish whose diet contained 100% maize had the lowest ESR. This implies that a higher inclusion of AbfPKS in the diets elicited an increase in the ESR.

Histopathological observations on liver, kidney and intestine of fish fed AbfPKS are presented in Table 2. The histological integrity of the organs (liver, intestine and kidney) is fundamental to the well being of the fish. Cellular degeneration and necrosis observed in liver of fish fed AbfPKS as well as those that were fed control diet implies that AbfPKS was not responsible for the pathological signs observed in the liver. Feeding AbfPKS did not cause any observable lesion in the intestine of all experimental fish. Tubular epitheliar degeneration and necrosis was observed in kidney of fish fed varying amounts of AbfPKS. While fish that were not fed AbfPKS did not have such signs in their kidney.

Conclusion

Pathological signs observed in liver of experimental fish were not as a result of feeding on AbfPKS because these signs were also observed in fish not fed AbfPKS. Feeding on AbfPKS did not cause any observable lesion in the intestine of all experimental fish.

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Table 1. Haematological parameters of *Clarias gariepinus* fed AbfPKS in replacement of maize

	PCV	HB	RBC	WBC	Platelets	Lymphocytes
	%	gm%	x $10^{12/L}$	x $10^{9/L}$	x $10^{9/L}$	%
Diet 1Ab	21.33±0.58^{c}	7.00±0.17^{c}	3.37±0.78^{b}	7.73±1.67^{b}	6.00±0.00^{b}	30.67±0.58^{c}
Diet 2Ab	16.33±0.58^{d}	5.30±0.17^{d}	3.50±0.41^{b}	10.53±0.83^{a}	4.00±0.00^{c}	37.67±0.58^{b}
Diet 3Ab	28.33±1.15^{ab}	9.30±0.35^{ab}	5.22±0.94^{a}	7.60±1.11^{b}	8.00±0.00^{a}	23.67±0.58^{d}
Diet 4Ab	27.33±0.58^{b}	9.10±0.35^{b}	3.49±0.54^{b}	6.80±1.83^{b}	8.00±0.00^{a}	45.67±0.58^{a}
Diet 5Ab	29.00±1.00^{a}	9.63±0.23^{a}	3.43±0.40^{b}	8.40±1.74^{ab}	8.67±1.15^{a}	30.33±0.58^{c}
Diet 6Ab	16.33±1.15^{d}	5.30±0.35^{d}	4.37±0.39^{ab}	6.27±1.40^{b}	4.00±0.00^{c}	22.33±0.58^{e}
RV	36.00±9.04	6.04±25.57	2.88±0.70	41.1±0.70	NA	34.12±17.51

Key : PCV = Packed Cell Volume, HB = Haemoglobbin, RBC = Red Blood Cells, WBC = White Blood Cells, ESR = Erythrocyte Sedimentation Rate. Values presented are means of six (6) readings. Triplicate samples of all fish samples were each done in duplicates. (n=6). Values followed by the same letter within the same column are not significantly different at 5% level of significance (DMRT). ($p<0.05$). RV= Reference value as reported by Erhunmwunse and Ainerua (2013). NA= Reference value for such parameter was not available.

Table 2 Histopathology of *Clarias gariepinus* organs when AbfPKS was used to replace maize in their diet

	Liver	Intestine	Kidney
Diet 1Ab	Moderate diffuse hepatocellular degeneration (swelling)	No observable lesion	No observable lesion
Diet 2Ab	Hepatocellular swelling and cholestasis	No observable lesion	Patchy tubular epithelia coagul
Diet 3Ab	Diffuse degeneration and necrosis of hepatocytes	No observable lesion	Marked diffuse tubular epitheli with atrophy of tubules
Diet 4Ab	Moderate cloudy hepatocellular degeneration (swelling)	No observable lesion	Moderate tubular atrophy and n cells
Diet 5Ab	Cloudy degeneration of hepatocytes	No observable lesion	Tubular epithelia coagulation n
Diet 6Ab	Degeneration and necrosis of hepatocytes	No observable lesion	No observable lesion

GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY OF WEANER RABBITS *(Oryctolagus cuniculus)* FED DIETS CONTAINING VARYING LEVELS OF COWPEA *(Vigna unguiculata)* MILLINGWASTE

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Abstract
Forty five (45) mixed sex weaner rabbits, aged 5 – 6 weeks, with average initial weights of between 694.42 and 761.10 g were used to investigate the effect of varying levels of cowpea milling waste (CMW) diets on their growth performance and nutrient digestibility. They were randomly distributed to five dietary treatments with nine rabbits per treatment. The control treatment (T_1) contained 0 % CMW while treatments T_2, T_3, T_4 and T_5 had 10, 20, 30 and 40 % CMW respectively. Clean water and feed were offered to the animals *ad libitum* daily and record of their feed intake and growth performance were taken for 12 weeks. At the 12th week, a nutrient digestibility trial was carried out. Results show that there were no significant ($p>0.05$) differences in final body weight, body weight gain, total feed intake and mortality among the dietary treatments. Feed conversion ratio (FCR) for diets T_4 and T_5 (containing 30 and 40 % CMW respectively) were as good as that of the Control Diet. Dry matter and crude protein digestibility showed no significant ($p>0.05$) difference across the treatments. Digestibility of crude fibre (CF), ether extract (EE), ash and nitrogen free extract (NFE), as well as total digestible nutrient (TDN) of the test diets compared favourably with that of the Control Diet. Hence, it can be concluded that CMW can be used safely as a protein source and included up to 40 % in weaner rabbit diets with no detrimental effect on their growth performance and nutrient digestibility.

Keywords: *cowpea milling waste, growth performance, weaner rabbits*.

Introduction

In most developing countries of the world today, there is high incidence of inadequate consumption of animal protein. It is estimated that on the average, animal protein consumed per person per day (4.5 g) falls short of the recommended 35 g requirement (FAO, 2009).The increasing demand for animal protein necessitates the need to intensify livestock production. *Increased rabbit production is a fast means of meeting the animal protein requirements of the Nigerian populace (Iyeghe-Erakpotobor et al., 2002).* Rabbit (*Oryctolagus cuniculus*) has short generation interval, high prolificacy, good mothering ability and easy management requirements, with ability to utilize waste and other non-conventional feed sources. Besides, rabbit meat is high in protein (about 22 %), low in fat (about 4 %) and cholesterol (about 5 %) which can contribute positively towards improving the good health of the populace (Aduku and Olukosi, 1990).

Cowpea, a legume crop, contains adequate amounts of protein, essential amino acids, dietary fibre and essential minerals and vitamins when compared to the other common legumes (Bhat and Karim, 2009). Studies have shown that 20 % dietary inclusion of cowpea seed produced better performance with no reported negative effect on weaner rabbits *(*Matondi *et al.,* 2015). However, there is paucity of information on the use of cowpea milling waste as a non-conventional feedstuff for feeding weaner rabbits; hence this research study is aimed at determining the growth performance and nutrient digestibility of weaner rabbits fed diets containing varying levels of cowpea milling waste.

Materials and Methods

This research study was carried out at the Rabbitry Unit of the Ministry of Livestock and Fisheries Development, Minna, Niger State. Minna lies within the Guinea Savannah zone of Nigeria. It is located within latitude 9°37' North and longitude 6°33' East (Niger State Agricultural Development Project, 2009). A total of 45 mixed sex weaner rabbits aged between 5-6 weeks, with average weights of between 694.42 and 761.10 g were randomly divided into five treatments and further sub-divided into three replicates with three rabbits per replicate in a Completely Randomized Design (CRD) Experiment. Specially constructed wooden cages of height 60 cm, length 45 cm and width 40 cm, with floor space of 0.39 to 0.55 cm^2 and net fitted floor were used for the experiment. Prior to the commencements of the experiment, the cages were thoroughly washed with disinfectant (Izal® solution). Feeders and drinkers were provided in each cage for easy access by the animals. The rabbits were de-wormed using Albendazole®; broad spectrum antibiotic and Vitalyte® were administered via the drinking water to reduce stress. The rabbits were allowed to acclimatize to the new environment for one week while being fed with the Control Diet (T_1). Thereafter, the experimental diets T_2, T_3, T_4 and T_5 (containing 10, 20, 30 and 40 % CMW respectively) and water were served *ad-libitum* to the rabbits in each replicate respectively for 12 weeks. The composition of the experimental diets is shown in Table 1.

Table 1: Composition of the experimental diets for weaner rabbits

Ingredients (%)	Diet 1 (0%)	Diet 2 (10%)	Diet 3 (20%)	Diet 4 (30%)	Diet 5 (40%)
Maize	43.38	37.21	31.62	26.03	20.50
Groundnut cake	29.62	25.79	21.38	16.97	12.50
Cowpea milling waste	00.00	10.00	20.00	30.00	40.00
Rice husk	20.00	20.00	20.00	20.00	20.00
Palm oil	2.00	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Limestone	0.50	0.50	0.50	0.50	0.50
Lysine	0.50	0.50	0.50	0.50	0.50
Methionine	0.45	0.45	0.45	0.45	0.45
Salt	0.30	0.30	0.30	0.30	0.30
*Premix	0.25	0.25	0.25	0.25	0.25
	100	**100**	**100**	**100**	**100**
Calculated Analysis					
Crude Protein	18.21	18.43	18.42	18.24	18.40
ME (Kcal/kg)	2712	2699	2690	2682	2674
Crude fibre	10.75	11.85	12.93	14.02	15.09
Protein: calorie	1:149	1:146	1:146	1:147	1:145
Calcium	1.39	1.37	1.36	1.35	1.33
Phosphorous	0.85	0.83	0.82	0.80	0.80
Lysine	1.27	1.38	1.53	1.79	1.79
Methionine	0.73	0.85	0.94	1.05	1.15

*2.5 kg of the premix supplied the following nutrients: Vitamin A, 500 IU; Vitamin D_2, 1500 IU; Vitamin E, 3 IU; Vitamin K, 2 mg; Riboflavin, 3 mg; Pantothenic acid, 6 mg; Niacin, 15 mg; Vitamin, B_{12} 0.8 mg; Chlorine, 3 mg; Folic acid, 4 mg; Manganese, 8 mg; Zinc, 0.5 mg; Iodine, 1.0 mg and Cobalt, 1.2 mg.

ME = Metabolizable energy

At the end of the 11th week of the feeding trial, a nutrient digestibility trial was carried out using two animals per replicate, housed in specially constructed metabolism cages. Known quantities of feed were fed to the animals in each replicate in the morning and left over collected the following morning for five days, after three days adjustment period in the cages. Using the total collection method, faecal droppings were collected daily in aluminium foils, weighed, preserved with boric acid and oven dried at 80 ^{0}C for 24

hours. At the end of the experiment, the dry matter, crude protein, crude fibre, ether extract, nitrogen free extract and ash content of the experimental diets, collected faecal samples and CMW were determined using the procedures of AOAC (2000). All data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS). Where treatment means were significant (P<0.05), Duncan's Multiple Range Test was used to separate the means (Duncan, 1955).

Results and Discussion

The proximate composition and energy value of cowpea milling waste (Table 2) shows that it is a potential source of protein and energy in livestock diets.

Table 2: Proximate composition and calculated energy value of cowpea milling waste (CMW)

Parameters	% Composition
Dry matter	97.00
Ash	9.00
Crude protein	24.85
Crude fibre	14.00
Ether extract	5.00
Nitrogen free extract	44.15
Metabolizable energy (Kcal/kg)	2892

Table 3 shows the growth performance of weaner rabbits fed diets containing varying levels of cowpea milling waste (CMW) while Table 4 shows the apparent nutrient digestibility of weaner rabbits fed diets containing varying levels of CMW. The results disagree with that of Iyeghe-Erakpotobor *et al.* (2006) who fed crossbred weaner rabbits with five treatment diets consisting of 100, 75, 50 and 25 % levels of soybean cheese waste/maize offal diet (SBW). Intake of concentrate was significantly higher for weaner rabbits fed the control diet than the 100 % diet of soya beans cheese waste. Similar concentrate intake was observed for 75 and 50 % diets of soya beans cheese waste.

Table 3: Growth performance of weaner rabbits fed diets containing varying levels of cowpea milling waste

Parameters (%)	$T_{1(0\%)}$	$T_{2(10\%)}$	$T_{3(20\%)}$	$T_{4(30\%)}$	$T_{5(40\%)}$	SEM	P-Value
Initial body weight (g)	733.33	694.42	761.10	711.13	744.47	14.68	0.6905
Final body weight (g)	1788.90	1711.20	1727.80	1816.70	1852.80	34.15	0.7203
Body weight gain (g)	1038.90	1016.70	966.70	1105.50	1108.30	40.00	0.8213
Total feed intake (g)	6238.40	7555.60	7487.20	7316.40	7294.40	259.38	0.5889
FCR	6.11^{a}	7.46^{b}	7.70^{b}	6.63^{ab}	6.66^{ab}	0.21	0.0836
Mortality	0.00	0.67	0.33	0.33	0.33	0.15	0.8335

^{ab}Means with different superscripts on the same row were significantly (P<0.05) different.

SEM = Standard error of mean. FCR = Feed Conversion ratio.

Dry matter and crude protein digestibility showed no significant (p>0.05) difference across the treatments. Digestibility of crude fibre (CF), ether extract (EE), ash and nitrogen free extract (NFE), as well as total digestible nutrient (TDN) of the test diets compared favourably with that of the Control Diet.

This result disagree with the report of Orji (2009) who fed cowpea hulls (CPH) at 0, 10, 20 and 30 % dietary inclusion levels to hybrid rabbits. They observed that there were significant ($p<0.05$) differences among the treatments on dry matter and crude protein digestibility. Also, significant ($p<0.05$) differences were observed in digestibility of crude fibre, ether extract and nitrogen free extracts. Generally, digestibility decreased gradually with increase in the addition of CPH in the diets. However, in this research study, crude fibre digestibility improved with higher inclusion levels of CMW.

Table 4: Apparent nutrient digestibility of weaner rabbits fed diets containing varying levels of cowpea milling waste

Parameters	$T_{1(0\%)}$	$T_{2(10\%)}$	$T_{3(20\%)}$	$T_{4(30\%)}$	$T_{5(40\%)}$	SEM	P-value
Dry matter	86.98	86.40	87.56	87.97	86.81	0.30	0.5468
Crude protein	81.42	81.41	82.29	81.26	81.85	4.92	0.4952
Crude fibre	72.94^{b}	72.64^{b}	80.16^{a}	84.04^{a}	80.90^{a}	1.29	0.0001
Ether extract	95.23^{ab}	95.98^{a}	94.90^{b}	96.04^{a}	94.38^{b}	0.20	0.0152
Ash	43.74^{c}	54.62^{b}	63.54^{a}	50.15^{bc}	44.07^{c}	2.17	0.0010
NFE	96.04^{a}	94.30^{bc}	95.18^{ab}	93.58^{c}	94.90^{ab}	0.26	0.0001
TDN	80.47^{c}	83.69^{a}	76.11^{d}	81.67^{b}	80.02^{c}	0.67	0.0001

^{abcd}Means with different superscripts on the same row were significantly ($P<0.05$) different.

SEM = Standard error of means NFE = Nitrogen free extract TDN = Total digestible nutrients

Conclusion and Recommendations

From the results of this research study, it can be concluded that cowpea milling waste can be used safely as a protein source and included up to 40 % in weaner rabbit diets with no detrimental effect on their growth performance and nutrient digestibility.

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DETERMINANTS OF ARTISANS' HOUSEHOLDS BEEF CONSUMPTION EXPENDITURE IN NEW BUSSA, NIGER STATE

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Abstract

This study determined the factors influencing households' beef consumption expenditure in New-Bussa, Niger State, Nigeria. Systematic sampling technique was purposively used to select 150 artisans' households for the study. Data were obtained through the use of a questionnaire. Percentages, means and Linear Regression were used to analyze data. Results showed that the respondents mean age, household size, household heads income and other household members' income were 39 years, 7 members, ₦38768.20 per month and ₦23, 632.33 per month respectively. Majority of the respondents (75.3%) were male, married (80.7%) and possessed Secondary School Certificate (45.8%). The study concluded that household heads' income ($\beta = 0.34$), other household members' income ($\beta = 0.51$) and expenditure on other meat types ($\beta = 0.04$) ***significantly*** ($p < 0.05$) determined artisans' household beef consumption expenditure in the study area. It is therefore recommended that price intervention programmes be introduced in order to stabilize the fluctuation in beef prices and also ensure increase in purchasing power of people's income so as to ultimately improve of nutritional status of the people.

Keywords: artisans, households, beef, consumption, expenditure

Introduction

In Nigeria, food supply is not distributed equally throughout the country and sometimes within the households (Onyeneke and Nwaiwu, 2012). A review on food supplies available for consumption in different countries showed that the per capital protein intake in developing countries, Nigeria inclusive, is comparatively low. Most of the foods consumed in Nigeria are carbohydrates which are obtained mainly in the form of starch (Oloyede, 2005). Beef is a major source of animal protein because it contains many nourishing substances needed by the human body. Beef being important source of protein has played important roles in the pattern of food consumption in Nigeria. The world demand for beef has risen sharply during the last few decades due to increase in population, improvement in technology and increasing incomes (Duruchukwu, 2010).

Nigeria is faced with an acute nutrition problem, which is mostly due to inadequate food supply, poor income and lack of proper education on food selection (Lamode, 2000).The tremendous decline in food production and supply brought about by the neglect of the agricultural sector as a result of the oil boom in the 1970's has a negative effect on the nutritional status of the Nigerian populace. The low level of animal protein consumption in Nigeria as reported by the Food and Agriculture Organization (FAO, 2006) revealed that the diet of an average Nigerian contains about 20% less than the recommended requirement. This is no doubt responsible for most problems of malnutrition among all age groups particularly infants and children. The extent to which Nigerians face the protein shortage problem calls

for an urgent solution. The Federal Ministry of Health indicated that malnutrition is the most serious health problem which directly hinders growth and development of the economy. This is because there is a great disparity between the required animal protein intake and the actual consumption (Okunola, 2001).

This study was conducted to add to the existing literature by determining the factors influencing households' beef consumption expenditure. The objectives of the study were to:
describe the socioeconomic characteristics of the respondents.

examine the expenditure, affordability and frequency of households' beef consumption .

determine the factors influencing respondents' household beef consumption expenditure.

Materials and Methods

The study was carried out in New Bussa, the headquarters of Borgu Local Government Area, Niger State. The major occupations of the people in the area include crop and livestock farming. Other occupations include civil service, trading and being artisans. The systematic sampling technique was used to select one hundred and fifty artisan households (n = 150) from the study area and data were collected through well-structured questionnaire. Analysis was done using descriptive statistics and regression analysis.

The regression equation is represented in the explicit form thus:

$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + e$

Where

Y = Artisans' household beef consumption expenditure

X_1 = Age

X_2 = Household size

X_3 = Household head income

X_4 = Other household members' income

X_5 = Expenditure on other meat types

X_6 = Frequency of beef daily consumption

b_i = Coefficient

a = Constant

e = Stochastic Disturbance

Results and Discussion

Socio-Economic Characteristics of the Respondents

Socio-economic characteristic is an economic and sociological combination of total measure of a person's economic and social position relative to others, based on sex, age, marital status, household size, education among others. These characteristics as

they relate to the respondents are presented in Table 1. Majority of the household heads (75.3%) were male while only 24.7% were female. This is expected because culture and religion have placed men over women where women's primary responsibility is basically home-making and supplementing the food needs of the households. The distribution of their marital status shows that about 80.7% were married, while only 19.3% were not married. The number of people in households where the head is married is expected to be higher than those of the unmarried hence, expenditure and consumption of beef is expected to be higher. About 56.1% of the respondents had less than 8 people in their households, while 43.9% had more than 7 persons. The mean household size was estimated at 7 persons. This is relatively large, thus the demand and consumption of beef is expected to be higher. On their educational levels, about 17.3% had no formal education, 9.3% attained primary education, while 56.1% attained secondary school. Only 17.3% of the household heads had attained tertiary education. The attainment of higher educational levels not only increases awareness of the importance of meat to the human body, but also enhances better paid job opportunities, which in turn increases disposable income leading to increase in demand and consumption of meat (David *et al*.***, 2015).On their income levels, 69.3% of the household heads earned monthly income of ₦40, 000 and below, while 30.7% earned ₦40,001 and above. The mean monthly income was at ₦38, 768.20, an indication that most artisan households in the study area were low income earners and this will affect the demand and consumption of meat.***

Table 1: Socio-economic Characteristics of the Respondents

Variable		Percentage	Mean
Sex	Male	75.3	
	Female	24.7	
Age (Years)	≤ 30	37.3	
	31 – 50	46.7	39
	≥ 51	16	
Marital Status	Not Married	19.3	
	Married	80.7	
Education	No Formal Education	17.3	
	Primary	9.3	
	Secondary	56.1	
	Tertiary	17.3	
Household Size (number of persons)	≤ 7	56.1	7
	≥ 8	43.9	
Household Head Income (₦/month)	≤ 40000	69.3	38,768.20
	≥ 40001	30.7	

Other Household Member Income (₦/month)	≤ 25000	72.4	23,632.33
	≥ 25001	27.6	

Expenditure, Affordability and Frequency of household beef consumption

The expenditure, affordability and frequency of artisans households beef consumption is presented in Table 2. From the table, majority of the respondents (76%) spent less than ***₦10, 000 while*** (24.0%) spent more than ***₦10,000. However,*** majority of the respondents (61.2%) spent less than ***₦10, 000 while*** (38.8%) spent more than ***₦10, 000. The artisans' households consumed beef once (28%), twice (43.6%), thrice (20.3%) and 8.1% consumed beef more than three times in a day.***

Table 2: Expenditure and Frequency of household beef consumption

Variable		Percentage	Mean
Beef Expenditure (***₦***)	≤ 10000	76	9,080
	≥ 10001	24	
Expenditure on other meat types (***₦***)	≤ 10000	61.2	4,710
	≥ 10001	38.8	
Frequency of Daily Consumption (***₦***)	Once	28	
	Twice	43.6	
	Thrice	20.3	
	> Thrice	8.1	

Determinants of artisans' households' beef consumption expenditure

The linear equation explains the regression results of the factors influencing artisans' household beef consumption expenditure in New-Bussa, Niger State. The regression results are presented below:

$Y = 20.19^{***} + 0.11X_1 + 0.86X_2 + 0.34X_3^{**} + 0.51X_4^{**} + 0.04X_5^{**} + 0.129X_6 + e$

(0.38) (1.45) (0.08) (5.29) (0.82) (0.71) (0.18)

R Square = 0.563; F Value = 30.22^{***}

Note: *** = ($\alpha_{0.01}$) ** = ($\alpha_{0.05}$)

Generally, the results showed that there was a significant relationship between respondents' household beef consumption expenditure and households' head income (X_3), other household members' income (X_4) and expenditure on other meat types (X_5) respectively. Respondents' household beef consumption expenditure increased with increase in households' head income (X_3). This implies that ceteris paribus, for each 1% increase of households' head income (X_3) would increase the respondents' household beef consumption expenditure by 34%. Other household members' income exercised the great impact on the prediction of the dependent variable by the independent variable with a beta value of 0.51. However, for each 1% increase of other household members' income would increase the respondents' household beef consumption expenditure by 51%. Furthermore, the results indicate that expenditure on other meat types is a critical factor influencing household beef consumption expenditure. Interestingly, the coefficient and t-statistics indicated that expenditure on other meat types have statistically significant positive effect on household beef consumption expenditure. The slope value of 0.04 means that for a

unit change in expenditure on other meat types, on the average, the probability of household beef consumption expenditure increases by 4 percent. However, it could also be confirmed that the model is significant and 56.3% of the variance in the household beef consumption expenditure has been explained by factors influencing respondents' household beef consumption expenditure in New-Bussa, Niger State.

Conclusion and Recommendations

This study revealed that majority of the artisans' household heads were male, married, and mature with large household size and educated. The study concluded that income of household heads, other household members' income and expenditure on other meat types are major determinants of artisans' household beef consumption expenditure in the study area. It is therefore recommended that government price intervention programmes should be introduced in order to stabilize the fluctuation in beef prices. Interventions that will ensure increase in purchasing power of people's income should be implemented as this will invariably contribute positively to improvement of nutritional status of the people.

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TRADITIONAL METHODS OF PREGNANCY DETECTION IN EWE AT HADEJIA LOCAL GOVERNMENT AREA, JIGAWA STATE

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Abstract
The study seeks to characterise socio-economics of sheep farmers and identify the traditional methods of pregnancy detection in ewe at Hadejia Local Government Area, Jigawa State. Seventy (70) respondents were selected using simple sampling procedure and analysed with descriptive statistics. Majority (41.4%) of the respondents were between 21-30 years, male (57.1%), married (51.4%), had tertiary education (52.9%) and farmers (58.6%). Most of the farmers kept sheep and goat (50.0%), had 6-10 sheep (47.1%) with 6-10 years experienced (40.0%) in small ruminant production and managed both ram and ewe (87.1%). The most accurate (50.0%) traditional method of detecting pregnancy in ewe is through mucous discharge from the vulva. It is recommended that further research on traditional method of pregnancy detection in ewe should be carried out.
Keywords: Ewe, Socio-economic characteristics, Pregnancy, Detection and Traditional Methods

Introduction

Various studies highlighted the importance of small ruminant production, (as opposed to large ruminant and non-ruminant production) not only for ensuring food security in rural regions, but also for helping to reduce poverty and overall household wellbeing (Peacock, 2005; Dossa *et al*., 2007). The emphasis is because sheep (*Ovis aries*) and goat (*Capra hircus*) are more efficient in converting non-grain feed into quality meat compared with beef, pork and poultry (Wilson, 1991). In subsistence agricultural economies, competition for productive inputs is less for small ruminants than for other livestock such as pigs, cattle and poultry (Terril, 1985). Capital investment in housing (such as iron sheets and wood) is lower for sheep production (Devendra, 1985). The smaller size of sheep also makes them more suitable for home consumption among poor households, thereby helping to improve the nutrition, animal protein requirements and food security situation of rural households (Oluwatayo and Oluwatayo, 2012).

Early diagnosis of pregnancy in livestock is useful to make culling, breeding, clinical and research purposes. Traditional methods for pregnancy diagnosis in small ruminants are through external abdomen and noting udder enlargement. However, these methods are applicable only in late pregnancy. The technique of trans-abdominal method has been used with great accuracy as a means of pregnancy diagnosis and estimation of fetal numbers in sheep (Vautial *et al.,* 2004), goat deer and reindeer (Martinez *et al.,* 2008), however information in this regard is meager in sheep and goat in developing countries. Estrus or heat is the period of time when the ewe and doe are sexually receptive to the ram and buck, respectively. Sheep and goat are seasonally polyestrous and short day breeders (Booth *et al.,* 2000). The main aim of the study was to identify the traditional methods of pregnancy detection in ewe at Hadejia Local Government Area of Jigawa state.

Materials and Methods

The study was conducted in Hadejia Local Government Area, Jigawa State. Hadejia emirate comprises of Hadejia, Kafin-Hausa, Mallam-Madori, Birniwa, Guri, Kirikasamma, Kaugama and Auyo Local Government Areas. It covers an area of 6,580 km^2 and located in the north eastern part of Jigawa State. It lies between $9^0 37^{'}$E and $10^0 35^{'}$E longitude and $11^0 57^{'}$N and $13^0 02^{'}$N latitude. Seven (7) wards were

selected using simple random technique and in each of the ward, ten (10) respondents were selected giving a total of seventy (70) respondents. The wards selected include Yankoli, Kasuwar kuda, Kasuwar kofa, Rumfa, Atafi, Gagulmari and Matsaro. Ten (10) respondents sampled from the seven (7) wards were served with a structured questionnaire each, thus, seventy (70) respondents were assessed. The data collected were analyzed using simple descriptive statistics.

Results

Majority (41.4%) of the respondents were between 21-30 years, male (57.1%), married (51.4%), had tertiary education (52.9%) and farmers (58.6%). Most of the farmers kept sheep and goat (50.0%), had 6-10 sheep (47.1%) with 6-10 years experienced (40.0%) in small ruminant production and managed both ram and ewe (87.1%). The most accurate (50.0%) traditional method of detecting pregnancy in ewe is through mucous discharge from the vulva.

Table 1: Socio-Economic Parameters of the Respondents

Parameter	Frequency	Parameter	Frequency
Age (Years)		Education Status	
10-20	24 (34.3)	Primary	01 (01.4)
21-30	29(41.4)	Secondary	19 (27.1)
31-40	08(11.4)	Tertiary	37(52.9)
41-50	04(05.7)	Arabic	13(18.6)
>51	05 (07.2)	**Total**	**70(100.0)**
Total	**70(100.0)**	Occupation	
Sex		Civil Servant	17(24.3)
Male	40(57.1)	Farming	41(58.6)
Female	30(42.9)	Trading	12(17.1)
Total	**70(100.0)**	**Total**	**70(100.0)**
Marital Status			
Single	25(35.7)		
Divorced	09(12.9)		
Married	36(51.4)		
Total	**70(100.0)**		

Figures in the parenthesis are the percentages

Discussion

The result showed that male farmers were dominant (57.1%). The finding implies that men are the owners of small ruminants in the household. Another reason may be attributed to societal customs and norms in Sub-Saharan African Countries where males control household productive assets (Faizal and Kwasi, 2014). The large proportion of male farmers is very crucial for transferring and adoptions of technology since men are mostly the decision-makers in most African Societies (Turkson and Naandam, 2006).

Table 2: Categories of animal reared

Parameter	Frequency	Percentage
Sheep	12	17.1
Goat	10	14.2
Cattle	09	12.9
Sheep and Goat	35	50.0
Sheep and Cattle	02	2.9
All of the above	02	2.9
Total	**70**	**100.0**

Table 3: Number of sheep owned per respondent

Parameter	Frequency	Percentage
1-5	16	22.9
6-10	33	47.1
11-15	16	22.9
16-20	04	5.7
21-25	01	1.4
26-30	00	00
Total	**70**	**100.0**

Table 4: How long (years) has the respondent been in the business?

Duration (Years)	Frequency	Percentage
1-5	27	38.6
6-10	28	40.0
11-15	11	15.7
16-20	04	5.7
Total	**70**	**100.0**

Table 5: Do you manage both ram and ewe?

Parameter	Frequency	Percentage
Yes	61	87.1

No	09	12.9
Total	**70**	**100.0**

Table 6: Which traditional method of detecting pregnancy is more accurate?

Parameter	Frequency	Percentage
Palpation	03	4.3
Udder enlargement	21	30.2
Restlessness	10	14.2
Frequent urination	01	1.3
Mucus discharge from vulva	35	50.0
Total	**70**	**100.0**

Similar results have been reported across sub- Sahara African countries (Turkson and Naandam, 2006; Baah *et al*., 2012; Oladeji and Oyesola, 2012; Umar and Kazaure, 2012; Ayalew *et al*., 2013). In contrast, Fakoya and Oloruntoba (2009) reported a high female participation of small ruminant farmers in Osun-state, Nigeria.

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CLIMATE CHANGE ADAPTATION STRATEGIES AMONG SMALL RUMINANTS FARMERS IN BORGU LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

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Abstract
The study examined the climate change effects and adaptation strategies among small ruminant farmers in Borgu Local Government Area of Niger State. A combination of purposive and simple random sampling techniques was adopted to select 80 small ruminant farmers in the Local Government Area. Data were collected using an interview guide. Descriptive statistics were used to analyse the data while Adaptation Strategy Use Index (ASUI) was used to rank the most frequently used adaptation strategies to climate change. The mean age and the mean family size of the small ruminant farmers were 46 years and 9 persons respectively. Majority (52.3%) of them had at least primary education with mean a mean farming experience of 8 years. Almost (97.7%) all the small ruminant farmers observed that there was climate change with flooding being the most perceived indicator of climate change. ASUI revealed that provision of housing for animals ((0.84), frequent cleaning of animals house (0.82) as well as keeping and feeding ruminants indoor during rainfall and cold (0.80) were the most frequently used adaptation strategies. The study recommends that efforts should be made to educate small ruminant farmers on the use of other adaptation strategies while assisting them by providing credit facilities and subsidies.
Keywords: Climate change, Adaptation Strategies, Ruminant farmers, perception, Constraints to use

Introduction

Climate change, which is attributed to natural climatic cycle and human activities, has adversely affected agricultural productivity in Africa and indeed Nigeria. According to Warrick and Barrow (1991), climate change is a long term shift in the climatic pattern of a specific location, region or planet measured by changes in features associated with average weather components, such as temperature wind pattern and precipitation. The climate is said to have changed when the patterns and sequence of occurrence of weather events have shifted significantly from what they used to be over a period of time (Food and Agriculture Organisation FAO, 2008). Climate change is caused by both natural and man-made factors over a period of time. The natural processes implicated in climate change include volcanic eruptions, variation in the sun intensity or very slow change in ocean circulation or land surfaces which occur on time scale of decades, centuries or longer. However, human activities are by far the major cause of climate change through the continuous release of greenhouse gases and aerosols into the atmosphere by changing land surface and by depleting the stratospheric ozone layer (Intergovernmental Panel on Climate Change IPCC, 2001).

Adaptation to climate change is the adjustment in natural or human system in response to actual or expected climatic stimuli or their effect (IPCC, 2001). With respect to small ruminant production, climate change adaptation aims at mitigating and developing appropriate coping measures to address the negative impact of climate change on small ruminant production. Adaptation to climate variability is not new but climate change is expected to present heightened risk with potentially grave consequences. Climate change alters global disease distribution, affects small ruminant feed intake, encourage outbreak of disease which invariably affects small ruminant output (meat). Also, access to food, stability of food, small farm size, low technology and low capitalization increase the vulnerability of small ruminant production. Fischer *et al.* (2005) asserted that developing countries including Nigeria were more vulnerable to climate change because of the scarcity of capital for adaptation measures, high level of poverty, inequitable land distribution and poor infrastructure. Thus, this study was carried out to assess climate change adaptation strategies among small ruminant farmers Borgu Local Governments

Area of Niger state. The specific objectives were to describe the socio-economic characteristics of the respondents, identify the indigenous adaptation strategies to climate change and ascertain the constraints to the use of climate change adaptation strategies.

Methodology

The study was carried out in Borgu Local Government Area of Niger State. The Local Government Area has an area of land of about 16,200sqkm and shares boundaries with Benin Republic to the West, Agwara Local Government to the South, River Niger or Lake Kainji to the East and Kebbi State to the North. Borgu Local Government Area lies between Latitudes 9^0N and 11^0N and Longitudes 2^0E and 4^0E with a population of 172,835 according to the 2006 census. Major crops grown in the area are rice, millet, maize, guinea corn, sorghum, cassava and melon while sheep, goat and cattle are the most commonly reared livestock. Four (4) out of the ten wards in the study area were randomly selected while twenty (20) small ruminant farmers were randomly selected from each of the four (4) wards. This gave a total of eighty (80) respondents as the sample size of the study. Data were collected from the ruminant farmers through the administration of interview guide. The data were analysed using descriptive statistics such as frequency, percentages and means while the Adaptation Strategy Unit Index (ASUI) was used to assess the extent of use of the different climate change adaptation strategies by small ruminant farmers. In analysing the extent of use of any of the strategies by the farmers, an Adaptive Strategy Index (ASI) was then expressed using a four-point Likert scale with the scoring order 3, 2,1 and 0 for frequently used, occasionally used, rarely used and not used respectively. The formula used to obtain the ASUI was adapted from Islam and Kasheem (1999) in Adesoji and Famuyiwa (2010) and modified by Umunna *et al.* (2013) as: ASUI = $\frac{[N1\times3+N2\times2+N3\times1+N4\times0]}{M}$

N1: Number of small ruminant rearers who frequently used adaptation strategies; N2: Number of small ruminant rearers who occasionally used adaptation strategies; N3: Number of small ruminant rearers who rarely used adaptation strategies; N4: Number of small ruminant rearers who did not use adaptation strategies.

M=nx3 where n=sample size

Results and Discussion

Personal characteristics of the respondents

Table 1 shows that majority (84.1%) of the respondents were male while the remaining (15.9%) constituted the female. This indicates that ruminant ownership is dominated by the male although the women play prominent role in the rearing of the animals such as feeding and marketing of the animals. The dominance of ownership among the male could also be due to the culture of the dominant tribes in the study area (Hausa/Fulani). Majority (70.6%) of the respondents were 31-50 years old while the mean age was 46years. This is an indication that the respondents were in their productive years and also ready to learn new ideas. Majority (70.1%) of the respondents were married, hence people with responsibilities to their families. About half (52.3%) of the respondents had at least primary education while the remaining 47.3% did not have formal education. Literacy level of farmers is expected to relate with the ability of the farmers to adapt to climate change effects. Adedoyin *et al.* (1991) pointed out that high level of education is a very good spring board for effective extension service. It was observed that majority (69.4%) of the respondents had 1-10 family size. The mean family was 9 persons. It was also observed that 88.7% of the respondents had farming experience of 1-15 years while the mean year of experience was 8.3 years. This experience is expected to assist the ruminant farmers to adapt to climate change and adopt necessary strategies as preventive or control measures.

Respondents' adaptation strategies, their frequency of use and ASUI (Adaptation Strategies Use Index).

From Table 2, the ASUI shows that provision of housing for animals (0.84) ranked best among the adaptation strategies, followed by frequent cleaning of animal house (0.82), keeping and feeding animals indoor during rainfall and cold/ harmattan (0.80) ranked third while prayer for God's intervention and provision of shade for animals during the day (0.76) and (0.75) were ranked fourth and fifth respectively. In a study carried out by Tolongbose *et al.* (2011) in North Central part of Nigeria almost all the farmers adopted the provision housing for their animals as a means of coping with the effect of climate change. Frequent cleaning of the pens and prayer for God's intervention were commonly used perhaps due to the low or no cost attached to them. Livestock insurance was ranked the least implying that livestock farmers did not adopt livestock insurance which could be due to its low awareness among farmers. This situation calls for increased awareness due to the fact that agricultural enterprises particularly livestock farming is not without uncertainties and risks.

Constraints to use of adaptation strategies

Table 3 shows that absence of government policy (2.34), high cost of equipment (2.34) and high cost of feeding (2.34) were the most serious constraints faced by the respondents, followed by lack of credit facilities (2.32), lack of improved breeds of goats and sheep (2.16) and shortage of water (2.00) as it is based on their mean. This implies that the most constraints to the use of adaptation strategies by respondents were absence of government policy, high cost of equipment and high cost of feeding. Salau *et al.* (2012) reported low income level, no government support and poor technology as the factors militating against adaptation strategies.

Table 1: Personal characteristics of the respondents

Variable	Frequency (n=88)	Percentage (%)	Mean	Standard Deviation
Sex				
Male	74	84.1		
Female	14	15.9		
Age (years)				
≤30	3	3.4	46	8.9
31-40	17	19.3		
41-50	53	60.3		
>50	15	17		
Marital status				
Single	13	14.7		
Married	67	76.1		
Divorced	7	18.1		
Widowed	1	1.1		
Educational level				
No formal education	42	47.8		
Primary education	5	5.7		
Secondary education	19	21.6		
Tertiary education	22	25		
Family size (persons)				
1-10	61	69.4		
11-20	23	26.1	9.3	5.7
21-30	4	4.5		
Farming experience (years)				
1-15	78	88.7		
16-25	8	9	8.3	6.9
26-35	2	2.3		

Source: Field survey, 2014

Table 2: Respondents' adaptation strategies, their frequency of use and ASUI (Adaptation Strategies Use Index)

Adaptation strategies	Frequently used	Occasionally used	Rarely used	Not used	ASUI	Rank
Provision of housing for animals	63(71.6)	12(13.6)	11(12.5)	2(2.3)	0.84	1st
Reduction in the number of animals	21(23.9)	37(42.0)	27(30.7)	3(3.4)	0.62	11th
Increasing number of animals	28(31.8)	26(29.5)	17(19.3)	17(19.3)	0.58	12th
Livestock insurance	9(10.2)	3(3.4)	26(29.5)	50(56.8)	0.16	17th
Use of traditional health care	14(15.9)	25(28.4)	10(11.4)	39(44.3)	0.39	14th
Seeking the help of veterinary doctors	44(50.0)	28(31.80	6(6.8)	10(11.4)	0.73	7th
Prayer for God's intervention	50(56.2)	20(22.5)	11(12.5)	7(8.0)	0.76	4th
Use of feed supplements	29(33.0)	36(40.9)	13(14.8)	10(11.4)	0.65	9th
Seeking and listening to information about climate change	37(42.0)	24(27.3)	20(22.7)	7(8.0)	0.69	8th
Combining goat and sheep	17(19.3)	12(13.6)	21(23.9)	38(43.2)	0.36	15th
Change from goat and sheep farming to other business	7(8.0)	18(20.5)	30(34.1)	33(37.5)	0.33	16th
Planting trees around animal house for cooling and shade	32(36.4)	17(19.3)	19(21.6)	20(22.7)	0.56	13th
Frequent cleaning of animal house	60(69.0)	15(17.2)	6(6.9)	6(6.9)	0.82	2nd
Provision of shade for animals during the day	48(55.8)	24(27.9)	7(8.1)	7(8.1)	0.75	5th
Keeping and feeding animals indoor during rainfall and cold/harmatan	54(61.4)	20(22.7)	10(11.4)	4(4.5)	0.8	3rd
Preservation of fodder/hay	44(50.0)	24(27.3)	17(19.3)	3(3.4)	0.75	5th
Free animals during dry weather to search for feed and water	35(39.8)	20(22.7)	27(30.7)	6(6.8)	0.65	9th

Source: Field survey, 2014

Table 3: Constraints to use of adaptation strategies

Constraints	Serious	Mild	Not a problem	Mean	Rank
Lack of credit facilities	42(47.7)	33(37.5)	13(14.8)	2.32	4th
Lack of information on climate change	14(15.9)	50(56.8)	24(27.3)	1.89	10th
Lack of improved breeds of goats and sheep	33(37.5)	36(40.4)	19(21.6)	2.16	5th
Absence of government policy on climate change	47(53.4)	24(27.3)	17(19.3)	2.34	1st
Shortage of water	27(30.7)	34(38.6)	27(30.7)	2	7th
Erratic/irregular power supply	28(31.8)	20(22.7)	40(45.5)	1.86	10th
High cost of equipment	44(50.0)	30(34.1)	14(15.9)	2.34	1st
High cost of feed supplements	44(50.0)	30(34.1)	14(15.9)	2.34	1st
Poor or low extension services	28(31.8)	41(46.6)	18(20.5)	2.09	6th
Inadequate knowledge to cope with climate change	20(22.7)	50(56.8)	18(20.5)	1.81	12th
Limited availability of adaptation measures	17(19.3)	50(56.8)	21(23.9)	1.95	9th
Risk of adaptation	18(20.5)	41(46.1)	29(33.0)	1.888	11th
Lack of access to weather forecasts	23(25.8)	41(46.1)	22(25.6)	1.97	8th

Conclusion and Recommendations

The study shows that respondents adopted some adaptation strategies to cope with the challenges of climate change. According to the ASUI, the most frequently used strategies include provision of housing for animals, frequent cleaning of animal house, keeping and feeding animals indoor during rainfall and cold/harmatan. The constraints to the use of adaptation strategies were absence of government policy, high cost of equipment and feeding. Based on the findings of this research the following recommendations are made:

Policy makers through agricultural extension should make efforts in educating the small ruminant farmers on the use of other adaptation strategies.

Assistance should be made available by the government through provision of credit facilities and subsidies to the small ruminant farmers.

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SHEEP AND GOAT FARMING IN IMO STATE SOUTH EAST NIGERIA: A TRADITIONAL VOCATION AT THE VERGE OF EXTINCTION?

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Abstract
This study investigated the current state of sheep and goat farming amongst households and possible options for economic improvement. Structured questionnaires were distributed to farmers randomly selected from three Local Government Areas (LGAs) in Imo state for a focus group interview. The results revealed significant reduction in sheep and goat farming amongst the households across four generations. Lack of interest due to poor policy framework, low productivity of existing breeds, difficulty in feed supply and high cost of breeding stock was identified as constraints while older people are more directly involved in sheep and goat farming than youths. 59.6% of the farmers were females, and 31-50% of the farmers were between the ages of 31 and 50 years. Farming was observed to be the most common occupation amongst the households while trading was the next occupation. Results also showed that 73% of the total families had a history of sheep and goat keeping. It was also observed that 33.7% of households were involved in poultry enterprise and 25.3% involved in fish farming as an enterprise. Only 4.8% engaged in sheep and goat farming. Results obtained also revealed that 48.3% of the identified sheep and goat farmers kept breeds of sheep and goat from northern Nigeria 34% of respondents believe that access to grants and credit facilities, 25 % believe provision of land in urban areas, while 21% think improvement in small ruminant feed technology, would improve production. If this current situation is to be reversed, adequate incentives such as grants and a revival of the moribund extension services should be provided for sheep and goat farmers combined with new technologies given the high literacy rate within the area to improve input and output respectively.

Keywords : sheep and goat farming, south eastern Nigeria, west African Dwarf breed, extension services

Imtroduction
Sheep and goats represent the predominant ruminant animals in south eastern Nigeria and the west African dwarf breed is indigenous to this area. In terms of contribution to house hold meat supply by aggregate demand, goat meat is second to beef followed by poultry (Aborishade and Carpio, 2017). Regrettably, over 90% of animals slaughtered within the region are supplied from northern Nigeria (Francis, 1990).In fact, the west African dwarf breed of sheep and goat just like the west African dwarf cattle, is at the verge of extinction. The west African dwarf breed of sheep and goats are adapted to the humid rainforest zone, along the Atlantic coast, which stretches from Nigeria to Cameroun, Congo to the east, Benin, Togo, Ghana, Liberia up to the Fouta Djallon highlands of the Gambia (Williamson and Payne, 1978). They are typano-tolerant and represent an important component of the crop-livestock farming system of the indigenous population. Besides provision of food, they act as a reserve of wealth, a living bank, a source of income, employment, manure, raw material and part of the social and customary ceremonies. Their size and adaptability and short generation interval make them the most preferred among domestic animals and makes for easy management among women and children. The short generation interval makes them easier to replenish stocks after disease outbreak. It is also a form of insurance against crop failure. Despite these advantages, an important vocation for small holder farmers, is at a danger of extinction. Sheep and goat production is largely concentrated in the hands of small holders who apply little if any, modern techniques required to meet the demand of meat in a fast changing

world where technology holds sway. Ownership of small sheep and goats is regarded as an investment since they could be sold to meet compelling family needs and obligations, slaughtered for consumption at home or at festivals. In addition, very little capital investment is required in buildings, maintenance and upkeep and purchase of stock since families could receive initial breeding stock as a gift or tied to joint sharing of offspring. Currently, there are four identified production systems. Subsistence system which is characterized by a small number of holding often less than 5. Extensive system allows the animals to graze and browse large areas of marginal land usually unsuitable for cultivation under the care of a herder. However, this system has given rise to frequent resource conflicts between crop farming communities and migrant herders within the southern parts of Nigeria. It is on the grounds of appraising the current state of production and strategies for economic improvement that this study was initiated.

Materials and Methods

The study was conducted in three Local Government Areas (L.G.As) namely; Oru West, Ahiazu Mbaise and Ezinihitte Mbaise. Imo state lies within latitudes 4°45'N and 7°15'N, and longitude s6°50'E and 7°25'E with an area of about 5,100sq km (Wikipedia,). Oru West lies within latitude 5.37° N and longitude 6.57° E. It has an area of 93 km2 (36 sq mi) and a population of 117,492 (NPC, 2006). Ahiazu Mbaise is situated within latitude 5° 32' 55.259" N and 7° 16' 8.364" E. It has an area of 114 km² and a population of 170,902 (NPC, 2006). Ezinihitte Mbaise lies between latitude 5° 28' 43.5" (5.4788°) North and longitude 7° 19' 34.5" (7.3263°) East. The study was conducted with the aid of structured questionnaires, using focus group and personal interviews and observations within the different communities of the three Local Government Areas (LGAs). The communities were selected using a stratified random sampling and thirty respondents were interviewed in Ahiazu and Ezinihitte Mbaise and twenty nine in Oru West making up a total of eighty nine (89) respondents overall.

Results and Discussions

The results indicated that 71.9% of respondents were rural dwellers, 20.2% peri-urban dwellers and 7.9% urban dwellers showing that the study area was majorly rural. The respondents were within the ages of 21 to over 70 years. While 42.7% were between the ages of 31-50 years, 37.1% were between the ages of 21-30 and 15.7% were between the ages of 51-70 while 4.5% were above 70 years. Results also indicated that there were more females- (59.6%) than males- (40.4%) as shown in Table 1. 56.2% of respondents were married and 43.8% were single, indicating that the current production methods may not be attractive to the single youths, a development which can be addressed by providing the enabling environment for youths to go into commercial sheep and goat production (Anyanwu *et. al.*, 2010). The educational status of the respondents showed that 32.6% had secondary education while 31.5% had tertiary education. About 16.9% had primary education while 19.1% had no formal education. We can report from this result that most of the respondents were educated. Access to education is related to the capacity of respondents especially women, to use appropriate information, technologies and skills for enterprise development and generation (Adeleye *et.al*,. 2016). Most of the respondents (15.7%) had a household size of 10, 14.6% had a household of 6, 12.4% have a household of 7, 9.0% have a household of 5, 6.7% have a household of 15, 9, 8 and 4 respectively. 2.2% have a household of 14, 11 and 3 respectively. It was also recorded that the primary occupation of most of the respondents (49.4%) was farming, 19.1% were involved in trading, 13.5% were civil servants, while 7.9% were students and businessmen respectively. Furthermore, 53.9% reported farming as secondary occupation, 30.3% as trading, It was also recorded from the study that 84.3% of the total respondents are engaged in agriculture whereas 15.7% were not.

Production systems and choice of enterprises

An analysis of the data revealed that 33.7% of the respondents preferred poultry as livestock enterprise of choice, 25.3% fish farming, 18.1% piggery and /marketing respectively while a very small number of respondents (4.8%) indicated sheep and goat as a livestock enterprise of choice. This is in agreement with the previous report by Okoli *et. al*,. 2004 that poultry business enterprise in Imo state, Nigeria is attractive and an enterprise of choice where practitioners are willing to continue in throughout their lifetime Again, 33.7% of the respondents affirmed that they would venture into crop farming if given a startup capital, 25.3% declared marketing of agricultural products as a choice enterprise, 18.1% also chose fishery and others respectively. Whereas a little number of them (4.8%) chose livestock as a choice

of enterprise upon having access to loan. It was also recorded that 76.4% of the respondents indicated that their communities had a history of sheep and goat farming while 73% of the households had a family history of sheep and goat keeping. The practice of sheep and goat keeping along the successive generations declined from , 48% for the great grandparents,,22% grandparents, 17% parents to 11% for the respondent The major reason for sharp decline in sheep and goat production among the respondents (30.3%) was lack of interest. Other reasons for sharp decline in sheep and goat production (14.6%) was low productivity of existing breeds. 10.1% recorded that lack of innovation in production system and high cost of breeding stock was the major reason for the sharp decline respectively. Incidence of pest and disease was recorded to be 7.9% and 5.6% was drudgery and high labour involvement. From the above results, it can be reported that low productivity of the existing breeds of sheep and goat and lack of innovation in production system resulted to lack of interest could be the major reasons for sharp decline in sheep and goat production in the study area. About 40.35% of the respondents practiced subsistence system of sheep and goat production while 37.1% practiced intensive system, 16.9% also practiced extensive system and 5.6% also practiced semi-intensive system. This is in contrary to the report from northern Nigeria that small ruminants were mostly managed under extensive system (Ajala and Gefu J,O. 2003). The subsistence system confirmed that small ruminants are not kept in commercial sizes and are actually kept to augment family income..

Strategies for economic improvement

The most workable solution to revamp sheep and goat production as consented by the respondents (33.7%) was the advancement of credit facilities. Other workable solutions to revamp sheep and goat production in order of importance was the provision of land by government in peri-urban centres for cluster sheep and goat farming (24.7%), improvement in ruminant feed technology (21.3%), establishment of planted fodder banks (12.4%) and innovation in housing and feeding systems. So, presumably, advancement of credit facilities such as loan or grant to the farmers can be a good workable solution to revamping sheep and goat production in the study area. This can be augmented by the government providing land in peri-urban centres for cluster sheep and goat farming as well as the improvement in ruminant feed technologies. The reports given by the respondents (59.1%) showed that the total annual income generated from agricultural enterprise per year was below ₦120,000 which was below the current minimum wage of public sector workers. Furthermore, 30.7% earned between ₦121,000 - ₦240,000 while 6.8% reported earnings between ₦481,000 - ₦1,000,000. This low income reported by this households could be the reason for the declining interest in sheep and goat farming. This could be explained by subsistence production system prevalent in the study area probably due to lack of capital and appropriate technologies to commercialize aspects of the enterprise value chain. 25.8% of the respondents affirmed that delivery of new research technologies to target farmers can best enhance sheep and production in the study area. Furthermore, 24.7% consented that technology can enhance sheep and goat production in the study area through improvement in genetic potential. 14.6% of the respondents reported that access to marketing information by linking farmers with consumers using cell phones can be useful in the technological enhancement of sheep and goat production in the study area. Also, 11.2% affirmed that use of ready-made packaged feeds and modified housing for urban and peri-urban producers can be another innovation to enhancing sheep and goat production in the study area respectively. In addition, only 9.0% reported that oestrus synchronisation can be used to enhance production. Overall, majority of respondents , 60 % agreed that deployment of new technologies holds the key to economic improvement..

Conclusion

It could be concluded that lack of interest in sheep and goat farming was the major constraint which could be attributed to the low productivity of existing breeds and low income derived from the enterprise relative to other farm enterprises. It was also recorded that lack of innovation in production system and high cost of breeding stock were also contributing factors. There should be concerted effort by government to revive this industry through the provision of incentives and a revival of the moribund extension services so as to bring the innovations and new technologies to the farmer.

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Table I: Socio-economic characteristics

Parameters	Class	Frequency	Percentage
Locality	Urban	7	7.9
	Peri-urban	18	20.2
	Rural	64	71.9
	Total	89	100.0
Age	21-30	33	37.1
	31-50	38	42.7
	51-70	14	15.7
	Above 70	4	4.5
	Total	89	100.0
Sex	Male	36	40.4

	Female	53	59.6
	Total	89	100.0
Marital Status	Single	39	43.8
	Married	50	56.2
	Total	89	100.0
Level of education	None	17	19.1
Primary occupation	Farming	44	49.4
	Trading	17	19.1
	Student	7	7.9
	Business	7	7.9
	Teaching	12	13.5
	Tailor	1	1.1
	Nursing	1	1.1
	Total	89	100.0

ADOPTION OF IMPROVED FEEDING TECHNOLOGIES AMONG FARMERS IN IWO LOCAL GOVERNMENT AREA OF OSUN STATE, NIGERIA

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ABSTRACT

The study was carried out to examine the adoption of improved feeding technologies among livestock farmers in Iwo Local Government Area of Osun state. A purposive sampling method was used to select 100 livestock farmers for the study. Primary data were collected from the livestock farmers with the aid of structured questionnaire. The data were analyzed using descriptive statistics such as means, frequency and percentages. Findings revealed that the mean age of the farmers was 48.44 years and most were married male with a mean family size of 6 persons. Most (83%) of the farmers were literate with majority (69.8%). The major source of awareness for the improved feeding technologies was agricultural extension agents. Soybean wastes had the highest level of awareness (85%) and adoption (55%) among the farmers. There was an increase in the cost feeding of the animals from ₦516.00 before the adoption of the innovation to ₦4146.00 after adoption. There was also an increase in the average income per production cycle from ₦54600.55 before adoption to ₦135500.50 after adoption. High cost of raw materials was ranked the first constraint to adoption of innovation. It was recommended that farmers should be encouraged to adopt innovation through the provision of financial assistance by relevant institutions while increasing awareness on benefits of adopting feeding technologies through extension.
Keywords: Adoption, Improved feeding technologies, Livestock farmers, Awareness

Introduction

Background of the study

Authors have emphasized the need for utilizing alternative feed ingredients which are wastes from human and industrial uses (Nsa *et al.,* 2007). There is, therefore need for animal nutritionists to seek for alternatives to the inadequate and expensive conventional feed stuffs to forestall an impending serious food crisis. Some authors (Kwari *et al.,* 2004) have stressed the need for utilization of alternative feed ingredient.

In Africa and other developing countries, feed and feeding comprises 60-70% of total production costs (Madubuike, 1993), with the present trend of rising feedstuffs prices and global inflation, livestock production is increasingly constrained by feed scarcity and the high cost of feeds (Ayantunde *et al.,* 2005). Shortages of feeds and forages are usually acute during the dry season. The situation is even made worse by the climate change phenomenon resulting to erratic weather. In an attempt to solve these problems, scientists have considered the use of agricultural by-products or wastes in the feed of livestock thereby giving rise to various feeding technologies to reduce cost and improve productivity of livestock.

In Iwo Local Government Area of Osun State, three specific feeding technologies have been introduced to farmers for adoption. These include the use of dried plantain peels, cassava peels and soybean wastes in the feed of livestock. Studies (Fanimo *et al.,* 2006; Adesehinwa *et al*., 2011) have been carried out on the effectiveness of including these materials in the feeds of livestock. Though, there are numerous feeding technologies developed by scientists a lot more needs to be done to ascertain the adoption of these feeding technologies by farmers who are the end users. DFID (2006) maintained that the issue of the level and determinants of adoption of technologies which is lacking among agrarian communities has been as important as their impact on livelihood. Thus the adoption of these technologies by the farmers as well as constraints to the adoption should be of great importance. It is based on this background that this study was conducted to assess the adoption of the introduced improved feeding technologies among farmers in Iwo LGA of Osun state. The specific objectives were to determine the awareness and use of the

technologies, ascertain the sources of awareness, determine the impact of the adopting technologies and constraints to adopting the technologies.

Materials and Methods

The study was carried out in Iwo Local Government Area of Osun State. It has an area of 245km^2 and a population of 191,348 as most populous Local Government in Osun State by the 2006 National census figures. The town is located on latitudes 7^0 39^1N and on the longitudes 4^0 9^1E. The primary economic activity of the area is agriculture with the major crops grown being cocoa, yams, maize, cassava, and oil palm. Livestock commonly reared in the area are poultry, goat and sheep. The population of the study included all the poultry, pig and rabbit farmers in Iwo Local Government Area. Ten wards were randomly selected from the fifteen wards in the Local Government Area. Ten livestock farmers were randomly selected in each of the selected wards to give 100 livestock farmers as the sample size of the study. Data collected from the livestock farmers with the aid of interview schedule were analyzed using descriptive statistics such as percentage, frequency and means.

Results and Discussion

Socio-economic characteristics of respondents

Table 1 shows that majority (88.0%) of the respondents were male while 12.0% were female. This indicates a greater involvement of the males in livestock in the study area. It further shows that 52.0% of the respondents were within the age range of 40-50 years while 16.0% fell in the range 40 years and below. The mean age was of 48 years implying that livestock production in the area was dominated by adults in their productive and active years. The table also reveals the mean of the household size to be 6 persons with majority (55.0%) of the respondents within the family size of 5-7 persons. A greater percentage (97.0%) of the respondents were married indicating that married people are more involved in livestock farming which may be due to household needs. Most (86.0%) of the respondents had formal education from ranging from the primary to the tertiary level while only 12.0% did not have formal education. This high level of education could positively affect adoption of innovation by farmers. Imoh and Essien (2005) reported that education enhances farmers' ability to understand, evaluate and adopt new production techniques. The table also shows that majority (60.0%) had their major occupation as farming thereby confirming that the study area is a typical agrarian locality. 51.0% were members of the farmers association while 39.0% were not members of farmers association. Farmers association serves as a medium where farmers meet for the purpose of sharing vital information. Adams (1982) in Idio and Okoro (2017) observed that the rate of adoption could be affected by social affiliation

Table1: Socio-economic characteristics of respondents (n=100)

Variable	Frequency	Percentage (%)	Mean
Age (years)			
40 and below	16	16.0	48.44
41-50	52	52.0	
50-60	29	29.0	
Above 60	3	3.0	
Household size (persons)			
2-4	24	24.0	8.00
5-7	55	55.0	

Above 7	17	17.0
No response	4	4.0
Marital status		
Single	1	1.0
Married	97	97.0
No response	2	2.0
Educational level		
No formal education	14	14.0
Primary education	38	38.0
Secondary education	30	30.0
Tertiary education	18	18.0
Major occupation		
Farming	60	60.0
Civil service	14	14.0
Trading	9	9.0
Artisan	2	2.0
Student	1	1.0
No response	14	14.0
Membership of farmers association		
Yes	51	51.0
No	39	39.0
No response	10	10.0

Source: Field survey, 2013

Awareness and use of feeding technologies among the livestock farmers

Table 2 shows that 62.0% of the respondents were aware of the cassava wastes inclusion, 56% were aware of the inclusion of ripe plantain peels while 85% had become aware of soybeans waste inclusion in livestock feeds. Only 20.0% adopted the cassava peel technology, 17% had adopted ripe plantain peel while 55% of the respondents had adopted the use of soybean waste. The result indicates that that soybean waste has the highest level of awareness, and the highest level of adoption among the livestock farmers followed by cassava waste. The least adopted technology was ripe plantain. A larger proportion of the farmers adopted the soybeans waste probably because it is a good source of high quality protein.

Table 2: Awareness and use of feeding technologies (n=100)

Feeding technologies*	Aware	Not aware	Adopted	Not adopted
Cassava peels	62(62)	38(38)	20(20)	80(80)
Ripe plantain peels	56(56)	44(44)	17(17)	83(83)
Soybeans waste	85(85)	15(15)	55(55.0)	45(45.0)

Source: Field survey, 2013 Percentage in parenthesis * Multiple responses provided

Sources of awareness of feeding technologies

As shown in Table 3, majority (73.0%) of the respondents were aware of the technology through the agricultural extension agents, 7.0% were aware through the means of television, 8.0% had no response, and 11.0% became aware through the Poultry Farmers Association while 1.0% got informed through other farmers. The result indicates that extension officer/agents were playing a vital role in creating awareness on improved livestock practices in the area of study. This result is similar to that of Adeokun *et al.,* 2008 where extension agents were found to be the major sources of information on improved goat packages to women farmers.

Table 3: Sources of awareness of feed technologies (n=100)

Sources of awareness	Frequency	Percentage (%)
Agricultural extension officers/agents	73	73.0
Other farmers	1	1.0
Television and Radio	7	7.0
Farmers association	11	11.0
No response	8	8.0

Source: Field survey, 2013

Impact of technology adoption among livestock farmers

Table 4 shows that the average monthly cost of feeding the animals increased from ₦516.00 before the adoption of the innovation to ₦4146.00 after adoption. This indicates an increase in cost of feeding after adoption of the innovation. Adoption of technology may lead to increased production cost caused by additional money used in purchasing feed materials. The table also reveals increase in the average income per production cycle from ₦54600.55 before adoption to ₦135500.50 after adoption. This implies that the adoption of the feeding technologies by the farmers had increased significantly their income per production cycle. This will also lead to an increase in the profitability of the farmers thereby improving their living standards. Farmers should be encouraged to adopt feeding technologies since these technologies are able to increase farmers' income. These same is expected for all innovations that are disseminated to farmers. One of the characteristics of every innovation is its economic viability.

Table 4: Impact of technology adoption among the livestock farmers

Variable	Before adoption	After adoption
Average monthly cost of feeding(Naira)	516.00	4146.00
Income per production cycle (Naira)	54600.55	135500.50

Source: Field survey, 2013

Problems faced in using the new feeding technologies

Table 5 shows that majority (78.8%) of the respondents faced the problem of high cost of feed raw materials followed by scarcity of raw materials (62.5%). 52.5% were of the opinion that the technology was of time consuming while 13.8% had the problem of difficulty in processing the feeds. These were ranked 1st, 2nd, 3rd and 4th respectively. The result reveals that high cost of feed raw materials was the most serious problem to the use of the technology.

Table 5: Problems faced in using the new feeding technologies (n=80)

Problems *	Frequency	Percentage	Rank
High cost of feed raw materials	63	78.8	1st
Scarcity of raw materials	50	62.5	2nd
Difficulty in processing	11	13.8	4th
Time consuming	42	52.5	3rd

Source: Field survey, 2013 ***Multiple responses provided.**

Conclusion and recommendations

Awareness of feeding technologies among livestock farmers was relatively high but with a low level of adoption except in the use of soybean wastes. The adoption of these technologies had increased the average monthly cost of feeding the livestock while also increasing the income per cycle of the farmers. The highly ranked constraints to using these technologies were high cost and scarcity of feed materials. It is therefore recommended that:

There should be increased awareness through extension on the benefits of adopting feeding technologies among livestock farmers.

Farmers should be encouraged to adopt innovation through the provision of financial assistance by relevant institutions and agencies.

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SOCIO-ECONOMIC ANALYSIS OF SMALLHOLDER PIG PRODUCTION IN SABON GARI LOCAL GOVERNMENT AREA, KADUNA STATE, NIGERIA

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Abstract
Multistage sampling procedures were adopted in this study to select Sabon Gari Local Government Area (LGA), 3 out of 11 wards in the LGA and 49 pig farmers. The aim was to analyze the socio-economic as well as costs and returns of pig production in the LGA. A structured questionnaire was used to generate primary data which were analyzed using descriptive statistics and gross margin analysis. Results showed that majority of the farmers fell within the active productive age of 30-50 years; 67% were males and over 67% were married. The total variable cost (TVC) amounted to ₦185,000 while the gross income was ₦ 539,000 yielding a gross margin of ₦ 354,000 and return on investment of ₦ 2.91. Major constraints identified include shortage of funds and poor pricing of produce. Recommendations proffered include better access to credit and membership of cooperative and farmer groups.

Keywords: Socio-economic analysis smallholder pig production

Introduction
Unarguably, Nigeria with a population of about 165 million (NPC, 2006) is grossly undersupplied with essential food components, notably animal protein. According to Odedire and Adekinle (2015), low supply and high cost of animal protein such as beef, pork, mutton, chevron, poultry, eggs and milk have brought about an acute shortage of animal protein in the diet of most Nigerians. Many have argued that one veritable area of the livestock industry that is rather ignored, but holds the key to animal protein sufficiency in Nigeria is pig farming.

Pig is one of the domestic animals reared in Nigeria and belongs to the family *suidea* and order *Antiodactayla*, but especially to the domestic animals known scientifically as *Susscorfa* from which domestic pig was developed (Adetunji, 2011). The special advantages of pig rearing are enormous; pig produces better twice a year and this may range from 8 to 16 piglets in a litter. Also, pigs eat anything that is edible when given.

Pig production in Nigeria has not fully developed to exploit its full potentials. A study by Adetunji (2011) revealed that the neglect or slow growth of the swine industry can be attributed to acceptability and management problems. Evidently, in Sabon-Gari LGA, most of the producers are small scale producers, some with as few as two animals; pens for the pigs are ramshackle structures which often breakdown making it easy for the animals to go free range. Feeding is mostly on haphazard basis, depending most of the time on waste products. Generally, little or no use is made of concentrate feed for enhanced growth and productivity. Furthermore, there is the preponderance of low productive breeds in terms of size and quality.

Inspite of the daunting challenges outlined, many people still engage in rearing pigs and make a living out of it. The objectives of this study are to:
describe the socio-economic characteristics of pig farmers in the study area,
describe the system of pig production in the area,
estimate the costs and returns of the enterprise,
identify the major constraints affecting pig production in the study area.

Materials and Methods

The Study Area

This study was conducted in Sabon-Gari Local Government Area of Kaduna State, Nigeria. With headquarters in Dogarawa, the LGA is situated within the Northern senatorial zone of Kaduna State alongside Kubau, Ikara, Makarfi, Soba, Zaria and Lere LGAs. Comprising of 11 wards, Sabon Gari LGA is situated at an elevation of 684mm above sea level, with annual average rainfall of 1000mm characterized by two seasons, the dry and wet seasons. The inhabitants of the area are predominantly Muslims, with others being rather Christians or animists.

Sampling and Data Collection

Purposive sampling was used to select Sabon Gari LGA and the three wards where pigs are commonly reared namely Basawa, Samaru and Sabon Gari. Secondly, considering the fewness of pig farmers in the area, a census of all 49 pig farmers in the three wards were covered using a structured questionnaire to elicit desired information.

Data Analysis

Primary data generated was analyzed using descriptive statistics including the measures of central tendency and dispersion. Gross Margin Analysis was used to estimate the costs and returns. Gross Margin (GM) is expressed as:

$$GM = GR - TVC$$
$$= \Sigma P_r Y_r - \Sigma P_i x_i$$

Where GR = Gross Revenue; TVC = Total Variable Costs
$\Sigma P_r Yr = Y_r$ = Output of pig production and Pr = Unit price of pig
$\Sigma P_i x_i = P_i$ = Unit price of i^{th} input (₦) and X_i = quantity of i^{th} input (₦).

Results and Discussion

Socio-Economic Characteristics of the Respondents

The socio-economic characteristics of pig production in Sabon Gari LGA are shown in Table 1 covering sex, age, marital status, educational status and years of experience.

Table 1: Distribution of Pig farmers based on socio-economic characteristics

Socio-economic Characteristic	Frequency	Percentage
Gender		
Male	33	67.3
Female	16	32.7
Age (Years)		
21 – 30	9	18.4
31 – 40	24	49.0
41 – 50	19	22.4
>50	5	10.2

Marital Status		
Single	7	14.3
Married	33	67.3
Divorced	3	6.1
Widowed	6	12.2
Educational Status		
No formal education	8	16.3
Primary education	27	55.1
Secondary education	10	20.4
Tertiary education	2	4.1
Years of experience		
<5	3	6.1
6 – 10	18	36.7
11 –15	23	47.0
>15	6	12.2
Membership of Cooperatives		
Yes	18	36.7
No	31	63.3

Source: Field study, 2018

The results in Table 1 showed that 67.3% of the pig farmers were males while 32.7% were females. This implies that males were more actively involved in pig production than females. This is in agreement with the findings of Ogunniyi and Omoteso (2011) who reported the dominance of males in their work on pig production in Oyo State.

On age, the results showed that 18.4% of the respondents fell within the age bracket of 21-30 years, 49% 31-40 years and 22.4%, 41-50 years only 10.2% of the pig farmers were above 50 years. Evidently, majority of the respondents (71%) fell within the active productive age of 30-50 years. This result agrees with the findings of Ajala and Adesheinwa (2007) in Southern Kaduna area of Kaduna State.

The educational status of the respondents showed that 55% had primary education while 20.4% had gone up to secondary education. Only 4.1% had tertiary education while 16% had no formal schooling. Regarding the years of experience in pig production, majority (83%) had put in 6-15 years; only 12.2% had put in over 15 years. The record of membership of cooperative societies was poor as only 18 farmers (31.7%) were members of cooperative/farms groups.

Pig Production Practices

The study revealed that most of the pig farmers were small scale operators with herd size ranging from 1-30 pigs. Details of production status and practices are shown in Table 2.

Table 2: Distribution of Pig Producers Based on production details

Items	Frequency (n=49)	Percentage
Herd size (numbers)		
1-10	13	26
11-20	27	55.1
>20	9	18.4
Breed Type		
Local	49	100.0
Exotic	0	0.0
Type of Housing/pens		
Concrete house	26	
Metal house	7	
Wooden house	16	
Type of Feed		
Concentrate only	0	0.0
House wastes	41	83.7
Mixture	8	16.3

Source: Field study, 2018.

The results on herd size, breed type, type of housing and feed types show the scale and status of pig farming in the area as below the commercial scale. Furthermore, the poor feeding regime and breed to type can only guarantee low yield (Petrus *et al*, 2011).

Costs and Returns of Pig Production

The costs and returns for pig production in the study area are based on average-sized farm using gross margin analysis as shown in Table 3.

Table 3: Summary of Costs and Returns of Pig Production

S/No	Items	Units	Unit Price (₦)	Total (₦)
1	**Variable Cost**			
	Piglets	14	5,000	70,000
	Feeding	14	3,650	51,100
	Labour (man-days)	22	1,500	33,000

	Drugs and vaccination	14	1,100	15,400
	Transportation	14	250	3,500
	Miscellaneous/contingency	14	500	12,000
	Total Variable Costs (TVC)			**185,000**
2	**Gross Returns**			
	Mature boar	7	35,000	245,000
	Mature sow	7	42,000	294,000
	Gross Revenue (GR)			539,000
	Gross Margin (GM) = GR – TVC			354,000
	Return on Investment (GR/TVC) = ₦2.91			

Source: Field study, 2018

The results in Table 3 showed that total variable cost (TVC) amounted to N189,000 while the gross returns from sale of mature boars and sows stood at N539,000 generating a gross margin of N354,000 and return on investment of N2.91 per naira invested. The enterprise is profitable and is in agreement with the findings of Ajala (2003) on the economics of pig production in Jama'a LGA of Kaduna State.

Pig Production Constraints

As earlier mentioned pig farmers in the area of study face a myriad of constraints which adversely affect productivity and returns.

Table 4: Distribution of Respondents Based on Identified Constraints

S/No	Constraints	Frequency*	Percentage*
1	Inadequate capital	43	87.8
2	Poor pricing of produce	37	75.5
3	High cost/unavailability of feedstuffs	41	83.7
4	Poor housing/pen facilities	22	44.8
5	Poor extension input	26	53.0
6	Pests and diseases	18	36.7
7	Poor sales patronage	38	77.5

Source: Field study, 2018 *Multiple responses allowed

Table 4 presents the major constraints limiting pig production in the study area with inadequate capital (87.8%) topping the list followed by high cost/unavailability of feedstuffs (83.7%) and poor sales patronage (77.5%). The 4th and 5th constraints respectively are poor pricing of produce (75.5%) and poor extension input (53%). It is interesting to note that poor housing (44.5%) and pests and diseases (36.7%)

did not feature prominently as constraints limiting pig production in the area. These constraints are similar to those identified by Adetunji (2011) in Oyo State.

Conclusion and Recommendations

The finding of this study indicates that pig production in Sabn Gari LGA of Kaduna State is a profitable venture, inspite of the many challenges faced by the farmers. The gross margin of ₦354,000 and return on investment of ₦2.91 are high profit indicators. For better returns the study recommends better access to credit and the formation and membership of cooperative and farmer groups by the respondents.

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FIELD OF INTEREST: ANIMAL WELFARE AND BEHAVIOR/CLIMATE CHANGE.

POPULATION DYNAMICS OF CATTLE SLAUGHTERED IN A TRANSIENT SLAB OF THE INTERNATIONAL CATTLE MARKET IBADAN, NIGERIA

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Abstract

The influx of cattle into Nigerian abattoirs is on the increase with little or no documentation on slaughtering activities and types of cattle slaughtered. This study was therefore conducted to evaluate the Population dynamics of cattle slaughtered in the study area. The study was carried out at Akinyele international cattle market, Ibadan over a period of 5 weeks between 7am-7pm to ascertain information on the population of cattle slaughtered, breeds, sex, size and the time of slaughtering. The result showed that a total of 1839 cattle were being slaughtered. These include White Fulani (43.2%), Red Bororo (35%), Gudali (19.8%) and Kuri (2%). Slaughtering activities starts at 7am with most of the animals (62.7%) slaughtered between 7-10am from Monday to Sunday. The highest number of cattle is processed on Fridays (35.9%) while the lowest are on Sundays (4.5%). More female cattle (73.3%) were slaughtered compared to 16.7% for male cattle with 57.2% (medium) of the cattle in the mid-age category. White Fulani and Red Bororo were the predominant breeds of cattle slaughtered at Akinyele international cattle market, Ibadan.

Introduction

Large number of cattle is offloaded daily in cattle markets from different parts of the country. When cattle arrive, they hardly stay for long before disposal. Early disposal at the expense of the owner is often necessitated by the physiological condition of the animal, consequence of long distance travel and nature of transportation. Under this condition, the cattle are hurriedly sold out for immediate processing which informed the creation of Transient Slaughter Slab (TSS). The TSS, also known as rescue slab was created about two decades ago along with the main cattle market to salvage the weak but seemingly healthy cattle. Filani (2005) reported that the initial kraal for receiving of cattle from the northern state to the southwest was moved to Akinyele in 1999 after Bodija ethnic conflict. There is scanty information on the number of animal and slaughtering pattern on daily basis in the different abattoirs in Nigeria. Thus, a study was designed to evaluate the population of cattle slaughtered and the pattern of slaughtering in the international cattle market, Ibadan, Nigeria.

Materials and methods

The study was carried out at the international cattle market, Akinyele, Ibadan. The study was conducted within a period of five weeks (Monday to Sunday) from 7am-7pm. Direct observation with the aid of check list was used to gather information on arrival time, breeds, sex and size of all the cattle brought for slaughtering in the TSS. Data were collected daily and subjected to descriptive statistics using SPSS 2020.

Results and discussion

Shown in Figure 1 is the average number of cattle slaughtered during the period of the study. Slaughtering activities were carried out every day of the week. The population of cattle slaughtered ranged from 4.5% on Sunday to 35.9% on Friday.

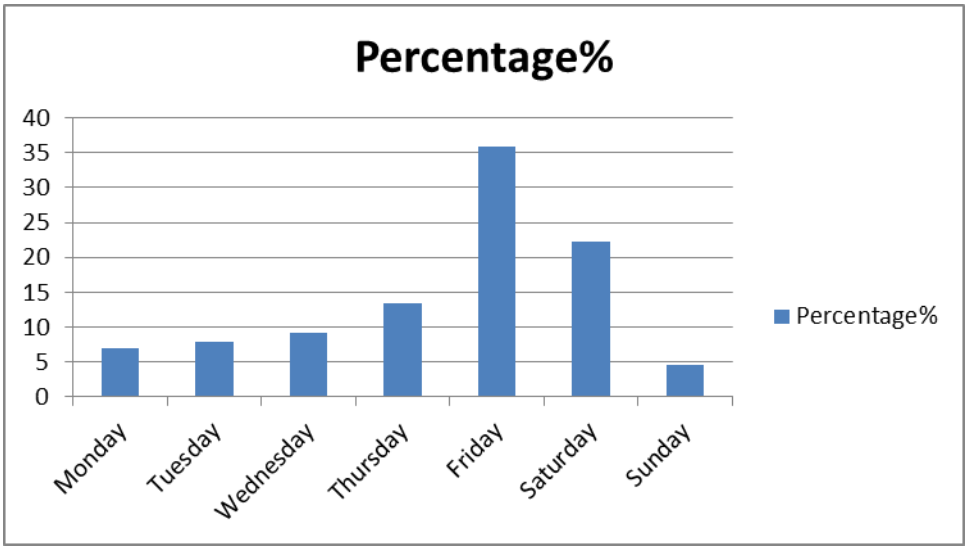

Figure 1: Bar Chat showing the population of cattle slaughtered per day

The peak of slaughtering observed on Friday followed by Saturday and Thursday could be as a result of the peculiarity of the days to be weekend. Ceremonies such as wedding, burial and other parties are mostly fix during the weekends am families also purchase meat for consumption. Slaughtering of cattle for the ceremony is mostly done a day to the program since slaughtering and processing of cattle could be time intensive.

Sunday which is observed to have the least records of cattle slaughtered could be indicative of the day being a day of rest for both butchers traders and consumers. Also, information gathered by interviewing of different butchers reported that there is a standing order by the state government that no butcher is allowed to slaughter animal on Sunday for the purpose of selling but could slaughter for individuals buying for occasion or personal use

Presented in Table 1 are the breed, size and time of slaughtering of cattle. Slaughtering activities were observed to commence as early as 7am. The peak of slaughtering activity was between 7am-10am (62.7%) and the least being 4-7pm (0.5%)

The massive number of animals slaughtered at this peak could be due to the fact that buctchers are in a rush to slaughter, process and display meat for sale in due time. They might want to sell on time, make money and possibly go to process more animals if they have hope of exhausting the sale. Butchers might also be in haste to process cattle so as to avoid left over of meat that might possibly loose value as a result of spoilage setting in if it has to stay over the night. Preservation of beef and most especially the intestines might be a challenge as the means of preservation might not be readily available and if available could be expensive which might not be cost effective.

Table 1: Types and Arrival time of cattle slaughtered.

Parameter		Frequency	Percentages (%)
Arrival time			
	7-10	1082	62.7
	10-1	390	22.6
	1-4	246	14.2
	4-7	9	0.5
Breeds			
	White Fulani	794	43.2
	Red bororo	644	35.0
	Sokoto Gudali	365	19.8
	Kuri	36	2.0
Size			
	Large	572	31.1
	Medium	757	41.2
	Small	510	27.7

Also presented are the breeds of cattle slaughtered. It was observed that four different breeds of cattle were slaughtered. White Fulani (43.2%), were mostly slaughtered followed by Redbororo (35%). The result is similar to the findings of Muhamma *et al*. (2008) who reported that more cattle of Bunaji breeds were slaughtered than the other breeds in Kaduna. However it is at variance with that of Opara *et al*. (2006) who reported that White Fulani and Sokoto Gudali accounted for 76% of the animals slaughtered at Owerri abattoir. The high percentage of White Fulani cattle (43.2%) slaughtered could be as a result of the breed being transported more to the south west market as a result of its ruggedness and high tolerance to trypanosomiasis. The breed is also known to withstand the extreme of weather conditions.

The sizes cattle slaughtered where adjudged to be large (adult), medium (growers) and small (calves). About forty one percent of the cattle slaughtered were medium sized. Slaughtering of

growers could be more as a result of the available cash the buyer has for purchase. It could also be as a result of fluctuation in the prices of cattle in the market thus compelling buyers to go for lesser size of animal than desired. Individuals that opted for the purchase of small animals sometimes do so since they are encouraged that they could buy live cattle that will give all the part of animal body instead of going for parts such as the laps, head, etc alone. Large sized cattle might be slaughtered by the butchers and other individuals that are relatively financially buoyant.

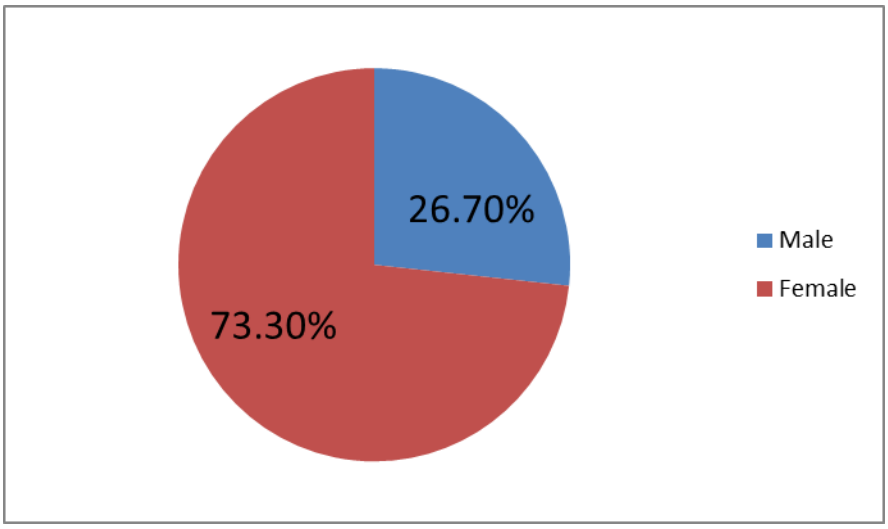

Figure 2: Pie chat showing Sex of cattle slaughtered

The sex of cattle slaughtered is as shown in figure 2. Female cattle (73.3%) are mostly slaughtered than male (26.7%). This could be due to the fact that the population of female cattle produced and transported to thereby to the market is more than that of male cattle. It could also be that the cost of purchase of female animal is less than that of male. So also, the price in which meat from female animal are sold might not be different from that of male. Therefore many of butchers might want to go for cattle that have the least cost effect so as to make more profit. Most of the female animals sold in the market could be inactive in age thus less productive and are sold out for consumption since it might not be cost effective for the owners to continue rearing such animals.

Conclusion

The results of this study showed that female cattle were slaughtered more than the male at the Akinyele transient slab. White Fulani and red Bororo were the breeds of cattle mostly slaughtered. Slaughtering is done more in the early hours of the day. Majority of the animals slaughtered during the period of the study were from Thursday to Saturday in which Friday records the highest percentage.

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