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Editorial

The Editorial Board is happy to announce the release of Volume 9(1) of our reputable Journal. This volume is coming with a new design and framework which will improve the aesthetics of the Journal. This Volume also marks the first time we are fulfilling our promise of making two numbers of a Volume in one year. The next stage of upgrading the Journal is to make our website (www.jaatfutminna.org) more functional and host the Volumes on it. We shall also now work with relevant databases and other cataloguing institutions on making the Journal truly international. As from Volume 10, we shall ask reviews if they want their names to be shown on the paper, as a form of transparency and promoting integrity in research and publications.

Let me express our profound appreciation to our numerous reviews for sparing their valuable time and scarce resources to review papers for this Volume in a timely manner in spite of their tight schedules. We appeal that they will oblige us this same privilege whenever we approach them for the same favour. I will however appeal to our reviewers to be more critical with the papers since we are dealing with a global audience.

We are very thankful for the support of the Dean of the School, Prof. R. J. Kolo, the Board of the School and the elders of the School for their fatherly roles for all the support. We also express our profound appreciation to our Editorial advisers for their sense of commitment and dedication. We are also appreciative of the role the Vice Chancellor and other Principal Officers in providing the enabling environment in the University for quality Journal publishing.

Editor-in-Chief

Prof. Job N Nmadu

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ANALYSIS OF TECHNICAL EFFICIENCY OF POULTRY EGG PRODUCTION IN AGRICULTURAL ZONE C, KOGI STATE, NIGERIA: PARAMETRIC APPROACH

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ABSTRACT

This research was on the analysis of technical efficiency of poultry egg production in agricultural zone C of Kogi State, Nigeria. Multistage sampling procedure was used to select 90 poultry egg producers in the study area through the use of structured questionnaires and interview schedule. Data were analyzed using stochastic frontier production model. The technical efficiency analysis showed that stock size(X_1) and drugs and medication(X_5) were positively significant at 1% and 5%, respectively while utility(X_6) was negatively significant at 5%. The findings of the inefficiency factors showed that household size (Z_4), and cooperative society (Z_6) were significant at 5% and 1%, respectively. The value of the sigma squared (δ^2) was 0.208 while gamma (γ) was 0.7853 and were both statistically significant at 1% level, respectively. The mean efficiency score of 0.823 showed that the farmers were not operating at the optimum level that is, they were not technically efficient as none of the farmers operated at the efficiency score of 1. Based on the findings of this research, it is recommended that solar power as an alternative power source should be introduced and installed for farmers at affordable rate by State government to reduce the operating cost of the farm.

KEYWORDS*:* Efficiency, poultry, parametric, production

INTRODUCTION

Agriculture is a key to economic development of Nigeria because of its role in the production of food, provision of raw materials for industries, as source of foreign exchange earnings and, provision of employment for over 65% of the population in Nigeria (Ajibefun *et al.*, 1996). Moreover, agriculture is also paramount in meeting the daily protein needs of an average Nigerian through the rearing of poultry for its meat and or, for its egg.

Poultry, usually refers to as domesticated birds which are nutritionally and economically useful to man, is a sub-sector of livestock

industry. It includes turkey, guinea fowl, ducks, pigeon, geese and chicken. Among these birds, rearing of chicken as broilers for meat or, as layers for egg is the most common in Nigeria livestock industry because they are a good converter of feed (Food and Agriculture Organization (FAO), 2005). Animal protein, especially egg and meat, is the most essential aspect of human nutrition because of the presence of amino acids as its major nutritional component. These include lysine, threonine, the sulphur-bearing amino acids (methionine and cysteine) and occasionally tryptophan. Eggs are also high in lutein which lowers the risk of cataracts and macular degeneration (FAO, 2013). Infact, apart from rice with net protein utilization (NPU) of 60, NPU of grains is generally less than 40, whereas NPU of chicken eggs is as high as 87 (FAO, 2013). Furthermore, an egg of average size (60g) contains an approximate value of 7 grams of protein such that two eggs contain as much protein as 100grams of meat. Egg is also rich in energy, lipid, vitamins especially A, D and E. Some trace element such as zinc and iron are also contained in egg (European Food Information Council (EFIC), 2015). Aside providing nutrition values, egg is also useful in the manufacturing of vaccines against infectious diseases and also useful in confectionery, bakery, ice cream, and cosmetics industries (Chukwuji *et al.* 2006, Tijani, Alimi, and Adesiyan (2006) and Nmadu *et al.*, 2014).

Despite the significance of protein in ensuring balanced diet for an average Nigerian, many Nigerians still suffer from protein deficiency causing retardation in the building and repair of their body tissues, inability of the body cells to replace the worn out tissues, lack of immunity against infectious diseases and prevalence of kwashiorkor among young people thereby leading to retarded growth and in severe cases, death. This is in consonance with the report of Tijjani *et al.* (2012) and FAO (1998) who reported that the current average level of animal protein consumption in Nigeria was 15g/head/day, which is grossly below the FAO recommended level of 35g/head/day. Therefore, there is the need for research focus on how production of eggs can be increased to meet the protein needs of ever increasing population as well as ensure that resources are combined optimally to ensure minimal wastage and maximum output. This can be achieved by examining the level of efficiency in the production process.

Efficiency measure is a very important concept in agricultural sector of the economy. It measures the relative performance of the processes used in transforming inputs into output given the best production techn ology available. Technically, it exami

nes how output could be maximized w ith a given set of inputs while ensuring minimum wastages in the use of these resources. Technical efficiency (TE) involves a comparison between the operational and optimal level of farmers in terms of the values of their output and inputs. This will assist in determining the extent to which the existing use of these resources deviates from the optimal-use level. Hence, appropriate recommendations could be made in terms of the means and methods adoptable in moving from the existing levels to the optimum-use of their resources so as to bridge the gap between demand and supply of poultry eggs and, ensure the sustainability of poultry egg production in the study area. It is against this backdrop that the research paper attempted to answer the question of how technically efficient are the farmers in the area.

METHODOLOGY

The study was carried out in Kogi State. It is one of the 36 states of the Federal Republic of Nigeria which is located in the central region of Nigeria. It has a total land mass of 3426km^2 with a total population of 722023 people according to the 2006 national census (Sunday, 2014). Agricultural Zone "C" of Kogi occupies a hilly sketch of guinea savannah grassland, The Zone shares common boundaries with the Yoruba speaking people of Owe, Akoko, Ijumu and Oworo; to the south - west. It is bounded by Ososo and other Akoko-Edo settlements; the Hausas, Nupes, and Ebiras are bounded to the north and river Niger to the east while the Igala and Bassa-nge settlements are fond across the river (Salami, 2011). The study area consists of five Local Government Areas (LGAs), namely Okene, Adavi, Okehi, Ajiakuta and Ogori-Magongo. The predominant ethnic group in the study area is Ebira while the minority group is Ogori-Magongo. The predominant occupations of the people are farming and cloth weaving while the major crop grown in the study area include yam, cassava, guinea corn, rice, cowpea and groundnut while the major livestock includes goat, ship, pig, poultry and dogs (Akomodi, 2006).

Sampling Procedure: A multistage sampling technique was used to select the poultry farmers in the study area. The State has four agricultural zones, namely, A, B, C and D. The first stage involved the random selection of three wards from Agricultural Zone "C" of the State while the second stage involved the random selection of four cells from each of the wards. The third stage involved the selection of 7 farmers from each cell making a total of 90 selected poultry farmers in the area.

Method of Data Collection: Primary data were collected for a one production season and relevant information was elicited from the farmers through the use of structured questionnaires. Data collected included farm size, labor input, capital input, feed cost, medication, stock capacity, utility, output and price.

Analytical Techniques: The technical efficiency of poultry egg production was achieved using the Stochastic Frontier Model. The stochastic frontier production function was developed by Farrel 1957 and has been used in previous studies (Oladeebo and Fajuyigbe, 2007; Ogundari, 2008; Binuomote, *et al.,* 2008; Ojo, 2013) to analyze the technical, allocative and economic efficiencies of farmers for different crops and livestock in Nigeria.

The general form of the model is expressed as:

$$Q_1 = \beta_0 + \beta_1 X_1 + (V_I - U_I) \ldots \quad (9)$$

Where

Q_i is the production (the logarithm of the production) of the *ith* firm;

X_i is a vector of (transformations of the) input quantities of the *ith* firm;

β is a vector of unknown parameters;

V_i are random variables which are assumed to be iid $(N, \delta^2 v)$, independent of U_i, identical and normally distributed with zero mean and constant variance that captures the stochastic effects outside the farmer's control, measurement control and other statistical noise while U_i are non-negative random variables which are assumed to account for technical inefficiency in production (*i.e* U_i measures the shortfall in output Q from its maximum value) and are often assumed to be iid $(0, \delta^2 u)$. The inefficiency of production, U_i was modeled in terms of the factors that are assumed to affect the efficiency of production of the farmers. Such factors are related to socio-economic variables of the farmers. Given functional and distributional assumptions, the value of unknown coefficients in equations (9) was obtained jointly using the maximum likelihood method (MLE). An estimated value of technical efficiency for each observation was calculated as:

$$TE_I = \exp(-U_i). \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

The Cobb-Douglas frontier model is assumed to describe the production function of the farmers on which data was obtained. The model in which the determinants of efficiency are incorporated was estimated simultaneously with the Cobb-Douglas stochastic frontier model. The model is represented as:

$$\ln Y_i = \beta_0 + \sum \beta_j Ln X_{ij} + (V_i - U_i)$$

.....(11)

Where
ln = Natural logarithm;
i = ith sampled smallholder farm;
Y_{ij} = Vector of Output of poultry egg (measured in physical output as the No of crates of eggs)
X_{ijs} = Vector of inputs.
The X_{ijs} are specified as:
X_1= Stock size (No of birds)
X_2= Labour used in poultry production (Man-day)
X_3= Capital input (depreciation)
X_4= Feed (kg)
X_5= Drugs and medication (₦)
X_6= Utilities (electricity, water etc) (₦)
β_j = Input coefficients for the resources used in production;
U_i = Farmer specific characteristics related to production efficiency;
Vi = Statistical disturbance term
Technical inefficiency model in addition to the general model, is defined to estimate the influence of some farmer's socio-economic variables on the technical and allocative efficiencies of the farmers.
The explicit form of the Cobb-Douglas functional form is written thus:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + V_i - U_i \quad \text{.....(12)}$$

Where Y, X_1, X_2, X_3, X_4, $X_5$and X_6 are as defined earlier. The V_i's are assumed to be independent and identically distributed (iid) normal random errors having zero mean and unknown variance. U_i's are non-negative random variables called technical efficiency of production of the respondent farmers which are assumed to be independent of the Vi's such that U_i's are the non-negative truncation (at zero) at the normal distribution with mean μ and variance σ^2

$$\mu = \delta_0 + \delta_1 Z_{1i} + \delta_1 Z_{1i} + \delta_2 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i} + \delta_8 Z_{8i} + \delta_9 Z_{9i} + \delta_{10} Z_{10i}$$

.... (13)
Where:
Z_1 = Farmer's sex (1, if male; 0, if female)
Z_2 = Years of experience
Z_3 = Level of involvement in poultry farming (0, if part-time; 1, if full-time)
Z_4 = Household size (No. of people available for farm work)
Z_5 = Education (Years)
Z_6 = Membership of cooperative society (1 if respondent is a member; 0 otherwise)
Z_7 = Age (Year)
Z_8 = Extension contact (1, if extension contact; 0 if not)
Z_9 = Credit usage (1, if credit is taken for farming; 0, if not)
δs= unknown scalar parameters to be estimated
∂'s, β's and γ coefficients are unknown parameters to be estimated along with the various parameters which are expressed in terms of $\delta s^2 = \delta v^2 + \delta u^2$; γ (gamma) = $\delta u^2 / \delta s^2$
Where
The γ - parameter has value between zero and one, ($0 \leq \gamma < 1$).

RESULTS AND DISCUSSIONS

Determinants of Technical Efficiency among Poultry Egg Producers in the Study Area: The summary statistics of the variables for the stochastic frontier model for poultry egg production was as presented in Table 1. They include the sample mean and the standard deviation for each of the variables. The larger size of the standard deviation confirmed that most of the farmers operated at different scales of operation. Analysis of the inputs also revealed an average stock size of 3,456.67 birds, the average labour/manday was 328.11 which implied that the farmers depended on families and hired labour or both for their farming operations The average capital input (depreciation), feed, drugs and medication, utilities (electricity and water) were ₦28,932.97, 4,483.22kg, ₦7,154.4 and 12,011.00, respectively, which further confirmed that the most of the farmers operated at medium scale of operation. However for Nigeria to be self-sufficient in poultry egg production, farmers need to expand their stock size.

Table 1: The summary statistics of the variables for the stochastic frontier model for poultry egg production

Variables	Mean	Standard deviation	Minimum	Maximum
Stock size (No)	3456	7,948	200	42,000
Labour (Man day)	328.11	961	456	22,204
Capital input (₦)	28932.97	43761.19	1150	232650
Feed (kg)	4,483.22	10,384.31	136	56,546
Drugs and Medication (₦)	7,154.44	5,377.19	300	40,800
Utility (₦)	124011.00	287971.4	8247	1524872

Source: Field Survey, 2015

Maximum likelihood estimates of the Cobb-Douglas frontier function for the poultry farmers: The maximum likelihood estimates (MLE) for the stochastic production (Table 2) was used to determine the determinants of technical efficiency of poultry egg production in the area as well as the effect of farmer specific characteristics on technical inefficiency of production. The parameters were estimated simultaneously using frontier 4.1c developed by Coelli (1996). The result showed that the coefficient of stock size (X_1) was statistically significant at $P < 0.01$ while drugs and medications (X_5) and, utility (X_6) were statistically

significant at $p < 0.05$, respectively. This showed that a percentage increase in these variables will lead to percentage increase in the crate of eggs produced. That is, 1% increment in the stock size and, drug and medication, will translate into 1.260% and 0.196% increment in the crates of eggs, respectively, while for utility (electricity & water), percentage increase in this variable will lead to percentage decrease in the crate of eggs produced. This might result from epileptic power and water supply by the government. The farmers may have resulted into alternative sources of power (use of generators) and water (Boreholes/wells) which are expensive to maintain.

The estimated coefficient of the inefficiency function provides some explanation for the relative efficiency levels among individual farms. Since the dependent variables of the inefficiency function represent the mode of inefficiency, a positive sign of an estimated parameter implies that the associated variable has a negative effect on efficiency while a negative sign indicates the reverse. Hence, household size ($P < 0.05$) which had negative coefficient implied that the farmers with high number of household size were more technically efficient than those who were otherwise. Therefore, these variables reduced the technical inefficiency of the farmers. However, the positive coefficients of membership of cooperative society ($P < 0.01$) showed that farmers' level of technical efficiency decreased with increase in cooperative membership. This may occur when a farmer (though a member of cooperative) could not access a substantial loan that could aid the farmer's business expansion as a result of low membership and hence, low capital base of the cooperative society. The accumulated interest on loan (in case of default) may also cause the farmers to lose some of the assets required to boost his farm operations to the society in order to settle his bill.

The value of sigma squared (δ^2) was 0.208 and was statistically significant at 1% level. This indicates a good fit and the correctness of the specified distributed assumption of the composite error term. It was also an indication that 20.8% of the observed variation in the output of poultry egg production in the study area was explained by the included explanatory variables. The variance ratio gamma was 0.557 and that was statistically significant at 1% level, was an indication that 55% of the observed variation in the output of poultry egg production in the study area was due to their technical inefficiencies which was explained by the included explanatory variables. This study is in conformity with the study conducted

Table 2: Maximum likelihood estimates of the Cobb-Douglas frontier function for poultry farmers in the study area.

Variables	Parameters	Coefficient	Standard error	T-ratio
Constant	β_0	10.905	1.085	10.053***
Stock size (x_1)	β_1	1.260	0.260	4.839***
Labour(x_2)	β_2	-0.139	0.120	-1.161
Capital (x_3)	β_3	0.088	0.074	1.202
Feeding (x_4)	β_4	-0.033	0.168	-0.198
Drugs and medication (x_5)	β_5	0.196	0.081	2.413**
Utility(electricity & water) (x6)	β_6	-0.429	0.186	-2.230**
Inefficiency model				
Constant	δ_0	0.083	1.121	0.074
Farmer's sex (z_1)	δ_1	-0.503	0.415	-1.210
Years of experience (z_2)	δ_2	0.012	0.026	0.462
Level of involvement (z_3)	δ_3	0.130	0.568	0.229
Household size (z_4)	δ_4	-0.198	0.078	-2.537**
Education (z_5)	δ_5	0.076	0.070	1.082
Membership of cooperative society (z_6)	δ_6	1.074	0.375	2.859***
Age (z_7)	δ_7	-0.024	0.023	-1.067
Extension contact (z_8)	δ_8	0.241	0.451	0.534
Credit usage (z_9)	δ_9	-0.369	0.423	-0.873
Variance parameter				
Sigma square	δ^2	0.208	0.072	2.870***
Gamma	γ	0.557	0.174	3.199***
Log likelihood function		–24.173		
L R test		28.701		

Source: computer output from frontier analysis

*** Significant at 1% level, ** significant at 5% and * significant at 10% level.

by Ohajianya *et al.,* (2013) in Imo State, Nigeria who reported that feeds, flock size, labour, drugs and medication, capital, management, and other inputs were all significant factors affecting the output of the farmers in the area but at variance with the study conducted by Alabi and Aruna (2006) who reported that expenses on feed, medicine/vaccine and capital were the main determinants of family poultry output in Niger-delta, Nigeria with a mean efficiency of 22%.

Technical Efficiency Indices of the Farmers: The technical efficiency indices were derived from the MLE results of the stochastic production function. The result of technical

efficiency indices was as indicated in Table 3. The highest efficiency class index was between 0.91 and 1.00 of 55.6% while the minimum index was between 0.21 and 3.00 (2.2%). Only 11% operated between 0.01 and 0.50 while 89% of the farmers operated between 0.51 and 1.00 with particular reference to class index of 0.91 and 1.00 of 55.6%. According to Yusuf and Malomo (2007), this high degree of technical efficiency suggests that very little marketable output was sacrificed to resource waste (i.e. only a small fraction of the output was attributed to resource wastage)**.** This implied that the farmers utilized their resources proficiently. The overall mean efficiency class index of 0.823 (82%) indicated that on the average, the farmers were 82% efficient in the use of combination of their inputs. This implied that an average poultry egg farmer observed output was 0.18 less than the maximum output which can be achieved from the existing level of inputs. Hence, in the short run, there is an opportunity for improvement of the present level of efficiency of the poultry egg farmers by about 18% if they adopt the technology and techniques used by the best-practiced poultry egg farms.

Furthermore, an average poultry egg farmer would enjoy input savings of 17.7% if he attains the technical efficiency level of the most efficient farmer in the area. And in addition, the most inefficient farmer would have an efficient gain of 30.6% for the farmer to attain the efficiency level of the most efficient farmer.

Table 3: Technical efficiency indices of the farmers

Eff. Class index	**Frequency**	**Percentage**
0.11 – 0.20	0	0.0
0.21 – 0.30	2	2.2
0.31 – 0.40	3	3.3
0.41 – 0.50	5	5.6
0.51 – 0.60	6	6.7
0.61 – 0.70	7	7.8
0.71 – 0.80	8	8.9
0.81 – 0.90	9	10.0
0.91 – 1.00	50	55.6
Total	90	100.0
Mean	0.823	
Maximum	0.986	
Minimum	0.684	

Source: Computed from MLE Result

CONCLUSION AND RECOMMENDATIONS

The research was carried out on the analysis of production efficiency of poultry egg production in agricultural zone "C" of Kogi State, Nigeria. The technical efficiency analysis showed that stock size, drugs and medication and utility (electricity & water) were main determinants of technical efficiency of poultry production in the area. The finding of the inefficiency factors showed that, high household size ($P < 0.05$) reduced the technical inefficiency of the farmers while

membership of cooperative society (P < 0.01) showed that farmers' level of technical efficiency decreased with increase in cooperative membership. The value of the sigma squared (δ^2) was 0.208 while gamma (γ) was 0.557 and were statistically significant at 1% level, respectively. The mean efficiency score of 0.823 showed that the farmers were not operating at the optimum level (they were not technically efficient) as none of the farmers operated at the efficiency score of Based on the findings of this research, the following recommendations are proffered:

i. Poultry egg producers should encourage more of their colleagues to join cooperatives for strong capital base and easy access to credit facilities.
ii. Solar power as an alternative power source should be introduced and installed for farmers at affordable rate by State government to reduce the operating cost of the farm
iii. State and local government should provide farmers with modern technology at subsidized rate to boost their technical efficiency.

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NUTRITIONAL QUALITY OF SHEA BUTTER SEED (*VITELLARIA PARADOXA*) MEAL COOKED AT DIFFERENT DURATIONS

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ABSTRACT
A test-tube experiment was carried out to investigate the effect of cooking duration on nutrients and anti-nutrient composition of shea butter seed meal (SBSM). Five grams of unprocessed SBSM sample labeled T1 (UP) was milled to a size of 0.5 mm. Another portion of about 500g of the wet unprocessed SBM was cooked at boiling point and samples were taken at 30, 60, 90 and 120 minutes and labeled T2, T3, T4 and T5, respectively. At the end of the processing, each treatment was replicated twice and samples were taken for analysis. There was no significant variation (P>0.05) in the proximate composition as well as the metabolizable energy value. However, cooking of SBSM for 60 minutes gave better crude protein value of 15.48% while 30 minutes cooking produced the lowest (2530.00 kcal/kg) metabolizable energy. There was significant variation (P<0.05) on the magnesium composition of shea butter cooked at varying times. Anti-nutritional factors namely tannin (0.00%), saponin (0.13 – 0.18%), phytate (0.01%), oxalate (0.01%), flavonoids (0.01%) and trypsin inhibitor activity (3.98 – 5.50 mg/g), of SBSM showed that there was no significant variation (P>0.05) due to the treatment. The fat and water soluble vitamins and amino acid composition were also not affected (P<0.05) by the treatment. Monogastric animal farmers can therefore, cook shear butter seed meal for at least 60 minutes and conveniently feed their animals as a replacement for conventional energy source without affecting the well-being of the animals.

KEYWORDS: Shea butter seed meal, proximate compositions

INTRODUCTION
Vitellaria paradoxa (formerly Butyrospermum parkii), commonly known as shea tree, is a tree of the Sapotaceae family. It is the only species in genus Vitellaria, and is indigenous to Africa. The shea fruit consists of a thin, tart, nutritious pulp that surrounds a relatively large, oil-rich seed from which shea butter is extracted (Byakagaba et al., 2011).

The shea tree is a traditional African food plant. It has been claimed to have potential to improve nutrition, boost food supply in the "annual hungry season" (Masters *et al.,* 2010), foster rural development, and support sustainable land care (NRC, 2006). Shea butter is composed of five principal fatty acids: palmitic, stearic, oleic, linoleic, and arachidic. About 85 to 90% of the fatty acid composition is stearic and oleic acids. The relative proportion of these two fatty acids affects shea butter consistency. The stearic acid gives it a solid consistency, while the oleic acid influences how soft or hard the shea butter is, depending on ambient temperature (Maranz et al., 2004). The proportions of stearic and oleic acids in the shea kernels and butter differ across the distribution range of the species. Ugandan shea butter has consistently high oleic acid content, and is liquid at warm ambient temperatures. It fractionizes into liquid and solid phases, and is the source of liquid shea oil. The fatty acid proportion of West African shea butter is much more variable than Ugandan shea butter, with an oleic content of 37 to 55%. Variability can be high even locally, and a tree that produces hard butter can grow with one that produces soft butter. Nuts are gathered from a wide area for local production, so shea butter consistency is determined by the average fatty acid profile of the population. Within West Africa, shea butter from the Mossi Plateau region of Burkina Faso has higher average stearic acid content, and so is usually harder than shea butter from other West African regions (Maranz et al., 2004).

The shea tree grows naturally in the wild from Senegal in the west to Sudan in the east, and onto the foothills of the Ethiopian highlands. It occurs in 19 countries across the African continent, namely Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Ethiopia, Ghana, Guinea Bissau, Ivory Coast, Mali, Niger, Nigeria, Senegal, Sierra Leone, South Sudan, Sudan, Togo, Uganda, Democratic Republic of the Congo, and Guinea. A testa found at the site of the medieval village of Saouga is evidence of shea butter production by the 14th century (Masters et al., 2010). The tree was formerly classified in the genus Butyrospermum, meaning "butter seed". The species name parkii honors Scottish explorer Mungo Park, who

learned of the tree while exploring Senegal.

According to Matthew and Alu (2016), shea butter cake is a non-conventional feed resource and it is not consumed by man and presently regarded as waste. It is unlike other conventional energy sources, which have high human food preference; hence might be a very good substitute; but has some anti-nutritional factors like tannins and saponins that could limit its usage in poultry nutrition. Most of the conventional feedstuffs for poultry are very expensive and in high demand by human beings and industrial users for consumption and usage respectively. Shea butter cake unlike other conventional energy sources has low human food preference; hence might be a very good substitute; but it has some anti-nutritional factors that could limit its usage in poultry.

The use of non- conventional feed ingredient and the search for other feed resources that are not expensive is therefore necessary (Farinu *et al*., 2006). Non-conventional feedstuff offers the best alternative in our environment for reduction in feed cost (Dafwang *et al.*, 2001*).* In terms of total cost, energy is the main factor influencing diet cost (Afolayan *et al.*, 2009). However, according to Vantsawa (2001), high cost of maize had led to high cost of poultry feeds. Surprisingly, energy sources (grains) had turned out to be more expensive, thereby increasing the cost of production (Abeke *et al*., 2003; Bawa, 2003). The aim of this study is therefore; to evaluate the effect of cooking duration on nutrient and anti-nutrient composition of shea butter seed meal with the view to feeding monogastric animals.

MATERIALS AND METHODS

Study Area: The experiment was carried out in the Biochemistry Laboratory of the Department of Animal Science, Faculty of Agriculture, Nasarawa State University, Keffi, Shabu-Lafia Campus.

Source of SBSM: The SBSM was obtained from villages around Shabu in Lafia of Nasarawa State.

Method of processing: Five grams of unprocessed SBSM sample labeled T1 (UP) was milled to a size of 0.5 mm. Another portion of the wet unprocessed SBSM was cooked at boiling point and samples were taken at 30, 60, 90 and 120 minutes and labeled T2, T3, T4 and T5, respectively. At the end of the processing, each treatment was replicated twice and samples were taken for analysis. ***Proximate analysis*** Proximate analyses of the samples of milled SBSM were carried out at the IAR&T, Moor Plantation, Ibadan, Nigeria, using the procedure outlined

by AOAC (1990). Dry matter (% DM) was calculated as the difference between 100 and the percent moisture content while the nitrogen free extract (%NFE) was calculated by difference; using the formula: 100 – (%CP +% CF + %EE +Ash + % Moisture).

Vitamins and mineral analyses: For the determination of vitamins and mineral profile, 0.5g of each wet digested samples of SBSM was analyzed by the method described by AOAC (1990).

Amino acids concentration: The Technicon Sequential Multi-sample Amino acid analyzer (TSM) – Model DNA 0209 was used to determine the profile of the amino acids according to the methods outlined by Speckman *et al.* (1958).

Anti-nutritional factors: Phytic acid determination was done according to the modified method described by Wheeler and Ferrel (1971) and Steward (1974) while trypsin inhibitor activity was determined according to the methods described by Gupta and Deodhar (1975) and Hammerstrand *et al.* (1981). The methods share the same principles of determining trypsin inhibitors in soybeans products based on the tryptic hydrolysis of synthetic substrate, Benzoyl-DL-Arginine-Nitroanilide (BAPA). The Spectrophotometric method of Brunner (1984) was used for saponin analysis; tannin and oxalate were determined using the methods outlined by Swain (1979). Flavonoid contents and their presence were determined by the method of Harborne (1998), using quercetin as a standard. The extracts were analyzed by means of Thin Layer Chromatography.

Statistical analysis and model: All the data collected were statistically analyzed using the general linear model of Statistical Analysis System (SAS, 2008). The following statistical model was used:

$Yij = U+T1+€ij$,

Where Yij= Individual observation,

U = Population Mean,

T1 = Treatment Error

€ij = Random error.

RESULTS AND DISCUSSION

Effect of cooking durations on proximate and energy composition of SBSM: The result of the effect of cooking duration on proximate and energy composition of SBSM is presented in Table 1. There was no significant variation ($P>0.05$) in the crude protein, crude fat, crude fibre, ash, dry matter and nitrogen-free extract as well as the metabolizable energy value. However, cooking of SBSM for 60 minutes gave higher numerical crude protein value of 15.48% while 30 minutes cooking produced the lowest (2530.00 kcal/kg) metabolizable energy. These observations are in agreement with

those reported by Barampama and Simard (1995) for cooked common beans (*Phaseolus vulgaris*). Also, Khatoon and Prakash (2004) reported that microwave-cooking and pressure-cooking do not affect the nutrient composition of eight legumes. Similarly, the results of the findings also agree with the previous assertion of Alu (2016) who noted non-significance in the values of all fibre fractions, ether extract (3.23 – 4.53%) and ash (3.73 – 4.50%) content of cooked flamboyant seed. The high value of dry matter (88.65 – 90.38%) shows that the test ingredient has low moisture content which indicates that it would store well and nutrients would be preserved. It has been reported that higher moisture content leads to food spoilage through microbial actions (Onyeike *et al.*, 1995). Reduced moisture content ensures the inhibition of microbial growth, hence is an important factor in food preservation (Chew *et al.*, 2011).

Table 1. Proximate and energy composition of SBSM cooked at different durations

Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**SEM**	**LOS**
Crude protein (%)	15.19	10.93	15.48	14.99	15.07	0.89	NS
Crude fat (%)	4.53	3.23	4.37	4.35	4.40	0.24	NS
Crude fibre (%)	6.38	10.41	6.27	6.24	6.21	0.82	NS
Ash (%)	4.50	3.73	4.42	4.34	4.17	0.14	NS
Dry matter (%)	90.35	88.65	90.43	90.38	90.39	0.39	NS
*ME(kcal/kg)	4140.00	3030.00	3130.00	3140.00	3140.00	25.00	NS
Nitrogen-free extract (%)	59.72	60.04	59.92	60.34	60.61	0.14	NS

LOS= Level of significance, NS= Not significant at 5% (P>0.05), SEM=Standard error of means, *Calculated from Pauzenga (1985) ME (kcal/kg) = 37x %CP + 81.1 x% EE+ 35.5 x % NFE, ME=Metabolizable energy.

Effect of cooking durations on mineral composition of SBSM: Table 2 summarizes the effect of cooking duration on mineral composition of SBSM. There was significant variation (P<0.05) in the magnesium composition of SBSM cooked at varying times. The values obtained in cooked treatments were lower than that of the raw (0.27%) whereas those of sodium, potassium, calcium and phosphorus were not affected by the treatment. Alu (2016) earlier reported similar results where calcium (0.15 – 0.18%), phosphorus (0.28 – 0.36%) and potassium (0.27 – 0.36%) content of flamboyant seeds were not affected by cooking durations. However, the significant variations in magnesium were same in

the two experiments. The results recorded in the present study did not agree with the earlier findings of Haytowitz and Matthews (1983) who reported that cooking in boiling water causes great losses of K, Cu and Fe. According to Amarowicz *et al.* (2009), minerals are not destroyed by exposure to heat however; the reduction recorded in the present study for magnesium may be as a result of leaching of minerals into the boiling water. It is an activator of many enzyme systems and maintains the electrical potential in nerves (Shills and Young, 1992). Phosphorus is always found with calcium in the body, both contributing to the blood formation and supportive structure of the body (Ogunlade *et al.*, 2005).

Table 2. Mineral composition of SBSM cooked at different durations

Parameters (%)	**T1**	**T2**	**T3**	**T4**	**T5**	**SEM**	**LOS**
Sodium	0.09	0.08	0.08	0.08	0.09	0.00	NS
Potassium	0.36	0.27	0.36	0.36	0.36	0.02	NS
Calcium	0.18	0.15	0.18	0.17	0.18	0.00	NS
Phosphorus	0.35	0.28	0.35	0.35	0.36	0.02	NS
Magnesium	0.27^{a}	0.22^{b}	0.22^{b}	0.23^{b}	0.22^{b}	0.01	*

LOS= Level of significance, a,b= means on the same row bearing different superscripts differ significantly, *=Significant at 5% (P<0.05), NS= Not significant at 5% (P>0.05), SEM=Standard error of means

Effect of cooking durations on anti-nutritional factors of SBSM: The result of the effect of cooking duration on anti-nutritional factors namely tannin (0.00%), saponin (0.13 – 0.18%), phytate (0.01%), oxalate (0.01%), flavonoids (0.01%) and trypsin inhibitor activity (3.98 – 5.50 mg/g), of SBSM (Table 3) shows that there was no significant variation (P>0.05) due to the treatment. Trypsin is an enzyme inhibitor (Protease inhibitor) that causes pancreatic enlargement and growth depression (Aletor and Fetuga, 1987); they depress animal growth by interfering with the digestion and absorption of nutrients in the gastrointestinal tract. Phytate binds minerals like calcium, iron, magnesium and zinc and make them unavailable thus interfering with animal metabolism. The non-variance of anti-nutritional factors in the present study agrees with the earlier report of Alu (2016) who noted non-variation in the values of phytate and oxalate. However, the results disagree with that of Hefnawy (2011) who reported a significant decrease of anti-nutritional factors in lentils (*Lens culinaris*). It has been reported that

some anti-nutrients are heat labile and therefore will be reduced to a great extent by the application of heat to the food (Apata and Ologhobo, 1994).

Table 3. Phytochemical screening of SBSM cooked at different durations

Parameters	T1	T2	T3	T4	T5	SEM	LOS
Tannin (%)	0.00	0.00	0.00	0.00	0.00	0.00	NS
Saponin (%)	0.14	0.18	0.14	0.14	0.13	0.01	NS
Phytate (%)	0.01	0.01	0.01	0.01	0.01	0.00	NS
Oxalate (%)	0.01	0.01	0.01	0.01	0.01	0.00	NS
Flavonoids (%)	0.01	0.01	0.00	0.01	0.01	0.00	NS
Trypsin inhibitor (mg/g)	5.43	4.05	3.98	5.64	5.50	0.42	NS

LOS= Level of significance, NS= Not significant at 5% (P>0.05), SEM=Standard error of means

Effect of cooking durations on vitamins composition of SBSM: Table 4 summarizes the effect of cooking duration on the vitamin composition of SBSM. The fat and water soluble vitamins were not affected (P<0.05) by the treatment. The observations in the present studies tally with the previous report of Alu (2016) and the values are comparable to those earlier reported by Matthew and Alu (2016). In general, cooking as a method of processing reduces the chemical contents of organic matter as indicated in the present study.

Table 4. Effect of cooking duration on vitamins composition of SBSM

Parameters (%)	T1	T2	T3	T4	T5	SEM	LOS
Vitamin A	93.07	67.41	93.18	93.08	92.20	5.11	NS
Vitamin B	3.39	2.23	3.35	3.30	3.23	0.22	NS
Vitamin E	24.44	12.92	24.32	24.27	23.98	2.27	NS

LOS= Level of significance, NS= Not significant at 5% (P>0.05)

Effect of cooking durations on amino acid composition of SBSM: There was no variation (P>0.05) on the amino acid composition of SBSM (Table 5) as affected by cooking duration. The mean lysine, methionine and tryptophan values ranged between 1.14 – 1.87, 0.41 – 0.67 and 0.35 – 0.61%, respectively. However, transamination and deamination reactions might be responsible for the slight changes in the amino acid profiles. This finding supports the earlier report of Aremu *et al.* (2009)

who studied the nutritional value of raw and processed red kidney bean seed flours.

Table 5. Amino acid profile of SBSM cooked at different durations

Parameters (%)	T1	T2	T3	T4	T5	SEM	LOS
Lysine	1.87	1.14	1.76	1.80	1.77	0.14	NS
Methionine	0.67	0.41	0.59	0.62	0.62	0.05	NS
Tryptophan	0.61	0.35	0.55	0.56	0.56	0.05	NS

LOS= Level of significance, NS= Not significant at 5% (P>0.05)

CONCLUSION AND RECOMMENDATION

Monogastric animal farmers can cook shea butter seed meal for at least 60 minutes and use it to feed their animals as a replacement for conventional energy sources like maize, sorghum etc. without affecting the performance of the animals. Feeding trial using this recommended cooking time is however suggested to confirm the suitability of this ingredient.

Since treatment or processing of ingredients generally reduces some nutrients by leaching or bleaching, it is also recommended that comparative studies of feeding raw and any other type of processed shea butter seed meal be carried out to ascertain their acceptability and utilization by the animals.

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INCOME DIVERSIFICATION AND POVERTY STATUS AMONG ARABLE CROP FARMERS IN SHIRORO LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

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ABSTRACT
This study examined income diversification and poverty status among arable crop farmers in Shiroro Local Government area, Niger state, Nigeria. Sample size of 117 households was obtained through a multi-stage sampling technique. Tobit regression model was used to find the determinants of the degree of diversification measured by Simpson's Index of Diversity (SID). The results showed that the level of diversification was low with SID of 0.307. The result revealed that the share of household income from farm sources accounted for 58.11% while non-farm income accounted for 41.89% of the total household income. Sex, age, years of schooling, household size, number of extension visits and household income were found to be statistically significant in determining income diversification of farmers in the study area. The result of the Foster-Greer-Thorbeck (FGT) model revealed that 50.43% of the respondents were poor, while 49.57% were non-poor, the depth of poverty was 0.67 and severity of poverty was 0.47. The study suggests the need for arable crop farmers to get involved in non-agricultural activities in order to earn more income and diversify income sources. Government and private sector need to support farming households to increase the gains made in participating in various diversification strategies through policy, provision of public goods, skill acquisition and training on modern farming to raise standard of living.

KEYWORDS: Income diversification, Poverty status and Arable Crop Farmers

INTRODUCTION
Arable crop farming is predominantly practiced on the agricultural landscape in Nigeria. Inadequate finance and limited access to farm credit amenities constitute the major challenge faced by these farmers. Therefore, they find alternative means in non-farm enterprise in order to generate sustainable income for their farming venture (Ogbanje, *et al.*, 2014). Off-farm work refers to activities from which farmers earn income apart from their own farm. According to (Ibekwe

et al., 2010; Ogbanje, *et al.,* 2014), off-farm work is grouped generally into agricultural, non agricultural wage employment, and self-employment.

Income diversification is the process of switching from low-income crop production to higher value crops, livestock and non-farm activities. Income diversification is a potential source of income expansion and means of poverty reduction. It is the process of switching from crop production generating low return or income to higher value crops, livestock and non-farm activities crops that yield high economic return per unit of labour of land such as cassava, Cocoa etc. (Escobal, 2001).

Poverty is said to be the lack of empowerment essential for an individual to control the challenges of the environment while poverty alleviation is seen as ways that are being adopted in the society to reduce poverty. The increase in poverty levels has led the arable crop farmers to develop several strategies to mitigate its harmful effects. Poverty among the rural households is as a result of lack of assets, limited economic opportunities and poor education and capabilities, as well as the negative effects resulting from social and political inequalities.

In Nigeria, the poverty situation is quite alarming. The situation contradicts the vast human, mineral and physical resources the country is blessed with. Despite successive government intervention whereby huge resources have been committed to reduce the incidence of poverty, it is quite unfortunate that the actual depth and severity of poverty is still at its worst in the country.

There are significant differences in relation to the reasons or motives for diversification among rural households as well as the existing opportunities across settings and income groups (Joshi *et al.*, *2005*). This creates a distinction between diversification undertaken to manage risk, cope with shock or escape from agricultural seasonality. Ellis (2000) argued that, the seasonal pattern of farm operations which result to labour inefficiency during off-farm seasons prompted families to engage in activities which are mostly of non-agricultural origin in order to utilize their human capital. This study, therefore, explicitly seeks to: describe the socio-economic characteristics of the sampled farmers, identify their various income sources, estimate the share of farm and non-farm income in the Total Household Income (THI), estimate the degree of income diversification, examine the determinants of income diversification, and determine the poverty status of the respondents in the area.

METHODOLOGY

Study Area: This research was carried out in Shiroro Local Government Area of Niger State. The state capital is Minna and other major cities that constitute the state are Suleja, Bida and Kontagora. The state got its name from the predominant river Niger and the principal hydro-power plants in Nigeria are located in the state which include the Shiroro and Kainji dams. The land mass is about 77, 000 sq/km, 85% of which is arable land. The tribes that are predominant are the Gbagyis and the Nupes. Shiroro LGA has its Headquarters located at Kuta. It has an area land mass of 5,015 Km^2 and a population of about 236, 000 as at 2006 population census count. The 2016 population figure for the LGA was estimated to be 317164 persons at an annual growth rate of 3%. The seasons that characterize the state are dry and wet seasons. The rainfall ranges from 1,600mm and 1200mm in the southern and Northern parts respectively with a temperature of 32^0F towards the half of the year. There are three major soil types which are hydromorphic, ferosols and ferruginous soils and the major ecological problem in the state is flooding, particularly when the Niger River overflows its banks.

Sampling procedure and data collection: Primary data were used for this study. The data were collected using questionnaire**.** A multi- stage sampling technique was used for this study. The first stage was the purposive selection of Shiroro LGA from the state based on the apriori knowledge that the rural household engage in arable farming. Secondly, three communities were randomly selected from Shiroro LGA. Third stage involves the proportionate selection of 15% of the registered arable crop farmers from each of the three communities. This gave a total of 117 farmers as the sample size.

Method of Data Analysis: Data on socio-economic characteristics of the farmers, the various income sources were analyzed using descriptive statistics such as mean, frequency table and percentage.

The Mean of Income Shares approach: This was used to estimate the income shares obtained by the farm households. This approach estimates the shares of incomes at the individual household level (Davis *et al*., 2007) by finding the share of each income source in THI for each household. The mean share for each income source for all households is then found. The general Mean of Income Shares formula is given in equation 1:

Table 1: Sample frame and sample size of the respondents

Local Government Areas	Selected Communities	Sample Frame	Sample Size
Shiroro	She	329	49
	Muntun Daya	140	21
	Bangajiya	312	47
TOTAL		**781**	**117**

Source: Niger State Agricultural and Mechanization Development Agency (NAMDA) (2016)

$$M\,S_i = \frac{\sum_{h=o}^{n} {}^{y_{ih}}/_{Y_h}}{n} \quad (1)$$

Where;
i = the income source,
Y=Total Income,
y = income from particular activity,
h =the household,
n = the number of households.
The sum of Total Household Income (THI) is given equation 2:

$$T\,H\,I = \sum_{j=1}^{9} Y_j \quad (2)$$

Where: THI=Total Household Income, thus income coming from all sources *j*
j =1, 2, 3, 4….9, farm and Non-farm income.
The mean Share of Farm Income (SFI) is given in equation 3:

$$SFI = \sum \left(\frac{\sum {}^{fi}/_{thi}}{n} + \frac{\sum {}^{ami}/_{thi}}{n} + \frac{\sum {}^{nri}/_{thi}}{n} + \frac{\sum {}^{livsti}/_{thi}}{n} + \frac{\sum {}^{fwi}/_{thi}}{n} \right) \quad (3)$$

The mean Share of Non-farm Income (SNFI) is given in equation 4:

$$SNFI = \sum \left(\frac{\sum {}^{tradi}/_{thi}}{n} + \frac{\sum {}^{csi}/_{thi}}{n} + \frac{\sum {}^{carpi}/_{thi}}{n} + \frac{\sum {}^{othersi}/_{thi}}{n} \right) \quad (4)$$

Where;

SFI = Share of Farm Income;

SNFI = Share of Non-Farm Income; thi = total household income; fci = fish keeping income; cci = arable crop income; ami = agricultural marketing income; livsti = livestock income; fwi = farm wage income; carpi = carpentry income; csi = civil service income; tradi = trading income; others = other sources income and n = number of households.

Estimating the degree of income diversification: The Simpsons Index of Diversity (SID) was used in this study to estimate the degree of income diversification among farm households. The SID takes into consideration both the number of income sources as well how evenly the distributions of the income between the different sources are (Minot *et al.*, 2006). The SID ranges between Zero (0) and One (1). Thus, 0 denotes specialization and 1 the extremity of diversification. The more the SID value is closer to one, the more diversified the household is.

The SID general formula is given in equation 5:

$$SID = 1 - \sum_{i=1}^{n} P^2{}_i \qquad (5)$$

$$SID = 1 - \sum_{i=1}^{9} \left(\left(\frac{fci}{thi}\right)^2 + \left(\frac{cci}{thi}\right)^2 + \left(\frac{nri}{thi}\right)^2 + \left(\frac{livsti}{thi}\right)^2 + \left(\frac{fwi}{thi}\right)^2 + \left(\frac{nfwi}{thi}\right)^2 + \left(\frac{sei}{thi}\right)^2 + \left(\frac{rei}{thi}\right)^2 + \left(\frac{othersi}{thi}\right)^2 \right) \qquad (6)$$

SID=Simpsons Index of Diversity, *n*=number of income sources, *Pi*=Proportion of income coming from the source *i*, the value of SID ranges from Zero (0) to One (1), however, if there is only one Source of Income, P*i*=1, then SID=0.

Determining income diversification: The Tobit regression model was used to estimate the determinants of income of income diversification in the study area. The implicit form is expressed below;

$Y = f\ (X_1, X_2, X_3, X_4, X_5, X_6 \ldots\ldots X_n)$ The explicit form is expressed as:

$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \ldots.. + \beta_{11}X_{11}$

Where;

Y = Individual Diversity index

X_1 = Gender; Male = 1; otherwise = 0

X_2 = Age (years)

X_3 = Educational level (years)

X_4 = Marital status (Married = 1, Others = 0)

X_5 = Household size (Number)

X_6 =Occupation (farming = 1, Others = 0)

X_7 = Access to credit (Yes =1, No = 0)

X_8 = Number of extension visit
X_9 = Access to electricity (Yes = 1, No = 0)
X_{10}= Distance from market (Kilometer)
X_{11} = Household income **(₦)**
β_0 = Constant
$\beta_1 - \beta_{11}$ = regression coefficients

Foster –Greer-Thobecke (FGT) Poverty Measures: The Foster – Greer-Thorbecke (1984) was used to determine the poverty status of the respondents in the study area.

PCHMI = $\left(\frac{THMI}{HHS}\right)$

PCHAI = $\frac{THAI}{HHS}$

MPCHMI = $\frac{TPCHMI}{TNR}$

Where;
PCHMI = Per capital household monthly income
PCHAI = Per capital household annual income
THMI = Total household monthly income
THAI = Total household annual income
HHS = Household size
MPCHMI = Mean per capital household monthly income
TPCHMI = Total per capital household monthly income
TNR = Total number of respondents

$$Pa = \frac{1}{N}\sum_{i=1}^{Hi}\left(\frac{Z - yi}{Z}\right)^{a} \quad (8)$$

Where N = total number of respondents;
Yi = Annual income;
Z = Poverty line using $\frac{2}{3}$ of mean income of respondents in the study areas
q = number of households with income less than Z
α = Poverty Aversion Parameter index which takes on the values of 0,1, and 2 representing incidence of poverty, poverty gap and severity of poverty respectively (Foster *et al*.,1984).
The measure relates to different dimensions of the incidence of poverty.
The poverty line was placed at two-third mean income of respondents. Based on this, respondents will be classified into three groups.

- Non-poor: those with income above two-third mean income of respondents, i.e , NP > $\frac{2}{3}$ (mean income)
- Poor: those with income between one-third and two-third income of respondents, i.e. between $\frac{1}{2}$ and $\frac{2}{3}$ (mean income)
- Very poor: those with income below one-third mean income of respondents ,i.e. VP < $\frac{1}{3}$ (mean income)

$$P_0 = \frac{Ho}{N} \quad (9)$$

This is proportion of the population that falls below the poverty line which is called the head count of incidence of poverty.

If $\propto = 1, FGT becomes:$

$$P_1 = \frac{1}{N}\sum_{i=1}^{Hi}\left(\frac{z-yi}{z}\right)\alpha \quad (10)$$

The depth of poverty which is the percentage of income required to bring each individual below the poverty line up to the poverty line was estimated with the equation (10).

If $\propto$=2, FGT becomes:

$$= \frac{1}{N}\sum_{i=2}^{H2}\left(\frac{z-y2}{z}\right)\alpha$$

(11)

This is the severity of poverty. It is indicated by giving larger weight to the extremely (core) poor. It is achieved by squaring the gap between their income and the poverty line to increase its weight in the overall poverty measure.

RESULTS AND DISCUSSION

Income sources of the farming households: Table 2 comprises the various income sources of the respondents; arable crop farming has the highest percentage of (87.18%) as a source of income because all the respondents engage it but not all recover income from it being just for their own family consumption only. Livestock with (29.91%), others (bricklayer, blacksmith, carpentry, mechanic, tailoring, gold mining) with (29.91%), carpentry, civil service, trading, handicraft, agric marketing, hired labour and fish keeping with varying percentages respectively.

Table 2: Distribution of the respondents according to the various sources of income

Source of income	Frequency*	Percentage
Arable crop	102	87.18
Livestock	35	29.91
Carpentry	4	3.42
Civil service	38	32.48
Trading	11	9.40
Handcraft	4	3.42
Agric marketing	5	4.27
Hired labour	10	8.55
Fish keeping	5	4.27
Others	35	29.91
Total	***249**	

Source: Field Survey, 2016.

Mean Share of Farm and Non-farm Income in Total Household Income: Table 2 reveals the share of farm and non farm income in the total household income of the farming family. In the farm income category, arable crops income source recorded the highest income share of 43.44%. Livestock income share had (8.37%) of the total household income. The low share of fish keeping, agricultural marketing, and farm wage income with (1.24%), (1.74%), (3.33%) respectively is as result of the fact that, most of the respondents are purely arable crop farmers and these other activities are just to sustain their family during the off seasons. Thus, in total the farm income share represents 58.11% of Total Household Income. This result indicates the importance of farming and its related activities to the Study area. This provides a justification for these villages in Shiroro local government as one of the agrarian community.

Furthermore, in the non-farm income, Civil service income share (29.13%) represents the largest share in the Non-farm income share category. Others income share follows with (8.08%), trading, carpentry and handcraft income share recorded 3.24%, 1.08%, 0.35% respectively. In total, the Share of Non-farm income in Total household income was found to be 41.89%, lower than the share of income generated from the farm sector by farm households. This finding on the shares of income coming from farm and Non-farm source is in line with the findings of Schwarze *et al*.,(2005) who found larger shares of farm income of 68% and 32% coming from the Non-farm sector of farm households in Indonesia. The results reveal that the farm sector continues to be vital to farm households in the study area, since a major portion of their income is derived from activities in this sector and buttresses the argument for supporting farm households in the study area.

Degree of Income Diversification of Farm Households: Result presented in Table 4 reveals a mean degree of diversification of 0.3072 (30.72%), which implies that the level of diversification is low. Given that the closer the SID is to zero, the more the specialization and the further it is from zero the more the diversification. Arable crop farmers from She, Bangajiya, Mutundaya villages recorded 0.2894, 0.3586, and 0.2324 mean SID respectively. The mean degree of diversification of 0.3072 can be compared to that observed by Bernard *et al*. (2014) of 0.338. The result of the SID shows what farm households in the study area are more specialized in. Therefore, farm households concentrated on farm related activities since it is their main income source.

Table 3: The share of farm and non-farm income in the total household income of the farming families

Income sources	Mean income (₦)	Mean income share (%)
Arable crop	278324.79	43.44
Livestock	53598.29	8.37
Agricultural marketing	11145.30	1.74
Farm wage from hired labour	21307.21	3.33
Fish keeping	7914.53	1.24
Total farm income	**372290.11**	**58.11**
Carpentry	6923.08	1.08
Civil Service	186630.74	29.13
Trading	20752.14	3.24
Handicraft	2264.96	0.35
Others	51777.78	8.08
Total non-farm income	**268348.68**	**41.89**
Total income per year	**640638.79**	**100.00**

Source: Field Survey, 2016.

Table 4: Distribution of respondents according to degree of income diversification

Village	Proportion of diversification (Pi)	Simpson's Index of Diversity (SID)
She	0.7106	0.2894
Bangajiya	0.6414	0.3586
Mutun Daya	0.7676	0.2324
Pooled	**0.6928**	**0.3072**

Source: Field Survey, 2016.

Determinants of Income Diversification: Table 5 shows the effect of sex, age of household heads, years of schooling, household size, number of extension visits and household income on income

diversification. Age coefficient of the respondent has a negative significant relationship at $p<0.05$ probability level which implies that as respondent increase in age; they tend to reduce their level of diversification as most of them don't have much inner strength to engage in other activities that will increase their income sources and they even has less burden on them as most of their wards have matured and have taken up the responsibilities of their parents. This also agrees with the findings of Fikru (2008) who affirmed that as the household head gets older, he/she is expected to be less active and hence would rely more on farm than non-farm income.

The sex of the respondents has a negative significant relationship with diversification, which implies that male farmers tend to diversify more than the female counterpart in the study area. The years of schooling of the respondents in the study area had a positive relationship with diversification at $p<0.01$ level of probability since it increases the opportunities of the respondents to diversify income sources, in which those with fewer years in school might find this difficult or impossible. So the more the education of the respondents, the more they diversify into other income activities as education tends to open more employment opportunities for income generation, making people to be aware of more opportunities as a result of the level of exposure and experience they have. This is also consistent with the findings of Minot *et al*. (2006) who found out that education facilitates access to a number of different economic activities, either as a formal requirement for wage earning jobs or because it helps setting up and managing own small businesses.

Household size was found to be positively significant at $p<0.05$ level of probability which has an adverse effect on the level of diversity, as respondents with larger family size tend to have more mouths to feed, so they are forced to venture into more off farm activities in order to acquire more income. This is in line with the findings by Ibrahim and Onuk (2009) who found out that household with a very high ratio of dependants had a higher tendency to diversify into non-agricultural activities in order to feed more persons and cope with the needs of the household.

The coefficient of number of extension visit was found to be positively significant at $p<0.05$ probability level. This shows that, number of extension visits increases the level of diversification among the households and this could as a result of extension agents been present to offer support to farm households such as provision of credit and other agricultural services which could help

them engage in other income generating activities. Table 4 further reveals household income to be negative and statistically significant at $p<0.01$ probability level. Thus, households with larger income will diversify less than households with less income.

Poverty Profile of the farming households: The poverty head count or incidence (P_0), poverty gap or depth (P_1) and squared poverty gap or severity (P_2) were also calculated and the results are presented in Table 6. The mean income of all farm households was ₦640, 638 per annum. The poverty line is an income-based threshold line that divides the poor and the non-poor farm households in the study area. The value of the poverty line is ₦429, 227.99 per annum. The P_0 for the entire households was 0.5043. This means that 50.43% of the respondents were poor, while 49.57% were non poor. The poverty gap index (P_1) usually Teaching, Civil Service, Handcraft, Bricklayer Worker, Tailoring, Gold mining, and Traditional Medical Practitioner. 50.43% of the respondents were poor, while 49.57% were non-poor, the depth of poverty was 0.67 and severity of poverty was 0.47. The study recommends the need for arable crop farmers to get involved in agricultural and non-agricultural activities in order to earn more income and diversify income sources. referred to as the depth of an average poor person from the poverty line was 0.6678. This implies that 66.78% of the poverty line (₦429,227.99) that is ₦286,638.45 was required to bring an average poor person in the study area to the poverty line. The poverty index (P_2) which measures the distance of each poor person to one another was found to be 0.4675. This means that among the poor household heads, 46.75% were severely poor.

CONCLUSION

The study has shown that diversification into a number of income sources especially to non-farm work is very low among the arable crop farmers since the degree of income diversification of farm households was found to be generally low indicating that farm households generate their incomes from few livelihood activities. Non-farm activities identified in the study area were carpentry, Trading, Blacksmith, Tailoring, Palm wine tapping, Government and private sector need to support farming households to increase the gains made in participating in various diversification strategies through policy, provision of public goods, skill acquisition and training on modern farming to raise standard of living.

Table 5: Determinants of income diversification among respondents

Variables	Coefficient	t-value
Sex	- 0.1536566	-3.39***
Age	- 0.002183	-2.03**
Years of schooling	0.0143612	4.70***
Marital status	0.0377637	0.95
Household size	0.0181126	2.18**
Major occupation	0.0131343	0.51
Access to credit	- 0.0714652	-1.00
No of extension	0.0231647	2.05**
visit	0.0684662	1.39
Access to	- 0.0006197	-0.26
electricity	- 0.84e-07	-4.08***
Market distance	0.2973305	2.95*
Household income		
Constant		

F-value =19.77***; Pseudo R^2 = 2.7571

Note. *** = p<0.01, ** = p<0.05 and * = p<0.10 level of probability

Source: Field Survey, 2016.

Table 6: Distribution of respondents according to poverty profile

Poverty status	Frequency	Percentage	
Non-poor	58	49.57	
Poor	59	50.43	
Total	117	100.00	
FGT indices	Head count(P_0)	Poverty depth(P_1)	Poverty Severity(P_2)
Value	0.5043	0.6678	0.4675

Source: Field Survey, 2016.

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SPAWNING PERFORMANCE OF AFRICAN GIANT CATFISH (*HETEROBRANCHUS BIDORSALIS*, (GEOFFRROY SAINT-HILAIRE, 1809) INDUCED WITH OVATIDE AND OVARY-PRIM IN SEMI-ARID REGION (SOKOTO), NIGERIA

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ABSTRACT
The efficiency of two synthetic hormones analogue ovary-prim and ovatide on breeding performance of Heterobranchus bidorsalis in Sokoto, North-Western Nigeria were investigated. Three brood fish were injected intramuscularly with ovary-prim and ovatide at manufacturers recommended dose 0.5 mlkg-^{1} and 0.2mlkg-^{1} respectively. The males received half dose of the hormones according to treatment, with respect to their body weights, treatments were set up in a completely randomized design (CRD). The results showed that a latency period of 11 hours was recorded at temperature range of 28^{o}-30^{o}C. The egg output was estimated at about 109,000 with ovary-prim and 104,640 with ovatide as recorded during the breeding exercises. Fertilization rate was greater (78%) with ovary-prim as against 76% recorded for ovatide but were not significantly (P > 0.05) differed. The hatching success was however significantly (P < 0.05) greater (86%) with ovatide than 72% with ovary-prim. Percentage survival also followed the same trend. It was hence concluded that while both synthetic hormones are good for inducing ovulation, ovatide is a more effective synthetic hormone analogue for induced spawning and seed production of Heterobranchus bidorsalis in the prevailing climatic condition of semi-arid environment of Sokoto, North-Western Nigeria.

KEYWORDS: *Heterobranchus bidorsalis*, Spawning performance, ovary-prim, ovatide, hormones

INTRODUCTION

Reproduction in fish is controlled by several factors which include sex steroids in the regulation of reproductive processes (Kime, 1993). These reproductive processes are controlled through the brain-pituitary gonadal axis, the brain is stimulated by environmental cues like water rise, temperature, feeding, rainfall,

and photoperiod to release gonadotropin releasing hormones (Zohar *et al*., 2001). Hence ovulation and permeation are induced as a result of the sex steroids that have been produced. However, most fish species will not readily breed in captivity all year round, thus the need for artificial seed production using hormones.

The use of both synthetic and natural hormones brings about quick ovulation and higher percentage of hatched fish, although synthetic hormones have been found to give higher yield than the natural hormones (Krol *et al*., 2006). Administration of gonadotropin releasing hormone analogue, in artificial spawning of fish has been reported to increase levels of plasma sex steroids in female fish to induce ovulation (Zhuo *et al.*, 2011). The author, from his study also showed that Gonadotropin releasing hormone analogue multiple injections potentially accelerated testicular maturation of male yellow catfish. Ovary-prim and Ovatide are some among synthetic hormones imported and used for artificial spawning of fish in Nigeria. Both are synthetic hormone preparations containing salmon gonadotropin releasing hormone analogue and domperidone (SGnRHa + Domperidone) antagonists.

The Giant African Catfish *Heterobranchus bidorsalis* is a hardy specie for aquaculture, it is widely accepted in the tropics and commands good commercial value. However, there is generally dearth of knowledge on the reproductive biology of this species, except for few studies on its haematological and nutritional characteristics, salinity tolerance, digestive enzymes profile and parasite fauna (Fagbenro *et al*., 1991, 2013; Adebayo and Fagbenro 2004). This is probably due to the species' limited availability, breeding constraints of longer timed sexual maturity and short breeding period which is at the peak of rainy season. Though the species has not been listed as endangered, there is risk of extinction because of environmental problems that affect the breeding sites (Honji *et al.* 2009, 2012). Further threats are anthropogenic activities like the construction of dams, riparian habitat destruction, water pollution and fishing (Honji *et al*. 2009, 2012; Olaniyi 2014). Hence the need to conduct more studies on the reproductive behavior of this species in a bid to alleviate the threat of extinction, through artificial propagation should remain a research priority. More so not a lot of research has been done to test the effectiveness and potential of these two hormone on *H. bidorsalis* spawning in semi-arid region of Nigeria.

This research is therefore conducted to investigate the effect of ovary-prim and ovatide hormones on the reproductive index of giant African catfish *H. bidorsalis* in Sokoto, semi-arid region of Nigeria.

MATERIALS AND METHODS

Experimental Location: The experiment was conducted in August 2016 at the Fish Hatchery Unit, of the Department Fisheries and Aquaculture, Usmanu Danfodiyo University, Sokoto on latitude 13°07'7"N and longitude 05°12'25"E at 275m above sea level (Google Earth, 2011). The Ovary-prim hormone (containing Salmon Gonadotropin Releasing Hormone Analogues and Domperidone) by ZDHF PHARM, China, was used While the Ovatide (containing a synthetic peptide protein that is analogue to naturally occurring gonadotropin releasing hormone (GnRH), and dopamine antagonist) was supplied by Hemmo Pharma, Mumbai, India with the recommended dosage of 0.20ml/kg body weight of catfish.

Broodstock Preparation: Six broodstocks of *H. bidorsalis* (2 males and 4 females) were collected from the Unit's broodstock pond. Identification of sex was based on external morphological characteristics – the observation of protruded and reddish genital papilla in the males, while the females were gravid with a round, soft and bulging abdomen, with pinkish and protruding reddish genital openings – as described by Metwally and Fouad, (2008). The fish samples were each weighed, while the two males weighed as 1600g and 1900g, the females weighted between 3000g to 3600g (Table 1). The hormones were administered according to manufacturer's recommendation, which is 0.5ml per kg of female fish for Ovary-prim and 0.2ml per kg of the male fish for ovatide. The females were given full dosage of the hormone while the males received half the doses administered to the females (Viveen *et al.*, 1985).

Experimental Design: The experimental design consisted of two treatments, based on the different hormones tested (ovary-prim and ovatide), and these were replicated three times in a Completely Randomized Design (CRD). Six plastic bowls of 75litres were used as spawning troughs after they were washed and thoroughly dried. The bowls were filled to about 75% capacity and constantly aerated with aerator pump, while temperature ranged from 24 to 31^{o}C (Table 3). Nets (Spawning mats) were washed and placed inside each of the experimental units. The fish were injected intramuscularly above the lateral line towards the dorsal fin using a graduated hypodermic syringe

of 2ml (Haniffa and Sridhar, 2002), at an angle of approximately 30° in the direction of the head as described by (Viveen *et al*., 1985). The injected spawners were then kept separately in containers to avoid disturbances and self-injuries.

Collection of Milt: The male broodstocks after observing the latency period, were removed from the troughs. They were placed dorsally on a wet towel, and held firmly down to ensure careful removal of the testes using a sharp blade. The abdominal cavity of the fish was dissected and testes were carefully removed from the ventral wall of the abdominal cavity and mopped with clean tissue paper to remove stains of blood. The extracted testes were then incised and squeezed of the milt. The milt was diluted with physiological saline to prepare a sperm suspension, and was afterwards stored in refrigerator.

Stripping of Eggs and Fertilization: After observing the ovulation period (Table 3.1), the female broodfish were removed from the trough and weighed. Each fish was carefully held firmly with a wet towel at both ends by two operators, and the abdomen was then pressed carefully to release the eggs into a dry bowl. Each spent female was carefully weighed and returned into the trough. Content of the testes (milt) was spilled on the eggs for fertilization, the eggs were then poured inside the labeled spawning troughs already containing water for the sperm activation, and the fertilized eggs were left in the spawning troughs for incubation with water temperature between 25 and 27°C. Sub-samples of each treatment were collected using spoon of approximately 1g. The fertilized eggs were then spread on the net in each of the bowls, prepared earlier for this purpose and continuously aerated. After fertilization, the viable and dead eggs were determined. The viable eggs were translucent while the non-viable eggs were white and opaque (Sahoo *et al*, 2005) and these were carefully removed by siphoning. Hatching occurred at about 14 hours, and completed after 16 hours. The percentage hatchability was estimated after two days of hatching and the yolk sac had been absorbed. Water quality parameters such as the Temperature, pH, and Electrical conductivity were monitored with the aid of a pen type pH meter that was fixed with mercury in glass thermometer.

Analytical Procedure: Fecundity, fertilization and hatchability indices were calculated for each treatment to determine the performance (efficacy) of Ovatide and ovary-prim at manufacturer recommended dose levels as follows:

Stripping percentage = $\frac{\text{weight of stripped eggs}}{\text{Body weight}}$ x 100

Brzuska (2003)

The total number of eggs stripped (spawned) was estimated by counting the number of eggs in 1g of egg weight as described by Sahoo *et al.* (2005).

The relative fecundity was calculated as described by Billard (1990) in Fraud *et al.* (2010), as follows:

Relative Fecundity = $\frac{\text{Number of stripped eggs}}{\text{body weight}}$

The mean fertilized eggs in all the replicated bowls was recorded and expressed as percent fertilization per female (Adebayo and Popoola, 2008) as follows:

Fertilization = $\frac{\text{Number of fertilized eggs}}{\text{Total no of egg counted}} \times 100$

Hatchability was determined by direct counting of the number of hatchlings of two days old (Haniffa and Sridhar, 2002) and estimated as follows:

Percentage Hatchability = $\frac{\text{Number of hachlings (two days old)}}{\text{Total no of fertilized egg}} \times 100$

The per cent survival was determined according to the method in Adebiyi *et al* (2013)

Percent survival rate = $\frac{\text{Total number of suvived larvae until d}}{\text{Total number of counted larvae at d}}$ x100

RESULTS AND DISCUSSION

Table 2 presents the results obtained for the various tests conducted. The average latency period under mean temperature of 28°C was 11hours 1 minute for TRT I and 11 hours 6 minutes for TRT II, both of which were statistically similar. The weight of the brood fishes used were higher (Table 1) than the lower limit postulated in Viveen *et al.*(1985), who stated that *Clarias gariepinus* become sexually mature at 200 to 500g, This is also in consonance with the findings of Nwoke *et al*., (2007) who spawned successfully with, *H. bidorsalis* of weight range from 310 to 550g.

Zonnelveld *et al*. (1988) reported that *C. gariepinus* exhibited a latency period in excess up to 15hours, at temperature of 25°C. Olaniyi and Omitogun, (2014) reported that when *H. bidorsalis* broodstock was induced to spawning using ovaprim, ovulation was achieved within the latency period of 14hours at ambient temperature of 27°C. Khan *et al*., (2014) reported 11-12 hours of latency period for giant catfish

(*Sperata seenghala*) at water temperature range of 28-29°C when ovaprim, HcG, LHRH and ovatide were used. These studies unanimously support the findings of this experiment in terms of latency period. The spawning success of *H. bidorsalis* when subjected to ovary-prim and ovatide hormone in inducing ovulation and final maturation of eggs (Table 2) indicates that the broodstock responded well to both hormone treatments. Complete spawning success of ovatide has been reported in several fish species such as African catfish (*Clarias gariepinus*) (Shinkafi and Ilesanmi, 2014), Carp (Thakur and Reddy, 1997), Pabo catfish (*Pabda ompok pabo*) (Mukherjee and Das, 2001), Stinging catfish (*Heteropneustes fossili*), and Snake head murrel (*Channa punctatas*) (Marimuthus *et al.*, 2000; 2007). Likewise ovaprim hormone was successfully reported to induce ovulation on several fish species such as Common carp (*Cyprinidae; Cyprinus carpio*) (Lin *et al*., 1988; Haniffa *et al.*, 2007), Australian eel-tailed catfish (*Neosilurus ater*) (Cheah and Lee, 2000), Red-tailed tinfoil barb (*Barbonymus altus*, formerly *Puntius altus*) and walking catfish (*Clarias batrachus*) (Sahoo *et al*., 2005). Moreover this research provide a rare information on the reproductive performance of *H. bidorsalis* on ovary-prim and ovatide in the semi-arid region of Nigeria. Ovapy-prim (TRT II) was seen to have greater weight of eggs (183.23±51.70), spawning fecundity (109,000±34,261.39), percentage of stripped eggs (6.89±0.91), relative fecundity (39.92±6.73), number of fertilized eggs (80441.67±20991.97) and percentage fertilization (78.00±7.02) than Ovatide (TRT I). There was however no significant difference ($P>0.05$) between both treatments in all of these parameters. The stripping percentage of ovulated eggs of the broodstock body weight, was higher than that recorded in Ipinjolu *et al*., (2013) who record stripping percentage of 11.77% on cross of exotic Dutch *Clarias*, *H. bidorsalis* and *H. longifilis* using ovatide hormone. This could be as a result of the brood fish size and weight used in this experiment which was higher than in the Ipinjolu *et al*., (2013) findings. Fertilized eggs usually develop normally if the incubation

conditions (Temperature, cleanliness, oxygen etc) are adequate (FAO, 2011). These factors were taken care of during the experimental period. This finding is similar to an Ivorian study where African catfish *Heterobranchus longifilis* (*Clariidae*) showed percentage fertilization of 76% when treated with HcG (Legendre *et al*.. 1986). Also, Khan *et al*., (2014) reported a lower percentage fertilization rate of 56% on Giant Catfish (*Sperata seenghala*) with ovatide. Nwoke *et al*., (2007) however reported higher percentage fertilization rate of 98.31% on *H. bidorsalis* using ovary-prim. The relatively lower percentage fertilization recorded in the present study result might be attributed to asynchrony between maturation and ovulation. Since, blood on the stripped eggs clogs the micro pile, which could result to poor fertilization as reported by (Piper *et al*., 1982). Ovatide was seen to have performed significantly better ($P<0.05$) than ovary-prim in terms of percentage hatchability (Table 2). While 86.67±8.84% was recorded for broodstock subjected to ovatide, 72±3.06% was recorded for broodstock subjected to Ovary-prim. In a similar experiment, Shinkafi and Ilesanmi (2014) recorded the highest hatchability of eggs when 0.2ml of ovatide per kg weight of brood stock was used as compared to other doses. Nwoke *et al.* (2007) recorded hatchability of 91% for *H. bidorsalis* using ovaprim while Khan *et al*. (2014), reported a lower hatchability of 43% for Giant Catfish (*Sperata seenghala*) with ovatide. However, Aluko and Popoola, (2002) reported higher percent hatchability 96.09% in the crosses of *H. longifilis*, While Nwaduke (1993) recorded 40 to 75% hatching success in *Heterobranchus longifilis*.

The percentage survival rate was found to be higher in hatchlings treated with ovatide (69.42±0.39) significant difference ($P < 0.05$) with those treated with ovary-prim (58.21± 0.51).

Environmental and Water Quality Parameters: The results for the environmental and water quality parameters monitored during the experiment include Water temperature, room temperature, hydrogen ion concentration (pH), and electrical conductivity (EC) (Table 3). The highest mean water temperature (28.80±0.25) was recorded in the

evening, while water temperature generally ranged between 30.50°C and 28.10°C. Room temperature generally had similar readings with water temperature, ranging from 26.90°C to 30.70°C. The highest mean room temperature was 28.82±0.30°C, recorded for afternoon. pH mean values ranged from 7.97±0.12 to 7.96±0.29. Throughout the duration of the experiment, the highest pH reading recorded was 8.01 while the least was 7.18, indicating that a slightly alkaline water condition was maintained throughout the experimental duration. Electrical conductivity (EC) also ranged between 451.00 and 569.00, with a maximum mean of 556.71±14.45µs/cm recorded for evening. The water quality parameters measured during this study were within the acceptable range for *H. bidorsalis* in (Table 2) Viveen *et al.*, (1985) and Boyd, (1979) reported that warm water fishes grows best at temperature between 25-32^{0}C, pH value of 6.7 to 8.5 and dissolved oxygen ranged from 5mg/l to 7mg/l. The results obtained in the two treatments was within these averages. The optimum water conditions could easily be attributed to the continuous aeration of water the experimental period.

CONCLUSION

The use of synthetic hormone is a better way of improving catfish production with respect to reproductive performance in aquaculture. The efficacy of these synthetic hormones in the Sokoto semi-arid region of Nigeria was evident on the reproductive performance as tested on *H. bidorsalis*. However, the obtained result clearly indicated that induced spawning with regard to high percentage hatchability and fry survival after one week was obtained from ovatide, this shows that, ovatide was more efficient when compared with ovary-prim. There is need to conduct further and intensive studies on the proper domestication of African giant Catfish *Heterobranchus bidorsalis* in order to have a better understanding of the species specific reproductive behavior in such environment.

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Table 1: Parameters Used in Spawning

Parameter	Treatment I (Ovary-prim)			Treatment II (Ovatide)		
	1	2	3	1	2	3
Weight of brood fish (g)	3000	3150	1600	3000	3600	1900
Hormone dose (ml)	0.5	0.5	0.5	0.2	0.2	0.2
Actual dose (ml)	1.5	1.58	0.8	0.6	0.72	0.38
Time of injection (hrs:min)	11:35	11:38	11:41	12:06	12:07	12:11
Time of stripping (hrs:min)	10:37	10:38	10:41	11:12	11:14	11:16

Table 2: Spawning Performance of *Heterobranchus bidorsalis* on Comparison between Ovary-prim and Ovatide inducing Hormones

Parameters	Treatment I (Ovary-prim)	Treatment II (Ovatide)
Latency period (Hrs.)	11:00	11:06
Average weight of egg spawned (g)	183.23±51.70	180.57±20.56
Spawning fecundity	109,000±34,261.39	104,640±26,160.00
Stripped percentage	6.89±0.91	6.55±0.56
Relative fecundity	39.92±6.73	35.82±4.64
Number of fertilized eggs	80441.67±20991.97	60690.67±22181.31
Percentage fertilization (%)	78.00±7.02	76.00±6.11
Percentage hatchability (%)	72 ± 3.06^{b}	86.67 ± 8.84^{a}
Percentage survival (%)	58.21± 0.51	69.42 ± 0.39^{a}

Table 3: Mean water quality parameter during experimental period

Parameters	Morning	Afternoon	Evening
Water Temperature (°C)			
Mean	28.05±0.81	28.79±0.87	28.80±0.25
Minimum	28.1	28.7	28.3
Maximum	28.7	29.3	30.5
Room Temperature (°C)			
Mean	27.08±0.13	28.82±0.30	28.73±0.36
Minimum	26.9	28.2	27.8
Maximum	27.7	30.6	30.7
pH			

Mean	7.97±0.29	7.92±0.12	7.96±0.12
Minimum	7.21	7.18	7.18
Maximum	7.98	7.98	8.01
Electrical Conductivity (µm/cm)			
Mean	548.64±11.80	550.43±15.92	556.71±14.45
Minimum	463	451	453
Maximum	561	569	557

Google Earth, 2011. Image. Viewer.

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INFLUENCE OF CLIMATE VARIABILITY ON THE OCCURRENCE OF CATTLE REPRODUCTIVE AND URINARY TRACT INFECTIONS

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Abstract

The inadequate study on the intersection between climate change and livestock in The Gambia coupled with high abortion rates in cattle that are manage under the extensive management system prompted this research. The research was conducted in Upper River Region, The Gambia due to its high cattle population. Frequency, Spearman's correlation and regression analyses were carried out between climate variables (rainfall, temperature, wind speed and humidity) and the monthly occurrence of reproductive and urinary tract infections (RUT). The research revealed that in the Upper River Region, The Gambia, monthly occurrence of reproductive and urinary tract infections is positively significantly correlated to average monthly minimum temperature, relative humidity, wind speed and monthly total rainfall at $p < 0.05$. However, using the Backward method of the regression analysis, it was found that with the highest possible coefficient of determination (R^2) value of 0.346 and lowest variance inflation factor (VIF) of 1.018, rainfall, minimum temperature and wind speed provided the best equation that statistically significantly predicted the occurrence of reproductive and urinary tract infections.

KEYWORDS: Reproductive and Urinary Tract Infection; Climate variability; Cattle; The Gambia

INTRODUCTION

The contribution of the livestock sector to The Gambia economy is huge. Even though its contribution to enhancing crop production (fertilising the agricultural lands and providing the much needed labour in pulling the sine hoe and seeder) are not accounted for, the livestock sector still contributes about 8.6 % of the National GDP and almost 30 % of the Agricultural Gross Domestic Product (FAO, 2012). To the rural farmer, livestock is not only a means of saving

wealth to ensure food security, but serves as a form of prestige and honour in society. As population and urbanization continue to increase, these benefits are expected to increase. Despite its immense contribution, livestock, especially cattle production in The Gambia, is still traditional, depending largely on natural vegetation and water bodies for feed and water respectively, thus making it prone to climate variability. In the traditional management system, increasing herd size is often the priority of the herdsman. However, this is seriously challenged by high abortion rates. Prevalence of abortions or immature births and long calving intervals are many in livestock particularly in cattle.

Although one of the least contributors to global greenhouse gases emission, less than 0.01 % (INDC, 2017), The Gambia is still seriously challenged by the consequences of climate variability. There are already catalogue of droughts, floods, increased temperature and sea level rise (Jaiteh and Sarr, 2011; Yaffa, 2013), which are expected to increase in the future. These changes will in no doubt affect the agricultural system particularly the livestock sector. For instance, with variations in both the length and onset of rain, herders resort to unregulated transhumance as means of minimising the effects of feed and water shortage. This leads to the introduction and re-emergence of diseases. In spite of all the benefits and the magnitude of the changes that are likely to befall livestock systems, the claim made by Thornton *et al*. (2009) that intersection of climate change and livestock in developing countries is a relatively neglected research area is particularly true for The Gambia. There is very little research done on climate change and livestock in The Gambia. These concerned issues are a motivation to find out the impacts of climate variability on livestock.

One of the challenges affecting the desire of cattle owners to increase their herd size may be high abortion rates. According to Wikse (2005) the seven pathogens; *Brucella abortus*, *Leptospira hardjo-bovis, Campylobacter fetus*, Infectious Bovine Rhinotracheitis (IBR) virus, Bovine Viral Diarrhoea (BVD), *Tritrichomonas foetus* and *Neospora caninum* are of worry to beef cattle herd as these pathogens cause lots of damages including embryonic deaths, stillbirths and weak calves. The survival and distribution of these pathogens and many others could be influenced by some climate variables (Aune *et al*., 2012). In Iran, Gupta *et al*. (2016) discovered that incidence of human Brucellosis, a disease characteristics of abortion is positively correlated to monthly average temperarure and wind speed and negatively associated to monthly

average precipitation. Mai *et al*. (2013) also suggested that the prevalence of genital Campylobacteriosis and Trichomonosis that are characterised by infertility, embryo mortality and abortion were higher in zero-grazing herds.

Amongst other factors, climate, herd confinement, and feeds were responsible for the difference in regional occurrence of infectious diseases causing bovine abortion and foetus loss (Barr and Anderson, 1993). Albeit the findings that pathogens survival and distribution could be influenced by climate variables and the fact that human Brucellosis is associated with temperature, wind speed and precipitation, there is not much evidence to associate climate variability and reproductive and urinary tract infections in cattle raised under the extensive management system. Thus, this article seeks to find out the relationship between variability in climate parameters (temperature, humidity, wind speed and rainfall) and reproductive and urinary tract infections in cattle reared under an extensive management system.

METHODOLOGY

The study area: The Gambia has a tropical climate characterized by a seven-month long dry season (November - May) and a five-month rainy season stretching between June and October. In the dry season, temperatures range between 18^0 and 30^0 Celsius while it ranges from 23^0 to 33^0 Celsius in the wet season. According to GCCPD (2016), temperature has been rising in the order of 0.5^0 Celsius per decade, recording the lowest mean temperature of 25.8^0 Celsius in 1947 and the highest mean temperature of 28.2^0 Celsius in the year 2000. The annual rainfall amounts have decreased by 30 % from 1950 to 2000 (Jaiteh, 2010).

The Upper River Region, the second largest region in the country occupying about 2000 Square Km was the focus of the study (Figure 1). It is located in the eastern part of the country with latitude and longitude of 13.42570 N and 14.00720 W, respectively (GBoS, 2013). The Agro ecological zone of Upper River Region is characteristics of a growing period of over 135 days and the start of the growing season falls around the first half of June. The cumulative rainfall is between 700 to 800 mm per annum. The natural vegetation in this zone consists of grasslands with scattered trees. The vegetation in this zone has been heavily modified through human interference in the form of cultivation and bush fire. Cattle production is a major activity practiced in Upper River Region where 500 households are reported to own over 70,000 cattle. However,

cattle production is still traditional, depending mainly on the natural vegetation as source of feed. This natural vegetation is communally owned and the rules guiding its usage and management are not enforced.

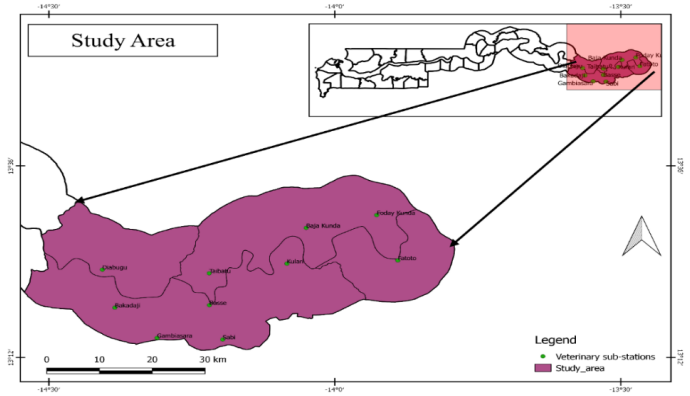

Figure 1 Map of the Study Area

Data collection: Meteorological data of the Basse Meteorological Stations including average monthly minimum and maximum temperatures, humidity, wind speed and total monthly rainfall were collected from the Department of Water Resources (DWR). The data were from January 1981 to December 2016.

Veterinary Clinic Records from 1995 to 2016, which was a little over 75 % complete were collected from the Regional Veterinary Office in Basse. The data consist of compiled monthly reports of trained staff of the Department of Livestock Services (DLS) called Livestock Assistants who are posted across the length and breadth of the Region. The dataset contains only the number of cases reported to the livestock assistants by the farmers, which the livestock assistants compiled as their monthly reports. The Regional Veterinary Officer in turn compiles the reports from the various sub-stations at district level as the Regional monthly report. The dataset contains several years but is not detailed enough to show date of occurrence, age and sex of cattle and specific villages where the outbreaks occurred.

Data Analysis Mann-Kendall test: Mann Kendall test was used to statistically detect the trend in temperature, rainfall, humidity and wind speed for Basse Meteorological Data. Mann Kendall test was used

because it does not require the data to be normally distributed and moreover have low sensitivity to abrupt breaks due to non-homogenous time series (Karmeshu, 2012). The null hypothesis (H_0) of this test assumed that there is no trend, that is, the data is independent and randomly ordered. The H_0 is tested against the alternative hypothesis (Ha) that assumed that there is a trend (Karmeshu, 2012). The Excel plugin XLSTAT 2015 was used to conduct this test.

Frequency, Spearman's Correlation and Regression Analyse: The frequency analysis of the monthly occurrence of reproductive and urinary tract infections was carried out. Spearman's correlation tests were performed between the veterinary clinic data (monthly occurrence of RUT infections) and the monthly climate variables of the Basse Meteorological stations. The data were initially tested for stationarity using the Dickey-Fuller Method, which uses the null hypothesis (H_0) $p = 1$ and the alternate hypothesis (Ha) as $|<1$.

Multiple linear regression analysis was performed, monthly RUT infections as the dependent variable and minimum and maximum temperatures, rainfall, humidity and wind speed as the independent variables. To ensure the assumptions were not violated, diagnostic tests of multicolinearity, homoscedasticity and normality distribution of the residuals were performed. To reduce the collinearity effects, maximum temperature, which was not correlated with RUT infections, was removed from the regression analysis. All these tests were performed using statistical software JASP.

RESULTS AND DISCUSSION

Climate variables trend: The Mann-Kendall test was performed to determine the trends in climate variables. The Mann-Kendall test demonstrated that there were statistically significant monotonic trends in rainfall (Kendall's tau = 0.248, p = 0.034) and minimum temperature (Kendall's tau = -0.367, p = 0.005) of the study area. Maximum temperature, humidity and wind speed have not showed any monotonic increase or decrease (Table 1). Fitted trend lines revealed an upward trend in rainfall and a downward trend in minimum temperature (Figures 2 and 3).

As illustrated by the Mann-Kendall test result (Table 1), climate variability does exists and to a great extent. The variabilities in both rainfall and minimum temperature is monotonic. Variabilty in these climate variables could suggest threats to cattle health. For instance, changes in rainfall pattern may influence the expansion of vectors (Thornton *et al.*, 2009) and provide favourable

conditions for many pathogen (Kimaro and Chibinga, 2013; Abdela and Jilo, 2016). The increasing rainfall may cause floods, which are favourable conditions for survival and proliferation of many pathogens.

Table 1 Mann-Kendall Test Result

Variable	Kendall's tau	S	p-value	Alpha
Rainfall	0.248	156.000	0.034	0.05
Humidity	0.190	50.000	0.220	0.05
Wind Speed	0.181	67.000	0.203	0.05
Maximum Temperature	0.253	76.000	0.080	0.05
Minimum Temperature	-0.367	-149.000	0.005	0.05

S – Mann-Kendall Statistics

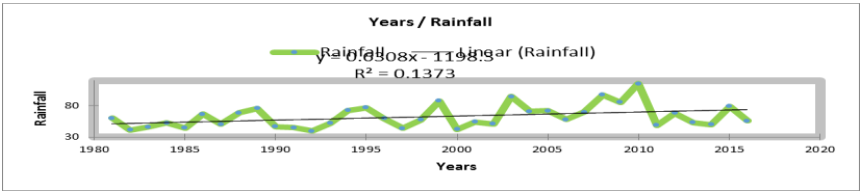

Figure 2. The Rainfall Trend

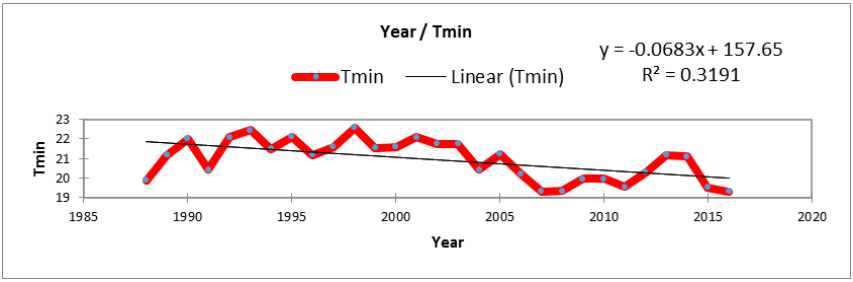

Figure 3 Minimum Temperature Trend

RUT occurrence: From January 1995 to December 2016, 551 cases of reproductive and urinary tract infections were reported with a mean of 3.555 and standard deviation (3.950). Most of these cases (52 %)

occurred in the rainy season, that is, from June to October (Figure 4) and on a monthly basis, the highest cases of RUT were reported in August and the lowest number of cases were received in November (Figure 5).

The disease surveillance system in most countries in Africa is challenged by under reporting (Mshelia *et al*., 2010; OIE, 2017). The reported RUT infection cases of only 551 for more than a decade in Upper River Region, The Gambia may have verified this statement. An explanation for the under reporting of diseases by farmers could be their inability to pay for drugs and veterinary services. As farmers are unable to pay for drugs and veterinary services, they may regard it unnecessary to report cases to veterinary officers. Another contributing factor is the difficulty in accessing veterinary officers. The livestock assistant to farmer ratio is huge such that it can reach 1 : 1500. Some farmers may have to travel for more 10 km to access a veterinary assistant. The inadequate access to veterinary services coupled with the inability to pay for drugs are eminent contributing factors to disease under reporting

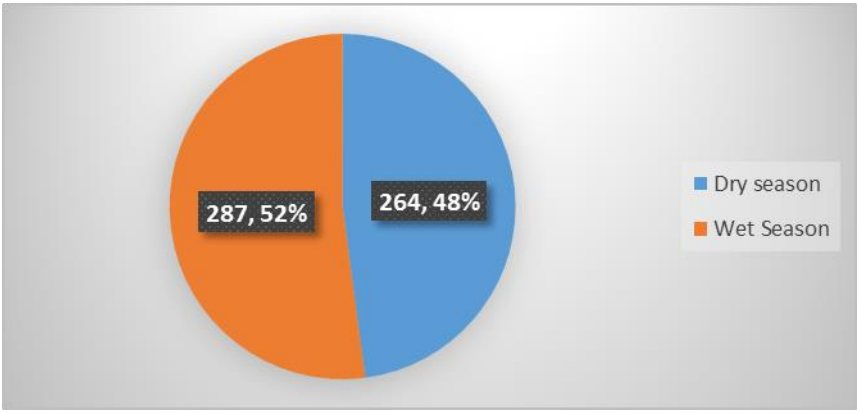

Figure 4 Seasonal Occurrence of Reproductive and Urinary Tract Infections

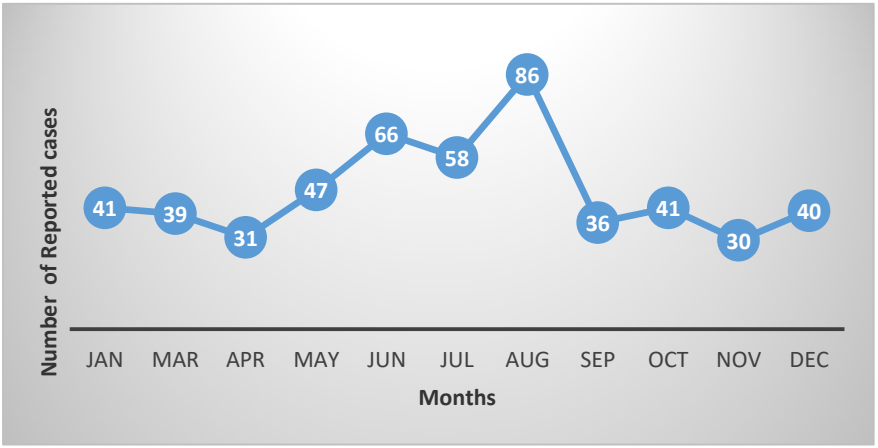

Figure 5 Monthly occurrence of reproductive and urinary tract infections

RUT and climate variables correlation: To determine the association between the occurrence of reproductive and urinary tract infections and variabilities in climate variables of the Region, Spearman correlation test was performed. This analysis revealed that average monthly minimum temperature ($r = 0.218$, $p = 0.007$), wind speed ($r = 0.158$, $p = 0.041$), humidity ($r = 0.185$, $p = 0.041$) and total monthly rainfall ($r = 0.263$, $p < 0.001$), were all positively correlated to the monthly occurrence of RUT infections. However, there was no statistically significant association between monthly maximum temperature ($r = -0.088$, $p = 0.382$) and the monthly occurrence of RUT infections average (Table 2).

This study establihsed that occurrence of reproductive and urinary tract infection is strongly associated with minimum temperature, rainfall, humidity and wind speed. This is in line with the study of Gupta *et al.* (2016) who suggested correlation between rainfall and human Brucellosis, which is characteristics of abortion. However, while Gupta *et. al.* (2016) revealed a negative correlation, this study discovered a positive association. Their result which established that Brucellosis in human is positively associated to wind speed and humidity is similar to the result of this study, which indicated that wind speed and humidity are positively in association with monthly occurrence of RUT infections.

Disease transmission and distribution is very complex as there are several factors that are responsible. However, the positive correlation between RUT infections and these climate variables could be linked to a number of factors that occur in the Region. One possible explanation could be attributed to high infestation of endo-parasites (worms) during the rainy season. In the Upper River Region, herdsmen practice early morning grazing with the intent to produce more milk. Incidentally, worms are very active during this period, thus worms infestation load become heavier. This problem is further aggravated by the lack of routine deworming programmes. Farmers mostly react to disease outbreak situations rather than adopting preventive practices and commonly seek for veterinary services only when the lives of their animals are endangered. It is not characteristics of cattle owners to carry out routine deworming of their cattle, thus exposing cattle to the effects of high worm infections. Another reason that could be related to the positive correlation between rainfall and RUT, is the traditional form of cattle management system practiced. In the study area, as a result of the traditional cattle rearing system, there is no proper disposal of dead cattle. Aborted foetuses and placentas are not properly dispose but allowed to decay in grazing lands, cattle tracks and watering points, potentially allowing these places to be reservoirs of infections (Daffeh, 2001). Furthermore, with heavy rainfalls, some grazing areas are flooded rendering it inaccessible to cattle. As herders practice temporal nomadism especially to reduce this impact, cattle from different areas are gathered in a grazing area, enhancing the transmission of RUT infections.

Another possible cause for the positive correlation between RUT infections and wind, humidity and rainfall is the influence these variables have on pathogens and animals. According to Kimaro and Chibinga (2013), there are a number of pathogens that are sensitive to humidity and temperature changes. Humidity and wind speed have great abilities to influence the development and spread of pathogens. In the Gambia, cattle are rarely housed especially under the extensive management system. The continual exposure of cattle to increasing temperature, high humidity and strong wind may add stress thus supressing cattle immune system (Abdela and Jilo, 2016; Bett *et al*., 2016), making cattle prone to infections.

Table 2 Correlation Matrix of RUT infections and Climate Variables

Variable	Spearman's rho	p- values
Minimum temperature	0.218**	0.007
Rainfall	0.263***	< 0.001
Wind Speed	0.158*	0.050
Humidity	0.185*	0.041
Maximum temperature	-0.088^{ns}	0.382

*p < .05, **p < .01, ***p <.001, ns – not significant

In addition, Backward multiple linear regression analysis (Table 3) was calculated to ascertain the capacity to which minimum temperature, rainfall, wind speed and humidity can predict the occurrence of reproductive and urinary tract infections in cattle. The assumption of normality, multicollinearity, homoscedasticity and existence of outlier were ensured not to be violated by conducting the assumption tests. In model 1, which took into account all the variables (minimum temperature, rainfall, wind speed and humidity), 33.9 % of the variance was described. Although the overall model was statistically significant (F4, 117 = 3.797, p = 0.006), by individual contribution, wind speed (p = 0.006) was the only statistically significant variable.

In the second model where humidity was controlled, the explained variance was reduced by 0.001 but both rainfall and wind speed were statistically significant in the prediction. The model established that minimum temperature, rainfall and wind speed statistically significantly predict RUT occurrence ($F_{3,118} = 5.059$, p = 0.002). In the third and final model, after controlling for minimum temperature and humidity, rainfall and wind speed were both statistically significant in predicting RUT occurrence ($F_{2,119} = 6.768$, p = 0.002), with R^2 value of 0.320.

Considering the highest possible R^2 value and the lowest Variance Inflation Factor (VIF), minimum temperature, rainfall and wind speed presented the best model to predict the occurrence of monthly RUT infections in cattle in the Upper River Region, The Gambia ($F_{3, 118} = 5.059$, p < 0.002, R^2 = .338). Although the contribution of minimum temperature was not significant (Beta = 0.117, t = 1.254, Sig = 0.212), the contributions of rainfall (Beta = 0.224, t = 3.2.405, Sig. = 0.018) and wind speed (Beta = 0.254, t = 2.847, sig = 0.005) to the prediction of RUT infections were both statistically significant (Table 4). An increase of 1.0 % in the monthly occurrence of RUT infections in the

Upper River Region would occur with a millimetre (mm) increase in the monthly total rainfall. On a bigger scale, one knot increase in the average monthly wind speed will likely increase the monthly occurrence of RUT infection in the region by 28.8 %. The equation for RUT, with the highest possible R^2 Value of .338 and the lowest possible variance inflation factor of 1.059 is represented as;

RUT = -2.385 + .010 x RF + .288 x WS + .129 x T Min,

where RUT refers reproductive and urinary tract infections, RF is rainfall, WS stands for wind speed and T Min meaning minimum temperature.

CONCLUSION AND RECOMMENDATION

Based on the outcomes of this study, there are strong indications that rainfall, minimum temperature, humidity and wind speed variabilities clearly influence the occurrence of reproductive and urinary tract infections in cattle that are manage under the extensive management system. The influence rainfall for instance has on the availability of feed and water availability looks crucial to the epidemiology of reproductive and urinary tract infections. Low rainfall leads to inadequate feed and water prompting herders to practice temporal nomadism. Similarly, with heavy rains, flood may occur preventing cattle from accessing some grazing areas, which may also prompt temporal momadism.

Although there is need to distinguish the individual diseases that make up the reported RUT infections, it is evident that climate variability strongly influences the monthly occurrence of RUT infections. As rainfall, wind speed and humidity are expected to continue to increase, the occurrence of RUT is equally expected to increase except much more efforts are done. This will inturn hinder farmers' desire to increase their herd sizes. The strong association between reprductve and urinary tract infection may have negetive impact on farmers income level and food security. Increase abortion rates would not only reduce milk production but would as well threaten food security.

It is thus recommended that management systems be improved and more efforts be excerted on early disease diagnosis and treatment to reduce losses.

Table 3 RUT Regression Matrix

Model	Variables	Unstandardized Coefficients (B)	Standardized Coefficients (Beta)	t	Sig	VIF	df	f	Sig of model	R^2
	Constant	-2.812		-1.021	0.31					
	TMin	0.12	0.11	1.136	0.258	1.231	4			
1	Rainfall	0.008	0.185	1.298	0.197	2.698	117			
	Humidity	0.011	0.055	0.355	0.723	3.148	121	3.797	0.006	0.339
	Wind speed	0.3	0.265	2.797	0.006	1.185				
	Constant	-2.385		-0.966	0.336					
2	TMin	0.129	0.117	1.254	0.212	1.167	3			
	Rainfall	0.01	0.224	2.405	0.018	1.154	118	5.059	0.002	0.338
	Wind speed	0.288	0.254	2.847	0.005	1.059	121			
	Constant	0.405	-	0.376	0.707		2			
3	Rainfall	0.011	0.262	2.963	0.004	1.033	119	6.768	0.002	0.32
	Wind speed	0.268	0.236	2.678	0.008	1.033	121			

t = student t test, df = degree of freedom, f = f statistics, Sig = Significance value, TMin = Minimum temperature

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INBREEDING COEFFICIENT, HETEROZYGOSITY AND HAEMOGLOBIN POLYMORPHISM IN CATTLE, SHEEP AND GOAT REARED IN KOGI STATE UNIVERSITY LIVESTOCK FARM

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ABSTRACT

Sixty five animals (10 Yankasa sheep, 30 West African Dwarf goats and 25 cattle of mixed breed) were used to evaluate Haemoglobin (Hb) polymorphism, local inbreeding coefficient, and the degree of heterozygosity (genetic diversity) in animals reared at the livestock farm of the Kogi State University, Anyigba using cellulose acetate gel electrophoresis. Results showed that Hb AB was predominant in cattle (0.52) followed by Hb BB (0.32) and Hb AA (0.16) with a gene frequency of 0.42 and 0.58 for the A and B gene locus, respectively. In sheep, only Hb AA was observed in the animals sampled with genotype frequency of 1.00 and gene frequency of 1.00. In goats, Hb AA was more with genotype frequency of 0.80, followed by Hb AB (0.20) while Hb BB was absent. The gene frequency for the A and B locus were 0.90 and 0.10, respectively in goats. The inbreeding coefficient and expected heterozygosity were: for cattle (0.02 and 0.48), for sheep (0.05 and 0.00) and for goats (0.02 and 0.18), respectively. All the genotypes evaluated were in Hardy-Weinberg equilibrium as there were no significant (P>0.05) differences between the observed and expected number of genotypes. Conclusively, Hb polymorphism was observed in all the animals studied with a higher frequency of Hb AA observed in the sheep and goat while Hb AB was more predominant in cattle. The level of inbreeding is still relatively low in the animals studied but appropriate breeding programmes needs to be instituted to keep it at that level, or better still lower it to the barest minimum.

KEYWORDS: cellulose acetate, electrophoresis, genetic diversity, Hardy-Weinberg equilibrium.

INTRODUCTION

Haemoglobin is a coloured blood protein which is very important for its role in the transportation of oxygen to tissues, and carrying away carbon dioxide from the tissues. Its inheritance follows simple Mendelian fashion (Akinyemi and Salako, 2010).

Due to this characteristic, Hb could be used as a biomarker for selection purposes in farm animals. Differences exist in the structure of Hb mainly in its globin component and this difference (called polymorphism), leads to variants of Hb, and the variation may confer or limit the animal's abilities/productivities.

A population is said to be polymorphic for a character if two or more forms of the character are each represented in high enough frequencies to be readily noticeable (Campbell and Reece, 2002). Egena and Alao (2014) in their review of Hb polymorphism in selected farm animals, observed that variation in Hb have been reported to confer selective advantages in different geographical areas to animals. Such selective advantages include effect on meat quality parameters (Bezova *et al*., 2007) and on hair and horn length (Akinyemi and Salako, 2010). Linking Hb type to productive abilities and other factors as enumerated above could be a means of using it as a genetic marker for selection purposes and genetic improvement programmes.

Although there are more recent methods of evaluating the genetic merit of animals with the intention of using information so obtained for improvement purposes, such high technology inclined methodologies/equipment are still to a large extent, largely inadequate in most developing countries. This study is a pilot work which focuses on the identification of genetic diversity amongst the White Fulani cattle, Yankasa sheep and West African Dwarf goats reared at the livestock farm of the Kogi State University, Nigeria via electrophoretic detection of polymorphism at the Hb locus.

MATERIALS AND METHODS

Study area: Anyigba, the study area is located on latitude $7^{o}15'$ and $7^{o}29'$ North and longitude $7^{o}11'$ and $7^{o}32'$ East with an average altitude of 420 meters above sea level. The study area falls within the tropical wet and dry climatic region and the southern guinea savanna ecological zone with mean annual temperature of $25^{o}C$ and rainfall of 1600 mm. The map of the study area relative to its position in Nigeria, Kogi State and Dekina Local Government Area is presented in Figure 1 (Ifatimehin and Ufuah, 2006).

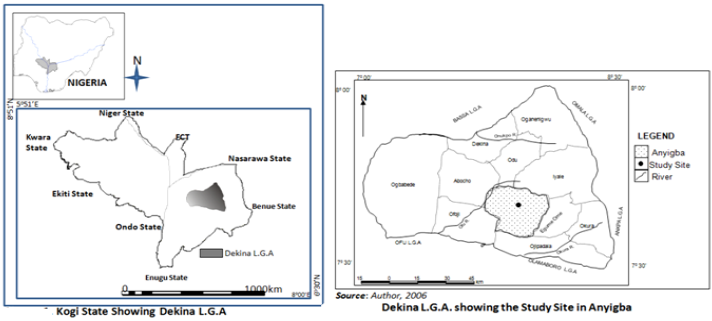

Figure 1: Map of Nigeria showing the relative positions of Kogi State, Dekina Local Government Area and Anyigba town

Sample collection: The animals used for the study were semi-intensively managed. A total of sixty five animals (10 Yankasa sheep, 30 West African Dwarf goats and 25 cattle of mixed breed) were used for the study. Sampled animals were adults within breeding age group. 2 ml of blood was collected from each of the sampled animals by jugular venipuncture into tubes containing Ethylene Diamine Tetra Acetic acid (EDTA) and properly labelled. The blood samples were placed in the refrigerator to keep them from spoilage until when required for laboratory analysis.

Laboratory analysis: The blood samples were lysed directly using distilled water without any prior washing with saline water. The red cell lysates were subjected to electrophoresis using a cellulose acetate gel medium according to standard procedure (Cheesbrough, 2000). The Hb types were identified based on their migration on the electrophoretic substratum detected from the start line towards the cathode zone. Analysis was carried out using a locally fabricated electrophoresis machine (Chikpas Genopack Electrophoresis, Nigeria).

Statistical analysis: The resulting frequencies of the alleles corresponding to the banding pattern were estimated by direct count. Haemoglobin genotype and gene frequencies were estimated as follows:

$$\text{Genotype frequency of AA} = \frac{\text{Number of individuals with AA} \times 100}{\text{Number of individuals sampled}}$$

$$\text{Genotype frequency of AB} = \frac{\text{Number of individuals with AB} \times 100}{\text{Number of individuals sample}}$$

$$\text{Genotype frequency of BB} = \frac{\text{Number of individuals with BB}}{\text{Number of individuals sampled}} \times 100$$

$$\text{Gene frequency of A} = \frac{2AA + AB}{\text{Total number of alleles}}$$

$$\text{Gene frequency of B} = \frac{2BB + AB}{\text{Total number of alleles}}$$

Data on Hb alleles and genotype frequencies were subjected to chi-square analysis to test for goodness of fit for observed and expected frequencies under Hardy-Weinberg Equilibrium (HWE). Heterozygosity (genetic diversity) was estimated as the expected proportion of heterozygotes under Hardy-Weinberg Equilibrium (HWE). The degree of genetic diversity was calculated using the formula;

$$1 - \sum_{i=1}^{k} p_i^2$$

Where P_i is the gene frequency of the i^{th} allele in the k^{th} locus; and i is the number of loci.

Inbreeding coefficient was also estimated to identify the extent of inbreeding in the animals studied. Local inbreeding coefficient was calculated using Lush formula;

$$F = \frac{1}{8M} + \frac{1}{8F}$$

Where M = number of male and F = number of female animals in the population, respectively.

RESULTS

Results of the study showed the existence of three haemoglobin genotypes in the cattle (Hb AA, Hb AB and Hb BB), two in goats (Hb AA and Hb AB), while only one haemoglobin genotype (Hb AA) was observed in the sheep. The haemoglobin distribution of Hb AA, Hb AB and Hb BB for cattle were observed to be 4, 13, and 8, respectively; for the sheep, it was 10, 0 and 0 for Hb AA, Hb AB and Hb BB, respectively while WAD goats were 24, 6 and 0 for Hb AA, Hb AB and Hb BB, respectively (Table 1, 2 and 3). The genotype frequency (Hb %) of the sampled animals (pooled) were: 16, 52 and 32 % for cattle; 100, 0 and 0 % for sheep and, 80, 20 and 0 % for the WAD goat, respectively. The gene frequencies (pooled) were observed to be 0.42 and 0.58 (for cattle), 0.90 and 0.10 (for goat), and 1.00 and 0.00 (for sheep). Chi-square statistics revealed no significant ($P>0.05$) influenced on the observed

and expected genotypes. Estimates of heterozygosity and inbreeding coefficients were 0.48 and 0.02 for cattle, 0.58 and 0.02 for goats, while it was 0.05 and 0.00 for the sheep, respectively.

Table 1: Genotype, gene frequency, inbreeding coefficient, expected heterozygosity and Chi-statistics of cattle

		Genotype frequency			Gene frequency	
	Number	**AA**	**AB**	**BB**	**A**	**B**
Male	9	1.00 (0.11)	7.00 (0.78)	1.00 (0.11)	0.50	0.50
Female	16	3.00 (0.18)	6.00 (0.38)	7.00 (0.44)	0.375	0.625
Total	25	4.00 (0.16)	13.00 (0.52)	8.00 (0.32)	0.42	0.58
		Chi-statistics				
Observed		4.00	13.00	8.00		
Expected		4.41	12.18	8.41		
Deviation		-0.41	0.82	-0.41		
Chi-square		0.038	0.055	0.020		0.113ns

Local inbreeding coefficient **(**F) = 0.02; Heterozygosity expected = 0.48; ns= not significant.

Table 2: Genotype, gene frequency, inbreeding coefficient, expected heterozygosity and Chi-statistics of goat

		Genotype frequency			Gene frequency	
	Number	**AA**	**AB**	**BB**	**A**	**B**
Male	11	9.00 (0.82)	2.00 (0.18)	0.00 (0.00)	0.91	0.09
Female	19	15.00 (0.79)	4.00 (0.21)	0.00 (0.00)	0.89	0.11
Total	30	24.00 (0.80)	6.00 (0.20)	0.00 (0.00)	0.90	0.10
		Chi-statistics				
Observed		24.00	6.00	0.00		
Expected		24.30	5.40	0.30		
Deviation		-0.30	0.60	-0.30		
Chi-square		0.004	0.067	0.30		0.37ns

Local inbreeding coefficient **(**F) = 0.02; Heterozygosity expected = 0.18; ns= not significant.

Table 3: Genotype, gene frequency, inbreeding coefficient, expected heterozygosity and Chi-statistics of sheep

		Genotype frequency			Gene frequency	
	Number	**AA**	**AB**	**BB**	**A**	**B**
Male	6	6.00 (1.00)	0.00 (0.00)	0.00 (0.00)	1.00	0.00
Female	4	4.00 (1.00)	0.00 (0.00)	0.00 (0.00)	1.00	0.00
Total	10	10.00 (1.00)	0.00 (0.00)	0.00 (0.00)	1.00	0.00
		Chi-statistics				
Observed		10.00	0.00	0.00		
Expected		10.00	0.00	0.00		
Deviation		0.00	0.00	0.00		
Chi-square		0.00	0.00	0.00		0.00ns

Local inbreeding coefficient **(**F) = 0.05; Heterozygosity expected = 0.00; ns= not significant.

DISCUSSION

The control of the three Hb genotype by the two co-dominant alleles A and B as observed in this study has been reported in Nigerian cattle, sheep and goat (Akinyemi and Salako, 2010; Akinyemi and Salako, 2012; Agaviezor *et al.,* 2013; Yakubu *et al.,* 2014). The absence of Hb BB in goats is similar to the observation of Kuwar *et al.* (2001) in Nepalese Hill goats; Johnson *et al.* (2002) in Omani Dhofari goats, and Yakubu *et al.* (2014) in West African Dwarf goats of Nigeria. Osaiyuwu *et al.* (2013) reported that the degree of polymorphism of haemoglobin system of goat breeds is defined by the number of alleles, the ratio between them, the inter-allelic combinatory capacity, number of genotypes expressed, their distribution and the range of variability. Hb AA had selective advantage over Hb AB and Hb BB in the goat. Sam (2012) reported Hb AA to be superior to other Hb genotypes in Red Sokoto goats in reared in Western Nigeria. The predominance of Hb A could be due to its properties (biophysical and biochemical), and its physiological peculiarities.

The very low frequency observed for Hb BB and Hb AB in sheep is contrary to the report of Akinyemi and Salako (2012) who observed very high percentages of the two genotypes among indigenous Nigerian sheep breeds. The frequency of Hb A was very high in the absence of the other haemoglobin types (Table 3). Pieragostini *et al.* (2006) observed that Hb A is found more frequently in sheep living above 40^{o}C latitude. This might be due to specific abilities such as a high relative affinity for oxygen and is therefore very important for survival of the sheep in mountainous areas at latitude above 3000m

(Tsunoda *et al.*, 2006). It is possible that vegetation or climatic factors might have an influence on Hb type. There are reports indicating that even when no deliberate selection pressure was applied at the locus, Hb A genotype increases toward the forest zone. This was reported in Yankasa sheep (Tella *et al.*, 2000). The absence of Hb AB and HB BB in the sheep sampled is not a conclusive proof however, that other form of haemoglobin does not exist generally in sheep in the area where the study took place. The small sample size (mostly due to mortality which might have been brought about by a decrease in fitness) could have been responsible for the occurrence of only Hb A genotype.

Mojabi *et al.* (2001) and Pal and Mummed (2014) reported on studies carried out on Hb polymorphism in cattle although most of the study seem to be in dairy cattle. Gene frequency for the allele A was observed to be higher than that for allele B, in sheep and goat similar to the findings of Agaviezor *et al.* (2013); except in cattle where the allele AB was predominant. However, the gene frequency corresponds with Hardy-Weinberg's equilibrium as no significant differences were observed between the observed and expected genotypes. No conclusion could be drawn however, that sex has an effect on the differences observed in Hb types. This is based partly on the fact that not the same numbers of both sexes were sampled in the study.

The inbreeding coefficient and heterozygosity observed in the study revealed that the extent of inbreeding in the populations studied although quite low is not too encouraging. There's an inverse relationship between inbreeding and expected heterozygosity. If inbreeding coefficient is 0, it means that the observed number of heterozygotes is equal to the expected number, and this equally means that the population is in Hardy-Weinberg's equilibrium. If it is positive and equal to 1, it means that there are no heterozygotes in the population at all implying a completely inbred population (none of the population studied was in this state). Thus, the higher the inbreeding coefficient, the more inbred the population is likely to be while the higher the degree of heterozygosity, the less inbred the population is, and wider is the genetic diversity of the population in question. The values obtained for the two indices in the sheep point to the fact that urgent action needs to be taken to introduce new genetic material into the sheepfold in order to shore up the genetic merit of the sheep. Further decline in heterozygosity will simply usher the sheep population into inbreeding depression with its accompanying negativity and or effect

on productive traits and those traits that have to do with fitness.

There's also the danger of the allele (A) becoming fixed in the sheepfold, and this might not be too advantageous especially if it does not confer any selective advantage in terms of productive, adaptive or reproductive abilities. Fixation of certain alleles and loss of others within the sheep could be due to evolutionary changes either as a result of natural selection for the allele A, random genetic drift, or it might well be that the genes of these blood proteins have been linked with genes that affect economically important traits whose selection (naturally or artificially) might have indirectly change the allele frequency, leading to reduction in diversity at the haemoglobin locus. Genetic drift also causes allele frequencies to fluctuate randomly in each generation. However, if the frequency of an allele ever reaches zero due to genetic drift, it will be permanently eliminated from the population. The other allele, whose frequency is now 1 then becomes "fixed", which means that all individuals in the population will be homozygous for that allele. This continues for all future generations (in the absence of mutation). The average rate at which alleles become fixed is a function of the population size. Hence the larger the population the longer it will take before an allele becomes fixed and vice versa. The tendency toward fixation for allele A in the sheep is therefore not too surprising because of the small population sampled. Perhaps, the nature of the result was also affected by the low number of animals sampled.

The fact that more Hb A genotype was observed compared to Hb AB genotype in goats, is an indication that the population may not currently be undergoing dissortative mating or may not be experiencing a Wahlund effect (Wahlund effect occurs when there are more heterozygotes observed than the normal or as expected in a population). Hence, there is a need to design appropriate breeding and conservation schemes to prevent the erosion of the valuable adaptive traits of the West African Dwarf goats. Cattle were the most diversified at the haemoglobin locus due in part to higher level of heterozygosity and low inbreeding. Inbreeding accumulates in any closed population because of the mating of closely related individuals. Small, closed and or selected populations can rapidly lose heterozygosity and allelic diversity tending toward homozygosity and the possible onset of inbreeding depression. Within breed and high rates of loss of genetic variation may lead to reduced chances of breed survival due to decrease in fitness brought about by inbreeding depression. Such breeds become

subject to faster changes in gene frequencies leading to greater rate of loss of genes and genetic constitutions. Another negative effect in domestic animals is a decrease in selection response and in potential genetic gains in economic traits. Measurement of the effect of inbreeding on economic traits is therefore important in order to estimate the magnitude of change associated with increase in inbreeding. Once the impact of inbreeding has been estimated, its economic impact upon a particular trait can then be determined.

CONCLUSION

The study has shown the nature of Hb polymorphism in cattle, sheep and goat reared at the Kogi State University livestock farmer. Higher frequency of Hb AA was observed in sheep and goat while Hb AB was more predominant in cattle. The study shows that the level of inbreeding in the animal herds is still relatively low. It is recommended that appropriate breeding programme be instituted to keep it at that low level, or better still lower it to the barest minimum. This study was highly limited by the small number of animals reared at the Kogi State University livestock farm.

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PERCEIVED EFFECT OF ECONOMIC RECESSION ON FOOD SECURITY STATUS OF SMALLHOLDER FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF NIGER STATE, NIGERIA

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ABSTRACT
The recent economic recession in Nigeria has been associated with numerous socio-economic challenges among the populace and in particular, the smallholder farmers. This study therefore determined the effect of the economic recession, as proxied by farmers' perception of recession, on the food security status of smallholder farmers Niger State, Nigeria. A multi-stage sampling technique was employed to select 90 respondents from Bosso and Chanchaga Local Government Areas of the State. Data analysis was through descriptive, inferential statistics and attitudinal measuring scale. Majority (74.4%) of the respondents were males, 61.1% were married, with mean household size of 6 and average annual income of ₦36,033.33. Also, considerable proportion (93.3%) of the respondents was aware of economic recession, through the extension agents (60.0%) and cooperatives (52.2%). The weighted means (X) of the Likert scales revealed that respondents had strong negative perception of economic recession on food security, as it relates to changes in consumption pattern (X=4.33), threat to household food security (X=4.07), adjustment in household expenditure (X=3.98) and high cost of food production (X =3.72). Considerable population (61.1%) were food insecure, while respondents' perception of recession (proxy for economic recession) had significant and inverse relationship with the food security status of respondent at 5% probability level. The study recommended that farmers should diversify their economic activities, adopt sustainable and smart coping strategies and maintain manageable household sizes in order to ameliorate the effect of economic recession.

KEYWORDS: Economic recession, food security, socio-economic challenges, Nigeria

INTRODUCTION

Nigeria has the potential to adequately feed its growing population by virtue of its human and natural resource endowments. However, this potential has remained elusive over the years, since the shift in emphasis from agriculture to crude oil and gas in the

late 1960s. As a result, the country's growth continued to be driven by consumption and high oil prices (Federal Ministry of Budget and National Planning, 2017). After more than a decade of economic growth, the sharp and continuous decline in crude oil prices since mid-2014, along with a failure to diversify the revenue sources and foreign exchange in the economy, led to economic recession in the second quarter of 2016 (Federal Ministry of Budget and National Planning, 2017). According to the Central Bank of Nigeria (2012) and Shido-Ikwu (2017), recession represents a stage in the business cycle contraction, and it refers to a general slowdown in economic activity for two consecutive quarters. This period is associated with decline in certain macroeconomic indicators such as gross domestic product (GDP), investment spending, capacity utilization, household income, business income, and inflation, with the attendant increase in the rate of unemployment. CBN (2012) affirmed that when an economy recorded two consecutive quarters of negative growth in real GDP, it can be said to be in recession. Nigeria entered into recession, given negative GDP growths of - 0.36% and - 1.5% within the first and second quarters of 2016 respectively. According to Agri *et al.* (2017), the recession affected socio-economic lives, general living standards, production, as well as consumption. Shido-Ikwu (2017) affirmed that Nigeria's economy lost over 500,000 jobs, witnessed downward power supply, unemployment, stagnant wages, decline in retail sales and downward trend in labour productivity of -0.4 per cent. Several other researchers (Sell *et al.* 2010; and Oyewole *et al.* (2017) have also linked food insecurity to economic recession. Arising from the aforementioned, it is not unlikely that the recession influenced socio-economic activities of the rural populace, including, but not limited to consumption and farming activities in Nigeria. Salaudeen (2017) also argued that food accounts for a large and increasing share of the family budget for poor and that if prices of staple food soar as a result of recession, poor people mostly bear the brunt. The source further averred that there was a general economic decline during recession, as the purchasing power of the citizen was eroded due to poor or low income as the price of food and other commodities soared high. These are attendant effects of the economic recession as posited by CBN, 2012).

According to the Food and Agriculture Organization (2009), food insecurity exists when people do not have adequate physical, social and economic access to food. This according to the organisation, could result in undernourishment when caloric intake is below the minimum

dietary energy requirement (MDER), defined as the amount of energy needed for light activity and a minimum acceptable weight for attained height. FAO (2009) further established that increase in food insecurity could be attributed to high domestic food prices, low personal incomes and increasing unemployment. Against this backdrop, this study determined the effect of farmers' perception of economic recession on their food security status in Bosso and Chanchaga Local Government Areas of Niger State, Nigeria. Specifically, the study determined the extent and sources of awareness of economic recession among farmers, farmers' perception of economic recession, determined respondents' food security status and ascertained the effect of farmers' perception of economic recession on their food security status. The study hypothesized that there was no significant relationship between farmers' perception of recession and their food security status. Without preconception to the fact that Nigeria recently moved out of economic recession, this study will support the Nigerian Economic Management Team, Niger State Government and Federal Government in fully stabilizing the economy and avoiding relapse into recession or worse still depression, while providing policy options for ameliorating the effect of recession on food security status of farmers in the study area.

Conceptual and Theoretical Frameworks: Economic recession is an economic phenomenon, which refers to the reduction of economic activities, manifesting in the decline of the gross domestic product, investment spending, capacity utilization, household and enterprise incomes and inflation, with associated high rate of unemployment, bankruptcies, currency fluctuation, mostly devaluations, financial crisis (CBN, 2012; Fapohunda, 2012). A country is classified as being in recession, when its economy recorded two consecutive quarters of negative growth in real GDP (CBN, 2012).

From the conceptual perspective, economic recession is associated with the business cycle, connected with periods of boom, recession, slump and economic recovery as reflected by fluctuations in GDP growth. Contributing to the dialogue on business cycle viz-a-viz the Austrian theory of business cycle, Horwitz (2011) noted that the fluctuations in the business cycle was not unconnected to the effect of excess supplies of money on interest rate, thereby causing inter temporal dis-coordination that initially manifested as an unsustainable boom and then a bust. However, arguments on the theory of recession have been varied.

While some schools of thought have argued that recession was a consequence of boom as detailed by the Austrian Business Cycle and Hangover theories, the neo classical economists on the other hand, are of the view that state interference in market, labour union, monopolies and technological shocks are external causes of recession. However, the Keynesians attributed economic recession to ineffective demand and poor economic planning. This school of thought opined that because wages and prices adjust slowly during recession, distortion in production and consumption may move the economy away from its desired level of production and employment for an extended period of time. They rather refocused attention on the relationship between investment decline and the entire economy, which the two theories were deficient in explaining. Gordon (1999), in the review of the hangover theory, harped on the hasty conclusion in Krugman's hangover theory and aligned with the Keynesian position which relegated both the Austrian and Hangover theories.

Economic recession is a product of internal and external factors. According to CBN (2012), the former is borne out of conflict of ideas, misapplication of economic theory and regulatory negligence or policy inconsistency. Other factors were the overheating of private sector, excessive investment in real estate, with non-commensurate returns, corruption, structural and policy distortion. In Nigeria however, Shido-Ikwu (2017) averred that the recent recession of 2016 was associated with factors such as over dependence on oil and gas revenue, low sovereign savings, political risks, fiscal leakages and official corruption.

Food and Nutrition Security: According to the definition of food security concept of the 1996 World Food Summit, food security refers to a condition in which all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preference for an active and healthy life. The United States Department of Agriculture (undated) refers to household food security as access by all household members at all times to enough food for an active healthy life. Further on food security, Salaudeen (2017) noted that the measurement of food security is based on the concepts of availability, access, utilisation, stability. While the availability criteria relates to physical presence of food, access has to do with the ability of the households to acquire adequate amount of food through varied combinations, comprising home production and stocks, purchases, gifts, borrowing and aid. Utilization on the other hand refers to

household's ability to consume the food it has access to and stability entails condition where food is regularly and periodically available and affordable so that it contributes to nutritional security. FAO (2017) in its "State of Food and Nutrition in the World" established that the number of chronically undernourished people in the world increased in 2016 to 815 million, up from 777 million in 2015. The report further affirmed that the food security situation worsened in sub-Saharan Africa, situated mainly in conflict zones combined with drought and floods. At the home front, Nwajiuba (2012) noted that Nigeria faces huge food security challenges, as about 70 per cent of the population lives on less than US$1.25 per day, thus suffering from hunger and poverty. The challenges of sustainable food security in the country, as highlighted by Salaudeen (2017) were conflicting government policy, rudimentary agricultural practices, population increase, environmental issues and corruption.

Perception and Behaviour Analysis: Literature is replete with numerous theories on perception and behaviour analysis. Duvel (1987) for instance, showed that the causes of behaviour were largely human needs, perception and knowledge. These variables influence adoption or a given cause of action, while the consequences of this behaviour are manifested in household physical and economic efficiencies and human social activities. Parminter and Wilson (2003) in the theory of reasoned action; posited that peoples' behaviours are strongly related to their attitudes towards the behaviour.

METHODOLOGY

Study Area: Niger State lies in the North Central of Nigeria and is located between Latitudes 8^{o} 20´ and 11^{o} 30´ North and Longitudes 3^{o} 30´ and 7^{o} 20´ East (Bako, 2018) in the sub-humid climate zone of the tropics. The State comprises mainly of two dominant seasons, namely the wet and dry seasons. Mean rainfall ranges between 750mm and 3,000mm, while average annual minimum temperature is put at 22^{o}C (African Development Bank, 2013). The soil consists of two zones; the interior zone of laterite and the zone of alluvial soils. The main types of soil are regosols, gleysols, acrisols, ferrasols and alisols. Others are luxisols, cambisols, luvisols, nitosols, arenosols and vertisols ((African Development Bank, 2013). Climatic conditions in the state support numerous crops such as yam, rice, maize, cassava, millet, ground nut and cowpea (Bako, 2018).The study was conducted in Chanchaga and Bosso Local Government Areas of Niger State.

Sampling Techniques and Sample Size: A multi-stage random sampling technique was adopted. Stage one

involved the random selection of two Local Government Areas (Bosso and Chanchaga) out of the twenty five LGAs of Niger State. Stage two entailed the random selection of five per cent of villages in each LGA, while stage 3 covers the selection of 90 respondents from the sample frame using the Yamane Sample size determination model at 5 per cent precision level. In all, 52 and 38 respondents were selected from Bosso and Chanchaga LGAs respectively.

Method of Data Collection: The study utilised cross sectional data obtained from primary source, collected with the aid of questionnaires. Primary data collected covers the socio-economic characteristics of farmers, input and output data and perception related data on food security and effect of recession of food security. Relevant data were sourced from Niger State Agricultural Mechanization and Development Agency. Data collected were analysed using descriptive statistics, Likert Scale, Foster Greer and Thorbecke (FGT) model and Probit model.

Model Specification: A 5-point Likert scale was utilised to determine farmers' perception of economic recession on their food security status. The perception weights were rated as strongly agreed (5), agreed (4), undecided (3), disagreed (2) and strongly disagreed (1). A cut-off mean score of 3.0 was used as decision threshold. The results obtained served as proxy for economic regression. The cut off mean was calculated as:

$$= \frac{5+4+3+2+1}{2} = 3 \qquad (1)$$

Foster, Greer and Thorbecke (FGT) model: This model was employed to determine the food security status of respondents

$$\text{FGT Index} = \frac{1}{N}\sum_{I=1}^{H_I}\left(\frac{Z-Y^I}{Z}\right) \propto \qquad (2)$$

Where:
N = Total number of respondents;
y_i = Income of each individual I;
Z = Food security line using mean income of farmers in the study areas
H_i = The number of individuals who are not food secured (those with incomes at or below z)
α = Food security aversion parameter index which takes on the values of 0 and 1 representing incidence of food unsecured and food secured (Foster *et al.*, 1984)
FGT_0, FGT_1 and FGT_2
Where α = 0, the formula reduces to the headcount ratio: the fraction of the population that lives below the food security line, represented as equation 3

$$FGT_0 = \frac{H}{N} \qquad (3)$$

With α = 1, the formula reduces to the food secured gap index, equation 4.

$$FGT_1 = \frac{1}{N}\sum_{I=1}^{H_I}\left(\frac{Z-Y^I}{Z}\right) \qquad (4)$$

With α = 2, the formula reduces to the food secured gap index, equation 5.

$$FGT_1 = \frac{1}{N}\sum_{I=1}^{H_I}\left(\frac{Z-Y^I}{Z}\right)^2 \quad (5)$$

Probit Regression Model: The Probit model was employed to determine the effect of recession (proxied by farmers' perception of recession) on their food security status. The model is explicitly defined in equation 6.

$$Y_i = \propto + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots \beta_n X_n \quad (6)$$

Where;

Y = Food security status; Y_i = 1, if respondents are food secured and Y_i = 0, if respondents are not food secured

X = Vector of independent variables

β_1- βn = Coefficients of the independent variables

α = error or disturbance term

X_1 = Age (years)

X_2 = Household size (numbers)

X_3 = Education (years)

X_4 = Experience (years)

X_5 = Farm size (hectare)

X_6 = Farmers' perception of recession (Likert Score)

X_7 = Cooperative (years)

RESULTS AND DISCUSSION

Demographics and Awareness of Economic Recession: The results in Table 1 show that majority (74.4%) of the respondents were males, implying male domination of agricultural production in the study area. This agrees with the findings of Ogunlade (2007) who reported male dominance of agricultural production, but runs contrary to the outcome of African Development Bank (2014) which reported that 70% of Africa's small holders are women and account for 90% of Africa's agricultural production. Considerable proportions (61.1%) of the respondents were married. Egwu *et al.* (2008) reported that married people play active role in agricultural production, based on poverty levels. Almost half of the respondents maintained household sizes of between 6 and 10 persons, with mean household size of 6. This implies that respondents maintained fairly large households, which has implications for household expenditure pattern and farm enterprise operation, all things being equal. Majority (77.8%) of the respondents earned between ₦20,001 and ₦50,000 per annum, with mean income of ₦36,033.33. Placed against the ₦18,000 monthly minimum wage, it thus implies that most of the farmers in the study area are low income earners. In addition, 93.3% of respondents were aware of economic recession, with extension agents and cooperative societies, being the main sources of awareness.

Food security status of respondents: The results in Table 3 show that majority (61.1%) of the respondents were food insecure, translating to a

food security incidence of 0.61. Moreover, the food security line was ₦ 17,126.72 per month, thus indicating the minimum income needed for the household to be food secured. The food security gap which measures the extent by which the respondents were below the food security line was 0.50 (50.0%), while the severity of food insecurity was 0.02 (2.0%). These outcomes differ from the findings of the study of Omolori (2017), which reported food security gap and severity of 14.0% and 8.0% respectively.

Effect of Respondents' Perception of Economic Recession on their Food Security Status: The results of the Probit regression (Table 4) show that the pseudo R square (coefficient of determination) was 0.7446, indicating that 74.5% of the variation in food security status was explained by the specified explanatory variables in the model. From the z-values of the regression coefficients, four out of the seven variables included in the model were found to be statistically significant. Household size and experience were statistically significant at 1% probability level while education and perception on recession were significant at 5% probability level. However, while farmers' experience and education were positive, household size and farmers' perception of economic recession were negative. The implication of the negative coefficients is that as economic recession continued or deepened farmers in the study area were less food secure. Set *et al.* (2010) reached same conclusion. Similarly, increased household size decreased household food security. Amaza *et al.* (2009) established that household size influenced farmers' food security status.

The results of the marginal effect estimates, as presented in Table 5 revealed that the probability of becoming food secured by the respondents increases or decreases by the coefficients of the significant variables. The coefficients of experience and education were 0.0216 and 0.0480 respectively, implying that an increase in these variables will lead to 2.2 % and 4.8% increase in the probability of being food secure through enhanced farming experience and improvement in farmer education. On the contrary, the probability of being food secure decreases with 8.5% increase in household size and an increased negative perception of recession of about 30.3%.

CONCLUSION AND RECOMMENDATIONS

The study concluded that most of the respondents were aware of economic recession, through the extension agents and their cooperative societies. Respondents also had a strong

perception of economic recession as it affects household food security. Most households in the study area were food insecure, while perceptions of economic recession and household size, as perceived by the respondents have a significant and inverse effect on the food security and nutrition status of respondents. On the contrary, respondents' education and farming experience have positive relationship on their food security status. Against this backdrop, the study recommended that farmers in the study area should diversify their economic activities, adopt sustainable and smart coping strategies and maintain manageable household sizes in order to ameliorate the effect of the economic recession, while the State Agricultural and Mechanization Agency should make effort to extend viable, pragmatic technologies and practices, which will help reduce the effect of the recession

Table 1: Demographic characteristics of and awareness of economic recession by farmers

Variables	Frequency	%
Gender of respondents		
Female	23	25.6
Male	67	74.4
Marital status of respondents		
Single	31	34.5
Married	55	61.1
Widowed	4	4.4
Household size of respondents		
< 6	38	42.2
6-10	41	45.6
>10	11	12.2
Income of respondents		
≤ 20,000	10	11.1
20,001 - 30,000	23	25.6
30,001 - 40,000	28	31.1
40,000 - 50,000	19	21.1
> 50,000	10	11.1
Awareness of Economic Recession		
Not Aware	6	6.7
Aware	84	93.3
Total	**90**	**100**
Sources of Awareness of Economic Recession		
Extension Agents	54	60
Cooperative	47	52.2
Friends	36	40
Relatives	20	22.2
Neighbours	11	12.2
Mass Media	6	6.7

Source: Field survey, 2017

Table 2: Farmers' perception of economic recession on food security

Perception Statements	**Sum**	**Weighted Mean**	**Decision**
Economic recession affects the cost of food production	335	3.72	Agreed
Economic recession cause reduction in household income	308	3.42	Agreed
Economic recession causes limited food preference	351	3.9	Agreed
Economic recession causes food scarcity	245	2.72	Disagreed
Economic recession threatens household food security	366	4.07	Agreed
Economic recession changes consumption pattern	390	4.33	Agreed
Economic recession causes adjustment in expenditure	358	3.98	Agreed

Source: Authors' computation from field data, 2017

Table 3: Food security status of respondents

Category	Frequency	%
Food secure	35	38.89
Food insecure	55	61.11
Total	90	100
Food security line/month	₦ 17,126.49/month	
Food security incidence	0.61	
Food security gap	0.5	
Severity of food insecurity	0.02	

Source: Field survey, 2017

Table 4: Probit estimates of effect of respondents' perception of economic recession on food security

Variables	Coefficients	Standard Error	z- value
Constant	-10.3251	5.9655	-1.73*
Age	-0.0507	0.0755	-0.67
Household size	-0.8669	0.2823	-3.07***
Education	0.2303	0.106	2.17**
Experience	0.5109	0.1865	2.74***
Farm size	0.2935	0.4144	0.71
Perception of economic recession	-3.2245	1.3826	-2.33**
Cooperative	-0.4161	0.2845	-1.46
Pseudo R squared	0.7446		
Chi-squared	91.70***		
Log likelihood function	-15.7295		

Source: Computed from field survey, 2017; *** Significant at 1% probability level; ** Significant at 5% and * Significant at 10%.

Table 5: Marginal effects of the estimated probit model

Variables	Coefficients	z-values
Household	-0.0847	-4.10***
Education	0.0216	2.51***
Experience	0.0480	3.47***
Perception of economic recession	-0.3031	-2.68***

Source: Authors' computation from field survey data, 2017. *** Significant at 1% probability level; ** Significant at 5% and * Significant at 10%.

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GROWTH PERFORMANCE, CARCASS AND ECONOMIC CHARACTERISTICS OF WEANER RABBITS FED VARYING LEVELS OF PELLETED BOILED NEGRO COFFEE (*SENNA OCCIDENTALIS*) SEED MEAL

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ABSTRACT
The growth performance, carcass and economic characteristics of weaner rabbits fed diets containing graded levels of pelleted boiled Senna occidentalis seed meal were studied. Forty five (45) mixed breeds and sexes' weaner rabbits were used for the experiment. The rabbits were randomly assigned to five (5) dietary treatments containing boiled Senna occidentalis *seed meal (BSOSM) at 0.0 %, 2.50 %, 5.00 %, 7.50 % and 10.00 % inclusion levels. The experimental design was a completely randomized design. The data collected included body weight and feed intake, while the body weight gain, feed conversion ratio (FCR), protein efficiency ratio (PER), energy efficiency (EE), cost of feed per kg body weight gain and nutrient digestibility were calculated. The data collected were subjected to analysis of variance. The results revealed that there were significant ($P < 0.05$) differences in all parameters measured and rabbits fed 7.5 % BSOSM had the best performance in terms of growth rate, Protein efficiency ratio and energy efficiency (EE). They also had the lowest cost of feed per Kg body weight gain. The result of the carcass characteristics measured showed that these characteristics were significantly ($P < 0.05$) affected by the levels of inclusion of BSOSM. It can be inferred that BSOSM is of good nutritional quality if the anti-nutritional factors are eliminated. It was therefore concluded that up to 7.5 % of boiled* Senna occidentalis *seed meal could be used in formulating diets for rabbits with no deleterious effect on growth performance and carcass characteristics.*

KEYWORDS*:* Weaner rabbits, *Senna occidentalis* seed meal, feed cost/body weight, growth rate, boiling.

INTRODUCTION

There is need to increase the production of protein of animal source in Nigeria. This is due to the fact that the large quantities of proteins consumed in Nigeria are of plant source and this sources lack one or more essential amino acids, whereas proteins of animal sources are balanced in amino acids (Aduku, 2004). The contributions of traditional livestock (cattle, sheep, goat and pig)

to this national problem has been indeed marginal, providing help to only few Nigerians who mostly are urban dwellers (Ahamefule *et al.*, 2000).

In order to meet up with the animal protein requirements of Nigerian population, increased production of monogastric animals like rabbit is necessary because of their high productive potential and short generation interval (Ayanwale, 2006). With the increasing awareness of the great potentials of the domestic rabbit (*Oryctolagus cuniculus*) in the tropics as pet, meat producer, research animal and veritable sources of income; notable efforts are now being directed towards the full exploitation of these desirable potentials even under the harsh tropical intensive husbandry.

The potential of livestock in extenuating the problem of protein insufficiencies in human nutrition in developing countries is becoming less accomplishable (Ari, 2006). This has been attributed to inadequate supply and high cost of some conventional feed ingredients such as soybean, groundnut, maize and wheat in addition to animal protein sources such as fish meal and blood meal. The prices of these conventional feed ingredients have been increasing continuously in recent times; at the same time, availability is often fickle. The problem has been worsened due to the increasing competition between humans and livestock for these conventional feed ingredients (Odunsi, 2003). Feed forms a very important component in livestock production and if not available, livestock will not exist. The search for novel high quality but cheap sources of protein and energy are major sources of concern to nutritionists and bodies charged with the responsibility for food in many parts of the developing world (Kudu *et al*., 2010). This high cost of conventional feed ingredients has necessitated the research into alternative feed ingredients that have high nutritive value, readily available, less expensive and of no use for human consumption, such as senna coffee seeds (*Senna occidentalis*). The utilization of senna coffee seeds (*Senna occidentalis)* in livestock feed is not popular because of lack of information about its nutritional qualities and the presence of anti-nutritional factors such as polyphenols, toxalbumin, cyanide, phytates, anthroquinones and triterpenoids (Abdullahi *et al*., 2003). Boiling is one of the methods which had been used to eliminate the anti-nutritional factors of non-conventional feedstuffs (Yahaya, 2014). Most of the methods used in processing feedstuffs do not completely remove the anti-nutritional factors but only lower the levels of their concentrations to tolerable limits (Akinmutimti, 2004).

This particular research work is aimed at exploring the potentials of *Senna*

occidentalis seeds on the performance of weaner rabbits. It is expected that from this research, useful suggestions would be made that could be favourable to both small and large scale farmers.

MATERIALS AND METHODS

Experimental Site: This experiment was carried out at the Rabbit Unit of the Department of Animal Production Teaching and Research Farm situated at the Main Campus, Gidan Kwano, Federal University of Technology, Minna, Niger State. Minna is located within latitude 09^0 30' and 09^0 45' north and longitude 06^0 30 and 06^0 45'East of the equator. It falls within the Southern Guinean Savannah Agro-Ecological Zone of Nigeria. The mean annual rainfall varies from 1100 - 1600 mm, it has a mean temperature of between 21^0C and 36.5^0C (Federal Metrological Station, Minna, 2015).

Source of Experimental Materials: Forty five mixed breed weaner rabbits of five weeks old with an average body weight of 546.67g were purchased from the Ministry of Livestock and Fisheries Development, Minna, Niger State; while the S*enna* coffee seed pods were harvested from the matured stands along road sides in Bida, Niger state, at the beginning of dry season (October to November). The pods were properly dried and threshed to obtain the seeds. The seeds were cleaned through winnowing, and undesirable particles like sand, undersized seeds, stem and leaves were removed. The quantities required for this experiment were collected.

Processing of *Senna occidentalis* Seeds: All the sorted seeds were boiled. The method of Omoikhoje *et al.* (2009) adopted by Yahaya (2014) was used. The method involved putting the cleaned seeds into heated water at 100^0 C for 60 minutes. At this temperature, majority of the hard cotyledons of the seeds were expected to be softened. After which the boiled seeds were removed, put into a sieve to drain the water and later sun dried. After the cooked seeds have dried considerably (hard to break with hand).they were milled into fine particles by using grinding engine equipped with 600µm mesh screen size. They were thereafter allowed to cool and then stored in air tight containers and labelled boiled *Senna occidentalis* meal (BSOM), The BSOM was analysed for phytic acid, tannin, cyanide and trypsin inhibitor at the Biochemistry Laboratory at the National Cereals Research Institute Baddegi, Niger State,using the methods described by Onwuka (2012).

Experimental design and Management of the Experimental Animals: Forty five mixed breeds of weaned rabbits were randomly divided into five treatment groups. Each group comprised of nine rabbits, which was

further sub-divided into three, such that each replicate groups of three rabbits were obtained for each sub-group with three rabbits per replicate. The rabbits were housed in cages and the floor of the cage were covered with wire mesh for faeces and urine to drop, thus, preventing the rabbits from coming in contact with them. The cages were enclosed in a house under intensive management system, where the floor was cemented. The walls were netted to the roof to prevent entry of foreign bodies and this enhanced cross ventilation. Before the commencement of the experiment, the rabbits were acclimatized for the period of five days, during this period, they were fed control diets. The rabbits were also treated against endo and ecto-parasites using sodex^{R} (deformer) and Ivomectin^{R} respectively. Further medications were administered where necessary. The experiment lasted for the period of twelve weeks.

Experimental Diets: The ground boiled *Senna occidentalis* Seed Meal (BSOSM) was mixed into rabbit's rations at 0.00, 2.50, 5.00, 7.50 and 10.00 % inclusion levels designated as T_1, T_2, T_3, T_4 and T_5 respectively.The compositon of the experimental diets is shown inTable1. Diet T_1, which contained 0.00 % BSOSM, was served as the control diet. The diets were pelleted by a using pelleting machine equipped with 4 mm screen size. The rabbits were fed with the respective ration *ad-libitum* from 6:00 am – 6:00 pm and was supplemented with water spinach (*Ipomoea aquatica*) from 6.00 pm - 6.00 am. Water was also made available to all the rabbits *ad-libitum*. The left over feed was collected and weighed on daily basis in order to know the feed intake. The feeders were cleaned every morning before the provision of fresh feed, and the drinkers were washed and rinsed with clean water every morning and evening.

Data Collection: The records of weekly body weight, weight gain and feed intake were kept while the feed conversion efficiency, protein efficiency and energy efficiency were calculated.

Economic benefit analysis: The method adopted by Yahaya (2014) was used. In this method, the following parameters were determined.

Feed cost / kg weight gain =FCR x cost / kg feed. ; Where FCR= Feed Conversion Ratio

Statistical Analysis: The performance records of the animals were subjected to one-way analysis of variance based on the completely randomized design (CRD) model (SAS, 2008 version 9.2). Duncan multiple range test (Duncan, (1955) was used to separate

the means where significant at 5 % level of significance.

RESULTS AND DISCUSSION

Anti-nutritional factors of raw and boiled *Senna occidentalis* seeds: The results of the effects of boiling process on the anti-nutritional factors of *Senna occidentalis* seed are presented in Table2. The results showed that the percentages of cyanide, phytate, tannin, saponin and trypsin inhibitors in the raw Senna occidentalis seeds were reduced significantly (P<0.05) by the boiling process. The reduction observed in the content of cyanide, phytate, tannin, saponin and trypsin inhibitor are in line with the report of Yahaya (2014) who reported that boiling and malting are effective processes of removing anti-nutritional factors in *Senna occidentalis* seeds and also agreed with the findings of Omoikhoje *et al.* (2009) who observed higher percentage of reduction in ANFs of cooked Bambara nut and attributed it to broken down of intermolecular forces that bind the anti-nutritional factors together in Bambara nut.

Proximate composition of raw and boiled *Senna occidentalis* seeds: The proximate composition of raw and boiled *Senna occidentalis* seeds meal is presented in Table 3. The results show that boiling increased significantly (P<0.05) some nutrients present in *Senna occidentalis* seed used in this experiment. The level of crude protein, crude fibre, ether extract and dry matter content were increased significantly (P<0.05) in boiled *Senna occidentalis* seed meal; this is in line with the finding of Obun *et al*. (2011) who reported that boiling of leguminous seed concentrate the nitrogenous compounds by reducing the water molecules thereby improving the dry matter, crude protein and ether extract content. The NFE (nitrogen free extract), was increased significantly (P<0.05) in the boiled *Senna occidentalis* seed meals, which agreed with the finding of Yahaya (2014) who reported that boiling reduced the moisture and energy content of *Senna occidentalis* seed. The dry matter content of both raw and boiled *Senna occidentalis* seeds was moderately high. This indicated that the seeds whether raw or boiled could be stored for long period of time without spoilage, as the dry matter content values were within 85 to 100 % required for safe storage of foodstuff of plant origin (Anhwange *et al*., 2004).

Table 1: Composition of the experimental diets

Parameters	T1(0.00)	T2 (2.50)	T3 (5.00)	T4 (7.50)	T5 (10.00)
Maize	36.00	36.50	37.00	37.00	37.50
Soybean	27.00	25.00	24.00	24.00	20.00
Blood meal	2.45	2.45	2.45	2.50	2.00
BSOSM	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 Nutrients					
Crude protein	18.05	18.02	18.03	18.05	18.00
Met. Energy (kcal/kg)	2999.26	3000.05	3003.63	3002.78	3004.11
Crude fibre	11.43	11.27	11.24	10.97	11.12
Calcium	1.01	1.02	1.03	1.03	1.02
Phosphorus	0.62	0.60	0.61	0.62	0.59

*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, 1 mg vitamin $B_{12,}$ 15 mgretinol, 165g vitamin $D_{2,}$ 1000 mg DL-tocopherol acetate, 1700 mg copper, 200 mg iodide, 3000 mg manganese, 5000 mg zinc,10,000 mg iron. 0.00: 0 % boiled *Senna occidentalis* Seed Meal 7.50: 7.5 % boiled *Senna occidentalis* Seed Meal 2.50: 2.5 % boiled *Senna occidentalis* Seed Meal 10.00: 10 % boiled *Senna occidentalis* Seed Meal. 5.00: 5 % boiled *Senna occidentalis* Seed Meal Met. = Metabolizable

Table 2: Anti-nutritional factors of both raw and boiled *Senna occidentalis* seed meals

Anti-nutritional factors	Raw	Boiled	% Reduction
Phytic acid(mg/100g)	503.10	356.38	29.16
Tannin(g/kg)	25.64	17.83	71.22
Cyanide(mg/100g)	18.07	6.49	64.08
Trypsin inhibitor(g/kg)	36.85	16.80	54.41

Table 3 Proximate composition of the experimental diets (%)

Parameters	T1 (0.00)	T2 (2.50)	T3 (5.00)	T4 (7.50)	T5 (10.00)
Dry matter	89.21	90.21	90.13	90.47	90.29
Crude protein	18.13	18.04	17.94	18.06	17.92
Ether extract	3.54	3.69	3.98	3.72	4.17
Crude fibre	11.02	10.86	10.74	10.68	10.55
Ash	8.72	8.86	9.23	9.08	9
NFE	47.8	48.76	48.24	48.93	48.65
Total	100	100	100	100	100

*NFE: Nitrogen Free Extract; Diet 1(T1) = 0% SOSM; Diet 2(T2) =2.5% SOSM Diet 3(T3) =5.0% SOSM; Diet 4(T4) =7.5% SOSM; Diet 5(T5) =10.0) % SOSM

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
Initial 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	**
PER	1.43^{c}	1.25^{bc}	0.81^{ab}	0.68^{a}	1.30^{c}	0.21	**
EER	2.36^{c}	2.08^{bc}	1.34^{ab}	1.14^{a}	2.17^{c}	0.30	**

Av.d =Average daily, FCR=Feed conversion ratio, EE=Energy efficiency, PER=Protein Efficiency ratio, SEM = Standard error of the mean, LS = Level of significance.

Table 5 Percentage carcass cuts relative to dressed weight of 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
Hind leg	21.62[a]	22.23[a]	21.45[a]	19.86[ab]	18.40[b]	1.20	**
Fore leg	23.02[a]	12.35[b]	12.75[b]	12.61[b]	21.42[a]	0.73	**
Loin	23.77[ab]	21.67[ab]	23.14[ab]	24.76[a]	20.66[b]	1.71	**
Rib	16.97[bc]	16.01[c]	19.35[a]	17.83[b]	16.17[c]	0.72	**

[a,b,c] Means in the same row with different superscripts are significantly ($P < 0.05$) different, LS: Level of significance, **: Significant, SEM : Standard Error of the Mean.

0.00: 0 % boiled *Senna occidentalis* Seed Meal ;2.50: 2.5 % boiled *Senna occidentalis* Seed Meal;5.00: 5 % boiled *Senna occidentalis* Seed Meal;7.50: 7.5 % boiled *Senna occidentalis* Seed Meal;10.00: 10 % boiled *Senna occidentalis* Seed Meal

Table 6: Organ percentages relatives to dressed weight 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
Liver	6.57[a]	4.17[b]	3.90[b]	3.94[b]	3.77[b]	0.42	**
Lung	2.28[a]	1.87[b]	1.32[c]	1.08[d]	1.23[cd]	0.07	**
Kidney	1.72[a]	1.59[ab]	1.50[b]	1.29[c]	1.25[c]	0.09	**
Heart	0.62[a]	0.46[c]	0.55[b]	0.38[d]	0.63[a]	0.03	**
Spleen	0.26[a]	0.19[b]	0.16[b]	0.16[b]	0.14[b]	0.03	**

SEM = Standard error of the mean, LS = Level of significance.

Table 7: Economic characteristics of 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
Feed intake(g)	4746.00[a]	4480.56[b]	3822.84[c]	3690.12[c]	3400.39[d]	81.91	**
Cost of feed (₦/kg)	155.30[a]	152.70[b]	151.40[c]	150,00[d]	148.10[e]	0.00	**
Total cost of feed (₦)	736.82[a]	684.05[b]	578.76[c]	533.52[c]	503.52[d]	12.23	**
Weight gain (g)	628.30[bc]	651.70[bc]	868.30[ab]	1003.30[a]	506.70[c]	117.85	**
Cost/kg wt gain (₦)	1224.20[a]	1062.50[a b]	676.30[bc]	563.20[c]	1066.20[a b]	176.14	**

SEM = Standard error of the mean, LS = Level of significance.

Growth performance of weaner rabbits fed graded levels of pelleted boiled *Senna occidentalis* seed meal: The results of the effect of graded levels of pelleted boiled *Senna occidentalis* seed meal on growth performance of weaner rabbits are presented in Table 4.. The best performance in final body weight, average daily body weight gain, feed conversion ratio, protein efficiency ratio and energy efficiency recorded in those rabbits fed 7.5 % BSOSM might be attributed to nutritional quality of boiled *Senna occidentalis* seed meal. This is in agreement with the findings of Augustine *et al.* (2010) who reported that feeding of processed *Cassia obtusifolia* to broiler chickens increased weight gains and reduce feed conversion ratio. The average daily feed intake was gradually reduced as the levels of BSOSM increased in the diet which agreed with the findings of Yahaya (2014) who reported that the feed intake of guinea fowls decreased progressively as the levels of boiled *Senna occidentalis* seed meal increased in the diet. The lowest final bodyweight obtained in rabbits fed 10 % BSOSM could be as a result of lower feed intake which might be attributed to higher levels of anti-nutritional factors in *Senna occidentalis* seed meal contained in the diet as reported by Midala *et al*. (2013). This is an evidence that boiling did not completely remove the anti-nutritional factors in the feedstuff (Yahaya, 2014).

Carcass cuts percentages relative to dressed weight of rabbits fed graded levels of pelleted *Senna occidentalis* seed meal: The carcass cut up - parts as percentage of dressed weight of rabbits fed graded levels of pelleted boiled *Senna occidentalis* seed meal are presented in Table5. The rabbits fed 10 % BSOSM had lower hind leg, loin and ribs as percentage of dressed weight except forelegs that are lower in those rabbits fed 2.5 % BSOSM which could be attributed to lower feed intake as this agreed with the finding of Amaefule (2001), who reported that rabbits might have been surviving on less feed due to high level of anti-nutritional factors. The hind legs weight recorded in this experiment was lower; but the fore legs, loin and ribs as percentage of dressed weight were higher than the values reported by Jiya (2012). The difference observed in this study may be as a result of different protein quality used in the diets.

The weight of the internal organs as percentage relative to dressed weight of rabbits fed graded levels of pelleted boiled *Senna occidentalis* seed meal are presented in Table 6. The results showed significant differences ($P<0.05$) in all the parameters measured. Similar pattern of percentage was observed in the liver,

lung, kidney, heart and spleen which decreased progressively as the inclusion levels of BSOSM increased in the diets. This agreed with the finding of Yahaya (2014) who reported that the heart and lung of guinea fowls were reduced as inclusion levels of BSOSM increased in the diet of guinea fowls and attributed it to the negative impact of anti-nutritional factors in *Senna occidentalis* seed. Also, Tasaka *et al*. (2000) reported cardiomyopathy in group of rabbits fed 4 % raw *Senna occidentalis* seed meal and concluded that the liver and heart were the most affected organs.

Economic characteristics of rabbits fed graded levels of pelleted boiled *Senna occidentalis* seed meal: The results of the economic characteristics of rabbits fed graded levels of pelleted boiled *Senna occidentalis* seed meal are presented in Table 7. The levels of inclusion of BSOSM had effect in all parameters measured. The feed intake decreased as the inclusion levels of BSOSM increased in the diet. This result agreed with the findings of Yahaya (2004) who reported that the feed intake of guinea fowls decreased as the inclusion levels of processed *Senna occidentalis* increased in the diets .The cost of producing 1 kg diets varied from ₦155:30 to ₦148:10. The lowest cost of producing 1 kg diets recorded by those rabbits fed 10 % BSOSM was due to cheap cost of *Senna occidentalis* seed. The highest weight gain recorded by those rabbits fed 7.5 % was in agreement with findings of Yahaya (2014) who reported that feeding boiled *Senna occidentalis* seed meal diet to guinea fowls increased weight gain and was equally cost effective. The cheapest cost of feed per kg weight gain of ₦563:20 was recorded in rabbits fed 7.5 % BSOSM. This might be attributed to nutritional quality of boiled *Senna occidentalis* seed which is in agreement with finding of Augustine *et al*. (2010) who reported that feeding of processed *Cassia obtusifolia* to broiler chickens increase weight gain and reduced cost of production.

CONCLUSION AND RECOMMENDATION

This study show that pelleted *Senna occidentalis* seed meal could be of good nutritional quality if the anti-nutritional factors are removed; the highest body weight gain and the cheapest cost of feed per kg body weight gain were recorded at 7.5 % dietary inclusion level of boiled *Senna occidentalis* seed meal.This level could be tolerated by the rabbits, and is also cost effective. It could then be recommended that up to 7.5 % boiled *Senna occidentalis* seed meal can be included in the diets of weaner rabbits. Further researches should be carried out to explore other processing methods on *Senna occidentalis* seed

with aim of making it more available in the livestock industry.

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GROWTH AND EGG LAYING PERFORMANCE OF GROWING TURKEYS FED DIETS CONTAINING VARYING LEVELS OF HONEY

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ABSTRACT
An eighteen weeks feeding trial was conducted in two phases to determine the effects of feeding varying levels of honey, as a nutritive additive, on the growth and egg laying performance of growing turkeys. A total number of 90 twelve-weeks-old growing turkeys with an initial mean body weight of 1,760.81 g and of mixed sexes were used for the study. During the first phase, the birds were randomly allotted to three dietary treatments designated as T_1, T_2 and T_3 containing 0, 2 and 4 % of honey respectively; with 30 birds per treatment, each replicated thrice with 10 birds per replicate in a completely randomized design experiment. Nutrient digestibility trial was conducted at the end of the 9^{th} week of the experiment. During the second phase, 54 twenty-two-weeks old growing turkey were randomly allotted to three treatments, which were standard diets for laying turkey containing 0, 2 and 4 % of honey respectively, and replicated three times with six birds in each replicate in a completely randomized design experiment. With the onset of egg laying, eggs were collected daily and the number recorded per replicate. Results show that there were no significant ($p>0.05$) differences in daily feed intake, body weight gain and feed conversion ratio (FCR) among growing turkeys fed the different treatment diets. Also, there were no significant ($p>0.05$) differences in nutrient digestibility among the treatment groups, except in nitrogen free extracts where birds on Diet T_3 (4 % honey) had significantly ($p<0.05$) higher values. For laying turkeys, FCR and HDP (hen day production) were significantly ($p<0.05$) improved as the dietary levels of honey increased, with the best values obtained at 4 % dietary inclusion level.Hence, 4 % honey should be included in the diets of both growing and laying turkeys for optimum growth performance, nutrient digestibility and egg production.

KEYWORDS: Growth, egg laying performance, honey, growing turkey.

INTRODUCTION
Poultry production is an age long occupation. Emphasis on commercial poultry production in the past had been on the use of broilers and laying chickens for the production of meat

and eggs respectively. However, these have proved inadequate in meeting up the animal protein demand with increasing human population in Nigeria (Ugwuene and Onwudike, 2010).

Turkey is a more efficient converter of dietary protein into edible meat protein than broiler chickens, and its breast meat has relatively higher value (Case *et al*., 2010). There is the need to increase turkey production in Nigeria; to take advantage of these attributes and other merits of the bird such as its large size, fast growth rate and high fecundity. Turkey breast is whitish in colour and packed with more flavour than chicken (Odunsi, 2006).

There are several feed additives in use in the poultry industry today, most of which like antibiotics are artificial in nature. These additives are used in addressing the dietary deficiencies affecting the growth and development of poultry birds. However, they have health and welfare implications; these include bacteria resistance, long withdrawal time and residual effects (Kizilaslan and Kizilaslan, 2007). To avoid these risks in the use of antibiotics as growth promoters, the discovery and use of prebiotics and probiotics, having no withdrawal time and no residual effect, have become necessary. Hence, there is a paradigm shift towards the use of natural prebiotics and probiotics. One of such prebiotics is honey. Honey is a sweet natural product widely available worldwide (Malacalza *et al.*, 2005). Apart from its ability to reduce multiplication of some pathogens, it is a powerful aphrodisiac and a valuable antibacterial wound dresser (Kizilaslan and Kizilaslan, 2007). Also, honey improves the palatability of feed, serves as a feed binder and improves the growth rate of animals, in addition to the fact that it improves the nutritive value, digestibility and feed efficiency of livestock feeds and acts as an antioxidant against rancidity in feeds (Adebolu, 2015). Therefore, the aim of this research study was to evaluate the growth and egg laying performance of growing turkeys fed diets containing varying levels of honey.

MATERIALS AND METHODS

Experimental site: This research work was carried out at the Poultry Unit of the Department of Animal Production Teaching and Research Farm, Federal University of Technology, Minna, Niger State, Nigeria. Minna is located within the Southern Guinea Savanna vegetational zone of Nigeria, lying between latitude 9^0 28′N to 9^0 37′N and longitude 6^0 23′E to 6^0 33′E, with mean annual rainfall of 1000 – 1500 mm (FUTMIN, 2012).

Sources of feed ingredients and the experimental diets: Honey used for this study was purchased from the Office of the Agricultural Development Project (ADP), Minna, Niger State, Nigeria. The viscosity of the honey was lowered by heating it slowly on a low flame for 10 minutes at 60^0 C, in order not to impair or distort its flavour and volatile aroma and to ease its mixing with the feed (Obun *et al*., 2010). This was then added to the diets at 0, 2 and 4 % dietary inclusion levels to form Diet T_1, T_2 and T_3 respectively. Other ingredients used for compounding the feed were obtained at feed ingredients depots within Minna. The composition of the experimental diets formulated to contain 3, 000 Kcal/kg metabolizable energy (ME) and 20 % crude protein (CP) for the growing phase and 3, 000 Kcal/kg ME and 15 % CP for the laying phase are shown in Table 1 and Table 2 respectively.

Management of experimental birds and the experimental design: Ninety (90) twelve-weeks-old grower turkeys were randomly allotted to three treatment groups, made up of three replicates and 10 birds per replicate in a completely randomized design experiment. They were fed the experimental diets *ad libitum* for 10 weeks. At the laying phase, 54 female turkeys that were 22 weeks old were used. They were fed the experimental laying diets *ad libitum* during the laying phase. Each treatment had 18 turkeys, made up of three replicates of six turkeys per replicate, in a completely randomized design experiment. The birds were raised on deep litter system. Management practices such as sanitation and vaccination were strictly adhered to, to prevent the outbreak of any poultry disease. Routine management operations such as cleaning of drinkers, feeders and the environment were carried out.

Data collection: Parameters measured were feed intake and body weight gain. Weighed quantities of feed were supplied to turkeys in each replicate and the quantity consumed per day was obtained by subtracting the quantity of the left-over from the quantity supplied. The initial weights of the birds were recorded. Subsequently, average weekly body weight gain was obtained by subtracting the body weight of the previous week from the body weight of the present week. Feed conversion ratio (FCR) was determined by dividing the quantity of feed consumed by the body weight gain of the birds in each replicate. At the laying phase, FCR was determined in terms of feed consumed per gramme of egg laid (Malik *et al*., 2010).

Digestibility trial was conducted at the 9^{th} week of the experiment. Six birds per treatment were randomly selected

and placed in special metabolism cages for five days, for the birds to adjust to the conditions in the cages; thereafter, faecal samples were collected for four days using the total collection method. Faecal droppings were collected in aluminium foils and oven dried at 80 ^{0}C for 24 hours. The obtained samples were analysed for their proximate composition using the procedures of AOAC (1990) and the results used to calculate the digestibility coefficient as outlined by Lamidi *et al*. (2008).

During the laying phase, eggs were collected per replicate and the quantities collected were used to calculate hen day production (HDP) using the formula of Bawa *et al*. (2010) thus:

Hen day production (%)
= Number of eggs produced X 100
Number of birds x Number of days in lay

Chemical analysis: The proximate composition of honey, the experimental diets and the collected faecal droppings were determined using the standard procedures of AOAC (1990).

Statistical analysis: Data collected were subjected to analysis of variance (ANOVA) at 5 % probability level using Statistical Package for Social Scientists (IBM SPSS, version 21). Where means were significantly different, they were separated using Least Significant Difference (LSD).

Table 1 Composition of the experimental diets fed to grower turkeys

	Varying dietary levels of honey (%)		
Ingredients	0	2	4
Maize	58.00	56.00	54.00
Groundnut cake	29.00	29.00	29.00
Honey	0.00	2.00	4.00
Palm oil	2.00	2.00	2.00
Wheat offal	4.90	4.90	4.90
Fish meal	2.00	2.00	2.00
Lysine	0.30	0.30	0.30
Methionine	0.30	0.30	0.30
Bone meal	3.00	3.00	3.00
*Premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Total	100.00	100.00	100.00
Calculated nutrients composition			
Metabolizable energy (Kcal/kg)	3059	3067	3075
Crude protein (%)	20.30	20.29	20.28
Crude fibre (%)	3.19	3.13	3.08
Lysine (%)	1.08	1.08	1.07
Methionine (%)	0.50	0.56	0.55
Calcium (%)	1.34	1.34	1.34
Phosphorus (%)	0.94	0.93	0.93

*Each 2.5 kg of the premix contain the following: Vitamin A, 7500 IU; vitamin E, 1,000 IU, vitamin B_1, 375 mg; vitamin B_2, 125 mg; vitamin B_3, 500 mg; vitamin B_6, 150 mg; vitamin B_{12}, 2.5 mg; vitamin K, 15 mg; vitamin C, 10 mg; folic acid, 150 mg; pantothenic acid, 14.4 mg; Ca, 12.5

mg; Cu, 8.0 mg; Fe, 32 mg; I, 0.8 mg; Se, 100 mg; Mg, 0.25 mg and Cl, 250 mg.

Table 2 Composition of the experimental diets fed to laying turkeys

	Varying dietary levels of honey (%)		
Ingredients	0	2	4
Maize	60.00	58.00	56.00
Groundnut cake	15.00	15.00	15.00
Honey	0.00	2.00	4.00
Palm oil	3.00	3.00	3.00
Wheat offal	4.90	4.90	4.90
Fish meal	2.50	2.50	2.50
Lysine	0.50	0.50	0.50
Methionine	0.50	0.50	0.50
Bone meal	4.00	4.00	4.00
Limestone	6.00	6.00	6.00
*Premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Total	100.00	100.00	100.00
Calculated nutrients composition			
Metabolizable energy (Kcal/kg)	2942	2954	2958
Crude protein (%)	14.98	14.97	14.96
Crude fibre (%)	3.62	3.57	3.51
Lysine (%)	1.09	1.08	1.08
Methionine (%)	1.25	1.24	1.24
Calcium (%)	4.03	4.03	4.03
Phosphorus (%)	1.09	1.09	1.08

*Each 2.5 kg of the premix contain the following: Vitamin A, 7500 IU; vitamin E, 1,000 IU, vitamin B_1, 375 mg; vitamin B_2, 125 mg; vitamin B_3, 500 mg; vitamin B_6, 150 mg; vitamin B_{12}, 2.5 mg; vitamin K, 15 mg; vitamin C, 10 mg; folic acid, 150 mg; pantothenic acid, 14.4 mg; Ca, 12.5 mg; Cu, 8.0 mg; Fe, 32 mg; I, 0.8 mg; Se, 100 mg; Mg, 0.25 mg and Cl, 250 mg.

RESULTS AND DISCUSSION

The result of the proximate composition of honey used in feeding the turkeys both at the growing and laying phases is presented in Table 3. The dry matter, crude fibre and ash content of honey were similar to that reported by Nweze and Ekwe (2008) and Obun *et al*. (2010), showing that honey has an appreciable quantity of protein (8 %), no fibre (0 %) and very rich in nitrogen free extracts (73.06 %).

The result of the growth performance of growing turkeys fed diets containing varying levels of honey is presented in Table 4. Daily feed intake, body weight gain and feed conversion ratio (FCR) were not significantly ($p>0.05$) influenced by the varying inclusion levels of honey in the diets of the growing turkeys. This differs from the report of Obun *et al*. (2010) who observed improved feed intake and growth performance of broiler chickens as the dietary levels of honey increased. The improved feed intake was attributed to its palatability, its ability to reduce

dustiness in the feed and its capability to bind all the nutrients together leading to reduced wastage and proper utilization of feed. This was not well manifested in this research study with growing turkey.

Table 3 Proximate composition of honey fed to the experimental birds

Parameter	% Composition
Dry matter	89.98
Crude protein	8.81
Crude fibre	0.00
Ether extract	5.97
Ash	2.14
Nitrogen free extract	73.06

Apparent nutrient digestibility of dry matter, crude protein, crude fibre, ash and ether extract were not affected ($p>0.05$) by the inclusion of honey in the diets of the turkeys while that of nitrogen free extracts was enhanced ($p<0.05$) in birds fed honey (Table 5). The greater values observed for nitrogen free extracts (NFE) digestibility in turkeys fed honey based diets might be attributed to the higher sugar content of the diets. Obun *et al*. (2010) also reported significant ($p<0.05$) NFE digestibility

Table 4 Growth performance of growing turkeys fed diets containing varying levels of honey

	Dietary inclusion levels of honey (%)				
Parameters	0	2	4	SEM	LOS
Initial body weight (g)	1714.44	1768.56	1799.44	90.81	NS
Final body weight (g)	2926.10	3055.56	3218.33	1.62	NS
Daily feed intake (g)	151.31	150.85	152.90	5.27	NS
Daily body weight gain (g)	25.07	25.82	28.39	157	NS
Feed conversion ratio (FCR)	6.86	6.69	6.39	0.53	NS

SEM = Standard error of means, LOS = Level of significance, NS = Not significant ($p>0.05$)

Table 5 Apparent nutrient digestibility of growing turkeys fed diets containing varying levels of honey (%)

	Dietary inclusion levels of honey (%)				
Parameters	0	2	4	SEM	LOS
Dry matter	92.40	91.15	92.43	0.58	NS
Crude protein	91.62	90.25	92.19	0.66	NS
Crude fibre	84.39	77.46	84.79	1.77	NS
Ether extract	91.25	90.96	92.38	0.61	NS
Ash	76.32	64.91	69.42	2.63	NS
Nitrogen free extracts	82.25^{ab}	85.75^{b}	87.76^{a}	0.38	*

[ab] Means in the same row with different superscripts were significantly ($p<0.05$) different. SEM = Standard error of means, LOS = Level of significance, NS = Not significant ($p>0.05$), * = Significantly different ($p<0.05$)

Table 6 Performance of laying turkeys fed diets containing varying levels of honey

	Dietary inclusion levels of honey (%)				
Parameters	0	2	4	SEM	LOS
Initial weight (g)	3083.33	3133.33	3162.50	52.93	NS
Final weight (g)	3862.50	3758.33	3795.83	80.61	NS
Feed intake (g/day)	191.75	193.41	195.55	2.50	NS
FCR (g feed/g egg)	3.97^{b}	2.24^{a}	1.61^{a}	2.51	*
No. of eggs produced/bird	87.33^{a}	94.33^{a}	107.67^{b}	2.36	*
Hen day production (%)	13.12^{c}	17.90^{b}	28.76^{a}	2.31	*

[ab] Means in the same row with different superscripts were significantly ($p<0.05$) different. SEM = Standard error of means, LOS = Level of significance, FCR = Feed conversion ratio, NS = Not significant ($p>0.05$), * = Significantly different ($p<0.05$)

in broilers. The enhanced digestibility of NFE in birds fed honey could also be linked to the presence of enzymes and vitamins in honey. According to Farrel and Hardakar (2001), vitamins such as ascorbic acid, thiamine, riboflavin, pyridoxine and pantothenic acid from floral sources; and proline content of honey could contribute positively to the enhancement of the efficiency of feed digestibility.

The performance of laying hens fed diets containing varying levels of honey is presented in Table 6. The results show that there were no significant ($p>0.05$) differences in initial body weight, final body weight and feed intake among birds fed the different dietary treatments; only FCR and hen day production (HDP) showed significant ($p<0.05$) differences among the treatments. As in the growing phase, FCR at the laying phase was significantly ($p<0.05$) improved as the dietary level of honey in the diet increased, with the best value (1.61) obtained at 4 % dietary inclusion level of honey. This could be due to the antibiotic properties of honey as corroborated by Nweze and Ekwe (2008) and Obun *et al*. (2010). For HDP, results show that values obtained for birds fed 4 % honey (28.76 %) was significantly ($p<0.05$) higher than the values obtained for birds fed 2 % (17.90 %) and 0 % (13.12 %) honey respectively. This could be due to the fact that honey as a prebiotic beneficially affects the host farm animal by selectively stimulating the growth and

activity of one or limited number of bacteria in the colon (Gibson and Roberfroid, 1995). Hence, honey and other fermentable sugars improves the useful microbial population of the GIT, alter the immune system, prevent colon cancer and reduce pathogen invasion thereby translating into better performance in farm animals (Cummings and Macfarlane, 2002).

CONCLUSION AND RECOMMENDATION

Results from this study show that honey can be included up to 4 % in the diets of both growing and laying turkeys with no deleterious effects on their growth performance and nutrient digestibility. Rather, FCR and HDP were improved in laying turkeys fed the 4 % honey when compared to the other diets. Hence, 4 % honey should be included in the diets of both growing and laying turkeys for optimum growth performance, nutrient digestibility and egg production.

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