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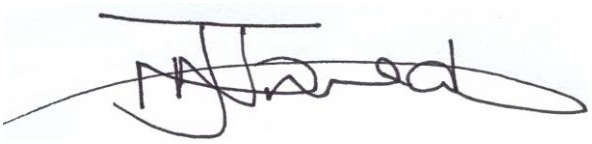
Editorial

The Editorial Board is happy to announce the release of Volume 8 of our reputable Journal. With this release, the Journal is now up to date and we hope to now stabilise and do all that is possible to bring out two issues i.e. April and October each year, baring all unforeseen circumstances. We shall also work towards making the review process fully online without the need to send email attachments to reviews.

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. It is our plan to have the names of reviewers for each Volume printed so as to give wider publicity to their expertise, which we shall commence with volume 9. 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

Errata:
Reproductive performance of rabbits fed varying levels of soya bean milk residue by Alemede, I.C., Abdulsalami, O., Ogunbajo, S.A., Banjo, A.A & Ibrahim, M.J was inadvertently published in Volume 7 twice. The version that appeared in Volume 7(2) is hereby withdrawn. The error is regretted.

In addition to the above, some typographical errors were spotted. We shall work hard to ensure error-free publishing.

Editor-in-Chief

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REPRODUCTIVE PERFORMANCE OF RABBITS FED VARYING LEVELS OF SOYA BEAN MILK RESIDUE

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Abstract
Twenty (20) female rabbits of mixed breeds aged between 5- 6 months were used to evaluate the reproductive performance of rabbits fed Soya bean Milk Residue (SBMR). They were divided into five dietary groups; formulated with soya bean residue replacing Groundnut Cake (GNC) as a source of protein at 0 %, 8 %, 16 %, 24 %, 32 % levels respectively. The litter size, birth weight, gestation gain, gestation length, kindling loss, neo natal mortality and coefficient of milking capacity were not affected (p>0.05) by the dietary treatment. However, significant (p<0.05) differences were observed in litter size at weaning, weight gain of kittens, weight of kitten at weaning and survival rate to weaning. It was concluded that soya bean milk residue could be included in the diets of rabbit does up to 24 % without any deleterious effect on both pre-natal and post-natal performance of kittens.

Key words: Rabbits, soya bean milk residue, reproduction.

Introduction

In developing countries, the rapid growth in human population coupled with the competition between human and animals for the few available conventional feed ingredients has necessitated the search for alternative sources of protein to meet up the population challenges. Economic indices indicate that as this population trend continues, more people are to be fed and Agriculture outputs needs to be increased rather through food importation into such countries (Allen, 1993). In order to maximize food production and meet animal protein requirements, viable options need to be explored and evaluated (Owen *et al.*, 2008).These options include the rearing of animals with short gestation periods such as rabbits. The rabbit (*Oryctolagus cuniculus)* is the most productive meat producer among all domesticated animals whose feeding habits offer no appreciable competition with man simply because it can subsist on greens as basal diets. Rabbit meat is acknowledged as being cheap and of high quality protein (about 22 %) and low in fat (4 %) and cholesterol (5 %) (Jones, 1990; Handa *et al.*, 1995) and thus possesses health promoting qualities (Aduku and Olukosi,1990).

Growing rabbits can be maintained satisfactorily on diets of 100-200 g green roughage and 40-60 g of concentrate mixture for maximum production (Ranjhan,1980) and about 4 months are required to produce a 2 kg market rabbit under subsistence condition (NRC, 1990). In addition to this, rabbits have a number of other characteristics that might be advantageous to subsistence farming system such as their small body size and short generation interval with a relatively short gestation period average of 30-31 days. The daily weight gain is high in proportion to the body weight which gives them a rapid growth rate, and sexual maturity is early. These factors result in the rabbit reaching the weight of a sexually mature animal 30% faster than other animals (Ajayi *et al.*,2005) and also make rabbits suitable as meat producing small livestock in developing countries (Arijeniwa *et al.*,2000).

Rabbit grow fast like broiler chickens and can utilize feed protein more efficiently than broilers. Improving the nutrition of breeding females is of primary importance for increasing the productivity of domestic rabbit (Ren *et al.,* 2003). Supplementation with soya bean meal as a source of protein has been suggested for enhanced growth and reproductive performance of rabbit (Rahim *et al.*,1997). The nutrition of rabbit in Nigeria is primarily based on *Tridax procumbens* and or *Centrosema pubescens* whose growth and availability in the dry season cannot sustain all-year rabbit production (Odeyinka *et al.*,2007). Soya bean belongs to the family of *fabaceae* and the kingdom of *plantae.* It is a specie of legume native to Africa. It plays an important role in livestock feeding by providing a reasonable animal protein The by-product of turning soya beans into soya beans milk or tofu which is the ground up fibrous part of the beans is referred to as soya bean milk residue. The soya beans milk residue is a nutritional powerhouse containing soluble and non-soluble fibre, protein, calcium and other minerals (Yang, 2005). However, the use of soya bean milk residue in livestock feeding has not been well documented, rather, it is discarded as waste following soya bean milk extraction. This study will evaluate the reproductive performance of rabbits fed soya bean milk residue.

MATERIALS AND METHODS

The study was carried out at the Rabbitry unit of the Ministry of Livestock and Fisheries, Minna, Niger State. Minna is located in the Southern Guinea savannah vegetation belt of Nigeria between

longitude $6^0$32 ' E and latitude $9^0$37 ' N, at an elevation of 258.5 m above sea level. Its mean annual rainfall is about 1312 mm, its annual temperature ranges from 19 - 37 ^{0}C. Minna is characterized by two seasons, the wet season (April – October) and the dry season from November to March (Federal University of Technology, Minna Student Handbook ,2008).

Twenty (20) female rabbits of mixed breed, obtained from Minna and its environs, and aged 5 - 6 months were used in the study which lasted for three months. Soya bean milk sievate was collected free of charge from within Minna. The sievate was air dried and ground afterwards to make it into a powdery, ready to use form to be included in the feed composition. The rabbits were randomly assigned in a complete randomized design into five dietary groups; T1, T2, T3, T4 and T5 formulated with soya bean residue replacing groundnut cake as a source of protein at 0%, 8%, 16 %, 24%, 32% level, respectively and were isonitrogenous and isocaloric. The rabbits were housed individually in metallic cages provided with feeders and drinkers. The major source of energy in the diet was maize, while rice bran served as source of fibre. Other ingredients used include bone meal, vegetable oil, salt, premix, lysine and methionine (Table 1). All routine management practices were carefully observed.

Data were collected on the following birth traits: Litter Size at Birth (LS), Litter Birth Weight (LBW), Gestation Length (GL), Gestation Gain (GG), Kindling Loss (KL), Neo- natal Mortality (NNM), Coefficient of milking capacity (M) and Weaning traits: Litter Size at Weaning (LSW), Litter Weight at Weaning (LWW), Litter Weight Gain (LWG), Weaning Sex Ratio (WSR) and Survival Rate to weaning (SRW) in the experimental rabbits. Data collected were subjected to one way analysis of variance. Duncan's multiple range tests was used to separate means using SPSS 16.0 (2006)

Table 1. Composition of the experimental diets

	DIETARY TREATMENT				
Ingredients	**0 %**	**8 %**	**16 %**	**24 %**	**32 %**
Maize	42.86	37.67	31.94	30.08	28.91
GNC	28.72	22.99	17.63	11.90	6.15
Rice bran	22.17	25.09	28.18	27.77	26.69
Vegetable oil	2.00	2.00	2.00	2.00	2.00
SBMR	0.00	8.00	16.00	24.00	32.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50	0.50
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated analysis					
Protein	18.10	18.01	17.99	18.01	18.00
Metabolizable Energy (kcal/kg)	2379	2371	2316	2309	2301

GNC- groundnut cake **SBMR-** soyabean milk residue

Vitamins: A = 10,000IU; D_3 = 2,000IU; E = 5IU; K = 2mg; Riboflavin = 4.2mg; B_{12} = 0.01mg; Pantothenic acid = 5mg; Nicotinic acid = 20mg ; Folic acid=0.5mg.

Minerals: Se = 100mg; Cu = 1.0mg; Fe = 20mg; Iodine = 0.8mg; Choline = 3mg; Mg = 56mg; Co = 1.25mg; Lysine, Methionine and Tetramycine (Broad-spectrum anti-biotics and growth promoters).

RESULTS AND DISCUSSION

The proximate composition of the soyabean milk residue and experimental diets as presented in Tables 2 and 3 revealed that soya bean milk residue is very rich in crude protein (34.47 %) and crude fibre (26.00 %) with low level of ether extract (8.50 %). These high levels of protein and fibre are qualities that portray SBMR as an ideal feed ingredient for rabbits. The same trend was observed with the formulated feed where crude protein, crude fibre and ash content were high. The high crude protein and fibre values of SBMR means it is adequate for both growing and breeding rabbits. The high values are in agreement with Pyke *et al*. (1981) and Okoye *et al.* (2008) who reported that legumes are good sources of ash, protein and fibre. The value obtained for crude protein was high and falls within the range of 9 – 20 % and 18.56 % reported by Dairo (2008) and Esonu *et al.* (2006) who fed dried bovine rumen digesta to growing rabbits and broiler finisher respectively.

Table 4 which shows the results obtained for birth traits of rabbits fed varying level of soya bean milk

residue revealed that there were no significant ($p>0.05$) differences among the mean values obtained for all the parameters measured (litter size at birth, litter birth weight, gestation length, gestation gain, kindling loss, neonatal mortality and coefficient of milking capacity). However, Table 5 showed that the values of the average litter size at weaning (LSW), litter weaning weight (LWW), litter weaning weight gain (LWG) and survival rate to weaning (SRW) differed significantly ($P<0.05$), revealing better performance with rabbits fed the test diets. SRW and LSW improved with addition of SBMR while LWW and LWG were significantly ($P<0.05$) better in rabbits fed the diets with 8 % and 16 % SBR level of inclusion. 'The better survival rate to weaning observed in rabbits on the 16% SBMR diet may be attributed to the lower number of kittens in that treatment which paved way and easy access to does nipples without much competition among the kittens thereby enhancing their chances of surviving. Similarly, increase in the average litter size at weaning with increasing level of SBMR in the diet may be attributed to the high level of crude protein and crude fibre in SBMR. According to Aganga *et al.*(1998), crude protein plays an important role in ovulation rates, fertility, development as well as litter size and has an important role in cell growth and transportation of substances in the body.Peteducation.com (2011) reported that because of the unique nature of the digestive system of rabbit, they require diets that are high in fibre while Ngu (2001) noted that high dry matter intake can be improved by supplementary feed with high fibre content.This in turn could facilitate the performance of rabbits

Table 2.Proximate composition of soya bean milk residue (%)

Composition	Soya bean milk residue (%)
Dry Matter	94.1
Moisture	5.9
Crude Protein	34.47
Crude Fibre	26
Ether Extract	8.5
Ash	6.5
Nitrogen Free Extract	18.63
Metabolizable Energy (Kcal/Kg)	2998.9

CONCLUSION AND RECOMMENDATION

Based on the results of this study, it is concluded that replacing of groundnut cake with soya bean milk residue as a source of protein has no harmful effect on the birth traits of rabbits, Also, up to 24 % level of soya bean milk residue can be included in the diet of rabbits to achieve a good reproductive performance.

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Table 3. Proximate composition of experimental diets

	DIETARY TREATMENTS				
Parameters	**0%**	**8%**	**16%**	**24%**	**32%**
Dry matter	94.2	93.8	94.8	93.5	94.3
Moisture content	5.8	6.2	5.6	6.5	5.7
Crude protein	18.16	17.73	17.9	17.26	18.26
Crude fibre	13.4	13.8	12.8	13.6	13.4
Ether extract	11.86	12.27	10.2	11.96	13.18
Ash content	19	19.38	18.5	18.42	18
Nitrogen free extract	31.78	30.62	35.4	32.26	31.46
Energy (kcal/Kg)	3185	3118.3	2934	3069.2	3091

Table 4. Birth traits of rabbits fed varying levels of inclusion of soya bean milk residue.

	DIETARY TREATMENT						
Parameters	**0 %**	**8 %**	**16%**	**24%**	**32%**	**SEM**	**LS**
Litter size at birth	12	12	10	12	12	0.32	NS
Litter birth weight (g)	49.75	56.25	57.75	54.25	46.50	1.59	NS
Gestation gain (kg)	0.28	0.32	0.39	0.36	0.21	0.04	NS
Gestation length (Days)	30	31	30	31	30	0.11	NS
Kindling loss (kg)	0.26	0.26	0.31	0.29	0.18	0.02	NS
Neo natal mortality (%)	6.25	6.25	0.00	2.08	4.17	1.41	NS
Coefficient of milking capacity	0.31	0.29	0.28	0.27	0.28	0.08	NS

Table 5. Effect of feeding SBMR on weaning traits of rabbits

	DIETARY TREATMENT						
Parameters	**0%**	**8%**	**16%**	**24%**	**32%**	**SEM**	**L**
Average Litter Size at Weaning(LSW)	9^{b}	9^{b}	10^{ab}	11^{a}	10^{ab}	0.34	*
Litter Weaning Weight (LWW) (kg)	0.56^{b}	0.67^{a}	0.61^{ab}	0.55^{bc}	0.50^{c}	0.02	*
Litter Weaning Weight gain (LWG) (kg)	0.51^{b}	0.61^{a}	0.56^{ab}	0.50^{b}	0.47^{c}	0.22	*
Survival Rate to Weaning (SRW) (%)	70.83^{c}	$79.17b^{c}$	100.00^{a}	91.67^{ab}	87.50^{b}	5.17	*
Weaning Sex Ratio (Male: Female)	5:04	6:03	3:07	4:07	6:04	23	

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NUTRITIONAL STATUS AND THE RISK OF OBESITY AMONG DISTANCE COMMERCIAL DRIVERS IN BIDA NIGER STATE

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ABSTRACT
Poor diet (high consumption of sugar, salt, saturated fat, etc.) and unhealthy lifestyle (smoking, alcohol consumption and physical inactivity) have been identified as major risk factors of cardiovascular diseases and other non-communicable diseases. The study assessed nutritional status and the risk of obesity among distance commercial drivers in Bida motor parks, Niger state Nigeria. A total of 114 registered commercial drivers were selected using systematic random sampling technique. Data were collected using a pre-tested, semi-structured administered questionnaire to obtain information on socio-demographic characteristic and physical activities. Anthropometric measurements (weight, height, waist circumference) were made using standard procedures. Nutrients intakes were estimated using frequency consumption pattern and food habits. Body Mass Index and Waist circumference were calculated and measured respectively and compared with WHO standards. Data were analyzed using descriptive statistics while Pearson product moment correlation/ chi-square were used to establish relationship between variables. The result showed (70.8%) of the respondent were between 20 – 50 years, while 25.1% were 60 years and above. Majority of the respondents (79.8%) are not involved in any physical activities while 20.2% engaged in light activities. Unhealthy eating was recorded .About 39.5% the respondents consumed snacks thrice and more in a week, 40.4% consumed carbonated drinks and 37.7% consumed alcoholic drinks. Also 30.7% preferred snacks to regular food, 73.7% and 52.6% consumed fruits and vegetables respectively. The prevalence of overweight and obesity among the respondents were 63.3% and 5.3% respectively. The mean waist circumference of respondents was 84.4±9.5. High prevalence of overweight and obesity exists among the commercial drivers, hence the need to sensitize them to reduce their energy intake and increase their physical activities in order to modify the risk factors of obesity.

Keywords: *Obesity, Nutritional Status, Anthropometry and Commercial drivers.*

INTRODUCTION
Nutrition and food science has been recognized in the recent years as the cornerstone of socioeconomic development (Park, 2009). However, adequate nutrition is important for a variety of reasons, including optimal cardiovascular function, muscle strength, respiratory ventilation, protection from infection, wound healing and psychological well-being Adequate nutrition entails a diet that contains the constituents (carbohydrate, fats, proteins, vitamins and minerals) that are required for body building, energy supply, body defense and regulatory functions in accordance with the body need. Intake of nutrients in excess of body requirement is due to poor dietary habit resulting in overweight and obesity.

In Nigeria, the prevalence of obesity among adults has been estimated to range from 8.1% to 22.2% (Chukwunwoye *et al*., 2013). Recent global figures indicate that the prevalence of obesity is not just a problem of the developed countries but is also on the increase in the developing world. About 65% of the world's population live in countries where overweight and obesity kill more people than underweight (WHO, 2014; Oladoyinbo *et al*., 2015).

Obesity is rapidly becoming a prominent disease in developing countries like Nigeria, due to increase westernization of societies and change in the lifestyle. The causes of obesity is said to be multi-factorial with a combination of genetics and environmental factors (Rotim *et al.*, 2004) studies have shown that obesity is a predisposing factor to many non-communicable diseases such as hypertension, cardiovascular diseases, coronary heart diseases, arthrosclerosis, certain cancers and a lot more.

According to (Rotimi, *et al*., 2004,) 79 cases of sudden cardiac deaths in Ile-Ife, Nigeria, was caused by hypertensive cardiovascular disease and was the cause of death in 83.3% of which only 30.3% were previously diagnosed. Similarly, Arodiwe, *et al.* (2009) reported a case of fatality rate of 435 in 445 Nigeria hypertensive cases that was presented to an urban tertiary hospital, suggesting that hypertension is a major cause of morbidity. Most of these people were ignorant of their sedentary lifestyle and were obese too. The broad objective was to assess the nutritional status and risk of obesity among commercial drivers in Bida local Government Area while the specific objectives was to describe the socio-demographic variables of respondents, asses

the nutritional status of the of the respondents and also assess the physical activity pattern of the respondents.

METHODOLOGY

The study was descriptive and cross-sectional covering major parks in Bida, Niger state.

Study population: The respondents were registered drivers who were identified with a driving license/any other identity in the motor park.

Sampling technique: Systematic random sampling technique was used to select the respondents within the motor parks.

Sample Size

$$n = \frac{N}{1 + N(e)^2} \quad n = \frac{162}{1 + 162(0.05)^2} = 112$$

n is the sample size
e is the desired level of precision at 5%
N is the total population (162) (Glen, 1992)
Therefore, the total sample size were 162 respondents

Sampling Procedure: The sample size was proportional to the population density (Gay and Diehl, 1992) of the registered drivers who were identified with a driving license/any other identity in the motor park.

Table 1: Motor parks, their Population and Sample Size Survey

Name of motor parks	Drivers population	Sample size
Low cost garage	16	12
Ilorin garage	27	19
EtsuYahaya parks	79	56
NSTA Garage		23
Etsu Usman		15
Total		**162**

A total of 114 registered commercial drivers were selected using systematic random sampling technique.

Data Collection Procedure: Standard questionnaire was administered with the following sections.

a) Socio-demographic characteristics
b) Physical activity level of the respondents.
c) Food habits/ Frequency consumption pattern
d) Anthropometric measurements

Socio-demographic and economic characteristics: Information on socio-demographic characteristics of the respondents was collected using the following age, educational level of the respondents, marital status, religion and ethnic group.

Physical Activity: Respondents filled out behavioural diaries for the last 7 days as baseline. The physical activity measure was modeled after the Bouchard Three-Day Physical Activity Record (Bouchard, et al., 1993; Bratteby, et al., 1997; Wickel, et al., 2006). The measure was adapted as follows: respondents filled out the measure for7 days and reported moderate to-vigorous physical activity.

Food Habits/ Frequency Consumption Pattern: This often shows the number of times the respondents consume meals. The instrument was designed for research purpose to standardize the collection of dietary intake data for large epidemiological Studies. It can have 60-126 food/beverage items that it queries a person on regarding type of food eaten

Anthropometry Measurement: Weights were measured by digital weight scales to the nearest 0.01kg. Subjects were weighed with light cloth on them with an empty bladder, preferably at the same time of the day (Han and Lean, 2001). Heights were measured by height-meter to the nearest 0.05cm, which was calibrated by meter rule before use. Respondents were encouraged to stretch upwards by applying gentle pressure at the mastoid processes and height is recorded with subjects taking in a deep breath for maximum measurement (Han and Lean, 2001) Body mass Index was determined by dividing the weight of each subject in kilogram by her height in metre square.

$$BMI = \frac{Weight\ (kg)}{Height\ (m)^2}$$

Waist and Hip circumferences were measured midway between the lower rib margin and iliac crest, with a horizontal tape at the end of gentle expiration, with feet kept 20—30 cm apart. Subjects were asked not to hold in their stomach (Han and Lean, 2001).

Ethical Consideration: The study protocol and letter of recommendation was submitted to the authority of the Local Government Area as well as the leaders of the Motor Parks. Individual consent from the selected respondents was also obtained, before initiation of the study in the respective Parks.

Statistical Analysis: The data was entered into the computer for analysis using Statistical Package for Social Sciences (SPSS) software, version 20.0. The data generated were subjected to descriptive statistics such as (means, standard deviations, percentages and frequencies). The association between observed parameters was determined using students chi-square. Spearman correlation was used to determine relationships among variables.

RESULTS

Table 2 shows the educational level of the respondents, 52.6% attained secondary school and

12.3% of the respondents are illiterates. 78.9% of the respondents are married, 11.4% singles and 9.6% divorced respectively. 72.8% practice Islam as religion while 27.2% are Christians, the predominant tribe in this study area is Nupe 38.6%, 28.9% are Gbagyi while 32.5% are other tribes.

Table 2: Socio-Demographic Characteristics of the Respondents

Variables	Frequency (F)	Percentage (%)
Age		
20-30	20	17.6
31-40	75	65.8
41-50	10	8.8
51-60	9	7.8
Total	**114**	**100**
Educational level		
No Education	14	12.3
Primary School	24	21.1
Secondary School	60	52.6
Tertiary institution	16	14.0
Total	**114**	**100.0**
Marital status		
Single	13	11.4
Married	90	78.9
Divorced	11	9.6
Total	**114**	**100.0**
Religion	**(f)**	**(%)**
Christianity	31	27.2
Islam	83	72.8
Traditional	0	0.0
Total	**114**	**100.0**
Ethnic group		
Nupe	44	38.6
Gbagyi	33	28.9
Others	37	32.5
Total	**114**	**100.0**

Table 3 shows the BMI classification of the respondents as 32.5% were normal while 62.3% and 5.3% were overweight and obese respectively.

Table 3: BMI Classification of Respondents

Variables	(F)	(%)
Underweight <18.5kg/m^2	0	0
Normal 18.5-24.9kg/m^2	37	32.5
Overweight 25.0 – 29.9kg/m^2	71	62.3
Obese I 30.0.39.9kg/m^2	6	5.3
Obese II$\geq$40kg/m^2	0	0
Total	**114**	**100.0**

WHO, 2006 Classification

Table 4 shows the mean anthropometry indices of respondents which revealed mean height of 170.5$\pm$4.7 m, weight of 76.2$\pm$6.7 kg, BMI of 25.7$\pm$2.0 and waist circumference to be 84.4$\pm$9.5cm respectively.

Table 4: Mean and Anthropometric Measurement of the Respondents

Variables	Range	Mean ± S.D
Height(m)	157 – 181	170.5 ±4.7
Weight(kg)	58 – 92	76.2 ± 6.7
BMI	20 – 30.5	25.7 ± 2.0
Waist circumference (cm)	60 – 104	84.4 ± 9.5

Table 5 shows distance travelled in BMI of respondents. More than average 57.9% are short distance drivers with 38.6% overweight, 16.7% normal and 2.6% obese grade I respectively. Average distance was 10.5% with 5.3% normal, 4.4% overweight and 0.9% obese grade I while 31.6% are long distance travelers with 19.3% overweight, 10.5% normal, and 1.8% obese grade I

Table 6 Shows the Food Habits of respondents based on meals scheduled as breakfast, lunch and dinner. It also revealed a large number of respondents 50.9% eat heavy meal at dinner.

Table 7 shows the frequency consumption patterns of respondents on how often respondents consume a particular food a day or in a week, which consist of Fruits, Vegetables, Alcoholic drinks and Snacking.

Table 8: Shows transport pattern of the respondents. Few (4.3%) of the respondents always go to work place with public transport, 14.1% always walk to work place while 6.2% always go to work place with personal car. About 13.2% go to work on public transport while 4.3% use personal car and 3.5% usually walk. Occasionally, 14.9% uses public transport, 8.8% by personal car while 2.6% walk.

Table 9 Shows positive correlation (r^2=0.011) between BMI and frequency of eating which is significant at (P<0.05), also positive correlation (r^2=0.011) between BMI and food habit which is significant at (P<0.05) but there was a negative correlation (r^2=-0.087, P<0.05) between distance travelled and food habit as well as distance travelled with alcohol consumption at (r^2=0.089, P<0.05) respectively.

DISCUSSION

Majority of the respondents (65.8%) were within the age range of 31-40. This shows that most of the drivers were still young. About 52.6% were not highly educated since majority of them had secondary education as their highest academic

Table 5: Distance travelled and their calculated BMI.

Variables	Underweight F (%)	Normal F(%)	Overweight F (%)	Obese I	Obese II	Total
Short distance	-	19(16.7)	44(38.6)	3(2.6)	-	66(57.9)
Average	-	6(5.3)	5(4.4)	1(0.9)	-	12(10.5)
Long distance	-	12(10.5)	22(19.3)	2(1.8)	-	114(100.0)

Table 6: Daily Food Habits of Respondents

Variables	Meal schedule Breakfast F(%)	Lunch F(%)	Dinner F(%)
Bread and Tea	36(31.6)	-(0.0)	6(5.3)
Pap	36(31.6)	-(0.0)	-(0.0)
Fura da Nono	-(0.0)	17(14.9)	1(0.9)
Rice and Bean	20(17.5)	35(30.7)	48(42.1)
Carbonated soft drinks	2(1.8)	25(21.9)	1(0.9)
Tuwo/Pounded Yam, Eba, Amala, Semolina, Yam Potage in a day	20(17.5)	37(32.5)	58(50.9)

Table 8: Physical activity Using Transport Patterns of the Respondents

Transportation	Always F (%)	Usually F (%)	Occasionally F (%)	Never or Rarely F (%)
Private vehicle	7(6.2)	5(4.3)	10(8.8)	92(80.7)
Public vehicle	5(4.3)	15(13.2)	17(14.9)	77(67.6)
Walking	16(14.1)	4(3.5)	3(2.6)	91(79.8)

Table 7: Food Frequency Consumption Pattern of Respondents

Variables	(F)	(%)
Fruits		
None	0	0
Once	0	0
Twice	30	26.3
Thrice/above	84	73.7
Total	**114**	**100**
Vegetables		
None	0	0
Once	15	13.2
Twice	39	34.2
Thrice/above	60	52.6
Total	**114**	**100.0**
Alcohol consumption		
Yes	43	37.7
No	71	62.3
Total	**114**	**100.0**
How often		
None	71	62.3
Once	17	18.9
Twice	19	16.7
Thrice/above	7	6.1
Do You Snack		
Yes	**98**	**86.0**
No	**16**	**14.0**
Total	**114**	**100.0**
How often		
None	**14**	**12.3**
Once	**36**	**22.8**
Twice	**29**	**25.4**
Thrice/above	**45**	**39.5**
Total	**114**	**100.0**

Table: 9: Correlation between BMI, Frequency of eating and Food Habit and also Correlation between distance travelled, Alcohol consumption and Food Habit

BMI	Pearson Correlation (r^2)	P=Value
Frequency of eating	0.011	P<0.05
Food habit	0.011	
Distance Travelled	Pearson correlation (r^2)	P<Value
Alcohol Consumption	-0.087	P<0.05
Food habit		

Significant at p<0.05

qualification this may affect their level of understanding in terms of nutritional education. Most 78.9% of the respondents were married but only few (9.6%) were divorced. However, most of the respondents eat away from their homes. Today, many fast food restaurants and food hawkers are being established in most developing countries including Nigeria. Most of their foods and snacks are made up of saturated fats and cholesterol. Meanwhile, as the financial status improves, the respondents tend to opt for non-healthy foods (Allagoa *et al.*, 2013).

This present study recorded high rate (62.3%) of overweight amongst respondents while (5.3%) were obese using WHO, BMI classification (WHO, 2006). However, the high rate of overweight recorded and lack of rigorous physical activity, as (79.8%) of respondents found in this study never or rarely take a walk as a form of exercise is an open

door to obesity if not well managed. Increased obesity rates are explained by dietary changes and increased inactivity, especially among low-income groups who improve their incomes but predominantly buy high fat, high carbohydrate and energy-dense foods (Uauy *et al., 2001)*, this findings correspond with that of Roger *et al*., (2008) in the North-West Province of South Africa where they investigated the association between measures and determinants of obesity in Africans. They found that physical inactivity showed the strongest association with measures of obesity in their study. Various studies reported that 25-65% of Nigerians are physically inactive (Abubakari *et al.,* 2008; Ekpenyong *et al.,* 2012) and involve less in regular exercises/sport (Akarolo-Anthony and Adebamowo, 2012).

Some of the respondents ate more carbohydrates, fats and oil, protein foods and their snacking rate was found to be high compared to their intake of fruits and vegetables. Meanwhile, those who took more of these energy foods developed overweight as a result of lack of regimented activities and the only form of physical activity of respondents recorded in this study is walking some distance to their various parks. There was also established relationship between BMI, frequency of eating and food habit of the respondents which was significant (r^2=0.011, at $p<0.05$, and r^2=0.011 at $p<0.05$ respectively) and the distance traveled and their food habit is negatively correlated at (r^2= -0.089, $p<0.05$). The association established could be attributed to consumption of high calorie diets/snacking coupled with low level of physical activities, as all the respondents attested that aside the driving routine, they are not involve in any other physical activity/sporting exercise.

CONCLUSION AND RECOMMENDATIONS

In this study, a high prevalence of poor dietary intake and unhealthy lifestyle was recorded among respondents. A high prevalence 62.3% of overweight was recorded which may probably degenerate to obesity. However, 5.3% of obesity was recorded in these findings. Therefore, it is recommended that there should be health education programs for enlightenment by Non-Governmental Organization (NGO) or health authority of government at either state or local level to promote healthy lifestyle and eating habits especially among this occupational group (commercial driving). Also, considering the increased nutritional health risk associated with the commercial driving, it is of importance not only to the health and safety of the drivers, but also to the whole population which uses their services. There is an urgent need to create awareness targeting this particular group, sensitizing them on the need for proper nutritional habit. Finally, the Federal government, Food agency, NAFDAC and other organizations that are much concerned with the healthy living, healthy lifestyle and healthy eating habits of the nation should team up together and fight against poor nutrient content of fast foods.

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GROWTH PERFORMANCE, NUTRIENT UTILIZATION AND BODY CONDITION SCORE OF CATTLE FED SUPPLEMENTAL DIET CONTAINING VARYING INCLUSION LEVEL OF FERMENTED MOLASSES TREATED SAWDUST

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ABSTRACT
A study was conducted to investigate the growth performance, nutrient utilization, body condition score and cost benefits of Brahman x Sokoto Gudali cattle fed inclusion level of fermented molasses treated sawdust diet. A total of 30 Brahman x Sokoto Gudali cattle aged 12-15 month and weighing averagely 80-110 kg were randomly assigned to five treatment groups designated as T_1, T_2, T_3, T_4, and T_5 each comprising of two replicate, with three animals per replicates. The fermented molasses treated sawdust was included in the cattle diets at 0%, 10%, 20% 30%, and 50% inclusion levels to the five treatments respectively. Feeding regimes were twice daily for all the treatment groups. Supplementary diets were supply to the cattle in the morning and in the evening with clean water given ad-libithium throughout the duration of the study that lasted for 12 weeks. The cattle were also allow to graze at the pasture field comprising of Brachria ruzizienses, Chloris gayana, Digiteria smutci, Stylozanthes hamata and laplap prurience for eight (8) hours. The result obtained showed that crude protein, nitrogen free extract, ether extract, and Methabolizable energy of the fermented molasses treated sawdust were higher than the unfermented sawdust. Cattle fed the control diet showed no significant ($P>0.05$) difference between the group of cattle fed 10 and 20 % (T_2, and T_3) inclusion level of fermented molasses treated sawdust diet. In feed conversion ratio there is statistical similarities between the cattle fed control diet and those fed 10 and 20 % inclusion level of fermented molasses treated sawdust diet. Dry matter digestibility values showed no significant ($P>0.05$) difference between the control and cattle fed 20 and 30 % inclusion level of fermented molasses treated sawdust diet. The feed cost per kg weight gain significantly ($P<0.05$) improved with cattle fed 10% and 20% inclusion level of the diet over the cattle fed control diet. It was concluded that up to 20 % of fermented molasses treated sawdust can be incorporated into the diet of Brahman x Sokoto Gudali cattle for optimum growth.

Keywords: Performance, Nutrient, Utilization, Treated Sawdust

INTRODUCTION

The daily animal protein (4.5g) intake in the diet falls grossly short of the recommended 35g of animal protein per person/day in Nigeria (Ibrahim, 2014). This low animal protein consumption may be as a result of decrease in animal protein production due to increase cost of feeds which generally account for up to 70% of the entire production cost (Olorede *et al*, 1999, as cited by Ibrahim, 2014).

Feed scarcities during the draught and increase cost of conventional feed ingredients are the two major problem affecting the profitability of commercial livestock farming this include both monogastric and ruminants (Hossain *et al.,* 2012). Interest is geared towards cheaper alternative feed stuffs, such as crop residues and industrial by- products to maintain livestock industry in Nigeria (Hossain *et al.*, 2012).

Large quantities of agro forestry and industrial wastes such as sawdust which are not being effectively utilized are produced annually in the tropics, thereby constituting environmental and health hazards (Agboola, 1993).

Sawdust is a product resulting from cutting, grinding, drilling or pulverizing wood with saw or other tool, it is composed of fine particles of wood, it could also be derived by certain animals, birds or insects which live in wood, such as wood pecker and carpenter ant (Hossain *et al.*, 2012) and it is abundant throughout the whole year in Nigeria. Encouraging results were reported when sawdust was included in beef finishing ration (Anthony *et al.*, 1969) and in high concentrate rations for dairy cattle (Cody *et al.*, 1968). Several other reports (Kinsman *et al.*, 1969: Dinius *et al*., 1970 as was cited By El-Sabban *et al.,* 1971) indicate satisfactory result with sawdust and shavings in ration for lambs.

Utilization of sawdust as alternative source of roughages may possibly reduce cost of conventional livestock feed as it does not compete with human being and reduce the challenge of feed scarcity during draught period (Hossain *et al.,* 2012).

Cattle play major role as a source of animal protein in Nigeria and account for half of the total meat supply from domestic animals (Usman, 2005). Cattle production is from the range cattle of Fulani pastoralists who are accustomed to extensive

system of production in Nigeria. The growing human population and livestock numbers, decreasing pasture availability and the increasing use of grazing land for crop production have made the use of improved feed in animal production systems all the more urgent. Sufficient quantities of high-quality feed are required for profitable livestock production (Bourn *et al*., 1994).

The Brahman breed varies from light gray or red to almost black in colour distinguished by their large hump and droopy ears and has been of great importance in commercial beef production (Cutrer *et al.,* 2010). The adaptative traits which specifically suit the Brahman breed for beef production in temperate, subtropical or tropical areas include: tolerance to internal and external parasites; tolerance to high solar energy, high ambient temperature and humidity and the ability to utilize high fibre forages (Randel, 2000). Therefore the present study was aimed at investigating the growth performance, nutrient utilization and cost benefit analysis of cattle fed diet containing varying inclusion level of fermented Molasses treated sawdust.

MATERIALS AND METHODS

Experimental Location: This experiment was carried out at Massohi Farms and Livestock Development Company, km12 Minna-Bida road of Niger State, Nigeria. Massohi farms specializes in livestock breeding, dairy production and fisheries. Minna is located in the southern Guinean savannah zone on latitude $9^0 31^1$ and $9^0 42^1$ North and longitudes $06^o\ 29^1$ and $06^o\ 41^1$ East with annual rainfall range of 1,200-1300mm and average temperature range of 38^0-40^0C. The area has an altitude of 1,475m above sea level , and is characterized by two season, the wet season (April-October) and dry season (November-March) (NSADP, 1995 as cited by Shiawoya, *et al*., (2011).

Collection and processing of Fermented Sawdust: Fresh sawdust was collected from timber mill Shango in Minna, Niger State. A 2mm size aluminium sieve was used to sieve the sawdust before fermentation. The process for the fermentation of corn-cob as described by Adeyemi and Familade (2003) as cited and modified by Akinwolere, (2013) was used to ferment the sawdust with the following modifications. A large plastic polythene bag was positioned in a plastic drum to take it's form and the blended mixture of sawdust and molasses in the gauge of 100kg per 10liters of molasses in 40 litres of Borehole water was pack inside the polythene bag. It was then tied securely with rope to make it air tight thus preventing exchange of gases between the fermenting material and the environment for a 15 day anaerobic fermentation period. The fermented sawdust was heated with Model AT-2 Steam Boiler (pressureless cooker) machine at 90^0 C for 30minutes in order to take care of some bacteria, after which it was sundried to reduce the moisture content.

Experimental diet: The diet were formulated with varying inclusion level of fermented sawdust (0%, 10% 20%, 30% and 40%) as source of roughage for the cattle, other ingredients include: maize, maize offal, GNC, limestone, mineral premixed in their various proportion Table 3 . The prepared diets were administered to the cattle as supplement twice daily (7-9:00 am and 5- 7pm). Clean water was given *ad- libitum* The animals were allowed to graze on the pasture field of the farm for 8 hours within the period of 9:00 am -5:00pm.

Experimental Design: The experimental design used was Completely Randomized Design (CRD). The 30 experimental cattle were randomly allotted to five treatment group (T_1-T_5) comprising of two replicate with three animals per replicate. Treatment one (T_1) were cattle fed diet with 0% fermented molasses treated sawdust, T_2 were cattle fed diet with 10% of fermented molasses treated sawdust, T_3 were cattle fed diet with 20% of fermented molasses treated sawdust, T_4 were cattle fed diet with 30% of fermented molasses treated sawdust, T_5 were cattle fed diet with 40% of fermented molasses treated sawdust Table 3. Feeding trial lasted for 12 weeks.

Experimental Animals and Management: Breed of cattle used for this research work were crosses between the exotic and indigenous breed i.e Brahman crossed with Sokoto Gudali (Bokolo). 30 Brahman X Sokoto Gudali cross bred cattle of 12 to 15 month of age, averaging between 100kg-120kg of weight, consisting of 10 female and 20 male were assign to five experimental treatments (T_1, T_2, T_3, T_4,and T_5). Six (6) cattle were assigned to each experimental treatment in 2 replicate and 3 cattle each per replicate. Three cattle each per replicate were housed in pens with aluminium roofing sheath partitioned with iron bars having the height of about 18 ft, with the length of 12ft and breadth of 12ft. The cattle were managed under semi-intensive system. They were allowed to graze extensively at the 7.5 hectare pasture field of Massohi farms comprising of *Brachria ruzizienses, Chloris gayana, Digiteria smutci, Panicum Maximum* and *Stylozanthes hamata* for 7-8 hours after which 1.5kg of the experimental diet comprising of maize, groundnut cake, corn offal, fermented sawdust, salt, mineral premix, limestone formulated to meet the nutrient requirement of the cattle were given twice daily before and after grazing. Clean water was given *ad-libitum*. Each

cattle was treated against ectoparasites using Amitix (Acaricides) spray; they were dewormed with Albendazol to take care of endoparasites and also injected intra-muscularly with Oxytetracycline 20% -long acting broad spectrum antibiotic as a precautionary measure against bacterial infections, and Samorine injection to take care of Trypanosomiases.

Parameter Measured: The animals were allotted into five treatment groups and fed the experimental diet for a pre-treatment period of two weeks to enable them adapt to the experimental diet before the commencement of the data collection. The parameters measured were feed intake, body weight gain, feed conversion ratio, Nutrient digestibility and cost benefit analysis.

Body condition score: The body condition scores were assessed according to the method proposed by Chest Worth, (1992) as was cited by Tsado (2010). Animals were awarded scores to the nearest one quarter on a scale of 1 to 5, depending on the prominent of the spines and the transverse processes feel visa-visa the fat cover. Score 1-spine prominent (dorsal processes) and transverse processes fill sharp to the touch with no detectable fat cover. Score 2- transverse processes can still be felt with the thumb but there is no detectable fat cover. Score 3- individual transverse processes cannot be felt with firm pressure from the thumb with the fat cover round. Score 4-transvers processes cannot be felt even with firm pressure. Score 5- transverse processes cannot be felt and are obviously covered with a very thick layer of fat.

Apparent Nutrient Digestibility Trial: The digestibility trial was conducted at the end of the feeding trial on two (2) cattle from each treatment to assess the level of the nutrient digestibility. The procedure for digestibility as describe by Tsado, (2010) was used with the following modification. The animals were individually isolated and kept in a metabolic cage with slated floors adapted for faecal collection. Experimental diets fed were the same as those used in the growth study. Feed intake was measured by finding the differences between the amount of feed offered and the amount refused. Feed refused was weighed just before fresh feed is offered. Faeces from animals on each treatment were bulked thoroughly mixed and sub-sampled taken. Feed and faecal sample of the diet collected were oven –dried at 80^{o}C to constant weight and kept in air tight containers until required for analysis. Samples of feed offered and of faecal were pulled from each replicate at the end of 7 days and used for the chemical analysis. Apparent digestibility of the diets was calculated as the difference between nutrient intake and excretion in the faeces expressed as a percentage of the nutrient in take (Maynard *et al*., 1979 .

Apparent nutrient digestibility (%) =

$$\frac{\text{Nutrient in Feed- Nutrient in Faeces}}{\text{Nutrient in Feed}} \times 100$$

Data collection and Statistical analysis: One week adjustment period was allowed before data collection commenced. The mean initial body weight, final body weight, weekly body weight gain, feed intake, nutrient digestibility and body condition score were calculated. Variance (ANOVA) Using General Linear Model (GLM) procedure of SPSS computer package 2016 and significant determination at 5% level of probability. The significant means were separated using Duncan's Multiple Range Test (1995).

RESULTS

Proximate composition of unfermented and fermented molasses-treated sawdust: The result of proximate composition of non-fermented and fermented molasses-treated sawdust are presented in Table 1. The results indicate that crude protein content (3.50), nitrogen free extract (36.64), ether extract (4.33) and metabolizable energy (1420.60) of the fermented molasses-treated sawdust are higher than the unfermented sawdust. However, dry matter (90.20), crude fibre (41.23) and ash content (4.50) of the fermented molasses-treated sawdust are lower than the unfermented sawdust.

Table 1: Proximate composition of fermented molasses-treated sawdust and unfermented sawdust

Parameter (%)	Unfermented sawdust	Fermented molasses-treated sawdust
Dry Matter	92.40	90.20
Crude Protein	2.80	3.50
Crude Fiber	42.27	41.23
Ether Extract	2.33	4.33
Ash	19.00	4.50
Nitrogen Free Extract	26.00	36.64
ME (Kcal/kg)	1361.70	1420.60

Keys:
ME = Metabolizable energy ([ME=36x%CP+81.8x%EE+35.5x%NFE. Pauzenga, (1985).

Table 2. Proximate composition of the experimental diets fed to Brahman x Sokoto gudali cattle.

	Treatments				
Parameters	T1	T2	T3	T4	T5
Dry Matter	90.20	90.40	90.80	90.80	91.00
Crude Protein	12.15	11.50	10.50	10.15	9.05
Crude Fibre	12.66	14.66	16.66	18.10	19.33
Ether Extract	16.00	16.00	15.00	14.00	14.00
Ash	10.50	9.00	8.33	8.00	7.50
Nitrogen Free extract	38.89	39.24	40.31	40.55	41.12
Energy (Kcal/kg)	3138.95	3126.60	3035.50	2958.50	2920.96

Keys

ME = Metabolizable energy ([ME=36x%CP+81.8x%EE+35.5x%NFE. Pauzenga (1985), T_1 = 0 % Inclusion of Fermented molasses-treated sawdust, T_2 = 10 % Inclusion of Fermented molasses-treated sawdust, T_3 = 20 % Inclusion of Fermented molasses-treated sawdust, T_4 = 30 % Inclusion of Fermented molasses-treated sawdust, T_5 = 40 % Inclusion of Fermented molasses-treated sawdust

Table 3 Percentage composition of supplemental diet diets fed to Brahman x Sokoto Gudali cattle.

	Percentage Composition				
Ingredient	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
Maize	30	30	30	30	30
GNC	20	20	20	20	20
Maize offal	45	35	25	15	5
Sawdust	-	10	20	30	40
Limestone	4.5	4.5	4.5	4.5	4.5
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated analysis					
Crude protein	17.40	16.65	15.98	14.85	13.96
Energy (kcl/kg)	2336.60	2330.80	2234.90	2219.10	2172.70
Fibre	8.01	11.18	14.42	17.87	20.83

keys

T_1 = 0 % Inclusion of Fermented molasses-treated sawdust, T_2 = 10 % Inclusion of Fermented molasses-treated sawdust, T_3 = 20 % Inclusion of Fermented molasses-treated sawdust, T_4 = 30 % Inclusion of Fermented molasses-treated sawdust, T_5 = 40 % Inclusion of Fermented molasses-treated sawdust, GNC = Groundnut cake

Table 4. Growth performance of Brahman x Sokoto gudali cattle fed diets containing graded levels of fermented molasses-treated sawdust

	Treatment						
Parameters	T1	T2	T3	T4	T5	SEM	LS
Initial body weight(Kg/hd)	100.34	100.50	99.67	100.50	100.17	6.32	NS
Final body weight (Kg/hd)	118.84	119.84	116.34	114.50	114.17	6.35	NS
Total weight gain (Kg/hd)	18.84ab	19.67a	16.67b	13.8c	13.50c	0.86	*
Weekly weight gain (Kg/hd)	1.57a	1.64a	1.38b	1.15c	1.12c	0.09	*
Total feed intake (Kg/hd)	124.83	124.75	124.75	124.42	124.50	0.06	NS
Weekly feed intake (Kg/hd)	10.400	10.395	10.395	10.370	10.380	0.00	NS
Feed conversion ratio	4.99a	4.77a	5.61ab	6.74b	6.92b	0.30	*

Mean with different superscript (a, b) are significantly (P<0.05) different

Keys

T_1 = 0 % Inclusion of Fermented molasses-treated Sawdust, T_2 = 10 % Inclusion of Fermented molasses-treated sawdust, T_3 = 20 % Inclusion of Fermented molasses-treated sawdust, T_4 = 30 % Inclusion of Fermented molasses-treated sawdust, T_5 = 40 % Inclusion of Fermented molasses-treated sawdust, Kg/hd = Kilogram per head (animal), SEM = Standard Error of Mean, LS = Level of Significance, NS = No Significance, * = Significant

Table 5 Body Condition Score of Brahman x Sokoto gudali cattle fed diets containing varying levels of fermented molasses-treated sawdust.

Treatment Parameter	T_1	T_2	T_3	T_4	T_5	SEM	LS
Initial Body Condition Score	2.17	2.17	2.17	2.17	2.17	0.06	NS
Final Body Condition Score	4.00^{a}	4.00^{a}	3.84^{ab}	3.67^{ab}	3.50^{b}	0.07	*
Total Body Condition Score Gain	1.84	1.84	1.67	1.51	1.34	0.09	NS
Weekly Body Condition Score Gain	0.15	0.15	0.14	0.13	1.11	0.01	NS

Mean with different superscript (a, b) are significantly (P<0.05) different

Keys

T_1 = 0 % Inclusion of Fermented molasses-treated Sawdust, T_2 = 10 % Inclusion of Fermented molasses-treated sawdust , T_3 = 20 % Inclusion of Fermented molasses-treated sawdust, T_4 = 30 % Inclusion of Ferme nted molasses-treated sawdust, T_5 = 40 % Inclusion of Fermented molasses-treated sawdust, SEM = Standard Error of Mean, LS = Level of Significance, NS = No Significance, * = Significant at P<0.05

Table 6: Apparent digestibility of Brahman x Sokoto gudali cattle fed diets containing varying inclusion levels of fermented molasses-treated sawdust diet.

Treatment Parameters	T_1	T_2	T_3	T_4	T_5	SEM	LSD
Dry Matter	74.4^{a}	75.01^{a}	71.32^{a}	68.41^{ab}	67.24^{b}	1.17	*
Crude Protein	50.32	52.75	47.48	41.07	41.89	1.95	NS
Crude Fibre	55.30	53.91	51.94	44.81	44.34	1.82	NS
Crude Ash	49.73	50.10	55.26	56.507	64.07	3.03	NS
Ether Extract	52.98^{b}	53.04^{b}	54.24^{ab}	60.24^{a}	59.11^{a}	1.18	*
Nitrogen Free Extract	51.04^{b}	52.25^{b}	54.87^{ab}	60.65^{a}	63.05^{a}	1.67	*

Mean with different superscript (a, b, c) are significantly (P<0.05) different

Keys

T_1 = 0 % Inclusion of Fermented molasses-treated sawdust, T_2 = 10 % Inclusion of Fermented molasses-treated sawdust, T_3 = 20 % Inclusion of Fermented molasses-treated sawdust, T_4 = 30 % Inclusion of Fermented molasses-treated sawdust, T_5 = 40 % Inclusion of Fermented molasses-treated sawdust, SEM = Standard error of Mean, LS = Level of Significance, NS = No Significance, * = Significant at P<0.05

Table 7. Cost Benefit Analysis of Brahman x Sokoto Gudali cattle fed diets containing varying inclusion levels of fermented molasses-treated sawdust diet

Treatment Parameters	T_1	T_2	T_3	T_4	T_5	SME	LSD
Ave weekly feed in take	10.40	10.395	10.40	10.37	10.38	0.01	NS
Cost of feed per kg(₦)	73.05^{a}	68.05^{b}	63.05^{c}	58.05^{d}	53.05^{e}	2.36	*
Ave weekly feed cost (₦)	759.92^{a}	707.44^{b}	655.46^{c}	601.87^{d}	550.39^{e}	24.73	*
Ave weekly weight gain	1.57^{a}	1.64^{a}	1.38^{b}	1.155^{c}	1.125^{c}	0.07	*
Feed cost per kg weight gain (₦)	484.99^{b}	432.41^{a}	475.07^{a}	521.18^{b}	489.33^{b}	10.69	*

Mean with different superscript (a b) are significantly (P<0.05) different

Keys

T_1 = 0 % Inclusion of Fermented molasses-treated sawdust, T_2 = 10 % Inclusion of Fermented molasses-treated sawdust, T_3 = 20 % Inclusion of Fermented molasses-treated sawdust, T_4 = 30 % Inclusion of Fermented molasses-treated sawdust, T_5 = 40 % Inclusion of Fermented molasses-treated sawdust, SEM = Standard error of Mean, LS = Level of Significance, NS = No Significance, *** =** Significant at p< 0.05

Proximate composition of experimental diet: Proximate composition of the experimental diet is presented in Table 2. The results showed that as the inclusion levels of fermented molasses-treated sawdust increases in the feed the crude protein, ether extract and ash content decreases. The dry matter composition were similar T_1 (90.20), T_2 (90.40), T_3 (90.8), T_4 (90.80) and T_5 (91.00) among the treatments groups. Crude fibre content increases with increase in inclusion level while ether extracts decreases with increase in inclusion levels of fermented molasses-treated sawdust in the diet. T_1 (0 % fermented molasses-treated sawdust) recorded the highest (12.15 %) crude protein content while the lowest (9.05%) was observed in T_5 (40 % fermented molasses-treated sawdust). Nitrogen free extract also increases slightly as the inclusion level of fermented molasses-treated sawdust in the diet increases.

Growth performance of Brahman x Sokoto Gudali cattle fed diet containing varying

inclusion levels of fermented molasses-treated sawdust: Table 4 showed growth performance of Brahman x Sokoto Gudali cattle fed diet containing varying inclusion levels of fermented molasses-treated sawdust. The results indicate that there was no significant difference (P>0.05) in the initial and final weight of the experimental animals among the treatment groups. Total and weekly weight gain values shows significant (P<0.05) difference among the treatment groups. Animals fed 0%, 10%, and 20% (T_1 T_2 & T_3) of fermented molasses treated sawdust (FMTS) recorded significantly higher values compare with animals fed 30 and 40% (T_4 and $T_{5)}$ fermented molasses treated sawdust (FMTS) in total and weekly weight gain. The results also shows that there was no significant difference (P>0.05) in total and weekly feed intake among the treatment groups. There were significant difference (P<0.05) in the feed conversion ratio between the treatment groups. Animals fed 0% and 10%, (T_1 & T_2) of fermented molasses treated sawdust diet shows significantly better feed conversion ratio 4.99 and 4.77 than animals fed 30 and 40% fermented molasses treated sawdust diet T_4 (6.74) and T_5 (6.92).

Body Condition Score of Brahman x Sokoto gudali cattle fed diets containing graded levels of fermented molasses-treated sawdust: Body Condition Score of Brahman x Sokoto gudali cattle fed diets containing graded levels of fermented molasses-treated sawdust is presented in Table 5.The result revealed that no Significant difference (P>0.05) was observed between the Animals fed 20% and 30% of fermented molasses treated sawdust diet with Animals fed diet 0%, 10%, and 40% in the final body condition score of the experimental animals among the treatment group. There was no (P> 0.05) significance difference in the total and weekly body condition score gain.

Apparent digestibility of Brahman x Sokoto gudali cattle fed diets containing varying inclusion levels of fermented molasses-treated sawdust diet: The results of Apparent digestibility of Brahman x Sokoto gudali cattle fed diets containing varying inclusion levels of fermented molasses-treated sawdust diet is presented in Table 6.The result showed that there was significant (p<0.05) difference in the dry matter apparent digestibility of the experimental animals among the treatment groups. Animals fed 40% fermented molasses treated sawdust shows significant (p<0.05) difference among the treatment groups, while animals fed up to 30% fermented molasses treated sawdust was not significantly (p>0.05) different between the groups in dry matter digestibility. No significant (p>0.05) differences in the apparent digestibility of crude protein, crude fibre and ash. However, it was observed that the value of crude fibre apparent digestibility decrease slightly as the inclusion level of fermented molasses treated sawdust increased among the treatment groups. Similarly, the ash values increases as the inclusion levels increases although no significant difference was observed. Ether Extract and Nitrogen Free Extract apparent digestibility values were significantly (p<0.05) higher than the control.

Cost Benefit Analysis of Brahman x Sokoto gudali cattle fed diets containing varying inclusion levels of fermented molasses-treated sawdust diet: The results of the Cost Benefit Analysis of Brahman x Sokoto Gudali cattle fed diets containing varying inclusion levels of fermented molasses-treated sawdust diet are presented in table 7. The result shows that there was no significant (P>0.05) difference in average weekly feed intake. The cost of feed per kg decreased significantly (P<0.05) as the inclusion level of the sawdust increases among the treatment groups. Significant (P<0.05) difference existed across treatment groups in the average weekly feed cost respectively. Animals fed 0% fermented molasses treated sawdust recoded highest value (₦759.92), while animals fed 40% fermented molasses treated sawdust recorded the lowest value (₦550.39) in the average weekly feed cost. There were significant (P<0.05) difference across the treatment group in average weekly body weight gain, however, animals fed 0% and 10% fermented molasses treated sawdust were observed to significantly (P<0.05) have higher values in average weekly body weight gain than animals in the other treatment groups. Feed cost per kg weight gain were observed to be significantly (P<0.05) better with animals fed 10% and 20% fermented molasses treated sawdust compare with animal fed 0%, 30% and 40%.

DISCUSSION

The results of the proximate analysis of unfermented and fermented molasses treated sawdust in this study are within the range reported by Hossain *et al*., (2011) who in his experiment reported. 1.8 – 3.5 % crude protein, 0.6 – 2.0 % ether extract, 39.5 - 74% crude fibre, 12.5 – 47.1% nitrogen-free extracts and 0.30 – 7.6 % ash on different types of sawdust. The non-significant differences recorded on the total body weight gain and feed conversion ratio between animals fed control diet and those fed 20% showed a positive effect of the tested diet. This is in agreement with earlier findings of Ibrahim *et al*., (2013) who reported that there were no significant effects of diets on the final body weight of goat fed variously treated sawdust at 50% replacement for molasses-treated wheat offal. Similarly the non significant

difference in feed intake and final body weight between the control diet and other treatment could imply that fermented molasses-treated sawdust inclusion in cattle diet has no toxic effects and equally palatable. This agrees with Ibrahim *et al*., (2013), Cody *et al*., (1963) who reported that 25% sawdust was found to be the most desirable level for roughage substitution.

The significant ($P<0.05$) decrease observed in final body condition score as the inclusion level of the test ingredient increases could imply that the inclusion of the test ingredient (fermented molasses- treated sawdust) in the diet above 30% had significant effect on the fat deposits in relation to skeletal features of animals. Encinias *et al.*, (2000) reported that Body condition score provides producers a relative score based on an evaluation of fat deposits in relation to skeletal features.

The statistical ($p>0.05$) similarity observed in the dry matter apparent digestibility between the animals fed control diet and those fed up to 40% inclusion level shows the tolerance level of the tested diet. Paterson, (2003) argued that the principal anti-nutritive factor in utilizing most wastes as ruminant livestock feeds is their high fibrous lingo-cellulose contents. The non significant ($p>0.05$) difference in crude protein and crude fibre apparent digestibility between the control diet and other treatment group could imply that fermented molasses- treated sawdust inclusion in cattle diet has no anti-nutritional effects. This agrees with Radwan, (1994) who reported that addition of sawdust as fibre source in rabbit ration had improvement effect on digestibility of protein, ether extract and crude fibre. The increase in apparent digestibility of ether extract and nitrogen free extract observed as the inclusion level of fermented molasses treated sawdust increases is in line with the findings of Afolabi, (2002).

Significant ($p<0.05$) difference observed in the cost benefit analyses of feed per kilogram and average weekly feed cost among the treatment group indicate that addition of fermented molasses sawdust may reduced the cost of feeding cattle significantly. Significantly lower ($P<0.05$) value recorded by animals fed 10% and 20% fermented molasses treated sawdust diet compare to animals fed 30% and 40% fermented molasses treated sawdust diet in the average weekly feed cost per kilogram weight gain, suggest that addition of fermented molasses treated sawdust up to 20% may improve economic benefit of cattle production significantly. This is in agreement with earlier findings of Anigbogu *et al*., (2010) who reported that incorporation of *Zymomonzas mobilis* treated sawdust at 15% and 20% in the ration improve economic benefit analysis in red sokoto goats.

CONCLUSIONS

It can be concluded from this study that up to 20 % of fermented molasses-treated sawdust can be included in the diet of Brahman x Sokoto Gudali cattle for optimum body weight gain, body condition score, and apparent digestibility and effective feed cost per kilogram weight gain of the animals. Therefore fermented molasses-treated sawdust can be suitably included in the diets of Brahman x Sokoto Gudali cattle up to 20 % level and improved weight gain.

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UTILIZATION OF DIETARY *MORINGA OLEIFERA* (DRUMSTICK TREE): ITS EFFECT ON ANIMAL PERFORMANCE AND PRODUCTIVITY

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ABSTRACT
The present review article gives a detailed discussion on the utilization and the effect of the inclusion of Moringa oleifera in animal diets on performance and productivity. Moringa has been fed to cattle, goats, sheep, poultry, pigs, rabbits and fish. The inclusion of moringa leaf meals as a supplement to low-quality livestock fodder has led to improved dry matter intake as well as the better digestibility of the fodder by livestock. It has also been used for the bright colouration of egg yolk, broilers skin, wattles, beaks, combs and shank, for improving meat quality, higher weight gain, better egg shell quality, higher egg weight and production, improved haematological profile, better milk production and quality and general improvement in animal health. It has been reported to reduce the cost of production when incorporated into the ration of animals as a partial replacement for conventional sources of protein.

Key words: *Moringa oleifera*, ruminants, monogastrics, fish, performance, productivity

INTRODUCTION

Conventional feed ingredients are costly in many developing countries that is the reason why researchers and farmers are in search of cheap and affordable alternative sources which are nutritious and also readily available (Moreki and Gabanakgosi, 2014; Akande *et al*., 2016). Browse plants have been used for livestock animals for many years. *Moringa oleifera* is an evergreen browse plant, which is drought tolerant and capable of adapting to a wide range of soils and climatic conditions. *Moringa oleifera* tree is a multipurpose plant also called drumstick tree, horseradish tree and ben oil tree (Afuang *et al*., 2003; Fahey, 2005; Bhupendra and Neikuozo, 2015). The production of *Moringa oleifera* is advantageous because it can be cultivated and managed with ease. Moringa leaves can serve as a good quality supplement in animal diets (Moreki and Gabanakgosi, 2014). Many leaf meals have been incorporated into animal feeds. Among many of these leaf meals, thus used is moringa leaf meal, an excellent leaf protein feedstuff (Abbas, 2013). All parts of the *Moringa oleifera* plant are considered to be edible and useful (Makkar and Becker, 1999). Over many years, research work has been carried out on how *Moringa oleifera* can be used to improve livestock production. Interestingly, success has been reported in this regard by several researchers globally (Aregheore, 2002; Adegun *et al*., 2011; Fayomi *et al*., 2014; Oliver *et al*., 2015; Sebola *et al*., 2015; Sultana *et al*., 2015; Briones *et al*., 2017).

Moreki and Gabanakgosi (2014) stated that *Moringa oleifera* is one of the plants that can be integrated with livestock production, a cheap protein source which can be used to boost the feed quality as well as used to enhance the digestibility of other diets. The fresh leaves of moringa plants are readily consumed by cattle, sheep, goats, pigs and rabbits. The leaf meal of moringa has been incorporated into the diets of poultry, fish and other animals in many countries. Nouman *et al*. (2014) recommended the use of *Moringa oleifera* as a good alternative for substituting commercial rations for livestock. Most countries and communities where moringa plant was not common have started growing it, due to its multiple uses and benefits. There is a lot of advocacy in Nigeria and other developing countries to encourage the planting and utilization of moringa for nutritional, medicinal, agricultural, industrial and economic purposes. The claim that *Moringa oleifera* enhances the productivity of animals may be associated with the increased and widespread research interest in various aspects of the moringa plant over several decades in the field of animal science.

Feeding ruminants with moringa: Several researchers have suggested and recommended the utilization of moringa as an alternative source of protein in ruminant diets (Kakengi *et al*., 2005; Sanchez *et al*., 2006; Mendieta-Araica *et al*., 2010; Gutierrez *et al*., 2012). Table 1 shows the dietary effect of *Moringa oleifera* on the performance and productivity of ruminants. Additionally, this leaf protein and its organic matter are digestible in the rumen (Kakengi *et al*., 2005; Gutierrez *et al*., 2012). Soliva *et al*. (2005) reported that moringa leaves enhance the microbial protein synthesis in the rumen due to the presence of readily fermentable nitrogen and substantial energy content it possesses. It can become a useful supplement for inclusion in animal

feeds, a source of nutritive food as well as serving as a medicinal plant.

Cattle: Cohen-Zinder *et al*. (2016) substituted wheat silage with *Moringa oleifera* silage in the diets of lactating Holstein cows. Cows fed supplements of ensiled *Moringa oleifera*, had 1.91% increase in milk yield as well as a 20% increase in milk anti-oxidative activity. These research authors also recommended the ensiling mixture of *Moringa oleifera* with soy hulls or corn grains as a higher digestible additive for lactating dairy cows. Creole Reyna breed dairy cows fed *Moringa oleifera* supplement of 2 and 3kg dried *Moringa oleifera* leaves per day had an increased ($P<0.05$) milk yield by 58% and 65%, respectively, in addition, the dairy cows recorded improved ($P<0.05$) dry matter intake and digestibility of the diet (Sanchez *et al*., 2006). Olorunnisomo (2014) reported improved ($P<0.05$) milk production and feed utilization by Sokoto Gudali cows with a higher proportion of moringa forage in the supplementary silage. Additionally, Olorunnisomo (2014) posited that the use of *Moringa oleifera* silage has the potential for increasing local milk production. Mendieta-Araica *et al*. (2010) established from their research findings that dairy cows fed moringa silage were able to produce the similar quantity and quality of milk as dairy cows fed conventional diets. Cows fed moringa supplement were reported to produce a significant ($P<0.05$) increase in daily milk yield as well as improved ($P<0.05$) milk composition (Khalel *et al*., 2014).

Sheep: The dietary inclusion of *Moringa oleifera* stem in the ration of growing Rahmani lambs was found to enhance ($P<0.05$) feed efficiency. In addition, it can also effectively serve as a replacement for clover hay and concentrate feed mixture in the diet of growing lambs without any detrimental effect on performance (Mahmoud, 2013). Fayomi *et al*. (2014) recommended the incorporation of *Moringa oleifera* leaf meal for producing multi-nutrient blocks for sheep diet (Yankasa ram) for improved performance and haematological profile. Adegun *et al*. (2011) suggested the use of *Moringa oleifera* as a protein supplement for improved performance of sheep in south-western Nigeria. Fadiyimu *et al*. (2010) from their research asserted that the inclusion of *Moringa oleifera* in the diets of West African Dwarf (WAD) sheep resulted in the improvement of the haematological profile, nitrogen balance and nitrogen retention. They recommended 25% inclusion of *Moringa oleifera* as the optimum level for the replacement of *Panicum maximum* in the diet of West African Dwarf (WAD) sheep.

Goat: Aregheore (2002) documented that the inclusion of up to 50% of moringa leaf in a low-quality forage ration produced increase in daily weight gain and diet digestibility of goats (Anglo-Nubian x Local Fiji). According to Moyo *et al*. (2014), the inclusion of moringa leaf meal in the diets of crossbred Xhosa lop-eared goats produced better ($P<0.05$) meat quality attributes when compared with the control group. *Moringa oleifera* leaf meal has a positive effect on milk composition and milk yield of Anglo-Nubian goats (Basitan and Jarcia, 2013). Kholif *et al*. (2015) conclusively stated that *Moringa oleifera* can serve as a replacement for sesame meal up to 75% (that is, an inclusion level of 15% *Moringa oleifera* leaf meal) in the diet of lactating Anglo-Nubian goats. These researchers reported that the incorporation of *Moringa oleifera* leaf meal led to higher ($P<0.05$) intake of feed, improvement ($P<0.05$) in nutrient digestibility and rumen fermentation and more ($P<0.01$) milk production. They further reported that the inclusion of moringa had a positive effect on the fatty acid composition of goat milk by producing an increase ($P<0.05$) in unsaturated fatty acid and a decrease ($P<0.05$) in saturated fatty acid. The lactation-enhancing effect of *Moringa oleifera* leaves was demonstrated from the increase of maternal serum prolactin levels (Dela-Cruz, 2012). Basitan and Jarcia (2013) pointed out from their research that *Moringa oleifera* has galactagogue effect, which can cause the increase in the production of milk. They further stated that the galactagogue effect of moringa can be obtained by feeding lactating goats 30 to 40% *Moringa oleifera* forage. Sultana *et al*. (2015) recommended moringa foliage (leaves, petiole, and soft stem) as a cheap substitute for conventional concentrate in the diet of growing Bengal goats. Their research report demonstrated that the highest average daily live weight gain of 63.45g/day was found in Bengal goats fed 75% moringa foliage plus 25% concentrate mixture diet while the lowest average daily live weight gain of 33.02g/day was recorded by goats fed 100% concentrate mixture diet. According to Briones *et al*. (2017), feeding goats with *Brachiaria mutica* (para grass) and moringa resulted in higher ($P<0.05$) dry matter intake and consequently increase ($P<0.05$) in weight gain

Feeding non-ruminants with moringa: The moringa leaf meal is a good source of protein for non-ruminant animals. There are interesting research reports on the effect of the inclusion of moringa in diets of monogastrics and several research authors have recommended its usage in monogastric nutrition. Table 2 presents the dietary effect of

moringa on the performance and productivity of non-ruminant animals.

Poultry: Moringa can be incorporated into poultry feeds, particularly by small-scale farmers, as natural and healthy feed replacements to synthetic feed supplements (Paguia *et al*., 2014). According to the reports of Donkor *et al*. (2013), the availability of *Moringa oleifera* in several rural areas in Ghana makes its use as a commercial poultry feed ingredient an economically viable one. *Moringa oleifera* can perform a key role in the economy of poultry production. Notably, the partial replacement of fish meal with *Moringa oleifera* leaf meal has been found to reduce feed cost (Zanu *et al*., 2012). Moringa is suitable for usage in poultry feeds (Foidl *et al*., 2001). *Moringa oleifera* leaves contain major nutrients required for healthy growth of poultry birds. Additionally, the dietary inclusion of moringa leaf meal in poultry diets has led to increase in weight gain, the bright colouration of chicken wattles, beaks, combs as well as the improvement in the yellow colouration of egg yolk, broilers skin and shank colour (Donkor *et al*., 2013). According to Ebenebe *et al*. (2013) the incorporation of moringa leaf meal in the diets of layers at lower levels improved egg production and egg quality but higher levels of inclusion resulted in lower productivity and poorer egg quality indices. Nkukwana *et al*. (2014) included *Moringa oleifera* leaf meal up to 25g/kg of feed and reported no negative effect on nutrient utilization efficiency and growth performance of broiler chickens. Feeding chickens with *Moringa oleifera* leaf meal resulted in better carcass characteristics and enhanced growth performance (Sebola *et al*., 2015). The use of *Moringa oleifera* as a feed additive for broilers resulted in the production of chicken breast with light appearance (Wapi *et al*., 2013). Allam *et al*. (2016) posited that *Moringa oleifera* leaf extract has played the role of an antioxidant, immune booster, growth promoter, anti-bacterial agent and also had a positive effect on haemato-biochemical parameters of broiler chickens. The utilization of *Moringa oleifera* seed meal in poultry diets is not so common. However, the high dietary levels of moringa seed meal in the diet of broiler chicks was reported by Ochi *et al*. (2015) to negatively affect the performance and carcass characteristics of the birds. Briones *et al*. (2017) reported that the inclusion of 5% moringa leaf meal in the ration of layer quails resulted in higher egg production, increased egg weight, better egg yolk colour and improved feed conversion ratio ($P<0.05$). Similar result was obtained for White leghorn chickens given drinking water mixed with 100ml moringa leaf extract. In addition, Briones *et al*. (2017) reported that the incorporation of *Moringa oleifera* seed meal in the diet of Babcock layer birds led to decrease ($P<0.05$) in the percentage of broken eggs as a result of the improvement of egg shell quality.

Rabbit: The dietary replacement of *Centrosema pubescens* with *Moringa oleifera* was reported by Odeyinka *et al*. (2008) not to have any negative effect on the reproductive performance of rabbits. Nuhu (2010) documented that *Moringa oleifera* leaf meal is naturally very nutritive and can efficiently serve as a replacement for soybean meal in the diet of weaner rabbits without adversely affecting blood indices and productive performance. Moringa leaf meal can be included up to 20% in the diets of weaner rabbits with no detrimental effect on performance (Nuhu, 2010). Ewuola *et al*. (2012) likewise replaced soybean meal with 15% moringa leaf meal in the diets of growing rabbits and achieved significant ($P<0.05$) increase in apparent nutrient digestibility.

Pig: Research carried out by Acda *et al*. (2010) demonstrated that performance of growing pigs fed diets containing 10% inclusion level of moringa leaf meal was not negatively affected. However, Mukumbo *et al*. (2014) reported that feeding increasing levels of *Moringa oleifera* leaf meal to finisher pigs resulted in a significant ($P<0.05$) decrease in intramuscular fat and stearic acid content of the pork. The authors concluded that moringa can be incorporated up to 5% in the diets of finisher pigs without adversely affecting feed conversion efficiency, meat quality and may also lead to improvement in the shelf life of the meat. The variation in the level of dietary inclusion of moringa recommended by the authors cited above may be attributed to the difference in the ages of the experimental pigs used (early growth phase versus late growth phase). Oliver *et al*. (2015) suggested the use of fermented extracts of *Moringa oleifera* as a promising natural growth promoter alternative for use in pig production.

Moringa in fish diet: Egwui (2013) recommended the use of moringa as an alternative source of protein in aquaculture feeds and advocated the need for further research on other aspects of the utilization of *Moringa oleifera* in aquaculture. In the experiment conducted by Olaniyi *et al*. (2013), they established that 12.5% inclusion level of *Moringa oleifera* leaf meal can efficiently replace groundnut cake in the diets of fish (*Clarias gariepinus*). In another study, Karpagam and Krishnaveni (2014) affirms that feeding fish, particularly, Tilapia (*Oreochromis mossambicus*) with moringa leaf resulted in a

significant (P<0.01) increase in weight gain and specific growth rate. Foidl *et al*. (2001) reported that moringa can be used in fish nutrition. Afuang *et al*. (2003) reported that inclusion level of up 33% solvent-extracted moringa leaf meal in the diet of Tilapia fish (*Oreochromis niloticus* L.) had no adverse effect. They further reported a significant (P<0.05) reduction in the carcass lipid and plasma cholesterol levels of fish fed higher levels of moringa (raw and methanol-extracted leaf meals). This is an evidence of the hypolipidaemic and hypocholesterolaemic properties of moringa.

CONCLUSION

In countries where there is the experience of a prolonged dry season or when there is a shortage of most forage plants, moringa will be an available and suitable substitute for feeding livestock animals. Various livestock species have in one way or another benefited from the utilization of moringa plant as documented in the literature by several research authors. The use of *Moringa oleifera* in animal feeding has resulted in improved performance, increased digestibility of feed, enhanced meat quality, brighter egg yolk colour, increased milk yield and improved haematological profile of animals. This plant protein has great potential as a feedstuff for future inclusion in the production of commercial livestock feed.

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Table 1: Dietary effect of *Moringa oleifera* on the performance and productivity of ruminant animals

Animal type	Moringa part fed	Dietary effects	References
Cow	Moringa leaf	Higher milk yield and increase in milk antioxidant activity	Cohen-Zinder *et al*. (2016)
Cow	Moringa leaf	Increased milk yield and improved dry matter intake and digestibility	Sanchez *et al*. (2006)
Cow	Moringa leaf	Increased milk production	Olorunnisomo (2014)
Cow	Moringa leaf	Improved milk yield and improved composition	Khalel *et al*. (2014)
Sheep	Moringa stem	Enhanced feed efficiency	Mahmoud (2013)
Sheep	Moringa leaf	Improved haematological profile and performance	Fayomi *et al*. (2014)
Sheep	Moringa leaf	Improved animal performance	Adegun *et al*. (2011)
Sheep	Moringa leaf	Improved nitrogen balance, nitrogen retention and haematological profile.	Fadiyimu *et al*. (2010)
Goat	Moringa leaf	Increased daily weight gain and diet digestibility	Aregheore (2002)
Goat	Moringa leaf	Better meat quality attributes	Moyo *et al*. (2014)
Goat	Moringa leaf	Improved milk composition and milk yield	Basitan and Jacia (2013)
Goat	Moringa leaf	Higher feed intake, improvement in nutrient digestibility, rumen fermentation, increased production of milk with increase in unsaturated fatty acid and decrease in saturated fatty acid of milk	Kholif *et al*. (2015)
Goat	Moringa leaf	Improved performance (weight gain)	Sultana *et al*. (2015)
Goat	Moringa leaf	Higher dry matter intake and increased weight gain	Briones *et al*. (2017)

Table 2: Dietary effect of *Moringa oleifera* on the performance and productivity of non-ruminant animals

Animal type	Moringa part fed	Dietary effects	References
Poultry (Chicken)	Moringa leaf meal	Improved egg quality and production	Ebenebe *et al*. (2013)
Poultry (Chicken)	Moringa leaf meal	Better carcass characteristics and improved growth performance	Sebola *et al*. (2015)
Poultry (Quail)	Moringa leaf meal	Better feed conversion ratio, better yolk colour, increased egg production and weight	Briones *et al*. (2017)
Poultry (Chicken)	Moringa leaf meal	Produced light appearance of chicken breast meat	Wapi *et al*. (2013)
Poultry (Chicken)	Moringa leaf extract	Increased growth and produced positive effect on haemato-biochemical parameters	Allam *et al*. (2016)
Poultry (Chicken)	Moringa seed meal	Improvement in egg shell quality which resulted in decrease in the number of broken eggs	Briones *et al*. (2017)
Rabbit	Moringa leaf meal	Produced positive effect on reproductive performance	Odeyinka *et al*. (2008)
Rabbit	Moringa leaf meal	Increased apparent nutrient digestibility	Ewuola *et al*. (2012)
Rabbit	Moringa leaf meal	Positive effect on blood indices and productive performance	Nuhu (2010)
Pig	Moringa leaf meal	Improvement of shelf life of the meat, decrease in intramuscular fat and stearic acid content of the pork.	Mukumbo *et al*. (2014)
Pig	Moringa leaf meal	Positive performance	Acda *et al*. (2010)
Pig	Fermented extracts of moringa leaf	Promotes growth	Oliver *et al*. (2015)

CONNECTION BETWEEN PRODUCER PRICES AND RICE OUTPUT IN NIGERIA: AN APPLICATION OF KOYCK'S DISTRIBUTED-LAG MODEL

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ABSTRACT
Favourable prices usually induce increased production in agricultural commodities globally. This study examined the relationship between producer prices and rice output in Nigeria using time series data spanning from 1980 to 2013. The study employed Koyck distributed-lag model. The results revealed that producer prices imposed a positive and significant effect on rice output. The producer price in a given year was found to impact significantly on the subsequent year's rice output while the lagged prices had a positive but decreasing effect on rice output. In terms of size, a one per cent change in a given year's producer prices resulted in increases in rice output by 0.102 ton whereas a one per cent change in the previous year's price increased rice output by 0.051 ton. In general, the time required for changes in producer prices to have a significant and noticeable effect on rice output in Nigeria was 1.01 year. Consequently, producer price stability could considerably result in a more predictable rice output in Nigeria. Government can stabilize price by guaranteeing a price to producers irrespective of the output produced.
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Keywords: Rice, Producer Prices, Koyck distributed-lag model, Nigeria

INTRODUCTION

Rice (*Oryza sativa*) is the staple food for a greater part of the world's population, particularly in developing countries. According to Borrero *et al*. (2007), more than 75 per cent of the world's poorest people still depend on rice. In Nigeria, rice used to be classified as a luxury food item prior to independence, however, rice now holds the status of a staple food, along with cassava and yam among others (Daramola, 2005). Although per capita consumption of rice in the country increased from as low as 3.4kg/year in 1976 to 20.9kg/yr in 2009 (FAOSTAT, 2013), production has failed to catch up with the increasing demand for rice . As at 2016, the total demand for rice was 7 million metric tones, only 2.7 million metric tones was produced, leaving a gap of 4.3 million metric tones (Thisday Newspaper, 2016). This has lead to a wide gap between domestic production and demand. Consequently, enhancing cereal output in general and rice in particular is closely associated with national food security and wellbeing of majority of the farming population. Accordingly, the impact of price changes in the supply and demand for food is critical.

In addition to the uncertainty farmers face with regard to the amount of output that will result from a given bundle of inputs and management decisions due to uncontrollable factors such as weather, they have to deal with price uncertainties and instability (Demeke, *et al*.,2012). The knowledge of price at the time of planting and harvest is very crucial for farmers considering growing any crop. Given that more than 90 per cent of Nigeria's agricultural output comes from small-scale peasant resource poor farmers who reside in the rural areas (Ismaila *et al*., 2010), low and fluctuating prices would cause problem for stable food production. This is because agricultural price volatility increases the uncertainty faced by farmers' especially small-scale farmers and affects their income and investment decisions as well as their productivity. It is therefore, very important that farmers have all the needed information for making good decision. As a consequence, price relationships have a significant influence on decisions regarding the type and quantity of agricultural production activity. It is against this backdrop that this study seeks to examine the connection between producer prices and rice output in Nigeria using the Koyck distributed lag model. Previous studies conducted in other crops using Koyck model to examine the relationship between production and prices include: Erdal (2006), Ozcelik and Ozer (2006), Erdal and Erdal (2008), Erdal *et al.,* (2009), De Silva *et al*.. (2014) and Hasan and Khalequzzaman (2015).

The objectives of the study were to describe the trend in producer prices and rice output in Nigeria, determine the optimal lag of producer prices that could have an effect on rice output and determine the effect of producer prices on rice output. Findings from this study will assist rice farmers in making a good prediction of price and aid policy makers in formulating polices that will stabilize producer prices of rice in Nigeria.

LITERATURE REVIEW

Price is generally the channel through which economic policies are expected to affect agricultural variables such as output, supply and export and income (Phillips and Abalu, 1987; Dercon, 1993). Producer prices are prices received by farmers for primary crops, live animals and livestock products as collected at the point of initial sale, that is, prices paid at the farm-gate (Food and Agriculture Organization, FAO, 2017). These prices are considered at the farm gate, that is, at the point where the commodity leaves the farm and hence does not include the costs of transport and processing. According to Enete and Amusa (2010), producer prices are usually an inducement for farmers to produce. Farmers are more likely to consider past experiences and make the best guess of the price (Ndhlovu and Seshamani, 2016). Increased price variability can have adverse impacts on both consumers and producers of agricultural commodities, consequently leading to alteration in the production levels of the commodity involved (Shively, 1996). The instability of agricultural prices negatively impacts the activity of farmers, because when prices are volatile, it becomes impossible for farmers to select the right production techniques or to plan their investments (Malan, 2013). This volatility of agricultural prices causes severe damage to farmers in the terms of well-being (Matthews, 2010; Onour and Sergi, 2011; Rapsomanikis and Mugera, 2011). This is because in general poor farmers do not have enough investment capital to sustain such unpredictability (Huka, *et al.,* 2014) which could be made worse by meager producer prices.

Prices of commodities give signals to the producers regarding the type and quantity of commodity to be produced in a particular place at a particular time in a viable economic system (Reddy *et al.,* 2009). Farmers are commonly believed to be quick to respond to producer prices (Ezekiel *et al*., 2007). According to Bor and Bayaner (2009), it is commonly thought that farmers have sufficient power to decide the physical procedure of agricultural production, meaning that the decisions on what to produce, how to produce and which inputs to use are in the hands of the farmers and the farmers take the prices as decision-making factor. Farmers are known to consider the previous year's price when planning what to produce and how much to produce. Such planning results in price and output fluctuations, which is referred to as the Cobweb theory in economic literature

The Cobweb theory describes the temporary equilibrium of market prices in a single market with one lag in supply (Hommes, 1994). The Cobweb theory is a dynamic analysis theory that employs the elasticity law to explain the different fluctuations in some commodities with long production periods when they lose balance (Zhan and Feng, 2008). The crucial supposition of the Cobweb theory is that the current production of the commodity is based on the price in the previous period. According to the assumptions of the Cobweb model, farmers will determine the current grain-sown area according to the price of the previous period before the grain production is carried out (Xie and Wang, 2017). Subsequently, the current grain price will have determined the grain yield of the next period to a certain extent. The higher the price of agricultural products, the stronger the enthusiasm of farmers and food production will increase (Xie and Wang, 2017). On the other hand, lower prices of agricultural products will reduce the eagerness of farmers to increase grain production leading to a decrease next year's planting plan, which will lead to a reduction of that year's grain production. Based on these structural features of agricultural production, relationship between agricultural output and price can be examined using distributed lag model.

THEORETICAL FRAMEWORK

Distributed-lag models play important roles in economic literature and econometric modeling. In estimating Distributed-lag models, the present values and past values are taken into account for modeling. Two major problems with distributed lag models are multicolinearity and the increasingly lowered degrees of freedom as lag length increases. In order to overcome these problems, Koyck model (Koyck, 1954) was developed for the estimation of parameters in distributed lag models. According to Gujarati (2003), the dependence of variable Y on variable (s) X is rarely instantaneous, because very often, Y responds to X with a lapse of time (lag). Given the following distributed-lag model in one explanatory variable (Gujarati, 2003):

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + ... + \mu_t \quad (1)$$

Assuming that the $\beta's$ are all of the same sign, Koyck assumes that they decline geometrically as follows:

$$\beta_k = \beta_0 \lambda^k \text{ Where } k = 0,1... \quad (2)$$

where λ, such that 0< λ < 1, is known as the rate of decline or decay of distributed lag and $1-\lambda$ is the speed of adjustment. Equation (2) postulates that each successive β coefficient is numerically less than each preceding β (since $\lambda < 1$), suggesting that as one goes back into distant past, the effect of that lag on Y_t becomes progressively smaller (Gujarati,

2003). β_k is the lag coefficient which varies by λ as well as by β_0. The closer λ is to 1, the less the decrease in β_k. On the other hand, the closer λ is to zero, the greater the decrease in β_k (Gujarati, 2003). In other words, when λ values is close to 1, it means that the values of the defining variables in remote past have a significant effect on dependent variable, and values of λ close to zero mean that values of the defining variable in the distant past have no significant effects of the dependent variable. Koyck's geometric-lag scheme implies that 'more recent values of X exercise a greater influence on Y than remote values of X.

As a result of equation (2), the infinite model in equation (1) may be written as:

$$Y_t = \alpha + \beta_0 X_t + \beta_0 \lambda X_{t-1} + \beta_0 \lambda^2 X_{t-2} + \ldots + \mu_t \quad (3)$$

Linear regression analysis cannot be applied to equation (3) since it has infinite lag and λ coefficients are not linear. In order to solve this setback, equation (3) is lagged by one period to obtain:

$$Y_{t-1} = \alpha + \beta_0 X_{t-1} + \beta_0 \lambda X_{t-2} + \beta_0 \lambda^2 X_{t-3} \ldots + \ldots \mu_{t-1} \quad (4)$$

Multiply equation (4) by λ to obtain

$$\lambda Y_{t-1} = \lambda\alpha + \lambda\beta_0 X_{t-1} + \beta_0 \lambda^2 X_{t-2} + \beta_0 \lambda^3 X_{t-3} \ldots + \ldots \lambda\mu_{t-1} \quad (5)$$

Subtracting equation (5) from equation (3) gives

$$Y_t - \lambda Y_{t-1} = \alpha(1-\lambda) + \beta_0 X_t + (\mu_t - \lambda\mu_{t-1}) \quad (6)$$

Rearranging equation (6) gives

$$Y_t = \alpha(1-\lambda) + \beta_0 X_t + \lambda Y_{t-1} + \nu_t \quad (7)$$

Where $\nu_t = (\mu_t - \lambda\mu_{t-1})$, a moving average of μ_t and μ_{t-1}. The procedure described above is known as the Koyck transformation. Equation (7) is the Koyck model. Instead of estimating α and an infinite number of β's, the Koyck's model allow the estimation of only three unknown: α, β_0, and λ. The problem of multicollinearity is resolved by replacing $X_{t-1}, X_{t-2}, \ldots$, by a single variable, that is, Y_{t-1}. The 'mean lag length' proposed by the model is: λ/ (1- λ) which can be expressed as the time period required for a unit change in the defining variable to have a noticeable effect on the dependent variable (Gujarati, 2003). Once the model is specified, the Classical Least Square method is used to estimate the parameters.

METHODOLOGY

Study Area: This study was carried in the Federal Republic of Nigeria. Geographically, Nigeria occupies a landmass of 923,768sq km. The country comprises 36 states with Abuja as the Federal Capital territory. The country's population was estimated to be 173.6 million (World Bank, 2015). The country's strength includes abundant land, labour, and natural resources. It has an area covering 92.4 million hectares, consisting of 91.1 million hectares of land. 1.3 million hectares of water bodies. The agricultural area is 83.6 million hectares, which comprises arable land (33.8 percent), land permanently in crop (47.9 percent) forest or woods (13.0 percent), pasture (47.9 percent) and irrigable land (2.4 percent) (Adetunji, 2006). Climate in Nigeria fluctuates from humid tropical in the South to sub-humid tropical in the north, having wet and dry seasons. Nigeria is agrarian, and agriculture remains the core of the economy, providing employment for over 70 percent of the population.

Data Source: This study used time series data on producer prices and rice output in Nigeria spanning from 1980 to 2013. Data on producer prices and rice output were obtained from FAOSTAT, statistical database of Food and Agriculture Organization of the United Nations (FAOSTAT, 2016).

Estimation Procedures: First, the Augmented Dickey Fuller (ADF) test was used to establish the time series characteristics of all the variables used in the study. This was done to avoid the problem of spurious regression which is the outcome of regressing of two or more non-stationary time series data. The Augmented Dickey Fuller (ADF) model is as specified below:

$$\Delta Y_t = \alpha_1 + \alpha_2 t + \beta Y_{t-1} \sum_{i-1}^{p} \lambda_i \Delta Y_{t-1} + \mu_t \quad (8)$$

Where Δ = the change operator; Y_t = series being investigated for stationarity; Y_{t-1} = Past values of variables; t = time variable and μ_t is the white noise error. The ADF test that the series is not stationary is represented by the null hypothesis ($H_0 : \beta = 0$) while the alternative hypothesis ($H_1 : \beta < 0$) shows that the series is stationary. The decision rule is that if the computed ADF statistics is greater than the critical at the specified level of significance, then the hull hypothesis of unit root is accepted otherwise it is rejected. In other words, if the value of the ADF statistics is less than the critical values, it is concluded that Y_t is stationary i.e. $Y_t \sim I(0)$. When a series is found to be non-stationary, it is

first-differenced (i.e. the series $\Delta Y_t = Y_t - Y_t\text{-}1$) is obtained and the ADF test is repeated on the first-differenced series. If the null hypothesis of the ADF test can be rejected for the first-differenced series, it is concluded that $Y_t \sim I(1)$.

Model Specification : To examine the connection between producer prices and rice output in Nigeria, this study estimated the following linear equation model.

$$RQ_t = \alpha + \beta_0 PP_t + \beta_1 PP_{t-1} + \beta_2 PP_{t-2} + .\beta_k PP_{t-k} + \mu_t \quad (9)$$

Where RQ_t, is rice output in period t (ton), PP_t is producer prices in period t (₦/ton), PP_{t-1} is the producer prices lagged one period, α and β are the regression parameters. In order to estimate the model in equation (9), it was necessary to first determine the lag value (lag length) of producer prices to include in the distributed lag model. In selecting the lag length for the producer prices, the Akaike and the Schwarz information criteria (Gujarati, 2003) were applied at different lags (four lags) see Table 2 for results.

Based on the determined lag length, the following Koyck model was specified in equation (10) as:

$$\Delta \ln RQ_t = \alpha + \beta_0 \Delta \ln PP_t + \lambda \Delta \ln RQ_{t-1} + \mu_t \quad (10)$$

The variables were transformed into natural logarithms and used for the estimation. This was done because according to Gujarati (2003), log transformation reduces problem of heteroscedasticity because it compresses the scale in which the variables are measured, thereby reducing a tenfold difference between two values to a twofold difference. Furthermore, the model was estimated in differences in order to prevent the possibility of spurious results owing to non-stationarity in the variables. The reason for doing this can be seen in the results of the ADF test (Table 1). The estimates of the Koyck Distributed-lag model equation (10) were analyzed with the aid of E-views statistics software package using the classical least squares method.

RESULTS AND DISCUSSION

Summary Statistics of Variables: The summary statistics of variables used in the study is presented in Table 1. Results show that the mean producer price of rice for the period under study was ₦ 489.0679/tonne with a maximum and minimum of ₦1246.942/tonne and ₦ 133.6736/tonne respectively. On average, the output of rice was 2935323 tonnes with a maximum and minimum of 5432930 tonnes and 1090000 tonnes respectively during the period under study. The graphical representation of trends in producer prices and rice output are shown in figures 1 and 2.

Augmented Dickey Fuller (ADF) Unit root test: Results of the ADF test for the presence of unit root are presented in Table 2. The results indicated that all the variables (PP and RQ) were found to have unit root at level. However, became stationary after first differencing. Differencing was needed so as to avoid the occurrence of spurious regression when series are used in their non-stationary form.

Optimal Lag Selection for Producer Prices: Lag length selection based on Alaike and Schwarz criteria is presented in Table 3. The results showed that producer prices lag one period (k=1) was the optimal lag. Since the lowest Alaike and Schwarz values were obtained for lag length k=1. Thus, effect of producer prices on rice output will be zero after one year.

Effect of Producer Prices on Rice Output: The model in equation (10) as mention earlier was estimated in differences in order to prevent the risk of spurious results due to non-stationarity in the variables. The reason for doing this was because after first difference, the non-stationary variables became stationary at 1% significance level based on the results obtained from ADF unit root test on producer prices and rice output as shown in Table 2. The estimates from the Koyck's distributed-lag model are reported in Table 4. The coefficient of determination (R^2) value, which is an indication of overall measure of goodness of fit, was relatively high. The result showed that R^2 was 0.892 indicating that 89.2% of the variation in rice output was explained by producer prices. The F-statistics being significant implies that the overall goodness of the model is satisfactory. The sign of the coefficient of the constant term was positive and significant for the model at 1% level. The results in Table 4, showed that the coefficient of producer prices were positive which is in agreement with theory and significant at 1% level. This result is consistent with Akpan (2007) and Ayinde *et al.* (2015) who found positive relationship between price and output for Nigerian grain sector. This implies that a change in producer price resulted in a change in rice output. In terms of volume, a one per cent change in producer price would cause about 0.102 per cent change in rice output. The reason for this is that high producer price would cause farmers to increase input use and land allocated to rice cultivation thereby leading to an increase in rice output. Consequently, rational

producers are expected to increase the use of inputs in reaction to crop price increases, suggesting that producers base their decisions on the expected crop prices (Bor and Bayaner, 2009).

In addition, the coefficient of lagged rice output (Table 4), showed a positive and significant impact on successive output. This implies that a one per cent change in the ton of rice produce in the previous year would cause about 0.503 per cent change in rice output. This suggests that an increase in output in a given year could be enhanced by an increase in rice output in the preceding year. The mean lag length, $\lambda/(1-\lambda)$ of 1.01 suggests that it takes about a year for rice output to respond to changes in producer prices in Nigeria.

To obtain values for equation (10), which is the Koyck distributed lag model estimated for this study, given that $\beta_k = \beta_0 \lambda^k$ where $k = 0,1...$ since $0< \lambda < 1$, the following calculation was carried out:

$\beta_0 = \lambda^0 \beta_0 = (0.503)^0 (0.102) = 0.102$

$\beta_0 = \lambda^1 \beta_1 = (0.503)^1 (0.102) = 0.051$

$\alpha = \alpha/(1-\lambda) = 6.433/1- (0.503) = 12.954$

From the results of the calculation, the Koyck distributed lag model estimated for this study can then be specified as:

$$RQ_t = 12.954 + 0.102PP_t + 0.051PP_{t-1} \quad (11)$$

Based on equation (11), lagged producer prices have a positive but decreasing effect on rice output, while a one per cent change in a given year's producer price increases rice output by 0.102 ton, a one per cent change in the previous year's price increased rice output by 0.051 ton. This implies that 'more recent values of producer prices exercise a greater influence on rice output than remote values of producer prices. This suggests that a given year's price were found to impact significantly on subsequent year's output than the lagged prices. This result is consistent with findings of Ozcelik and Ozer (2006), Erdal and Erdal (2008), Erdal *et al*. (2009), De Silva *et al*. (2014) and Hasan and Khalequzzaman (2015).

CONCLUSION AND RECOMMENDATION

This study examined the connection between producer prices and rice output in Nigeria using time series data spanning from 1980 to 2013. The study employed Augmented Dickey-Fuller (ADF) test, Koyck distributed-lag model and Ordinary Least Square (OLS) regression analysis. The results revealed that producer prices imposed a positive and significant effect on rice output. The producer price in a given year was found to impact significantly on the subsequent year's rice output while the lagged prices had a positive but decreasing effect on rice output. In terms of volume, a one per cent change in a given year's producer price resulted in increases in rice output by 0.102 ton while a one per cent change in the previous year's price increased rice output by 0.051 ton. In general, the time required for changes in producer prices to have a significant and noticeable effect on rice output in Nigeria was 1.01 year. Therefore, producer price stability could significantly result in a more predictable rice output in Nigeria. Government can stabilize price by guaranteeing a price to producers irrespective of the output produced

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Table 1: Summary Statistics of Variables

Variable	Mean	Minimum	Maximum	Std. Dev	CV (%)
Producer Price (PP)	489.0679	133.6736	1246.942	255.1900	52.18
Rice output (RQ)	2935323	1090000	5432930	1118421	38.10

Source: Author's computations using E-views

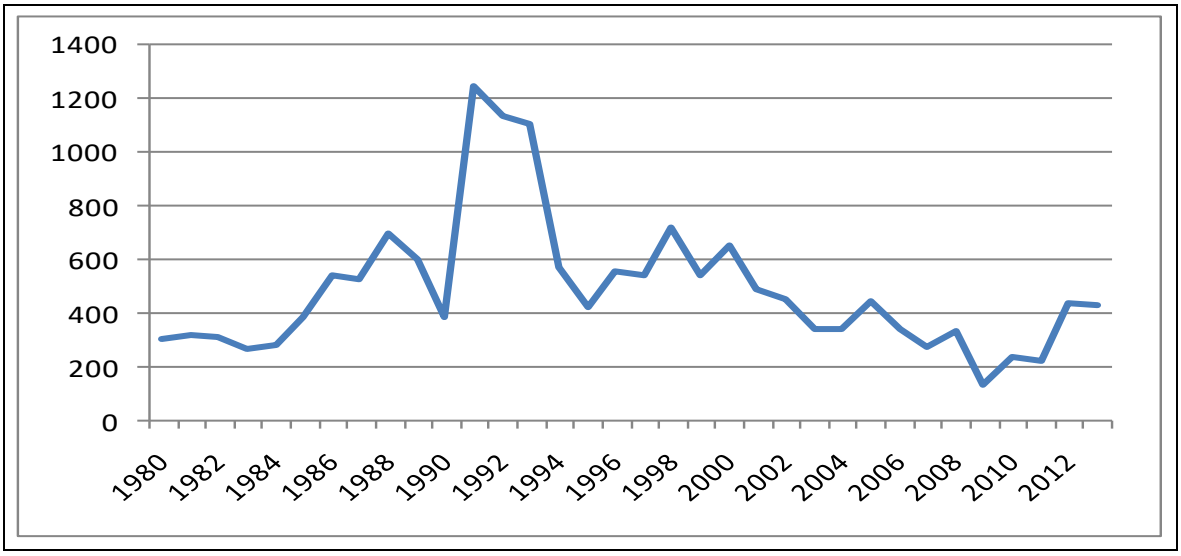

Figure 1: Trends in Producer prices in Nigeria, 1980-2013
Source: FAOSTAT (2016)

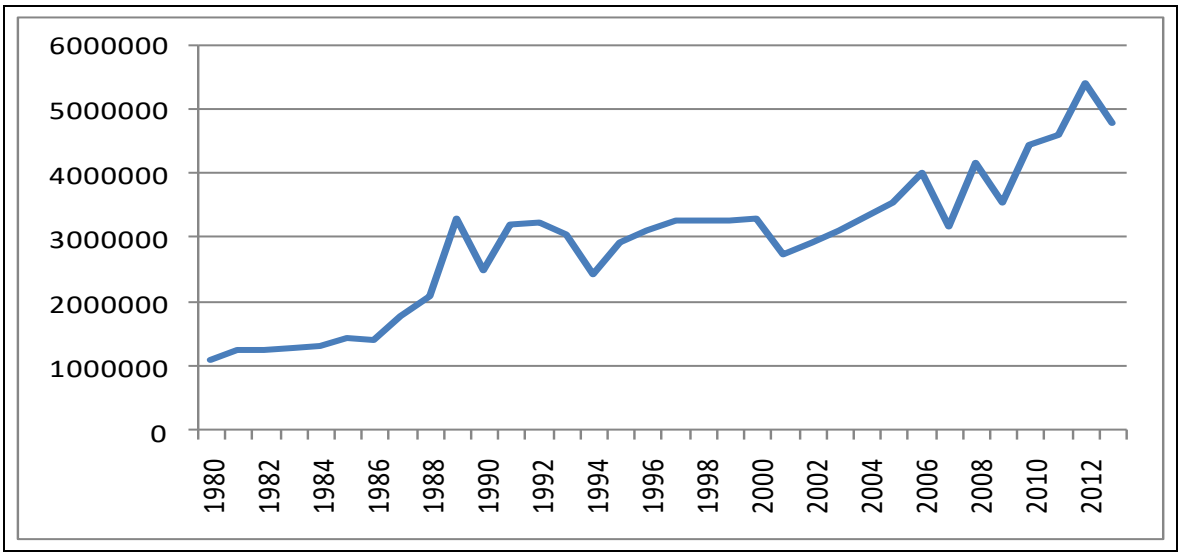

Figure 2: Trends in Rice Output in Nigeria, 1980-2013
Source: FAOSTAT (2016)

Table 2: Augmented Dickey-Fuller (ADF) Test Producer Price (PP) and Rice Output (RQ)

Variables	Levels			
	ADF Stat	Critical Values		
		1%	5%	10%
$\ln PP$	-0.721734	-3.653730	-2.957110	-2.617434
$\ln RQ$	-0.316594	-3.65370	-2.957110	-2.617434
	First Difference			
	ADF Stat	Critical Values		
		1%	5%	10%
$\ln PP$	-6.535917***	-3.661661	-2.960411	-2.619160
$\ln RQ$	-9.887052***	-3.653730	-2.957110	-2.617434

*** ' indicate variable is significant at 1% level; Lag length selection was automatic based on Schwarz information criterion (SIC).
Source: Author's computations using E-views

Table 3: Lag Length Selection based on Alaike and Schwarz Criteria

S/No.	Lag Length	Alaike Values	Schwarz Values
1	k=1	-0.71	-0.57
2	k=2	-0.64	-0.45
3	k=3	-0.57	-0.34
4	k=4	-0.46	-0.18

Source: Author's computations using E-views

Table 4: Estimates of Distributed-lag model

Dependent Variable: $\Delta \ln RQ_t$					
Variable	Parameter	Coefficient	Std. Error	t-Statistic	Prob.
C	$\alpha(1-\lambda)$	6.433312	2.043104	3.148794	0.0037***
$\Delta \ln PP_t$	β_0	0.102358	0.039552	2.587896	0.0147**
$\Delta \ln RQ_{t-1}$	λ	0.503355	0.161210	3.122358	0.0040***
R-squared		0.892333	Mean dependent var		14.83485
Adjusted R-squared		0.885155	S.D. dependent var		0.419054
S.E. of regression		0.142013	Akaike info criterion		-0.979295
Sum squared resid		0.605027	Schwarz criterion		-0.843249
Log likelihood		19.15836	Hannan-Quinn criter.		-0.933519
F-statistic		124.3178	Durbin-Watson stat		2.101078
Prob(F-statistic)		0.000000			
Mean lag length:	$\lambda/(1-\lambda)$	0.503/1-0.503 =1.01			

Note: *** and ** indicates significance at 1% and 5% level respectively
Source: Author's computations using E-views

ANALYSIS OF MARKETING STRUCTURE AND NET MARGIN OF FRESH MANGO FRUITS IN MINNA METROPOLIS OF NIGER STATE, NIGERIA

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ABSTRACT
The study analyzes the marketing structure and consumption of fresh mango fruits in Minna metropolis. Eight fresh mango fruit markets were sampled for the survey namely Gwadabe, Chanchaga, GidanMangoro, PZ, TunganGoro and Maikunkele. They were purposively selected within the metropolis. 99 traders were drawn using simple random sampling from the stated markets. Data were collected using questionnaires. Similarly, data were analyzed using descriptive statistics, Gini coefficient index, Ordinary least square regression techniques and marketing margin. Results of the analysis indicated that most (61.6%) of the traders were within the active age brackets of 25 – 54 years. All (100%), of the traders were found to be male, married (88.8%), literate (93.0%) and trading experience of 1 – 20years (57.6%). The result of OLS shows an R^2 of 0.52, which indicates that 52% of the variation in the consumption of fresh mango fruits in the area could be explained by the explanatory variables included in the model. The Gini coefficient index of the market was found to be 0.60, which revealed that the market is an imperfect market due to high net margin (63.1%),low producer share (22.7%) and economies of scale among few traders. Analysis of the challenges revealed high transportation cost (27.3%), poor storage facilities (23.2%) and inadequate credit facilities (17.2%). To improve the system, it is recommended that the traders should be encouraged to form cooperative societies or groups and government should be concerned with improvement of infrastructures, such as storage/processing facilities, construction and repair of feeder roads/rail-line, and above all traders should be assisted with marketing credit to avoid "forced" sell of their products which often erode their profit.

Keywords: Marketing, Structure, Consumption, fresh Mango Fruits, Niger State.

INTRODUCTION
The level of fruit consumption in Nigeria is rising annually owing to greater appreciation of their value (Haruna, 2003). However, most of the fruits including Mango (*Mangifera indica*) are perishable in nature and therefore, efficient marketing is a pre-requisite for the satisfaction of both producers and consumers. Mango production has risen by 7 percent annually since 1997, and the bulk of these fruit (98%) are grown in developing economies like Nigeria especially in the rural areas where agriculture or specifically farming is their principal occupation (Baba, 2004).

Latest figure of fruit production shows that pineapple accounts for 44 percent of the total traded volume and mango fruits ranked second (27%), followed by Avocados (12%) and papayas (7%) (Onu and Illiyasu, 2008). The main reason for increased demand of tropical fruits, including Mango is the growing familiarity of consumers with tropical fruits, their palatability and nutritivity and cooking qualities. Furthermore, as Lumpkin, Weinberger and Moore (2005) pointed out, worldwide production of fruits and vegetables have grown faster than the general crops. Nutritionally, fruits are rich source of vitamins and minerals, dietary fibre and provides additional calories and proteins (FAO, 2010). Economically, per capital income from horticulture has been reported up to five times higher than cereal production. Promotion of the production of, and trade in fruit and vegetable has recently become one of the key objectives of developing nations.

Most fruits are perennial trees and can live more than fifty years. Apart from their economic importance, they are forest and environmental friendly to fight against drought, used as shade, firewood, ornamental for agro-industry, export crop among others. Unfortunately, their status in agricultural policy was low in Nigeria. Moreso, because of the fact that substantial proportion of fruits consumed in Nigeria can come from wild, incidental and traditional cropping systems, there has been a general tendency to take their production and marketing for granted. (Yashitela, 2006).

Mango is a natural fruit all over the world, and is popularly known as "king of fruits". The fruit is believed to have originated from the North-West Bangladesh. However, the fruit also thrives well in most tropical countries (FAO, 2010), and belong to the family Anacardiaceae, in the plant kingdom (FAO, 2006). The major mango producing countries in the world include India, China, Thailand, Pakistan, Mexico, Indonesia, Brazil, Philippines and Nigeria.

Mango is a perennial plant which lives more than fifty years (FAO, 2006). The fruit have small point at done and known as beak (Yeshitela, 2004). It is usually harvested when the plant is fresh (Onu and Illiyasu, 2008), and high in moisture, and distinguished from field crops which are harvested at the matured stage for their grains, pulses, oil seeds or fibre.

It is universally recognized that mangoes are important dietary requirement and that its production, marketing and processing are significant economic contributors. In terms of poverty alleviation, the mango industry provides both employment and income to farmers, marketers and exporters (Ekesi and Billah, 2006).

Marketing of agricultural produce, including mango begins at the farm when the farmer plans his production to meet specific demands and makes proposals. The concept of utility are central in agricultural marketing (Ndanitsa, 2005). The primary role of an integrated marketing system is to add form, place, time and possession utility so that the subjective satisfaction of consumer is maximized (Kohls, 1985).

With the growing consciousness of health and better understanding of dietary role of fruits like Mango, increase in affluence of urban dwellers, fruit consumption has increased considerably. However, there is a huge gap between demand for, and supply of fruits. This problem is traceable not only to inadequate food supply but to inefficient marketing system. Mango fruit marketing system in Nigeria is poor and uncoordinated. The wide seasonal variations in quality and quantity, and price, relative perishable nature of fruits, inadequate transport system, poorly adapted and poor packaging and storage facilities result in heavy and these constitutes problems. Joseph and Adeoti (2006), revealed that the nature of distribution of fruits and vegetables in Nigeria marketing system is grossly inefficient, inadequate and that it is associated with high level of post-harvest losses and poor pricing. The whole marketing and distribution of fruits like mango in Nigeria is on the basis of supply and demand being catered for by a vast number of small individual efforts, disjointed, untrained and often part time, and as such, the system does not land itself to the necessary organization of transport, storage and efficient marketing. (Ndanitsa, 2005)

One of the major problems of mango marketing in Minna metropolis of Niger State, Nigeria is the post-harvest losses. This is attributed to the lack of processing and storage facilities available to the farmer, seasonable supply, high perishable nature of mango fruits, poor transport, poor packaging, which have led to heavy losses of fruits and as such, has reduced the amount available for consumption and increase the price of available ones. More of this is the indiscriminate pricing for mango due to lack of uniform grading, standard weight and measures. Therefore, there is high risk of spoilage of mango fruit. Complex supply chain is also an important problem for the development of Minna Mango industry. Weather and Climatic vagaries like wet and windy weather influenced the fruit potentiality for storage, by modifying physiology, chemical composition and morphology of fruits. Furthermore, fluctuation of market situation is also a major factor that affects the production and distribution of mango which results in no assurance of higher prices in market. Delay in getting payment of produce, pressing need of money for immediate payment (force selling) are also serious factors. (FAO, 2010).

In addition, the structure and conduct of fresh mango marketing in Minna metropolis is largely unreported in literature due to the absence of adequate information on fruit marketing in Minna metropolis derived from empirical studies, the behaviuor of actors in the market and the constraints they face, that imped further innovation and productivity in the fruit sub-sector. Structural characteristics have been used to classify markets as either perfect or imperfect. Structure can be identified in terms of the numbers, size and distribution of buyers and sellers, the degree of product differentiation, and the ease of entry and exist into the market.

The central theme of this study is that mango fruit marketing warrants special attention for several reasons. Firstly, the contribution as food (food security to our national life and their high nutritive value and secondly the structure of the fruit market can affect the economy of the people in the study area and consequently, the nations economy in significant ways. The study focuses exclusively on Minna metropolis because traders in the metropolis depend largely on the marketing of primary commodities such fruits and vegetables as a source of employment, livelihood, income and food supply. The study examined the socio-economic characteristics of the marketers, the structure of the marketing system and identifies the variables that determines the volume of fresh mango marketed.

Better marketing system will stimulate increased consumption and this will contribute to better health and improve the quality of life of citizenry. Similarly,

the study is aimed at contributing to the existing knowledge of the mango market with a view to improve their knowledge (marketers) on perceived problems of marketing mango fruit. The study also hopes to fulfill the need for data generation to grassroots which will serve as guide for the formulation of market policies by governments/non-governmental organizations towards improving mango production.

METHODOLOGY

Study Area: The study was conducted in Niger State of Nigeria. Niger State is located in the North-Central Nigeria. The state capital is Minna, and other major cities are Bida, Kontagora and Suleja. The State lies in the Guinea Savannah vegetation of the country with favourable climate. It lies between latitude $8^0 35^1$ North and longitude $3^0 30^1$ to $7^0 20^1$ East. The climate is sub-tropical and is characterized by a distinct dry and wet season with annual rainfall varying from 1,100mm in the North to 1,600mm in the south. The maximum temperatures which do not exceed 37^0c are between March and June with the lowest minimal temperatures of usually in December and January. The seasonal variations of air temperature are constant. The duration of the wet season ranges from 150 days between months of May to September in the Northern part of the state, and between the months of April to October in the Southern part (NSADP, 1997). The state has a population of 3,954,772 people (NPC, 2006), the estimated projection of population based on 3% growth rate per annum is 5,478,147 people by 2017. The state is bordered on the North by Zamfara State, to the East by Kebbi State and Federal Capital Territory (FCT) bordered the state at both North – East and South East. The state shares a common (International) boundary with the Republic of Benin in Borgu Local Government Area (ADP, 2008). The prominent linguistic groups within the state consist of Nupe, Gwari, Hausa, Fulani with small communities of other ethnic groups such as Yoruba, Ibo, Igbira, Kadara, Kakanda etc. The people's major economic activities are trading, farming craft and fishing. The climate, soil and hydrology permits the cultivation of most Nigerian staple crops and still leaves sample scope for grazing and forestry, and fresh water for fishing. The State has a total land area of 7 million hectares (92,800km^2) of agricultural land, which is about 10% of the total land area of the country, and in which 33 percent is under cultivation. The State potential of *Fadama* development is also enormous and the *Fadama* area of the state is 682,000 hectares (ha) of irrigable land with only 3.9 percent currently under irrigation farming of arable and tree crops. (NSADP, 1997).

Sampling Technique and Data Collection: Data collected for this research were from primary sources. The primary data was collected using structured questionnaires accompanied by interview schedule to the traders in the study area. The primary data collected included socio-economic variables such as age, household size, educational status, years of experience and source of finance and likewise problems associated with mango marketing. The study was conducted between January and March, 2016.

Purposive sampling was used to select eight markets within the metropolis namely Gwadabe, Chanchaga, Gidan Mangoro, Mobil, Bosso, Maikunkele, PZ and Tungan Goro. The sample for the study was drawn using simple random sampling from the stated markets. Ninety – nine (99) respondents (fresh mango marketers) were selected from the eight (8) markets. This number comprises of 23 local wholesalers, 13 distant wholesales or transporters, 29 commission agents and 43 retailers. Purposive sampling was adopted because these markets selected form clusters of mango marketing. All agents assembled in these markets for buying and selling of fresh mango fruits in Minna metropolis.

Method of Data Analysis: Descriptive statistics such as frequency distribution percentages, averages, tables etc, Gini concentration index, Ordinary least square regression techniques and marketing margin was used in data analysis. The models are specified below:

Gini Coefficient (G) =

$$I = \sum_{i=o}^{N} (aY_{i-1} + Y_i)(aX_{i-1} - aX_i) \text{.....(i)}$$

Where:

$\sum$ = Summation Sign

N = Number of elements or observations (markets)

Y = Percentage of trader income in fraction

X = Percentage of observation in fraction

aX = Cumulative percentage of X_s in fraction

aY = Cumulative percentage of Y_s in fraction

$aXi - 1$ = Difference between percentage of X_s (in fraction) and the one preceding it

aY_{i-1} = Difference between percentage of Y_s (in fraction) and the one preceding it.

Regression Analysis

Linear Function:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + U \quad \text{(ii)}$$

Where:

Y = Selling price of mango in ₦/kg

β = Constant

β_1 = β_6 = Coefficients of the variables

X_1 = Average cost of storage in ₦/kg

X_2 = Average cost of losses in ₦/kg

X_3 =Average cost of transport in ₦/kg

X_4 = Average quantity sold in ₦/kg

U = Error term.

Marketing Margin (MM)

$$MM = \frac{C_p - P_p}{C_p} \quad \text{..... (iii)}$$

Where:

P_p = Producer price

C_p = Consumer price

Net Margin (MM)

NM = MM – TMC…… (iv)

Where:

MM = Marketing margin

TMC = Total marketing cost

Percentage of Net Margin (%) =

$$\frac{MM - TMC}{MM} \times 100 \quad \text{..... (v)}$$

RESULTS AND DISCUSSION

Results of the descriptive analysis of the socio-economic characteristics of the respondents in the study area as shown in Table 1 shows that most (61.60%) of the traders were within the active age brackets of 25 – 54 years, which agrees with Ajayi (2000), who found out that most of the fruit traders are in their economic active years and in productive age brackets recommended by the FAO. The mean age of respondents was 39 years According to FAO (2010), the age of the decision – maker is an important factor influencing change and enhancing adoption of improved agricultural production technologies. It is expected that younger farmers will accept innovation more easily than the older ones, as they are higher risk takers in expectation of profit. All (100%) traders were found to be males, which indicate the dominance of men in the marketing of fresh mango fruit. The result conforms with the norms, beliefs and values of the study area where religion does not allow woman unnecessary exposure (women in purdah), moreso, fruit trading is tasking and may not be convenient for the female traders. Table 1 also shows that majority of the mango traders (88.80%) in the study area were married couples, 8.1% were single and 3.1% were widowers. This shows that most of the fresh mango traders were likely to have families, and a strong indication of their chances of getting family labour for use in the business. This may probably reduce the demand for hired labour, and suggests a reduction in operating cost and increase in profit, which translates to improvement in their standard of living. The family size distribution of the respondents showed that 75.8% and 20.2% had a household size between 1 – 16 and 17 – 24 members respectively. The average family size of respondents was 13 people. This is likely an indication of low level of awareness of planning and reproductive health issues among the traders. The implication of these is that this may positively influence household food security if the members helped to reduce expenses on hired labour in trading expenses or production/operations (Eboh, 1995). However, Baba and Etuk (1991) and Baba and Wando (1998) explained that the implication of the large household sizes is that household expenditure tends to draw more on family income so that only a meager sum is saved and invested eventually on production. For the borrowed capital in the business, this is likely to affect the repayment capacity of the respondent.

With regards to educational level, majority (93.0%) of the respondents were literate. The result conforms favourably with Ajayi and Mbah (2002), who observed that the literacy level of fruit traders to a large extent determines the strategies which he/she may use to adopt new technologies in terms of storage and good record keeping, which will increase his/her profit (Binswanger *et al*; 1993). However, in spite of high level of literacy which was largely due to modern educational stitches, mango fruit marketers had little or no record of their activities kept. Furthermore, Table I also shows that 57.6% of marketers had between 1 – 20 years experience in Mango marketing, which is an indication that experience can also determine the level of knowledge and innovations in the business. This agrees with Aminu (2009) and Tiri*et al* (2012), who both stated that experience matters in the adoption of recommended packages and innovation in modern marketing techniques of fruits and vegetables. The result in Table 1 also reveals that most (60.6%) of the marketers financed their businesses through personal savings, which is an indication that most of the traders were small scale traders who may not have the means of access credit or financial assistance from financial institution.

Table 2 shows the result of the Gini coefficient index of the mango marketers, which was found to be 0.60, and this reveals that the market is an imperfect market. This finding is in agreement with Apata and

Apata (2003), who in the analysis of vegetable market in Ibadan metropolis, Oyo State, Nigeria reported imperfect competition in the market.

Scale economies were used to determine entry or exit condition of the market. The least square estimation model was used to verify the existence of scale economies. The result in Table 3 indicated a negative relationship between marketing cost and volume of mango handled. This means that as quantity sold increases, average cost of marketing decreases. However, decrease in average cost of marketing was not a barrier to entry, especially by sellers that are not financially sound. The result also indicated a significant relationship between average cost of marketing and quantity sold at *P<0.1*.

The result also showed a negative relationship between average cost of marketing and volume of mango fruit handled. This result verifies the existence of economies of scale among few marketers; it showed that some of the market intermediaries attract their products at considerably lower cost than others. Table 4 shows the result of the marketing margin of mango in Minna metropolis. The gross margin rate among surveyed traders in the study area was relatively high (₦563.3/basket), representing 77.3% of the price paid by the consumers. The high marketing margin also confirms an imperfect competition in the market. Analysis of the marketing margin received by each of the traders revealed that commission agent's margin was highest (37.37%). The analysis of the net margin along all channels was found to be ₦3552/basket, representing 63.1% of the consumer price. Moreftenthan not, about 22.7% of the marketing margin (₦1650.20/basket) goes to the producers, which is very low.

Analysis of the myriad of problems faced by mango marketers is shown in Table 5. This includes high cost of transportation/poor transportation problem, which was ranked first (27.3%). This is as a result of the poor road condition and the distance between the point of production and the market. It may also be a result of the high cost of transportation due to high fuel price-consequent of the deregulation of the downstream sector of the petroleum industry. Inadequate storage facilities such as refrigerator were ranked second (23.2%). This corroborates with the findings of Adewale (1996) and Yusuf (2014), both observed that inadequate storage facilities cause insect attack and over-ripening, which could lead to economic loss to the farmer and the nation as a whole. Other identified problems include inadequate pricing information and lack of market infrastructure.

Table 1: Socio-Economic Characteristics of Fresh Mango Fruit Marketers

Characteristics	Frequency	Percentage
Age (Years):		
17 – 20	17	17.2
25 – 34	9	9.1
35 – 44	19	19.2
45 – 54	33	33.3
55 and above	21	21.2
Mean age		39
Family Size		
1 – 8	47	47.5
9 – 16	28	28.3
17 – 24	20	20.2
25 – 32	4	4
Average family size		13
Educational Status		
Primary School	70	70.7
Secondary School	16	16.2
Tertiary Education	6	6.1
Craft	7	7.1
Experiences (Years)		
1 – 10	36	36.4
11 – 20	21	21.2
21 – 30	25	25.3
31 – 40	12	12.1
Above 41	5	5.1
Source of Finance		
Loan from Bank	2	2
Inheritance	19	19.2
Cooperative group	8	8.1
Personal savings	60	60.6
Friends/relatives	10	10.1

Source: Field Survey data, 2015

Table 3: Regression estimates for the influence of Quantity sold on Marking cost

Variable	coef	SE	T-Values
Constant	1.457	0.4625	-2.14
R^2	0.52		
Adjusted R^2	0.49		
Quantity Sold (Q)	-0.206*		
F-Statistics	24.335*		

Note: *Significant at 10%

Table 2: Determination of Market Coefficient

Sales Range (₦)	No of Markets	Sales value (₦)	X	Y	aX	aY	$aX_{i-1-a}X_i$ (B)	aY_{i-1}-aY_i (A)	AXB
1,000 – 10,000	51	484,800	0.51	0.15	0.51	0.15	0.51	0.15	0.076
10,001 – 20,000	24	360,000	0.24	0.11	0.75	0.25	0.24	0.41	0.098
20,001 – 30,000	9	500,000	0.09	0.15	0.84	0.47	0.09	0.81	0.073
30,001 – 40,000	2	70,000	0.02	0.02	0.86	0.43	0.02	1.24	0.025
40,001 – 50,000	9	450,000	0.1	0.14	0.96	0.57	0.1	1.81	0.078
Above 50,000	4	1,266,000	0.04	0.4	1	1.97	0.04	2.78	0.111
Total	99	3,266,00	1						

G = 1 – 0. 401 = 0.599 = ≃ 0.60

Source: Field Survey Data Analysis, 2015

Table 4: Marketing Margin in N/Basket for fresh mango fruit marketing in Minna metropolis

Variables	Local Wholesalers	Distant wholesalers	Commission Agent	Retailer	Total
Sales	3046.03	4467.51	6295.13	7282.53	22091.2
Purchase	1650.2	3046.63	4467.51	6295.13	15458.87
Marketing cost	520	620	500	440	2080
Total cost of marketing service	2170.23	3666.03	496.75	673151	17538.86
Gross margin	1395.83	1421.48	1827.62	987.4	5632.33
Net margin (profit)	875.83	801.48	1327.62	547.4	3552.33
Net margin (%)	24.66	22.56	37.37	15.41	100

Table 5: Distribution of respondents based on constraints in fresh mango fruit marketing

Problem	Frequency	Percentage
High cost of transportation	27	27.3
Poor storage facilities	23	23.2
Inadequate credit facilities	17	17.2
Lack of marketing infrastructure	12	12.1
Poor patronage	8	8.1
Lack of pricing information	8	8.1
Lack of trading devices	4	4
Total	99	100

Source: Field survey, 2015

Conclusion

The study shows that the structural characteristics of mango marketing in Minna metropolis is that of imperfect due to a high Gini coefficient (0.60%), high net Margin (63.1%) and economies of scale among few traders. The study therefore, recommends the formation of cooperative society by the famers/traders, establishment of special cold rooms, provisions of storage facilities and credit facilities to improve the volume of trade. Government is encouraged to provide and improve on the existing infrastructures, such an roads, rail lines, water transportation, etc. which will reduce the cost of transportation, build a perfect competitive market, increase traders' share of marketing margin/profit.

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EFFECT OF COOKING TIME AND PAPAIN ON THE QUALITY OF BEEF

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ABSTRACT
The effect cooking time of level of papain enzyme and on the physico-chemical properties of beef was investigated. Beef cut from the shank of an aged cow was infused with varying quantities of 5% papain solution (15ml) and cooked for 30 and 60 minutes at 75^0C. Untreated beef sample served as the control. The effect of the treatments were determined by measuring the cooking yield, cooking loss, Water Holding Capacity (WHC), pH, soluble proteins, amino acid, minerals and sensory properties. The results show that increasing the level of papain enzyme significantly ($p<0.05$) reduced the WHC and cooking yield but significantly ($p<0.05$) increased the cooking loss, soluble protein, amino acid and mineral content of the beef samples. The samples cooked for 60 minutes and 15ml of 5% papain infusion was the most preferred by the sensory panelists.

Keywords: Beef meat, shank, aged, infused, physico-chemical, sensory

INTRODUCTION

Palatability of meat is affected by many factors principal among which is tenderness. Maiti *et al.* (2008) stated that meat tenderness is one of the most important attributes of meat eating quality. Meat tenderness is affected by pre and post slaughter factors. Pre-slaughter factors include breed, age, feeding, management and genetics while post slaughter factors include shortening, glycolysis, processing and cooking methods. The traditional animal husbandry system which is characterized by moving the animals from one place to another is widely practiced in developing countries such as Nigeria. Jiya (2001) reported that the physical activity of continuously moving from one place to another in search of pasture is a major cause of meat toughness. Consequently, meat from such animals will require a longer cooking or processing time before it can be tender or palatable for consumption. This is a major economic concern for meat processors.

Different methods are adopted, antemortem and postmortem, to improve meat tenderness. Antemortem methods of improving tenderness include oral supplementation of vitamin (Foote *et al*., 2004) and feeding of electrolytes (Maiti *et al.,* 2008) while postmortem methods include, aging, marination, electrical stimulation, cooking and treatment with enzymes such as papain (from papaya fruit), bromelain (from pineapple) and ficin (from fig tree) (Ionescu and Pascaru, 2008 and Istrati *et al*., 2012). Enzymes tenderizers usually break down peptide bonds between amino acids in collagen, producing a much tender cut of meat for cooking. The use of papain as a proteolytic enzyme and the mechanism by which it adds to the tenderness is well established: Pawar *et al*. (2003) reported that papain acts on the connective tissue of meat by breaking up the muco-polysaccharide of the substance matrix and progressively decreasing the connective tissue fibres to an amorphous mass; Ashie *et al*. (2002) reported that papain can degrade myofibrillar and collagen proteins yielding various sizes of protein fragments; Istrati *et al*. (2012) reported that beef muscle treated with papain had a softer texture and a lower resistance to applied pressure than untreated muscle; and Naveena and Mendiratta (2001) stated that the various ways by which meat is treated to improve tenderness have negative effects on the overall quality of the meat. However, information on the effect of papain infusion on the physico-chemical properties of muscle from the shank of spent cow is limited. In this paper, the effect of different quantities of papain infused into the shank of spent cow and cooking time on physical and chemical properties was studied.

MATERIALS AND METHODS

The experiment was carried out at Animal Production Department Laboratory, School of Agriculture and Agricultural Technology, Federal University of Technology, Gidan Kwano, Minna, Nigeria. The beef used for this study was obtained from Minna abattoir while the commercial papain powder (Starwest Botanicals: #210127-51) was ordered from India.

Samples preparation: The experimental beef was obtained from the shank of an aged cow of about ten years old (identified by dental set) that had finished gestation. The beef was cut into rectangular pieces of 5cm long, 3cm wide and 2cm thick. They were divided into 4 groups and infused with 5, 10 and 15mls of 5% papain solution and held at refrigerated

temperature of 4^0C (model HRI 70T) for 24 hours in order for the enzyme to get into the muscle tissue. Untreated sample served as the control. The infused meats were cooked for 30 and 60 minutes at 75^0C in a water bath (model HH 60).

Analysis of physical properties: The Water Holding Capacity (WHC), Cooking Loss (CL) and Cooking Yield (CY) of the meat samples were determined using the procedures reported by Kauffman *et al.* (1992). For WHC, 10g (w_1) of the sample was wrapped in polyethylene and placed between a screw jack and pressed until all the free water was expelled. The meat sample was then removed, unwrapped and re-weighed (w_2). WHC was calculated using the relationship: (w_1-w_2/w_2) X 100. CL was calculated as the difference in weights before (w_1) and after (w_2) cooking while the cooking yield was calculated as a ratio of the weight of the cooked sample and the weight of the uncooked sample multiplied by 100.

Determination of chemical properties: Total protein (crude) and soluble protein of the meat samples were determined as described by AOAC (2000). The amino acid of meat samples were determined using the method reported by Bidlingmeyer *et al.* (1984). Mineral compositions of beef samples were determined using the method of AOAC (2000). The pH of the meat was measured based on the procedure that was outlined by AOAC (2000). 10 g of the cut samples were homogenised for 2 minutes with 90mL of distilled water using a laboratory blender (Nakal, Japan: Model 242). The meat suspension was filtered and the pH of the filtrate was measured with a digital pH meter.

Sensory evaluation of enzyme processed meat: Sensory evaluations of the meat samples were carried out using the method outlined by Ihekoronye and Ngoddy (1985). The meat samples were cut into small, bite sizes of 5g and juiciness, flavour and overall acceptability were scored using a 9 point hedonic scale (where 1 = dislike extremely and 9 = like extremely). The order of presentation of the samples to the panelist was randomized. Cold water was also served to the panelist to gargle and rinse their mouth after each evaluation.

Data analysis: The data collected from this study were subjected to a 2X4 factor analysis of variance (ANOVA) in a completely randomized design using Statistical Analysis System (1998). The variations in means were separated using Student-Newman-Keuls (SNK) test at 5% level of probability

RESULTS AND DISCUSSION

The effect of cooking time and papain addition on the physical properties of beef shank is shown in Table 1. Cooking for 60 minutes resulted in significantly ($p<0.05$) higher water holding capacity, cooking yield and pH and lower cooking loss. Conversely, lower cooking time (30 minutes) resulted in significantly ($p<0.05$) higher cooking loss. On the other hand, increasing the enzyme level significantly ($p<0.05$) decreased the water holding capacity and cooking yield but increased the cooking loss significantly ($p<0.05$). The meat sample treated with 5ml papain enzyme had the least cooking yield of 44% while the sample treated with 15ml had the highest cooking loss of 52.31% and the lowest pH of 5.33. The WHC of foods is the ability to hold its own and added water during the application of external force or heat. The higher WHC and CL observed in the sample cooked for 60 minutes may be due to the higher pH observed in the samples cooked for 60 minutes. Huff-Lonergan and Lonergan (2005) reported that as meat pH approaches the isoelectric point, there is increased attraction between the proteins causing a reduction in the ability of the proteins to hold water. In this study, there is a strong correlation between pH and WHC. For both cooking time and level of enzyme inclusion, samples with pH closer to the isoelectric point of protein have lower WHC. The changes in pH may be due to the type of amino acid (acidic or basic) released as a result of the protein degradation. WHC also affects CL. According to Jama *et al*. (2008), CL decreases with improving WHC. Honikiel (2004) also reported that CL is lower at higher pH. The trend observed in this study is in agreement with the report of these workers as samples with higher WHC recorded lower cooking losses.

Table 2 shows that crude protein was higher at 60 minutes cooking time while soluble proteins were higher at 30 minutes cooking time. As for effect of enzyme, soluble protein increased with increasing papain level. The lower soluble protein recorded at 60 minutes cooking time may be due to denaturation (Murphy and Marks, 2000) as heat is applied for a longer time compared to cooking for 30 minutes. The increase in soluble protein with increasing papain level may be due to the action of papain on myofibrils and collagen yielding more soluble proteins. Ashe *et al*. (2002) reported that papain degrades myofibrillar and collagen proteins into smaller fragments leading to proteins of different sizes with higher solubility. This result is in agreement with (Ionescu and Pascaru, 2008) who reported increasing levels of protein solubility as proteolytic enzymes concentrations increased.

The amino acid and mineral content of the samples are shown in Tables 3 and 4. Cooking for a longer period and increased level of enzyme treatment both resulted in higher levels of minerals and accumulation of free amino acids. Hence, cooking for 60 minutes yielded more minerals and free amino acids than cooking for 30 minutes while the samples treated with the enzymes had higher amino acids than the untreated sample. Furthermore, the sample treated with 15mL papain solution recorded the highest accumulation of free fatty acids and mineral followed by 10mL and 5mL. The level of free amino acid accumulation is a reflection of the level of protein degradation by the enzyme as reported by Ionescu and Pascaru (2008). As the enzyme levels increase, the level of free amino acids also increase. Hence, it is necessary to exercise caution in order to avoid over tenderization.

The sensory scores of the meat samples are shown in Table 5. The results show that cooking time and enzyme level had no significant effect on the appearance of the meat samples. However, the sample cooked for 60 minutes was rated higher than the one cooked for 30 minutes on the basis of tenderness, juiciness, flavour and overall acceptability. Similarly, increasing level of enzyme resulted in higher sensory scores for tenderness, juiciness, flavour and overall acceptability. This may be due to more intense degradation and the release of higher levels of flavour and aroma compounds as cooking time and enzyme level increase causing the meat to be more tender, juicier and more acceptable.

CONCLUSION

Beef cut from the shank of an aged cow cooked for 60 minutes exhibited better quality as evidenced in higher pH, better water holding capacity and cooking yield, more free amino acid and mineral and higher sensory scores compared with cooking for 30 minutes. Furthermore, use of papain enzyme enhanced the quality of beef. Increasing levels of papain lower the pH of beef resulting in lower water holding capacity and increased cooking loss. However, increasing the papain level resulted in higher protein solubility, free amino acids and minerals.

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Table 1: Effect of cooking time and papain infusion on the quality characteristics of beef meat

Treatment	WHC (g/g)	CY (%)	CL (%0	pH
		Cooking time (mins)		
30	0.26^{b}	47.55^{b}	52.39^{a}	5.42^{b}
60	0.34^{a}	51.27^{a}	48.08^{b}	5.53^{a}
SE±	0.002	0.31	0.13	0.01
		Enzyme (mls)		
0	0.34^{a}	56.59^{a}	43.25^{c}	5.52^{b}
5	0.32^{b}	53.09^{d}	46.12^{b}	5.48^{c}
10	0.29^{c}	49.42^{b}	49.67^{b}	5.44^{c}
15	0.27^{d}	47.52^{c}	52.31^{a}	5.41^{a}
SE±	0.003	0.44	0.19	0.01
TxE	p<0.004	p<001	p<001	p<001

^{abcd} Means with different superscripts in the same column are significantly (p<0.05) different.
WHC: Water Holding Capacity, CY: Cooking Yield, CL: Cooking Loss

Table 2: The effect of cooking time, papain enzyme inclusion levels and their interaction on proximate and soluble protein of beef from shank of aged cow

Treatment	CP (%)	SP (% total protein)
Cooking time (mins)		
30	60.79^{b}	0.64^{a}
60	65.57^{a}	0.58^{b}
SE±	0.22	0.004
Enzyme (mls)		
0	53.64^{d}	0.58^{c}
5	63.81^{c}	0.59^{c}
10	65.85^{b}	0.62^{b}
15	69.43^{a}	0.64^{a}
SE±	0.31	0.01
TxE	p<001	P<001

^{abcd}Means with different superscripts in the same column are significantly (p<0.05) different.
CP: Crude Protein, SP: Soluble Protein.

Table 3: Effect of cooking time and papain enzyme inclusion of amino acid content on beef from shank of aged cow (g/100g)

Parameter	Cooking time (mins)			Enzyme (mls)					
	30	60	SE±	0	5	10	15	SE±	TxE
Lys	4.82[b]	4.91[a]	0.01	5.06[b]	3.96[d]	4.51[c]	5.97[a]	0.01	p<.0001
Hist	3.29[a]	2.98[b]	0.01	1.97[d]	3.63[b]	4.38[a]	4.57[c]	0.01	p<.0001
Arg	7.11[b]	7.37[a]	0.01	6.67[c]	8.13[a]	7.68[b]	8.48[d]	0.01	p<.0001
Aspar	8.02[b]	8.28[a]	0.01	7.25[d]	7.95[c]	9.08[a]	9.29[b]	0.01	p<.0001
Threo	2.80[b]	4.08[a]	0.01	1.99[d]	5.58[a]	4.08[b]	4.11[c]	0.01	p<.0001
Ser	3.79[b]	6.53[a]	0.01	3.34[d]	13.19[a]	4.11[b]	4.79[c]	0.01	p<.0001
Glut	9.92[b]	13.70[a]	0.06	12.62[b]	13.19[a]	12.17[c]	13.27[d]	0.06	p<.0001
Prol	5.16[b]	6.53[a]	0	3.79[d]	5.00[b]	10.06[a]	10.53[c]	0.01	p<.0001
Glyc	5.58[b]	5.89[a]	0.03	4.48[d]	6.07[b]	7.37[a]	7.02[c]	0.04	p<.0001
Alan	5.62[b]	6.22[a]	0.03	5.52[c]	6.38[b]	7.99[a]	8.79[d]	0.04	p<.0001
Cyst	4.99[a]	3.19[b]	0.01	1.15[d]	4.37[b]	8.18[a]	8.68[c]	0.01	p<.0001
Val	4.98[b]	6.38[a]	0.01	3.77[d]	6.51[b]	7.33[a]	5.09[c]	0.01	p<.0001
Meth	3.43[b]	4.19[a]	0.01	2.86[d]	4.29[b]	4.58[a]	4.52[c]	0.01	p<.0001
Iso	4.21[a]	3.87[b]	0.01	3.23[d]	3.69[b]	5.93[a]	6.32[c]	0.01	p<.0001
leu	5.97[b]	6.57[a]	0.01	6.35[b]	6.15[c]	7.81[a]	8.78[d]	0.01	p<.0001
Tyr	3.91[a]	3.87[b]	0.01	2.34[d]	3.28[c]	5.88[a]	5.07[b]	0.01	p<.0001
Phen	3.71[b]	4.50[a]	0.01	3.54[d]	4.53[a]	4.29[b]	5.07[c]	0.01	p<.0001

[abcd]Means with different superscripts in the same column are significantly (p<0.05) different. SE: Standard error, T =Time of cooking, E = Enzyme, Lys= Lysine Hyst= HystidineArg= ArginineAspar= Aspartic acid Threo= ThreonineGluto= Glutamic acid Prol= ProlineGlyc= Glycine Val = Valine Alan= Alanine Meth= MethionineIsoleu= IsoleusineLeus= Leusine Tyr= Tyrosine Phenyl= Phenylalanine

Table 4: Effect of cooking time and papain enzyme level on Mineral content of beef (g/100g)

Parameter	Na	K	P	Fe	Ca
Cooking time (mins)					
30	30.90[b]	43.50[b]	209.23[b]	1.99[b]	3.03[b]
60	36.27[a]	47.06[a]	238.08[a]	2.12[a]	3.22[a]
SE±	0.01	0.01	0.01	0.01	0.01
Enzyme (mls)					
0	30.74[d]	36.94[c]	241.69[a]	1.81[d]	2.68[d]
5	31.03[c]	35.32[d]	211.41[d]	2.09[b]	3.20[b]
10	31.65[b]	44.19[b]	217.79[c]	1.97[c]	3.16[c]
15	40.92[a]	64.68[a]	223.72[b]	2.38[a]	3.46[a]
SE±	0.01	0.01	0.01	0.01	0.01
TxE	p<.0001	p<.0001	p<.0001	p<.0001	p<.0001

[abcd]Means with different superscripts in the same column are significantly (p<0.05) different, Na: Sodium, K: Potassium, P: Phosphorus, Fe: Iron, Ca: Calcium

Table 5: Effect of cooking time and papain enzyme level on sensory parameters of beef

Treatment	Appearance	Tenderness	Juiciness	Flavour	O/Acceptability
Cooking time (min)					
30	4.36[a]	4.34[b]	5.23[b]	5.36[b]	4.59[b]
60	4.59[a]	6.01[a]	5.86[a]	5.96[a]	5.95[a]
SE±	0.12	0.10	0.17	0.17	0.10
Enzyme (mls)					
0	4.35[a]	2.53[d]	4.85[b]	5.00[b]	2.78[d]
5	4.43[a]	4.78[c]	5.28[b]	5.48[ab]	5.08[c]
10	4.58[a]	6.13[b]	5.98[a]	5.98[ab]	6.20[b]
15	4.55[a]	7.28[a]	6.08[a]	6.20[a]	7.03[a]
SE±	0.17	0.15	0.24	0.24	0.15
TxE	p<0.714	p<0.002	p<0.132	p<0.179	p<0.050

[abcd]Means with different superscripts in the same column are significantly (p<0.05) different. O: Overall

DETERMINATION OF THE MICRONUTRIENT COMPOSITION OF COMPLEMENTARY FOOD PREPARED FROM ORANGE FLESHED SWEET POTATO AND GERMINATED *MORINGA* SEED FLOUR BLENDS

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ABSTRACT
The micronutrient composition of blends prepared from orange fleshed sweet potato and moringa seed flours were evaluated. Orange fleshed sweet potato and moringa seed flours were prepared and blended at different ratios (100:0, 95:5, 90:10, 85:15 and 80:20). The water-soluble vitamins and minerals content of the samples were determined and compared to a commercial infant food (Nestlé CERELAC). Result showed that the samples contained calcium, magnesium, phosphorus, iron and zinc in the range; 248.08 - 259.10 mg/100g, 40.08 - 44.10 mg/100g, 51.90 - 59.00 mg/100g, 5.33 -10.25 mg/100g, 4.09 - 6.00 mg/100g, respectively. The samples would contribute approximately 27.00 - 51.25% and 24.54 – 120 % of the Recommended Daily Allowance for iron and zinc. The samples compared favourably with Nestlé CERELAC and could therefore be included in the diets of infant as a cheaper source of micronutrients or a healthier substitute for local preparations.

Key Words: Micronutrient, Orange Fleshed Sweet Potato, Moringa seed, Complementary feeding

INTRODUCTION
Child feeding practices determine the nutritional status of children including their vulnerability to malnutrition and illnesses (Anigo *et al.,* 2010; Solomon, 2005). Nutritionally deficient preparations that do not satisfy the minimum requirement for proper growth are usually made for infants in Nigeria (Agbon *et al.,* 2009). This is due to the fact that commercial infant formulas that are enriched with these micronutrients are unaffordable by most families and thus, they result in giving their children foods that are inadequate in nutrients (Solomon, 2005). Among the essential nutrients required for the optimum growth and wellbeing of children are micronutrients. According to Ekwuagwu *et al.,* (2008), micronutrients of public health significance include zinc, iron, iodine and vitamins A, C, D, E, B_1, B_2, and folate. Deficiency in these micronutrients increases the risk of death from common diseases and infections such as pneumonia, gastroenteritis and measles (Ekwuagwu *et al.,* 2008).

Orange Fleshed Sweet Potato (OFSP) is a bio-fortified crop developed through natural hybridization or genetic bio-fortifications (Tang, 2013). It is richly dense in beta carotene (300-1300 µg) and contains important micronutrients such as thiamine (0.08 mg), riboflavin (0.06 mg), niacin (0.56 mg), pyridoxine (0.21 mg), iron (0.32-0.88 mg), zinc (0.18-0.57 mg) vitamin C (22.7 mg), and Vitamin E (0.26 mg) (Low *et al.,* 2009). It has been shown that nutritionally improved foods can be developed using OFSP as the main or supplementing ingredient (Mamo *et al.,* 2014; Sinha *et al.,* 2015; Desalegn *et al.,* 2015). Despite the potential benefits of OFSP, Nigeria is one of the states in sub-sahara Africa where the utilization is very low (Fetuga *et al.,* 2013).

Moringa oleifera is an under-utilized plant attracting the attention of researchers over the years. This may be attributed to its versatility in terms of medicinal, nutritional and culinary uses (Gadzirayi *et al.,* 2013; Omotesho *et al.,* 2013; Kawo *et al.,* 2009). It is an oil rich plant food (Mbah *et al.,* 2012) and amazingly contains all the essential amino acids typical of an animal source. The seed has been reported to contain an ample of important minerals, essential amino acids, fatty acids and phyto-chemicals in addition to its adequate proximate composition (Ijarotimi *et al.,* 2013). It is rich in protein (18.63%), contains aluminium (144 ppm), calcium (602 ppm), potassium (732 ppm), phosphorus (0.619 mg/kg), sodium (86.2 ppm), manganese (17.5 ppm) and other elements (Kawo *et al.,* 2009). *Moringa* seed had been known to combat malnutrition in infant and nursing mothers (Abiodun *et al.,* 2012). Kawo *et al.,* (2009) showed that the seeds are sufficient to supply the daily nutrient requirements for children and lactating mothers.

It is imperative to seek for solutions to current challenges associated with child nutrition in Nigeria. The aim of this study was therefore to assess the suitability of OFSP and *moringa* seed flours in the development of complementary food in terms of their micronutrient composition.

MATERIALS AND METHOD

Orange Fleshed Sweet Potato (OFSP) tubers were obtained from Agbamu area in Kwara State while *Moringa oleifera* seeds were collected from Tanke Bubu area, Ilorin, Kwara State, Nigeria.

The OFSP tubers were sorted, washed, peeled and sliced into 2.5-5mm thickness. The slices were then blanched (80 ^{0}C for 2 min), subjected to cabinet drying at 60 ^{0}C for about 4 hours, milled into flour, sieved and packaged till further use. *Moringa oleifera* seeds were carefully sorted, rinsed and soaked in distilled water (1:3 w/v) for 24 hours (Alabi *et al.*, 2015). The drained seeds were allowed to germinate for 4 days (Ijarotimi *et al.*, 2013) after which they were dehulled and shade dried (28±2 °C) for 4 days. The properly dried seeds were hammer milled into flour, sieved and packaged till further use.

Formulation: The composite flours were formulated from OFSP and germinated *moringa* seed flour in the proportions (100: 0; 95:5; 90:10; 85:15 and 80: 20).

Determination of Mineral Content: The calcium, magnesium, phosphorus, iron and zinc contents of the samples were determined using the dry ashing method (AOAC 2005).

Water Soluble Vitamins: Thiamine, riboflavin, niacin, biotin, pyridoxine, folate and vitamin C were determined using standard analytical methods (AOAC, 1995). Biotin was determined using hydrolysis method.

Statistical Analysis: Data obtained were subjected to analysis of variance (ANOVA) and differences among means were separated by Duncan multiple range test at 5% probability level. All computations were made by statistical software SPSS (version 16).

RESULTS AND DISCUSSION

Mineral composition: The mineral composition of tested samples is presented in Table 1. The calcium contents ranged from 248.08 - 259.10 mg/100g, and significantly higher than that of the control (108.14 mg/100g). The sample containing 95/5 OFSP and germinated moringa seed flour had the highest value while 100% OFSP had the lowest. The aforementioned range of values is higher than that reported by Abiodun *et al.* (2012), for moringa (203.85 mg/kg) and moringa cake flour (249.85 mg/kg). Magnesium (Mg) content of the samples ranged from 40.08 - 44.10mg/100g, which was higher than 39.18mg/100g of the control. The 100% OFSP had the highest value (44.10mg/100g). Magnesium is an essential nutrient for the appropriate utilization of vitamin B and E and functions with other minerals such as calcium , sodium and potassium in maintaining osmotic balance (Nafiu *et al.*, 2011). The samples with *moringa* seed inclusion had higher concentration of phosphorus (51.90mg/100g – 59.0mg/100g) compared to the control (48.20mg/100g) with 95/5 OFSP and germinated *moringa* seed flour having the highest value (59.00mg/100g).

The sample containing 80/20 OFSP and germinated moringa seed flour had the highest concentration of Iron (10.25mg/100g) while 100% OFSP had lowest (5.33mg/100g). The 80/20 OFSP and germinated *moringa* seed blend also contained the highest value for zinc (6.0mg/100g) while 90/10 OFSP and germinated moringa seed flour had the lowest content (4.09mg/100g). The values increased with increment in moringa seed flour and were significantly higher than that of the control. Zinc is important in the production of insulin while iron together with hemoglobin help in oxygen transport (Okwu, 2005). This is an indication that these biochemical processes may be promoted better in children fed with these diets. The composite flours developed from OFSP and germinated moringa seed flour generally contained more minerals than Nestlé CERELAC. All the samples were significantly different at $p<0.05$. The mineral contents of the composite samples were generally higher than that of moringa and moringa cake flour (Abiodun *et al.*, 2012), indicating that OFSP also contributed considerably to the mineral content.

Contribution of the samples to the Recommended Daily Allowance (RDA): The contribution of the samples to the RDA of minerals for infants from six months is presented in Table 1. The calculated contribution of the samples to the RDA for calcium, magnesium, phosphorus, Iron and zinc was in the range 18.6- 19.5%; 30.1- 33.1%; 5.34 -5.9%; 27-51.25% and 24.54-120%, respectively.

Concentration of Water Soluble Vitamins: The result for the water-soluble vitamins is given in Table 2. The average thiamine values for the samples ranged between 0.041- 0.042µg/100g, with no significant difference among the blends. The values decreased with increasing amount of moringa seed flour and were higher than the control (Nestlé CERELAC) (0.04065µg/100g). All obtained values were significantly lower ($p\leq0.05$) than the RDA of 0.5mg/day (Lindsay, 2003).

The riboflavin contents ranged from 4.61 - 6.44 µg/100g. The control had 4.74 µg/100g of the vitamin. These values are also quite low with respect to the RDA of 0.5mg/day of infants (Lindsay, 2003). The mean values obtained for niacin (7. 48 mg/ 100 g - 11.42 mg/100 g) were significantly higher ($p \leq 0.05$) than the control (3.41 mg/100 g) and would adequately contribute to the RDA of infants (6 mg/day). Niacin assists in building cell tissues, body's resistance to infections and healing of wounds (Amadi *et al.*, 2012).

The biotin contents were generally higher than that of the control (9.79 mg/100g) with the exception of 90/10 OFSP and germinated moringa seed flour having the lowest biotin content (9.60 mg/100g). Sample containing 80/20 OFSP and germinated moringa seed flour had the highest value of 12.47 mg/100g. The sample containing 80/20 OFSP and germinated moringa seed flour recorded the highest content of biotin (12.47 mg/100g). The samples would contribute over 100% to the RDA of infants (8µg/day). The values within 9.40-11.49 mg/100g were obtained for pyridoxine content of the composite flours while the control had a lower content of 8.50 mg/100g. The values are considerably higher than the RDA of 0.5mg for infants (Lindsay, 2003).

The samples were also considerably rich in folate with recorded values higher than those of the control sample which had 0.21 mg/100g. The sample containing 80/20 OFSP and germinated moringa seed flour had the highest folate content while 100% OFSP had the lowest value. This might be due to increased addition of germinated moringa seed flour and the folate content in OFSP might have also reduced owing to blanching. Cooking can reduce the levels of folate in foods as it has been reported to be vulnerable to heat and dissolves in water (Ekwuagwu *et al.*, 2008).

Vitamin C content of the samples tended to increase on addition of moringa seed flour from 0.11 mg/100g to 0.22 mg/100g but decreased after 10% inclusion. There were significant differences ($p \leq 0.05$), among all the samples. The values for all samples were generally higher than that obtained for the control, (0.17 mg/100g). The average composition is much lower than the vitamin C content (2.65-6.85 mg/100g) of Madiga made from Wheat-Sweet potato composite flours (Idolo, 2011). Vitamin C is important for the manufacture of collagen and in maintaining healthy skin, bones and muscles (Amadi *et al.*, 2012).

Thiamine, riboflavin and niacin of the developed samples relatively decreased on inclusion of germinated moringa seed flour while the biotin, pyridoxine and folate contents increased. The values obtained for the complementary flour samples were generally higher than that of the control with biotin being most abundant in all samples. Water-soluble vitamins are those micronutrients that can be easily lost during processing but are needed to protect the body from various diseases and to facilitate the functioning/metabolism of various body systems (Abidin and Amoaful, 2015). Deficiencies in these vitamins result in the condition termed hidden hunger (UNICEF, 2013) which could manifest itself in several clinical symptoms such as beri-beri for thiamine, neurological problems when deficient in pyridoxine, pellagra in the case of niacin deficiency among others.

CONCLUSION

The Orange Fleshed Sweet Potato germinated moringa seed flour blends (100g) would adequately meet the RDA for iron, zinc and magnesium while higher amounts of the diets would be required to meet that of calcium and phosphorus. In most cases, the samples had higher concentrations of mineral and water soluble vitamins than Nigerian Nestlé CERELAC. Thus, the samples could serve as cheaper means of healthy complementary feeding. The blends could be prepared into porridge with the inclusion of other ingredients to diversify the diet or increase the nutrient content.

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Table 1: Mineral composition (mg/100g) of orange fleshed sweet potato and germinated moringa seed flour blends compared to RDA

Minerals	Calcium	Magnesium	Phosphorus	Iron	Zinc
***RDA**	400	5.00	300	6.00	4.00
$O_{100}M_0$	248.08^{e} ±0.02	44.10^{a} ±0.01	57.20^{b} ±0.03	5.33^{e} ±0.00	4.21^{b} ±0.00
$O_{95}M_5$	253.01^{d} ±0.01	40.08^{c} ±0.06	59.00^{a} ±0.03	6.15^{d} ±0.00	4.60^{b} ±0.00
$O_{90}M_{10}$	257.11^{b} ±0.01	42.46^{b} ±0.00	53.40^{c} ±0.03	7.91^{c} ±0.01	4.09^{b} ±0.01
$O_{85}M_{15}$	259.10^{a} ±0.00	43.02^{a} ±0.00	51.90±0.01	8.83^{b} ±0.00	4.10^{b} ±0.00
$O_{80}M_{20}$	255.06^{c} ±0.13	40.15^{c} ±0.02	54.10±0.23	10.25^{a} ±0.02	6.00^{a} ±0.03
Control	108.14^{f} ±0.03	39.18^{d} ±0.01	48.20±0.01	8.83^{b} ±0.01	3.08^{c} ±0.16

Values are means of triplicate determinations. Within each column, values with different superscript differ significantly ($p<0.05$)

$O_{100}M_0$ - 100% OFSP and 0% Germinated moringa seed flour, $O_{95}M_5$ - 95%OFSP and 5% Germinated moringa seed flour, $O_{90}M_{10}$ - 90% OFSP and 10% Germinated moringa seed flour, $O_{85}M_{15}$ - 85% OFSP and 15% Germinated moringa seed flour, $O_{80}M_{20}$ - 80% OFSP and 20% Germinated moringa seed flour, Ca- Calcium; Mg- Magnesium; P- Phosphorus, Fe- Iron, Zn- Zinc, *RDA- Recommended Dietary Allowance, adapted from Solomon (2005).

Table 2: Water soluble Vitamins of composite flour samples

Sample	Thiamin (ug/100g)	Riboflavin (ug/100g)	Niacin (mg/100g)	Biotin (mg/100g)	Pyridoxine (mg/100g)	Folate (mg/100g)	Cobala-mine	VitaminC (mg/100g)
$O_{100}M_0$	0.041^{a} ±0.00	5.53^{d}±0.01	10.68^{b}±0.01	11.81^{c}±0.00	10.60^{b}±0.01	0.27^{e}±0.00	ND	0.11^{e}±0.00
$O_{95}M_5$	0.042^{a}±0.00	6.25^{b}±0.11	9.14^{c}±0.01	12.10^{b}±0.05	9.40^{e}±0.02	0.28^{c}±0.00	ND	0.16^{cd}±0.00
$O_{90}M_{10}$	0.041^{a}±0.00	6.44^{a}±0.23	11.42^{a}±0.01	9.60^{f}±0.06	11.49^{a}±0.00	0.31^{b}±0.00	ND	0.22^{a}±0.00
$O_{85}M_{15}$	0.041^{a} ±0.00	5.71^{c}±0.01	8.60^{d}±0.00	10.70^{d}±0.05	9.80^{d}±0.01	0.27^{d}±0.02	ND	0.17^{bc}±0.00
$O_{80}M_{20}$	0.041^{a} ±0.00	4.61^{f}±0.11	7.48^{e}±0.01	12.47^{a}±0.06	10.40^{c}±0.00	0.33^{a}±0.00	ND	0.09^{f}±0.00
Nestle Cerelac	0.041^{a} ±0.00	4.74^{e}±1.61	3.41^{f}±0.03	9.79^{e}±0.06	8.50^{f}±0.23	0.21^{f}±0.00	ND	0.17^{c}±0.01

Values are means of triplicate determinations. Within each column, values with different superscript differ significantly ($p<0.05$)

$O_{100}M_0$ - 100% OFSP and 0% Germinated moringa seed flour, $O_{95}M_5$ - 95%OFSP and 5% Germinated moringa seed flour, $O_{90}M_{10}$ - 90% OFSP and 10% Germinated moringa seed flour, $O_{85}M_{15}$ - 85% OFSP and 15% Germinated moringa seed flour, $O_{80}M_{20}$ - 80% OFSP and 20% Germinated moringa seed flour, ND- Not Detected

NUTRITIONAL STATUS OF PRE-SCHOOL AGED CHILDREN IN SELECTED PRIVATE PRIMARY SCHOOLS IN CHANCHAGA LOCAL GOVERNMENT AREA, NIGER STATE

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ABSTRACT
Prevalence of malnutrition is a serious health problem among children. This study assessed the prevalence of malnutrition among pre-school children in selected private primary schools in Chanchaga Local Government Area Niger state. This study was conducted to ascertain the prevalence of obesity and overweight in 131 pre-school children (1-4 years) using the World Health Organization (WHO) BMI – for – age (z – scores) table. Information on age and gender of the respondents were collected from the school register. Data on height, weight and BMI was obtained using standard techniques. Simple random sampling and systematic random sampling techniques were used to select the schools and the respondents within the selected schools. Data were analyzed using descriptive statistics; While Pearson product moment correlation/ chi-square were used to establish relationship between variables. The prevalence of obesity and overweight was 30.5% and 8.4%, respectively. Males had higher prevalence of overweight (5.3%) compared to females (3.1%), while female had higher prevalence of obesity (16.8%) compared to males (13.7%) respectively. The respondents had higher prevalence of malnutrition of (54.2%) of which male (26.7%) and females (27.5%) which implies that females had higher prevalence of malnutrition than males. There was significant relationship between their BMI and the intake of some of the nutrients. The intake of root & tubers, plant proteins, animal proteins, fat and oil shows significant relationship at p- value ($p<0.05$) while intake of dairy products, snacks and fruits are not significant at p- value ($p>0.05$). The study confirmed the prevalence of malnutrition, obesity and overweight amongst the subjects. Prevention of malnutrition, obesity and overweight requires partnership that involves Government, International agencies, Medical Personnel, Parents, Industries, Consumers and Media in promoting healthy diets and appropriate levels of physical activities.

***Key Words**: Prevalence, BMI, Obesity, Overweight and Malnutrition*

INTRODUCTION
Childhood overweight and obesity is increasingly becoming a global public health concern. In view of this, adequate nutrition which is an important requirement for children, because nutrition transition is believed to be the driving force behind the global obesity epidemic. (Popkin, 2003; FAO, 2004, 2006). Obesity has traditionally being associated with developed countries, but increasingly affecting many low and middle income countries (LMICS), who are least prepared in coping with the consequences (WHO,2010). It is estimated that the number of obese/overweight children aged less than five years of age globally is 42million in 2010, while close to 35million (over 80%) of these live in the developing countries (WHO, 2010).

Children in lower and middle-income countries, especially those growing up in urban environments and following a western lifestyle, are facing a significant and rapidly growing epidemic of childhood obesity (Wang and Lobstein, 2004). The estimated prevalence of childhood overweight and obesity in Africa in 2010 was 8.5% and is expected to reach 12.7% in 2020 (Mercedes *et al.,* 2010). The broad objective was to assess the prevalence of obesity and overweight among pre-school aged children in selected private primary schools in Chanchaga Local Government Area, Niger State, while the specific objectives were to assess the anthropometric indices and dietary intake of respondents.

METHODOLOGY
Study Subjects and Location: Respondents were from eight selected private primary schools in Chanchaga Local Government, Niger State respectively.

Study Design: The study was descriptive and cross sectional covering selected private primary schools in Chanchaga Local Government Niger State.

Sample Size: Three criteria were needed to determine the appropriate sample size. The level of precision, the level of confidence or risk, and the degree of variability in the attributes measured (Glenn, 1992).

$$n = \frac{N}{1 + N(e)^2}$$

n = sample size
N = Total population (210)
e = level of precision at 5%

$$n = \frac{210}{1 + 210(0.05)^2}$$

n = 137

Therefore, the total sample size was 137, however 10% of the total sample size obtained was added to take care of non-response and non-retrieved, but a total of 131participated.

The sample size was proportional to the population density (Gay and Diehl, 1992) of the respondents. Systematic random sampling technique was used to select the respondents

Table 1: Sample size by proportionate allocation

Name of schools	Total population	Sample size
Brighter International	25	18
Himma International	25	18
Redeemer	35	26
Galaxy International	20	14
New Hilton	34	24
Ideal Royal	28	20
Bright Star Academy	20	14
Supreme International	23	16
Total	**210**	**150**

Sampling technique: Simple random sampling and systematic sampling techniques were used to select the schools and respondents within the selected schools.

Methods of data collection: A well-structured questionnaire was administered with the personal data, dietary habit and food intake pattern and anthropometric measurements.

Equipment used for data collection: Anthropometric heightometer was used to measure heights of the subjects in (m^2) and weighing scale was used to measured weight in (kg) and the BMI was calculated to the nearest kg/m^2.

Statistical analysis: Data was analyzed using SPSS, version 20.0. Data generated were analyzed using descriptive statistics (frequency and percentage), while Pearson product moment correlation/ chi-square was used to establish relationship between variables.

RESULTS AND DISCUSSIONS

Table 2 shows gender distribution of the respondents, (58.8%) were males while (41.2%) were females.

Table 2: Gender Distribution of the Respondents

Variables (Sex)	Frequency	Percent (%)
Male	77	58.8
Female	54	41.2
Total	**131**	**100.0**

Table 3 shows age distribution of respondents, (61.1%) were between 1-2 years, while (38.9%) were between 2-3 years and 0% (no respondents were between the age of 3-4 years.

Table 3: Age Distribution of the Respondents (Years)

Variable	Frequency	Percentage (%)
1 – 2	80	61.1
2 – 3	51	38.9
3 – 4	0	0
Total	**131**	**100.0**

Nutrient Intake of the Respondents (Food Frequency): Table 4 shows the food frequency intake of the respondents. More than average (58.0%) of the respondents consumes dairy products on daily basis, 45.8% and 45.8% of the respondents consume cereal products, roots and tubers frequently respectively. More than a quarter (38.2%) and 34.4% of the respondents consumed fats and oil, vegetables and animal proteins respectively, 29.8% and 22.8% of the respondents consumed fruits and snacks respectively while intake of plant proteins is considerably low at (7.6%)

Table 5 shows the relationship between BMI and Nutrient intake of the respondents, which indicates strong association between cereal intake, root and tubers, plant proteins, animal proteins, vegetables and fat and oil which are significant at p- value ($p<0.05$).

Table 6 shows no significant association between BMI and intake of dairy products, snacks and fruits at p- value ($p>0.05$).

Table 4 Nutrient intake of the Respondents (Food Frequency)

Food groups	Everyday	More than once a day	Once a week	Once a month	Rarely	Never
	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)
Cereal products (rice, custard, pap, oat)	60 (45.8)	39 (29.8)	25 (19.1)	_	5 (3.3)	2 (1.5)
Roots and Tubers (yam, cassava, gari, potatoes)	60 (45.8)	14 (10.7)	35 (26.7)	_	15 (11.5)	7 (5.3)
Plant proteins (beans, groundnut, soya beans)	10 (7.6)	5 (3.8)	80 (61.1)	_	15 (11.5)	21 (16.0)
Animal proteins (meat, fish, egg)	50 (38.2)	20 (15.3)	15 (11.5)	_	23 (17.5)	23 (17.5)
Dairy products (milk and milk products)	76 (58.0)	15 (11.4)	5 (3.8)	_	15 (11.5)	20 (15.3)
Snacks (cake, buns, chin-chin, puff-puff)	30 (22.9)	20 (15.3)	14 (10.7)	25 (19.1)	26 (19.8)	16 (12.2)
Vegetables (spinach, pumpkin leaf, waterleaf)	45 (34.4)	30 (22.9)	15 (11.4)	14 (10.7)	17 (13.0)	10 (7.6)
Fruits (orange, pineapple, banana, water melon)	39 (29.8)	37 (28.2)	25 (19.1)	10 (7.6)	20 (15.3)	_
Fat & Oil (palm oil, butter, groundnut oil)	50 (38.2)	35 (26.7)	25 (19.1)	7 (5.3)	14 (10.7)	_

Table 5: Relationship between BMI and Nutrient Intake of the respondents

	Severe Malnutrition	Mild Malnutrition	Normal weight	Over weight	Obesity	p- value
Food Groups	F (%)	F (%)	F (%)	F (%)	F (%)	
Cereal products (rice, custard, pap, oath)	60 (45.8)	39 (29.8)	25 (19.1)	5 (3.8)	2 (1.5)	0.000*
Root & Tubers (yam, cassava, gari, potatoes)	60 (45.8)	14 (10.7)	35 (26.7)	15 (11.5)	7 (5.3)	0.011*
Plant proteins (beans, groundnut, soybeans)	10 (7.6)	5 (3.8)	80 (61.1)	15 (11.5)	21 (16.0)	0.001*
Animal proteins (meat, fish, egg)	50 (38.2)	20 (15.3)	15 (11.5)	23 (17.5)	23 (17.5)	0.039*
Vegetables (spinach, pumpkin leaf, water leaf)	45 (34.4)	30 (22.9)	14 (10.7)	17 (12.9)	25 (19.1)	0.006*

Significant at $p<0.05$

Table 6: Relationship between BMI and intake of some foods

	Severe malnutrition	Mild malnutrition	Normal weight	Overweight	obese	p-value
Food Groups	F (%)	F (%)	F (%)	F (%)	F (%)	
Dairy products (milk and milk products)	15(11.5)	15(11.5)	5 (3.8)	20 (15.2)	76 (58.0)	0.151
Snacks (cake, buns, chin-chin, puff-puff)	14(10.7)	23(17.5)	30 (22.9)	28 (21.4)	36 (27.5)	0.211
Fruits (orange, pineapple, banana, water melon)	39(29.8)	37(28.2)	25 (19.1)	10 (7.6)	20 (15.3)	0.144

Not significant at $p>0.05$

Table 7 shows nutritional status of the respondents using their BMI with reference to the World Health Organization (WHO) BMI-for-age (z-scores) table. It shows that 54.2% of the respondents have severe malnutrition, 1.5% have mild malnutrition, 5.3% have normal weight, 8.4% were overweight and 30.5% were obese.

Table 7: BMI Classification of the Respondents

Characteristics (WHO Standard)	Frequency	Percent (%)
Severe malnutrition (below 15th percentile)	71	54.2
Mild malnutrition (15th- 84th percentile)	2	1.5
Normal weight (84th percentile)	7	5.4
Over weight (85th percentile)	11	8.4
Obese (95th percentile)	40	30.5
Total	**131**	**100.0**

Table 8 show that males had higher prevalence of overweight (5.4%) compared to females (3.1%). Females had higher prevalence of obesity (16.8%) compared to males (13.7%)

Table 8: Percentage of Male to Female BMI

Characteristics	F	(%)	F	(%)
	Male		Female	
Obesity	18	3.7	22	16.8
Overweight	7	5.4	4	3.1
Severe malnutrition	35	26.7	36	27.5
Mild malnutrition	2	1.5	0	0
Normal weight	2	1.5	5	3.8
Total	**64**	**48.8**	**67**	**51.2**

DISCUSSION

The age distribution of respondents between the age of 2-3years from the studied areas were 59% boys and 41% girls. However, from the data analyzed, it was observed that weight increases progressively with age likewise their body mass index, which was as a result of their dietary pattern and nutritional intake. There is also a relationship between BMI and Nutrient intake of the respondents.

In this study, the proportion of children who are obese is higher 30.5% as compared to overweight 8.5%. It was observed that higher percentage of the population 54.2% is at severe malnutrition, this was in agreement with (Mercedes and Blossner, 2000) where a national survey conducted showed that 6.7% of preschool children sampled were overweight. The prevalence of childhood overweight and obesity has increased worldwide in recent decades but, the concept "bigger is better" was widely acceptable decades ago this days the perception has drastically changed on the basis of evidence that obesity in childhood is associated with a wide range of serious health complications and an increased risk of premature illness and death later in life (Epstein *et al.*, 2002).

The result analyzed in accordance with that of Keupper – Nybelen *et al.* (2005) shows that these prevalence rates of overweight are lower than rates of malnutrition obtained on children < 5 years from Western countries (USA 35%, overweight, Germany 14.8% overweight, Greek 31.9% overweight, Denmark 10.4% overweight).

Comparing the result of the survey and the result of Harsha *et al.* (2008), using BMI criteria, it was found that (4.47%) children were Overweight (BMI of 85th percentile for the age and sex), (1.41%) children were obese (BMI of 95th percentage for the age and sex) and higher prevalence of severe malnutrition. The present analyses describe levels and trends of overweight and obesity in preschool children using the WHO standards, Obesity and Overweight rates in children has become a matter of growing concern as there is considerable variation in the prevalence of overweight, obesity and wasting between countries. Prevalence of obesity and overweight is of concern because overweight and obese children are likely to stay obese into adulthood and more likely to develop chronic diseases at older age (Ogden *et al.*, 2004). Obesity and overweight is primarily related to dietary intake and physical inactivity of an individual as can be seen from this present study where the BMI of the respondents is significantly associated with some of their nutrients intake. Diet plays a significant role both in development and control of overweight and obesity. For years, doubt has persisted that/ about the contribution of excessive food intake to overweight. Intake of excess dietary fat has been implicated as a major cause of obesity of decades (Lajous *et al.*, 2009).

CONCLUSION

It was observed that there was high prevalence of malnutrition compared to obesity and overweight as shown by the research work. It also revealed that BMI has a significant relationship with the intake of some nutrients of the respondents.

RECOMMENDATIONS

Based on the findings of the research, it is important to recognize that the prevention of obesity and overweight requires a partnership. Governments, International agencies, consumers, Industry, Trade

and the media all play important roles in promoting healthy diets and appropriate levels of physical activity. During infancy and early childhood, preventive measures should focus on the promotion and protection of breastfeeding. Schools should play an important role in teaching healthy eating habits and appropriate exercise regimen. There is a great need for nutrition education on dietary needs, good complimentary feeding practices of pre-school age children for parents and caregivers.

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BIO-ACCUMULATION OF SOME HEAVY METALS IN THREE COMMERCIALLY IMPORTANT FISH SPECIES TISSUES RELATIVE TO THEIR CONCENTRATIONS IN AGAIE-LAPAI DAM, MINNA, NIGER STATE, NIGERIA

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ABSTRACT
This research assessed bioaccumulation of heavy metal concentration in water and fish tissues of three species of fish of commercial importance from Agaie/Lapai dam. Water samples were taken from five locations on the Dam and Clarias gariepinus, Tilapia gallilaeus and Auchenoglanis occidentalis were obtained from the dam landing site for four months. One gram of the target organs (gill, muscle and intestine) of each species were collected and weighed after dissection. The weighed organs were digested and heavy metal concentrations were determined in them and water using Atomic Absorption Spectrophotometer. Results showed that the heavy metal concentration in the water descended as follows Zn>Cu>Fe>Mn> Pb> Cr. The concentrations of Zinc in February, March and June were 0.692, 0.632, and 0.28mg/l respectively were the highest concentrations in water while Cr concentration was the lowest throughout the sampling period. There were significant differences (P<0.05) among the concentrations of the heavy metal recorded during the period. It was revealed that Clarias gariepinus intestine accumulated the highest concentration of Zinc (7.65mg/l). The mean concentration of heavy metals in all the species revealed that; Auchenoglanis occidentalis and Clarias gariepinus intestines and gills showed no significant difference (p>0.05) except in the muscle that had significant difference (p<0.05) in Cu. However, the mean concentration of heavy metals in Tilapia muscle and intestine had no significant difference (p>0.05), there was significant difference (p<0.05) in Cu (1.575mg/l) concentration in the gills. It is therefore concluded that there is presence of heavy metal in the dam and the fish tissue in Agaie/Lapai dam.

Key words:, *Clarias gariepinus*, *Tilapia gallilaeus Auchenoglanis occidentalis*, Gills, Intestine, Musle.

INTRODUCTION

Aquatic environments are being polluted due to increasing natural and human anthropogenic activities. Currently, pollution of aquatic environments with heavy metals have become a worldwide problem because they are indestructible, potentially toxic to aquatic organisms and are able to bio-accumulate in aquatic ecosystems. (Abraha et. al., 2012). More et al., (2003) described metals as non-biodegradable elements that are major aquatic environmental pollutants. These metals are grouped into essential macro and micro elements (Dimari et al., 2008). Micro elements are those vital trace elements that are required in small quantity by living organisms like copper (Cu), zinc (Zn), iron (Fe) (Nduka et al., 2010) and they play roles in the metabolic activities of organism while cadmium (Cd), lead (P), nickel (Ni), mercury (Hg) and arsenic (As) tends to be toxic even at trace level and are known as the non-essential elements.

Fish serves as one of the major sources of protein that is low in saturated fat and contains sufficient omega 3 fatty acids which supports good physical condition. The rate of bioaccumulation of this heavy metals in fishes depends on the route of metal uptake, type of heavy metal, fish species and the concentration of such metals in the water body (Begum et al., 2009). Fishes are also known as good bio-accumulators of organic and inorganic pollutants (Abatha, 2010). Heavy metal accumulation in fish differs from one part of the body to another due to the varying affinity of those parts to metal (Benzer et. al., 2013). Therefore, fish can be used to assess the health status of aquatic ecosystems (Yousuf and El-Shahawi, 1999; Farkas et al., 2002). Heavy metals concentration in aquatic environments is dependent upon its temperature, hardness and pH (Yang and Chen, 1996, Abdel Baki et. al., 2011). This study therefore examined the bioaccumulation of heavy metals in water and fish from Agai/Lapai Dam, Niger State, Nigeria.

MATERIALS AND METHODS

Study Area: Agaie- lapia dam is located adjacent to Bakajiba village at latitude $9^0$39N and longitude $6^0$33E southwest of Minna, Niger State having about 38 million cubic meters holding capacity and a crest length of 1,600 meters. Rivers from different communities make up the dam such as water from Bakajiba river, Tunga mallam river, Tunga Gana river, Tunga Alhaji Usman river. Each of the rivers being named after the originating village.

Sample Collection: Water samples were collected from five stations, from Rivers Bakaja, Tunga Mallam, Tunga Gana, Tunga Alhaji Usman and also from the dam spillway. Three fish species (Clarias gariepinus, Tilapia gallilaeus and Auchoeglanis occidentalis) were selected and bought from the fishermen at the bank of the dam because of their economic importance. The samples were collected and stored in a cooler with iced blocks and transported to Water Resources, Aquaculture and Fisheries, Federal University of Technology, Minna, Niger State laboratory.

Laboratory analysis: Digestion of water sample: wet method of digestion was used to carry out this Analysis (APHA, 2005). 100 ml of water was taken from the water sample collected from the dam. Ten milliltres of nitric acid was added and to 100 ml of water collected from the dam and then digested on a hot plate at a temperature of 150oC till the water reached a boiling point. The resulting solutions were allowed to cool and the volume was then made up to 100 ml with distilled water.

Digestion of fish samples: wet method of digestion was used to carry out these analyses (APHA, 2005). 1g of the gills, tissue and intestine was each weighed from various fish species. 20ml of nitric acid was added to individual sample and digested on hot plate at 150oC till the samples were fully dissolved. 100ml of distilled water was added to the digested sample and then poured in a sample bottle with labels for further analysis.

Metal Extraction: Bulk Scientific Atomic Absorption Spectrophotometer (AAS) (model Accusy 211; manufacturer USA) was used for determining the bio-accumulation factors of the metals.

Statistical Analysis: One-way statistical analysis of variance (ANOVA) was used to determine the significant differences ($P< 0.05$) in the concentration of these metals both in the fish and the water at ($P\leq 0.05$) probability using SPSS package.

RESULTS

The concentration of Iron (Fe), copper (Cu), Zinc (Zn), Lead (Ld), Manganese (Mn) and Chromium (Cr) in fish (gills, muscles, intestine) and water from Agaie-Lapai dam were as presented in tables 1 - 6.

Water Sample: Heavy metals were found to decrease in the sequence Zn> Fe >Cu >Mn>Pb>Cr. There was no significant difference ($P>0.05$) in Mn and Cr among the months. There was significant difference ($P< 0.05$) in the copper concentration with the highest value in March. In June, mean concentration of metals recorded were Cr (0mg/L), Mn (0.042mg/L).Cu (0.178mg/L), Zn (0.28mg/L) and Fe (0.088mg/L). Results obtained in July showed significant difference ($p\leq 0.05$) between the metals.

Season: Results obtained during the dry season (February and March) and wet season (June and July) shows significant difference ($P< 0.05$) in Cu, Zn, Fe and Pb while no significant difference was observed in Mn and Cr as shown in table 2. The average concentrations of heavy metals in the dry season were higher than in the wet season and were found to be in the following decreasing order Zn>Cu>Fe>Mn>Pb>Cr. This could be as a result of concentration effect in the dry season. Seasonal variation of metals in fish organs shows that there is no significant different ($p> 0.05$) between all the metals during the dry season while during the wet season only Cr (0.022) shows significant different ($p\leq 0.05$). Within the seasons all the metals show significant different except for Cr which shows no different within the season as shown in Table .3.

Fish Organs: Heavy metal concentrations in gills of these species were in the following decreasing order Fe>Zn>Cu>Mn>Pb>Cr. They were in the same order in muscles but a little difference was observed in the intestine in the following order Fe>Zn>Mn>Cu>Pb>Cr. Intestine accumulated the highest concentration of Zinc while the highest concentration of zinc was found in the muscle of Clarias gariepinus. There was no significant difference ($p> 0.05$) among all the metals studied in Auchenoglanis occidentalis gills (AUGG) and Auchenoglanis occidentalis muscles (AUGM) except for Cu (2.375,1.325mg/l) respectively which show significant different ($p\leq 0.05$). However, in Auchenoglanis occidentalis intestine (AUGI), there was no significant difference ($p> 0.05$) for all the metals studied. Results obtained for Clarias gariepinus gills (CLRG) and Clarias gariepinus muscles (CLRM) shows that there was no significant difference ($p> 0.05$) among all the metals present apart from Cu (2.95, 1.125mg/l) respectively shows significant different in both. Also, Clarias gariepinus intestine (CLRI) shows that there was no significant difference ($p> 0.05$) in all the metals. In Tilapia gallilaeus gills (TPLG), Tilapia gallilaeus muscles (TPLM) and Tilapia gallilaeus intestine (TPLI)..

Table 1: Month Mean Variation of Heavy Metal Concentration in Water Samples.

Month	Mn(mg/L)	Cu(mg/L)	Zn(mg/L)	Fe(mg/L)	Pb(mg/L)	Cr(mg/L)
February	0.044a	0.224b	0.692a	0.19ba	0.006b	0a
March	0.046a	0.276a	0.632a	0.098b	0.01a	0.004a
June	0.042a	0.178b	0.28b	0.088b	0c	0a
July	0.026a	0.058c	0.076c	0.279a	0c	0.002a
± SE	0.009	0.016	0.045	0.039	0.01	0.002
USEPA (2008)	0.05	1.3	5.0	0.3	0.015	0.1
WHO (2008)	0.4	2.0	-	-	0.01	0.05

Mean in the same column carrying same superscript are not significantly different (P>0.05). Mn =Manganese, Cu= Copper, Fe= Iron, Cr= Chromium, Pb= Lead, Zn= Zinc.

Table: 2: Mean Season Variation of Heavy Metal Concentration in Water Sample

Season	Mn(mg/l)	Cu(mg/l)	Zn(mg/l)	Fe(mg/l)	Pb(mg/l)	Cr(mg/l)
Dry	0.045a	0.25a	0.662a	0.144a	0.008a	0.002a
Wet	0.034a	0.118b	0.178b	0.179a	0b	0.001a
±SE	0.006	0.023	0.042	0.038	0.009	0.001

Mean in the same row having same superscript are not significantly different from each other (p>0.05). Mn =Manganese, Cu= Copper, Fe= Iron, Cr= Chromium, Pb= Lead, Zn= Zinc.

Table 3: Mean concentration of heavy metals in the gills of the experimental fish species

Fish Species	Mn(mg/100g)	Cu(mg/100g)	Zn(mg/100g)	Fe(mg/100g)	Pb(mg/100g)	Cr(mg/100g)
AUGG	0.85a	2.375abcd	6.3ab	5.3ba	0.05a	0b
CLRG	2.075a	2.95abc	4.75ab	2.275b	0.0375a	0.175a
TPLG	1.425a	1.575cd	5.6ab	3.775ba	0.0375a	0.05ab
Permissible limits (FAO/WHO, 2008)	2-9	3	10	10	0.05	0.15

Table 4: Mean concentration of heavy metals in the musscles of the experimental fish species

Fish Species	Mn(mg/100g)	Cu(mg/100g)	Zn(mg/100g)	Fe(mg/100g)	Pb(mg/100g)	Cr(mg/100g)
AUGM	0.5a	1.325cd	4.25ab	4.075ab	0.05a	0b
CLRM	0.55a	1.125d	4.025ab	14.8a	0.025a	0.1ab
TPLM	0.425a	1.85abcd	1.8b	1.4b	0.0375a	0.025ab
Permissible limits (FAO/WHO, 2008)	2-9	3	10	10	0.05	0.15

Table 5: Mean concentration of heavy metals in the intestines of the experimental fish species

Fish Species	Mn(mg/100g)	Cu(mg/100g)	Zn(mg/100g)	Fe(mg/100g)	Pb(mg/100g)	Cr(mg/100g)
AUGI	0.95a	3.4ab	5.875ab	12.6ab	0.0375a	0.025ab
CLRI	3.925a	3.625a	7.65a	1.975b	0.025a	0.05ab
TPLI	4.05a	1.675abcd	2.175ab	5.5ab	0.025a	0.025ab
Permissible limits (FAO/WHO, 2008)	2-9	3	10	10	0.05	0.15

Table 6: Mean Concentration of Heavy Metal in Auchenoglanis occidentalis (AU), Clarias gariepinus (CLR) and Tilapia gallilaeus(TG) the Fish Organs.

Fish Species	Mn(mg/100g)	Cu(mg/100g)	Zn(mg/100g)	Fe(mg/100g)	Pb(mg/100g)	Cr(mg/100g)
AUGG	0.85a	2.375abcd	6.3ab	5.3ba	0.05a	0b
AUGM	0.5a	1.325cd	4.25ab	4.075ab	0.05a	0b
AUGI	0.95a	3.4ab	5.875ab	12.6ab	0.0375a	0.025ab
CLRG	2.075a	2.95abc	4.75ab	2.275b	0.0375a	0.175a
CLRM	0.55a	1.125d	4.025ab	14.8a	0.025a	0.1ab
CLRI	3.925a	3.625a	7.65a	1.975b	0.025a	0.05ab
TPLG	1.425a	1.575cd	5.6ab	3.775ba	0.0375a	0.05ab
TPLM	0.425a	1.85abcd	1.8b	1.4b	0.0375a	0.025ab
TPLI	4.05a	1.675abcd	2.175ab	5.5ab	0.025a	0.025ab
±SE	1.394a	0.619	1.908	4.3	0.0245	0.585
Permissible limits (FAO /WHO, 2008)	2-9	3	10	10	0.05	0.15

Mean in the same row having same superscript are not significant different from each other ($p>0.05$).AUGG=Auchenoglanis occidentalis gill, AUGI= Auchenoglanis occidentalisIntestine, AUGM= Auchenoglanis occidentalis Muscles, CLRG=Clarias gariepinus Gills, CLRI= Clarias gariepinus Intestine, CLRM=Clarias geriepinus Muscles, TPLG=Tilapia gallilaeus Gills, TPLI=Tilapia gallilaeus Intestine, TPLM= Tilapia gallilaeus Muscles.

Table 3-5 above showed the heavy metal concentrations in the various organs of the different species examined during the study. Table 3 showed that Auchenoglanis occidentalis gills accumulated the highest concentration of zinc (6.3mg/L) while the lowest concentration of lead was observed in all the gills of the experimental species. All the metals still fell within the permissible level except Chromium in Clarias gariepinus gills which was a little above the permissible level

Table 4 showed that Clarias gariepinus mussle accumulated more Mn, Fe and Cr compared to the muscles of other species examined while more concentration of Copper was found in Tilapia muscle. However, the highest concentration of metals examined was found in Clarias gariepinus muscle with the value of 14.8 which was far above the permissible limit recommended by WHO

Table 5 showed the mean concentration of heavy metal in the intestine of the experimental fish species. Clarias gariepinus intestine had the highest concentration of Zinc with mean value of 7.65 mg/l least concentration of lead was found in the intestine of Clarias gariepinus and Tilapia and chromium in Auchenoglanis occidentalis intestine. All the heavy metals fell below the acceptable limit, (WHO, 2008).

DISCUSSION

Concentration of heavy metals in the gills, muscles and intestine of three different species (Auchenoglanis occidentalis, Clarias gariepinus and Tilapia zilli) from the Dam do accumulate heavy metals. In line with other studies (Ekeanyanwu et. al., 2010;Abraha et. al., 2012) revealed that heavy metals accumulated in the gills, muscles and intestines of these species. The concentration of these metals in water and fish tissues suggested interrelation of metal accumulation in the various components of the fish as observed by Farag et. al., 2007. The concentration of zinc in the water sample constituted the major portion of the total metal ions determined while Chromium concentration was the lowest. Concentration of the metals fell below the permissible level as prescribed by USEPA and WHO, (2008).

The concentration of copper and Iron were slightly above the recommended level by FAO/WHO, (2008) while other metals fell below the permissible levels. The concentrations of these metals were generally lower in the water compared to their concentration in the fish tissues. This is in agreement with the findings of Chale, 2002; Ekeanyanwu et. al.,, 2010. The result obtained indicates the variation in the heavy metal present during dry and wet season. This variation and differences in concentration might also be attributed to temperature changes within the season, level of runoff during the dry and also level of water in the dam. This is in line with the report from (Akan.et al.,

2012). It was observed in Auchenoglanis occidentalis and Clarias gariepinus that only the muscles have significantly different ($P<0.05$) metal concentration. However, Tilapia gallilaeus gills shows significant difference ($P<0.05$) in Cu which is not in agreement with result gotten by (Isaq et.al., 2011). They reported that the highest concentration of heavy metals was found in tilapia gills while the lowest was found in the muscles while Clarias gariepinus had the highest concentration in the gills and lowest in the tissues. This may be as a result of the feeding habit of the fish and seasonal changes in the taxonomic composition of the different trophic levels affecting the concentration and accumulation of heavy metals in the body of the fish (Chen and Folt, 2000).

CONCLUSION

It was evident from this study that heavy metals from the water and fish samples were below the permissible level, however, the metal still accumulate in the tissues of fish which may gradually increase above the permissible level if care is not taken. It is equally evident that Agaie-lapai dam is polluted with heavy metal and this call for effective management of this natural resource. It is therefore suggested that regular biomonitoring of heavy metal contaminants in fish is essential in order to prevent excessive buildup of the toxic metals in bio-resources of the Dams.

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