MONOGASTRIC NUTRITION AND MANAGEMENT

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RESPONSE OF BROILER CHICKENS TO TIME LIMITED FEEDING

OF MASH OR PELLET FEED

O. A. ADEYEMI*, A. M. OYELEKE, L.T. EGBEYALE, A. O. OSO and C.P. NJOKU *Department of Animal Production and Health,*
Federal University of Agriculture, Abeokuta, Ogun State, Nigeria
***corresponding author:** *adeyemioa@funaab.edu.ng*

ABSTRACT
The effect of feed form (FF) and time limited feeding on performance of broiler chickens was studied. 160 marshal strain of broiler were allocated in a 2 × 4 factorial experimental arrangement with two FF (mash and pellet) at four Time limited feeding (TLF) (24, 6, 4, and 2 hours). Data collected were analysed using a completely randomized design. Significant differences were obtained on feed intake (FI), weight gained (WG), final weight (FW), feed conversion ratio (FCR) and mortality (M). FI reduced ($P<0.05$) as TLF reduced. FI was influenced by FF, birds fed pellet diet having higher ($P<0.05$) FI compared to mash at each corresponding level of TLF. WG was lower ($P<0.05$) at all levels of TLF in broilers fed mash compared to ad libitum group. However, birds fed for 4 and 6 hours on pellet diet during feed limitation had similar ($P>0.05$) WG compared to their control group. FW at 8 weeks of age was lower in birds fed mash compared to pellet. FCR was influenced by FF and TLF with birds placed on pellet having a better FCR compared to those fed mash. Pellet fed birds recorded higher M compared to the mash fed birds particularly during the first week of life because the pellet size of 2mm was too big for their mouth size hence inability to feed properly, thereafter improvements were observed from week two. The study revealed a better performance and better benefit of feed limitation when birds are fed pellet diet compared to mash.
Keywords: Broiler Chickens, Feed Forms, Growth Performance, Time Limited Feeding.

INTRODUCTION
Generally, broiler production is known to be capital demanding due to high cost of conventional feed ingredients especially the energy and protein sources. This is because it is one of the most efficient converters of feed to animal protein and it is generally assumed that when birds eat more, they attain higher body weight at market age. The high cost of feed in poultry production is threatening the sustainability of the enterprise. There is therefore, a need to identify methods of reducing costs (Khetani *et al*., 2009).
Various feed form including mash, pellet or crumble are supplied to broilers. Ration forms are the most important factor which directly influences the cost of mixed feed and production performance of broiler (Ghazi *et al*., 2012). The physical form of feed (mash and pellet) is a crucial factor in meat yield of broiler.
With the present widening protein deficiency gap due to high population and high cost of livestock production, there is the need to reduce production cost through feed cost savings, this will allow the product go round the population at affordable prices. (Azarnik *et al*., 2010). The benefits of feed savings, feed conversion rates, lean meat and a more uniform growth are worth serious consideration. These benefits can be realized by finding cheap, adequate and readily available ways of reducing feed cost in broiler chicken production. One of such method is reducing the amount of daily feed offer for some time (Novele *et al*., 2009). Quantitative and qualitative feed restrictions have been introduced; this is done by reducing the birds feed access time or by reducing the nutrient content of the feed. Restricted feeding can be done in early life of chickens (Lee and Leeson, 2001). Limiting feed access in boiler production has reduced excess fat deposition and therefore improving the carcass quality of broiler as well as reducing metabolic diseases and mortality rate. (Lee and Lesson, 2001).
Several studies on feed limitation in boilers has shown decrease in mortality, stimulation of compensatory growth, improved carcass quality by reducing excess fat deposition, reduce production cost and improved feed efficiency. However, in these studies birds were placed on the same form of diet. However, there is little information on feed restriction programme where there is comparison between different forms of feed fed to broiler chickens.

MATERIALS AND METHODS
Animal and housing
A total of one hundred and sixty marshal strain of broiler chicks raised on deep litter were used for the study.
Experimental procedure
The experimental birds were raised altogether for the first 7 days of age (1 week) and were fed *ad libitum* on mash diet during this period. At 1 week of age birds were balanced for weight and

allocated into a 2 × 4 factorial experimental arrangement in a completely randomized design with two feed forms (mash and pellet) and four levels of feed access time (24,6, 4, and 2 hours). There were 8 treatments which were replicated four times with five birds. Birds on all the feed limited groups were provided with same quantity of feed each day using the guide given by Aduku (2004). Leftover feed was withdrawn from feed limited groups at the stated time. The time limited feeding was carried out for a period of 3 weeks from 7 - 28 days of age. After the 21days of feed restriction all birds were fed *ad libitum* till eight weeks of age. A straight diet was used for the experiment. The Gross Percentage Composition of the Mash and Pellet are similar (Maize, 45.00; Soybean meal 15.00; Fish meal(72%CP) 1.00; Groundnut Cake 12.50; Wheat Offal 21.50; Oyster Shell 1.50; Bone meal 2.50; Lysine 0.25; Methionine 0.25; Salt 0.25; Vit./Mineral Premix 0.25). Necessary Vaccinations and medications were administered. Data collected were subjected to the following equations to obtain weight gain, feed intake, feed conversion ratio and Mortality (%)

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Chemical and Statistical analysis

Proximate analysis of mash and pellets (Table 1.) were carried out using the methods of AOAC (2005). Data collected were subjected to analysis of variance, significant (P<0.05) differences among each treatment means were separated using Duncan‘s Multiple Range Test (SAS, 1987).

RESULTS AND DISCUSSION

Main and interaction effects of FF and TLF are shown in Tables 2 and 3. Average daily feed intake/bird for the entire period of experiment reduced significantly (P<0.05) with reduction in time of access to feed. Feed consumption for the entire period of experiment was higher in pellet fed birds compared to mash fed birds at all corresponding level of feed access time.

The performance of pellet fed bird compared to mash fed birds (Table 2) indicates that broilers were able to utilize pellet diet better than mash diet. Average daily weight gain/bird for the entire period of experiment was higher in pellet diet compared to mash at all corresponding level of feed access time. Birds placed on pellet diet responded better to the feed restriction, birds fed for 4 and 6 hours during restriction on pellet diet were able to compensate for their initial body weight loss after realimentation. However, all groups of feed limited bird placed on mash diet failed to compensate fully for their initial weight loss after realimentation. Final body weight gain of birds on table indicated that birds limited to 4 and 6 daily feed access time and fed pelleted diet were able to compete favourably with birds fed *ad libitum* on mash diet. The general improved performance of pellet fed birds compared to mash can be explained to be due the fact that birds prefer feed in pellet form compared to mash (Behnke, 1998) which resulted in increased feed intake and subsequent higher body weight gain. Each pellet grain gives a balanced nutrient intake thereby eradicating ingredient segregation (Behnke, 1998). Also chicken spent less time feeding on pellets and expended less energy than on mash (Savory, 1974; Moran, 1989). Pellet fed birds had better feed conversion ratio for the entire period of experiment at each corresponding level of feed access time, this means that broilers were able to utilize pellet feed better than mash. Similar results were observed from earlier findings (Ghazi *et al*., 2012; Zakeri *et al*., 2013) who reported that pellet had a better feed efficiency of pellet over mash.

In this study no outbreak of disease was recorded, mortality was recorded only at the early period of feed limitation (1st week). Higher mortality recorded among the pellet fed birds may be a result of combination some factors (at the early period of restriction birds were not readily familiar with the pellet diet, the beak was not developed enough to effectively pick up the 2mm pellet, and feed was restricted giving them less time to feed) which might have contributed to a very low energy intake which was not sufficient to fuel necessary body processes, though birds that survived were able to adapt favourably at the second week of feed limitation. The study concluded that broiler chickens on pellet feed had better performance in terms of feed intake, weight gain, feed conversion ratio and final weight gain over those fed mash. Broilers subjected to 4 and 6 hours daily TLF competes favourably with groups of birds fed ad-libitum following realimentation.

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Table 1: Analysed Composition (%) of Mash and Pellet

	Dry Matter	Crude Protein	Crude Fibre	Ether Extract	Ash
Mash	88.35	21.05	3.97	3.74	5.65
Pellet	89.25	20.94	4.08	3.56	5.30

Table 2: Main effects of feed form (FF) and time limited feeding (TLF) on performance characteristics of marshal broilers Feed form Time Limited Feeding (Hours) Parameters Mash Pellet SEM 2 4 6 24 SEM Initial Weight (g) 145.25 146.75 1.76 143.00 149.50 146.50 145.00 2.35 Final Weight (g) 1799.38^{b}1980.00^{a}28.78 1786.25^{c}1878.75^{b}1875.00 ^{b}2018.75 ^{a}42.86 FI (during restriction)/bird (g)/day 29.40 ^{b}30.52 ^{a}3.89 17.36^{d}21.78^{c}25.18 ^{b}55.52^{a}0.52 FI (during realimentation)/bird (g)/day 115.72 ^{b}118.62^{a}0.74 116.88^{ab} 117.17^{ab} 115.34 ^{b}119.29^{a}1.04 FI (Entire Period)/bird (g)/day 78.72 ^{b}80.87^{a}1.87 74.23^{c}76.29 ^{b}76.70 ^{b}91.96^{a}0.66 WG (during restriction)/bird (g)/d 11.37 ^{b}12.96^{a}1.07 9.25^{c}9.42^{c}10.92^{b}19.07^{a}0.51 WG (during realimentation)/bird (g)/d 50.70 ^{b}55.96^{a}0.72 51.68^{b}54.96^{a}54.00^{ab} 52.66^{ab} 1.35 WG (Entire Period)/bird (g)/d 33.84 ^{b}37.53^{a}0.61 33.50^{c}35.44 ^{b}35.54^{b}38.27^{a}0.90 Feed conversion ratio during restriction 2.56^{a}2.23 ^{b}0.125 1.91^{c}2.40 ^{b}2.37 ^{b}2.92 ^{b}0.13 Feed conversion ratio after restriction 2.28^{a}2.13 ^{b}0.03 2.27^{a}2.14 ^{b}2.15 ^{b}2.27^{a}0.05 Total Feed conversion ratio 2.33^{a}2.16 ^{b}0.03 2.23 ^{b}2.16 ^{b}2.17 ^{b}2.41^{a}0.05 Mortality during Restriction 1.25 ^{b}12.5^{a}2.42 17.50^{a}7.50 ^{b} 2.50 ^{b}0.00 ^{b}3.04 Mortality after restriction 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 Total mortality 1.25 ^{b}12.5^{a}2.42 17.50^{a}7.50 ^{b} 2.50 ^{b}0.00 ^{b}3.04 a,b,c: means in the same row not sharing common superscript are significantly different ($p<0.05$)

Table 3:Effects of interaction between feed form (FF) and time limited feeding (TLF) on performance characteristics of Marshal Broilers

Feed form	Mash				Pellet				
time limited feeding (TLF) (Hours)	2	4	6	24	2	4	6	24	SEM
Initial Weight (g)	143.00	148.00	146.00	144.00	143.00	151.00	147.00	146.00	3.52
Final Weight (g)	1707.50^{c}	1760.00^{cb}	1745.00^{c}	1985.00^{a}	1865.00^{b}	1997.50^{a}	2005.00^{a}	2052.50^{a}	33.99
FI (during restriction)/bird (g)/day	17.73^{e}	21.81^{d}	24.49^{c}	53.56^{b}	16.99^{e}	21.74^{d}	25.88^{c}	57.49^{a}	0.57
FI (during realimentation)/bird (g)/day	115.05^{bc}	114.98^{bc}	112.90^{c}	119.95^{a}	118.72^{ab}	119.37^{ab}	117.79^{ab}	118.63^{ab}	1.13
FI (Entire Period)/bird (g)/day	73.34^{d}	75.05^{cd}	75.00^{cd}	91.50^{a}	75.12^{cd}	77.53^{bc}	78.40^{b}	92.42^{a}	0.77
WG (during restriction)/bird (g)/day	8.43^{de}	8.35^{e}	9.41^{cde}	19.29^{a}	10.07^{cd}	10.49^{c}	12.43^{b}	18.86^{a}	0.52
WG (during realimentation)/bird (g)/day	49.70^{b}	51.66^{b}	50.06^{b}	51.38^{b}	53.67^{b}	58.27^{a}	57.95^{a}	53.95^{b}	1.21
WG (Entire Period)/bird (g)/day	32.01^{c}	33.10^{cb}	32.63^{cb}	37.63^{a}	34.99^{b}	37.79^{a}	38.44^{a}	38.91^{a}	0.75
Feed conversion ratio during restriction	2.12^{b}	2.72^{a}	2.64^{a}	2.79^{a}	1.70^{b}	2.08^{b}	2.10^{b}	3.05^{a}	0.13
Feed conversion ratio after restriction	2.32^{a}	2.22^{a}	2.23^{a}	2.34^{a}	2.21^{b}	2.05^{bc}	2.04^{c}	2.20^{b}	0.05
Total Feed conversion ratio	2.30^{abc}	2.27^{bc}	2.30^{abc}	2.44^{a}	2.15^{cd}	2.06^{d}	2.05^{d}	2.38^{ab}	0.05
Mortality during Restriction	5^{cb}	0^{c}	0^{c}	0^{c}	30^{a}	15^{b}	5^{cb}	0^{c}	2.60
Mortality after restriction	0	0	0	0	0	0	0	0	0
Total Mortality	5^{cb}	0^{c}	0^{c}	0^{c}	30^{a}	15^{b}	5^{cb}	0^{c}	2.60

SOIL NUTRIENTS POTENTIALITY OF PIG DEEP LITTER INOCULATED WITH EFFECTIVE MICROORGANISM (EM) IN FERMENTED BED TECHNOLOGY PIG PRODUCTION

[*]Adewale I. Adeolu, [†]Adanne P. Agbafor, [†]Nancy C. Umezuruike, [§]Ukaegbu G. Nneji

[*]Department of Agriculture (Animal Science Programme), Alex Ekwueme Federal University Ndufu Alike, Ikwo. P.M. B. 1010, Abakaliki, Ebonyi State, Nigeria.

[†] Department of Biology/Microbiology/ Biotechnology (Biotechnology Programme) Alex Ekwueme Federal University Ndufu-Alike, Ikwo. P.M. B. 1010, Abakaliki, Ebonyi State, Nigeria.

[§]Department of Biotechnology, Federal Institute of Industrial Research Oshodi, P.M.B 21023, Ikeja, Lagos State, Nigeria.

ABSTRACT

A total number of thirty six (36) weaner pigs were randomly allotted to two (2) treatments of eighteen (18) weaner each, with each treatment having three (3) replicates of six (6) weaners. The study was designed for the assessment of soil nutrients potentials of pig deep litter inoculated with Effective Microorganism (EM) obtained from pig production using Fermented Bed Technology (FBT). Bedding materials were inoculated with the solution of EM-*Bacillus subtilis* (STL002)*, Lactobacillus plantarum* (MKL430)*, Saccharomyces cerevisiae* (RSU512) and *Actinomycetes* (OLT231). Samples were collected from each replicates of bedding without EM ($T_{1,}$ control) and with EM (T_2) and individuals sample from each replicate for T_1 and T_2 were mixed thoroughly in order to obtain homogeneous samples for nutrients analysis. Kjeldhal apparatus, flame photometer, molybdovanadate method and model 55B Atomic Absorption Spectrophotometer (AAS) were used for the analysis. Data obtained from triplicate determination for individuals sample were subjected to t-test analysis and results indicated significant different ($p<0.05$) between T_1 and T_2. Pig deep litter macronutrients analysis revealed that Mg=8.42ppm, K=7.25ppm, N=1.62%, P=52.01mg/l, S=9.55% while micronutrients depicted Fe=9.45ppm, Mn=6.60ppm, Zn=5.34ppm, Cu=8.11ppm, Cl=4.81ppm. This study therefore, showed that Fermented Bed Technology which make use of EM actively breakdown pig waste thus, significantly decreased offensive odour and flies populations. Pig deep litter nutrients content obtained further suggest future use of this biotechnology in a farming system that are economically, environmentally, and socially sustainable.

Keywords: Effective microorganisms, Soil nutrients, Pig deep litter, Inoculation, Pig.

INTRODUCTION

The issue of insufficient protein intake and malnutrition generally in developing countries can be attributed to the high cost of conventional sources of meat such as cattle, goat, sheep, pigs, poultry etc. and the demand-supply gaps which has not yet been bridged. FAO (2014) reported high per caput (more than 10 kg) consumption of meat in some industrialized countries while less than10 kg per caput consumption for developing countries was considered insufficient and often leads to under nourishment and malnutrition. Deficiencies occur when people have limited access to micronutrient rich foods such as meat, fish, fruit and vegetables. Therefore, bridging this gap can only be achieved by the increasing and consistent encouragement of production of short-cycled and highly prolific animals such as pigs.

Pigs have been described as one of the most prolific and fast growing livestock that can convert food waste to valuable products and being pure white meat, can excel above other red meat animals. Despite all these attributes, farmers are been discouraged to go into pig production because of challenges associated with pig production. These include offensive odour and large population of flies usually seen around pig farms.

Enforcing Federal Environmental Protection Agency Act No 59 of 1992, which regulates pig farms to be located not less than 500 meters away from residential areas has made many farmers to lose their land to residential owners and this has also continued to discourage farmers from investing in production of such animals. The Act argued that waste (feacal and urine) from pig farms have the potential of carrying pathogens, bacteria (often antibiotic resistant), and heavy metals that can be toxic

when ingested (Nicole, 2017). These waste products causes mucosal irritation, respiratory ailments, decreased quality of life, pollution of water bodies, release of greenhouse gases (ammonia, nitrogen oxide and methane). The foul odours, flies and mosquitoes breed in manure pit are grassed continually to the neighboring communities and these are capable of transmitting diseases such as cholera, dysentery, typhoid, and malaria. Annette *et al*. (2006) reported that pig farms are capable of spreading diseases like- Salmonella, Toxoplasma, and Campylobacter.

Studies by AfrII (2016) and Laishram *et al*. (2018), showed that Fermented Bed Technology (FBT) might be an effective technology in reducing occurrences of diseases and also increasing the immunity of the pigs. FBT with the help of EM‘s offers many benefits but the core benefit is the efficient way of turning both manure and urine into finished compost/litter. There is dearth of information about soil nutrient contents of pig deep litter in available literature. This study was therefore undertaken to assess soil nutrients potentiality of pig deep litter inoculated with EM‘s in FBT pig production.

MATERIALS AND METHODS

Study Location and Sources of Experimental Materials

This experiment was conducted at the Teaching and Research Farm of Ikwo Local Government, Ndufu Echara, Ikwo Ebonyi State. This location lies in latitudes $60^{0}4'$N and Longitude $08^{0}65'$E in the Derived Savanna Zone of Southern Nigeria (AE-FUNAI, 2012).Thirty six (36) weaner pigs, selected from existing population in the farm were used as experimental animals. They were randomly allotted to two (2) treatments of eighteen (18) weaners each, with each treatment having three (3) replicates of six (6) weaners each. Required quantity of rice straw was gathered as a left over waste after rice paddy harvest from selected farms within Ikwo Local Government Area (LGA). Rice husk and dried palm fronds used as bedding material were freely obtained from Nwakpu rice mill cluster and Obuegu Ndufu Echara palm tree plantation, respectively. Maize bran, used as substrate for culturing the Effective Microorganisms (EM‘s) was also obtained free from milling clusters within Abakaliki, metropolis. Pure cultures of EM‘s: *Bacillus subtilis* (STL002), *Lactobacillus plantarum* (MKL430), *Saccharomyces cerevisiae* (RSU512) and *Actinomycetes* (OLT231) were procured from Federal Institute for Industrial Research, Oshodi Lagos State. Other materials (loam soil, distilled water, table salt and glucose) were sourced locally. .

Experimental Procedures

The inoculum development was carried out at biotechnology laboratory, Alex Ekwueme Federal University Ndufu-Alike in line with the method of Balogun *et al.* (2016) with little modification.The solution (containing EM‘s) obtained were used to inoculate and ferment the bedding materials. Rice straws and dried palm fronds were laid firmly on non-cemented floor to a height of 30cm in a 12m x 12m size pen. Immediately after this, bedding materials was added to the height of 40cm. The bedding materials consists of rice husk (30 bags), 100kg or 3 wheelbarrows of loam soil, ash (10kg) and table salt (10kg). Solution of EM‘s were continually sprinkled on the bedding materials as they were mixed thoroughly using combination of shovel and garden forks. Turning of the bed was carried out daily and allowed to ferment for eight days before stocking. In order to maintain a healthy bed and also to encourage rooting, turning and mixing of the bed with sprinkle of EM‘s solution was carried out weekly within the period of the experiment. All animals were kept under the same management and climatic conditions.

Samples Collection and Nutrients Analysis

At the end of the experiment (6 months), samples were collected from each replicates of deep litter without EM‘s (T_1, control) and with EM‘s (T_2) for nutrients analysis. These were carried out at Home water Research Laboratory. Abakaliki, Ebonyi State. Nitrogen content was determined using Kjeldhal apparatus in a processes described by Pearson (1976) while Potassium and Magnesium were determined by the use of flame photometer. The molybdovanadate method (AOAC, 2010) was used to determine the total Phosphorous. Sulphur and micronutrients (Fe, Mn, Zn, Cu and Cl) content of the samples were obtained through variant 55B Atomic Absorption Spectrophotometer (AAS).

Data Analysis

Data obtained were subjected to pair t-test analysis using the procedure of Ogbeibu (2005). Significant difference ($p<0.05$) was observed between T_1 and T_2.

RESULTS AND DISCUSSION

Macronutrients and micronutrients content of pig litter from T_2 shows significant ($p<0.05$) better results than control, T_1. This may be attributed to the ability of the EM to ferment organic matter, decompose and convert fiber and lignin components of bed materials to release nutrients and nutrient rich organic acids (Higa, 2012).

Table1: Macronutrient composition of Fermented Bed Product (FBP) for T_1 and T_2.

Macronutrient	**T_1 (bedding without EM)**	**T_2 (bedding with EM)**
Mg (ppm)	2.25	8.42
K (ppm)	1.21	7.25
N (%)	0.90	1.62
P (mg/l)	28.62	52.01
S (%)	7.15	9.55

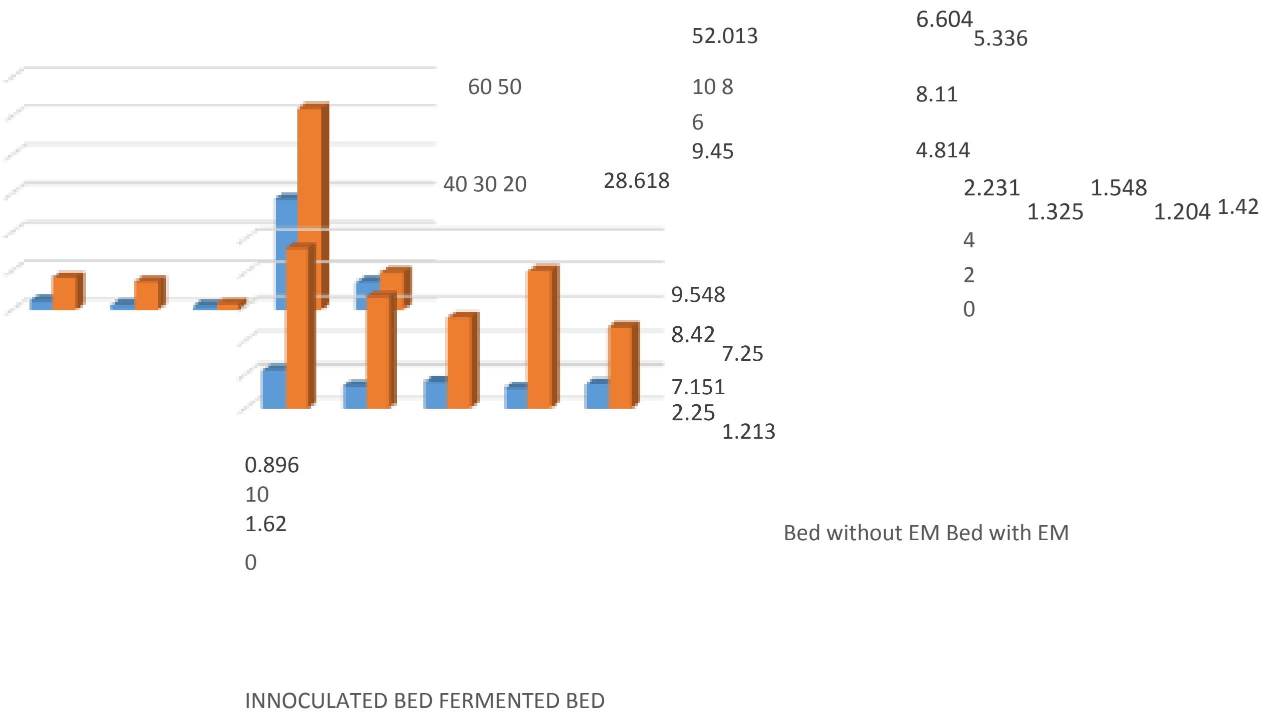
Mg= Magnesium; K=Potassium; N=Nitrogen; Phosphorous=P; S=Sulphur

There are inadequate information on soil nutrient contents of FBP in available literature. However, Ncube *et al.* (2011) and Javaid (2010) noted the efficacy of organic manure formulated with EM‘s in seed germination and vigour in carrot, cucumber, pea, beet, tomatoe and cowpea plants. Kim *et al.* (2012) reported that treatments with EM and EM-fermented compost in a greenhouse increased the yields of Spinach and Costmary by 10.4 to 24.8% and by 19.4 – 32.9%, respectively.

Table 2: Micronutrient composition of Fermented Bed Product (FBP) for T_1 and T_2.

Micronutrient (ppm)	**T_1 (bedding without EM)**	**T_2 (bedding with EM)**
Fe	2.23	9.45
Mn	1.33	6.60
Zn	1.55	5.34
Cu	1.20	8.11
Cl	1.42	4.81

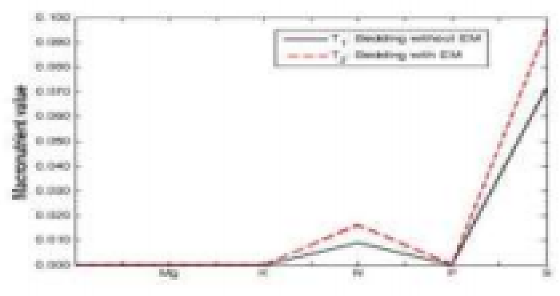
Fe= Iron; Mn=Manganese; Zn= Zinc; Cu=Copper; Cl=Chlorine



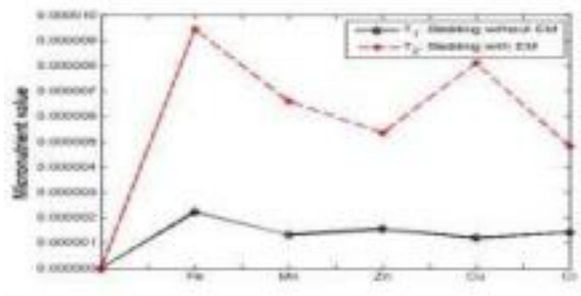
Macronutrients Micronutrients

Figure 1: *Graphical representation of soil nutrients composition of Fermented Bed Product (FBP)*

A cursory look at the Figure 3 reveals a great trends similarity between bedding with EM and bedding without EM. However, the proportionality trend of soil nutrients in bedding with EM confirmed the superiority of such technology over the control (bedding without EM).



Mg= Magnesium; K=Potassium; N=Nitrogen; Phosphorous=P; S=Sulphur
%Macronutrient data using 1%=10000ppm, 1mg/l=1ppm, 1ppm=0.000001



Fe= Iron; Mn=Manganese; Zn= Zinc; Cu=Copper; Cl=Chlorine
% Micronutrients data using 1ppm=0.000001

Figure 2: *Nutrients proportionality trend of bedding without and with EM's*

CONCLUSION

The present study presented the efficacy of FBT in breaking down pigs' effluent and urine into a compost/litter. It was also observed that this biotechnology allows pig natural behavior of rooting and minimizes frequent cleaning and the need for disinfection. Therefore, effective microorganisms

(EM‘s) based technology as a part of Fermented Bed Technology (FBT) is one such great technology that has the potential of minerals extraction, enhancement of agriculture and waste management for environmental protection and food security as it allows rearing of pigs in a clean environment without flies and offensive odour.

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PERFORMANCE AND COST IMPLICATION OF BROILER CHICKENS FED GRADED LEVELS OF PUMPKIN SEED MEAL

***Sudik, S. D., Amaza, I. B., Maidala, A., Lawan, A. and Makinde, O. J.**
Department of Animal Science, Faculty of Agriculture, Federal University, Gashua, Nigeria *Corresponding author's email: davidsudik@yahoo.com Mobile phone: +2348065633451

ABSTRACT
The high cost of conventional feedstuff has necessitated the search for alternative feedstuff. This study was conducted to determine the performance and cost implication of broiler chickens fed graded levels of pumpkin seed meal. Pumpkin seed sourced locally was toasted, milled and tagged as pumpkin seed meal (PSM). Four treatments (T1, T2, T3, and T4) were formulated in which soybean meal (SBM) was replaced with PSM by 0%, 2.5%, 5% and 7.5%, respectively. Treatment 1 served as control. One hundred and sixty (160) day-old Hubbard broilers chicks were used. They were randomly distributed into the four treatments. Each treatment had 40 chicks divided into four replicates of 10 each. The design used was a completely randomized design. The experimental treatments and drinking water were supplied *ad libitum*. The experiment lasted for 42 days. Total feed intake and daily feed intake were not significantly (P>0.05) affected by treatments. Total weight gain (TWG), daily weight gain (DWG) and feed conversion ratio (FCR) were significantly (p<0.05) affected by treatments. Birds fed T3 had highest TWG and DWG comparable to T1 while T4 had lowest. Also, birds fed T3 had best feed conversion ratio comparable to T1 while T4 had worst. Cost of feed reduced with increased inclusion level of PSM in the diets. However, T3 had the least total cost of feed consumed while T1 had highest. Again, T3 had least feed cost/kg body weight while T4 had highest. It may be concluded that 5% PSM is recommended for economics of broiler production.
Keywords: Broiler, Cost implication, Performance, Pumpkin seed meal, Soybean meal

INTRODUCTION
Feed is a major factor determining profitability of livestock production in general and poultry production in particular due to the over dependence on high cost conventional feedstuff (Adegbenro *et al*., 2020). Feed alone constitutes about 55-70% cost of poultry production (Umar *et al*., 2018). Therefore, to achieve economic of production least cost ingredients should be searched. In FAO (2012) report, the use of locally available raw materials with potentials as feed ingredients in poultry diets was emphasized. Another locally available raw material that has not been given much scientific attention is pumpkin seed. Pumpkin (*Cucurbita* spp*)* is an annual crop belonging to the family *Cucurbitaceae* (Ly and Delgado, 2009). In Nigeria it is predominantly grown in the north for its eatable fruits and leaves. The seeds are readily available and have limited food and industrial uses, thus cheap. It main anti-nutritional factor is trypsin inhibitor (Ly and Delgado, 2009). Harnessing pumpkin seed as feed resource would add value to pumpkin production. The objective of this study is; to determine the performance and cost implication of broiler chickens fed graded levels of pumpkin seed meal.

MATERIALS AND METHODS
The experiment was conducted at the poultry unit of the Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, Federal University, Gashua, Yobe State, Nigeria. The required quantity of pumpkin seed was sourced from Gashua Town and its environs. Thereafter, it was toasted using fire wood to reduce the level of trypsin inhibitor. It was milled using Lister grinder and was tagged as pumpkin seed meal (PSM). Sample of the pumpkin seed collected was analyzed to determine the proximate composition using AOAC (2006) protocol (Table 1).
Four treatments (T1, T2, T3, and T4) for starter and finisher broilers each with crude protein value of 23% and 21% respectively were formulated in which soybean meal (SBM) was replaced with PSM by 0%, 2.5%, 5% and 7.5%, respectively. Treatment 1 served as control (Tables 2 and 3). One hundred and sixty (160) day-old Hubbard broiler chicks were purchased from ECWA Rural Development, Jos, Plateau State, Nigeria. They had an average initial weight of 49.61g. The chicks were

Table 1: Proximate composition (% DM) and some essential nutrients of pumpkin seed

Ash Moisture Protein Fat Crude **Methionine** protein
fibre 2.1
Carbohydra te 4.31 10.04 30.56 24. 00 % protein
***Calcium *Phosphorus **Lysine** 15.09 16.00 0.24% 0. 43% 5.1 %

Values are mean of 3 samples
* **Source**: feed composition Table (2012); **Ly and Delgado (2009).

Table 2: Dietary composition of starter diets

Ingredients T1 T2 T3 T4 Maize 50.62 50.62 50.62 50.62 Soya Bean Meal 27.00 26.32 25.65 24.97 Pumpkin Seed Meal 0.00 0.68 1.35 2.03 Wheat Offal 8.00 8.00 8.00 8.00 Groundnuts cake 8.50 8.50 8.50 8.50 Fish Meal 2.00 2.00 2.00 2.00 Bone Meal 2.00 2.00 2.00 2.00 Lime Stone 0.88 0.88 0.88 0.88 Lysine 0.25 0.25 0.25 0.25 Methionine 0.25 0.25 0.25 0.25 Premix 0.25 0.25 0.25 0.25 Salt 0.25 0.25 0.25 0.25

Table 3: Dietary composition finisher diets

Ingredients T1 T2 T3 T4 Maize 52.12 52.12 52.12 52.12 Soya Bean Meal 26.00 25.35 24.70 24.05 Pumpkin Seed Meal 0.00 0.65 1.30 1.95 Wheat Offal 8.00 8.00 8.00 8.00 Groundnuts cake 8.00 8.00 8.00 8.00 Fish Meal 2.00 2.00 2.00 2.00 Bone Meal 2.00 2.00 2.00 2.00 Lime Stone 0.88 0.88 0.88 0.88 Lysine 0.25 0.25 0.25 0.25 Methionine 0.25 0.25 0.25 0.25 Premix 0.25 0.25 0.25 0.25 Salt 0.25 0.25 0.25 0.25

randomly allotted into four treatment groups. Each treatment group was assigned forty (40) birds and further divided into four replicates of 10 each. The design used was a completely randomized design (CRD). The birds were reared on deep litter system using wood shaving as litter material. The chicks were brooded for 2 weeks (because the prevailing environmental condition was warm) using charcoal as heat source while lanterns using dry cell batteries were used to provide light in case of electricity failure. The experimental treatments and drinking water were supplied *ad libitum.* Infectious bursal disease vaccine (IBDV) was administered at week one and repeated at week three. Newcastle disease vaccine (Lasota) was administered at week two and repeated at week four. Antibiotics, coccidiostats and anti-stress were administered as the need arise. Waste litter was removed weekly and replaced with clean litter. Mortality was recorded as it occurred. The experiment lasted for 42 days.
Feed intake was monitored by feeding weighed quantities of feed weekly and subtracting the left-over from the quantity fed the previous week. The birds were weighed weekly and weight gain calculated by difference between 2 consecutive weighing. Feed conversion ratio (FCR) was derived as the ratio of feed consumed to weight gain.

The cumulative cost of each ingredient in a dietary treatment as at the time of purchase gave the total cost per treatment. Total cost of feed consumed, total feed consumed/kg body weight and feed cost/ kg body weight were all determined
The results were statistically analyzed using one-way analysis of variance (ANOVA) using SPSS version 16.0 and significance of differences among treatments was determined using Duncan multiple range test.

Results

Generally, 5% (2 birds) mortality rate from each treatment was recorded in the first week of the experiment.
Table 4 shows the average total feed intake, daily feed intake, total weight gain, daily weight gainand

feed conversion ratio of broiler chickens up to 6 week of age. Total feed intake (TFI) and daily feed intake (DFI) were not significantly ($p>0.05$) affected by treatments. Total weight gain (TWG) and daily weight gain (DWG) were significantly ($p<0.05$) affected by treatments. Total weight gain, (TWG), daily weight gain (DWG) and feed conversion ratio (FCR) were significantly ($p<0.05$) affected by treatments. Birds fed T3 had highest TWG and DWG (2044.39±45.57 and 48.68±4.11g, respectively) comparable to T1 (2042.67±54.52 and 48.64±2.73g, respectively) while T4 had lowest (1790.43±58.36 and 42.63±3.19g, respectively).Birds fed T3 also had best FCR (1.60±0.05) comparable to T1 (1.64±0.10) while T4 had worst (1.86±0.06).
Table 5 shows the cost implication of broiler chickens fed diets replacing soybean with pumpkin seed meal up to 6 weeks of age. Cost of 100 kg feed and cost of 1 kg feed reduced with increased PSM in the diets. However, T3 had least total cost of feed consumed (460.58) while T1 had highest (480.44). Again, T3 had least total feed consumed / kg body weight (1.60kg) and feed cost /kg body weight (₦225.29) while T4 had highest (1.86kg and ₦ 259.07, respectively).

Table 4: Average total feed intake, daily feed intake, total weight gain, daily weight gain (g) and feed conversion ratio of broiler chickens up to 6 weeks of age

Treatments	TFI	DFI	TWG	DWG	FCR
T1	3349.86±23.26	79.76±6.23	2042.67±54.52^{a}	48.64±2.73^{a}	1.64±0.10^{e}
T2	3338.1±25.54	79.48±8.28	1907.48±43.16^{b}	45.42±3.38^{b}	1.75±0.09^{b}
T3	3272.97±26.44	77.93±10.46	2044.39±45.57^{a}	48.68±4.11^{a}	1.60±0.05^{c}
T4	3328.42±24.17	79.25±8.15	1790.43±58.36^{c}	42.63±3.19^{c}	1.86±0.06^{a}
Level of significant	NS	NS	*	*	*

Values are (Mean ± SEM): n=38, TFI = total feed intake, DFI = daily feed intake, TWG = total weight gain, DWG = daily weight gain, FCR = feed conversion ratio.
Means in the same column with different superscripts differed significantly, but similar superscripts did not differ significantly: * significantly ($P<0.05$); NS= Non- Significant ($P>0.05$).

Discussion

The insignificant difference observed in feed intake between the control and test diets indicates that the treatments probably had similar energy contents that reflected in similar intake. Otherwise higher intake would have been expected if any of the treatment had lower energy content. This is in conformity with the report of Patha *et al*. (2015) that birds first take feed to satisfy their energy requirements. The superiority of weight gain for broilers on T3 which favourably compared to T1 indicates that 5% PSM is the optimum inclusion level for broiler chickens without adverse effect on weight gain. Also, the high feed

Table 5: Cost implication of broiler chickens fed diets replacing soybean with pumpkin seed meal

Treatment	Cost of 100kg feed (₦)	Cost of kg feed (₦)	Total feed consumed (kg)	Total cost of feed consumed (₦)	Total feed consumed /kg body weight (kg)	feed cost /kg body weight (₦)
T1	14342.10	143.42	3.35	480.44	1.64	235.20
T2	14206.10	142.06	3.34	474.21	1.75	248.61
T3	14072.10	140.72	3.27	460.58	1.60	225.29
T4	13936.10	139.36	3.33	463.85	1.86	259.07

conversion ratio for birds fed T3 favorably compared to T1 further confirms 5% PSM as the optimum inclusion level. This agrees with the assertion of Zwoliński *et al*. (2017) that raw materials with high nutrient quality can be used to substitute for soybean. This again explains that reducing soybean by

5% and replacing that weight with PSM would give quality broiler diet. The mortality rate across the treatments at the early part of the experiment perhaps could be due to slow adaptability of the birds to the environment. This agrees with the statement of Oluyemi and Roberts (2000) emphasizing environment, genetics and nutrition as major factors play in animals‘ survival. The drastic reduction in feed cost as PSM replaces SBM upholds the report in FAO (2012) that least cost ingredients used in poultry diet cut down cost of feed and the resultant cost of production. The least total cost of feed consumed per weight gain and least feed cost per kg body weight observed in T3 indicate that for cost effective of broiler feed production, PSM may be used at 5% level.

CONCLUSION AND RECOMMENDATION

The performance and cost implication of broiler chickens fed graded levels of pumpkin seed meal conducted in this study showed that the optimum level to used PSM in broilers diets was at 5% without adverse effect on weight gain, feed intake and feed conversion ratio. Feed cost reduces as PSM replaces SBM. Therefore, 5% PSM is recommended for broiler chickens.

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GROWTH PERFORMANCE OF GROWER RABBITS FED GRADED LEVELS OF JATROPHA SEED MEAL AS A REPLACEMENT FOR SOYA BEAN MEAL

[1]Wafar*, R.J., [2]Abdullahi, U and [4]Sini, T.
[1]Department of Animal Production and Health, Federal University Wukari, Taraba State
[2]Department of Animal Health and Production, Federal Polytechnic Bauchi, Bauchi State
[3]Department of Agriculture Education, Adamawa State College of Education, Hong Adamawa State *Corresponding author Email: wafar@fuwukari.edu.ng phone number 08066320686

ABSTRACT

This study evaluated the utilization of fermented jatropha seed meal (FJSM) by grower rabbits. Thirty (30) grower rabbits of mixed breeds and sex were purchased and used for the study. The rabbits were assigned to five dietary treatments. Each treatment was replicated three times with two rabbits per replicate in a completely randomized design. Data collected during the experiments were growth parameters and were subjected to analysis of variance. The results from the growth performance showed that final body weights and total weight gain decreased progressively ($P<0.001$) as FJSM

increased in the diets. Final body weight of rabbits fed T1 (2561.20g) recorded significantly higher (P<0.001) weight compared to those on jatropha seed meals. However, among Jatropha seed meal based diets rabbit, fed T2 recorded significant higher (P<0.05) final body weight 2021.50g. Feed conversion ratio also differed significantly (P<0.001) across the treatments. It was observed that the superior feed conversion was recorded T1 (2.19) followed by T2 (4.42. Rabbit fed T5 had significant (P<0.001) higher mortality (50.00%). It was observed from the study that rabbits fed T3, T4 and T5 diets recorded lower feed intake. It was therefore, concluded that fermented Jatropha seed meal can be incorporated in grower rabbit diet up to 25% without adverse effect on the growth performance of rabbit.

Keywords: Fermentation, Growth, Jatropha, Rabbits, Performance

INTRODUCTION

The use of non -convention plant protein especially from tropical legumes as an alternative to conventional sources have been advocated by animal nutritionist in recent fast (Aslani *et al.* (2007). However, the utilization of these tropical seeds in livestock feeds is subject to some inherent constraints; of particular importance are problems associated with anti-nutritional factors. Processing methods such as cooking, toasting, fermentation and soaking have been reported to reduce the anti nutritional factor in seed (Antevy *et al.,* 2017). One of the non-conventional feedstuffs focused in this study is *Jatropha curcas* seed. The seed has been reported to contain 16-18% crude protein and anti nutrients such as lectin, trypsin inhibitor, saponin, phytate, and phorbolesters (Antevy *et al,* 2017). A study conducted by Antevy *et al*. (2017) to evaluate the performance of broiler chickens fed differently processed Jatropha curcas seed meal showed that broiler chickens fed fermented *Jatropha curcas* seed meal recorded higher feed intake, final body weight gain and superior feed conversion ratio. The study adopted fermentation as a method of processing. Fermentation is one of the oldest forms of feed processing and preservation and also has the capacity to improve nutritional and functional properties of the feed stuff (Frias *et al.* 2008). This study therefore examined utilization of fermented jatropha seed meal (FJSM) by grower rabbits

MATERIALS AND METHODS

The study was conducted at the Rabbit Unit of the Department of Animal Science and Range Management, Modibbo Adama University of Technology, Yola. *Jatropha curcas* fruits were purchased from Yola market. The fruits were cracked mechanically to remove the seeds. The seeds were then cleaned of dirts by washing and packed in a jute sack cooked for 48 hours, drained and put in an air tight container for 72 hours to allow natural fermentation. Thirty (30) grower rabbits of mixed breeds and sex were purchased from rabbit farmers within Yola metropolis, Adamawa State, Nigeria. The rabbits were assigned to five dietary treatments. Each treatment was replicated three times with two rabbits per replicate in a completely randomized design. Each rabbit was housed in a fitted with aluminium feeder and drinker. The experimental animals were given prophylactic treatment against endo and ecto-parasites. Five diets were compounded using FJSM to replace

soyabean meal at 0, 25, 50, 75 and 100% designated as treatment 1, 2, 3, 4 and 5 respectively as shown in Table 1.

Table 1 Ingredient and Percentage Composition of Experimental Diets

Replacement levels of fermented Jatropha seed meal Ingredients T1 (0 %) T2 (25%) T3 (50 %) T4 (75%) T5 (100 %) Maize 52.00 52.00 52.00 52.00 52.00 Soyabean meal 18.00 13.50 9.00 4.50 0.00 FJSM 0.00 4.50 9.00 13.50 18.00 Groundnut haulms 10.00 10.00 10.00 10.00 10.00 Maize offal 13.00 13.00 13.00 13.00 13.00 Fish meal 3.00 3.00 3.00 3.00 3.00 Bone meal 3.00 3.00 3.00 3.00 3.00 Premix* 0.25 0.25 0.25 0.25 0.25 Lysine 0.25 0.25 0.25 0.25 0.25 Salt 0.25 0.25 0.25 0.25 0.25 Methionine 0.25 0.25 0.25 0.25 0.25 Total 100 100 100 100 100 Calculated analysis
Crude protein 16.83 16.64 16.73 16.65 16.70 Crude fibre 8.84 8.76 8.70 8.63 8.69 ME Kcal/kg 2978.14 2998.13 2990.14 2992.88 2991.34

*Vitamin-mineral premix provider per kg the following: Vit. A 1500 IU; Vit.D3 3000 IU; Vit.E 30 IU; Vit.K 2.5mg; Thiamine B1 3mg; Riboflavin B2¬ 6 mg; Pyrodoxine B6 4 mg; Niacin 40 mg; Vit. B12 0.0 mg; Pantothenic acid 10 mg;Folic acid 1mg; Biotin 0.08 mg; Chloride 0.125mg; Mn 0.0956 g; Antioxidant 0.125 g; Fe 0.024 g; Cu 0.006 g; Se 0.24 g; Co 0.24. SBM *= Soyabean meal

Data were collected for 12weeks. Rabbits were weighed at the beginning of the experiment and weekly, subsequently. Weight gain was calculated as final body weight minus initial body weight. Feed intake was obtained as the difference between the quantity offered and quantity not consumed. Feed conversion ratio (FCR) was calculated as feed intake divided by weight gain and recorded as they occurred. Data collected were subjected to one-way analysis of variance means were separated using Duncan's Multiple Range Test using SAS (2003).

RESULTS AND DISCUSSION

The proximate compositions of the raw and fermented *jatropha* seed meal are presented in Table 2. The results showed higher values of crude Protein (CP) 43.67%, ash (9.13%) and lower values of crude fibre (2.41%), ether extracts (20.18%), nitrogen free extracts (NFE) (14.52%) and metabolizable energy (3765.83%) for the fermented Jatropha seed meal. The higher crude protein (CP) content observed in fermented Jatropha seed meal could possibly be due to the modification effect of the fermentation process that leads to crude protein improvement. The CP values of both raw and fermented Jatropha seed meal were within the range of 35-50% crude protein reported by Aslani *et al.* (2007). The ash content of the fermented Jatropha seed meal in this study is higher than that of soybean meal (6.40%). This indicates that fermented Jatropha seed meal may be comparable to soybean meal in its usefulness in rabbit diets. The crude fibre (CF) content of the raw and fermented Jatropha seed meal is lower than 9.10% reported by Sumaiti *et al.* (2012). The variation in the crude fibre composition when compared to other studies could be attributed to the differences in agronomic practices, laboratory analysis and edaphic factors (Taiwo *et al.,* 2005).

Anti-nutritional composition of raw and fermented Jatropha seed meal

The result of the anti-nutritional factors (ANFs) composition (Table 3) shows that raw Jatropha seed contained 3.32mg phorbolester, 20.45mg trysin inhibitors, 191.56mg saponnin, 278.67mg tannin, 94.67mg oxalates and 234.56mg phytates. It results showed decrease in antinutrients as a result of fermentation. The presences of anti-nutrients in the raw jatropha seed meal confirm the earlier report of Makkar and Becker, (1999) that jatropha seed meal contained high concentration of anti-nutritional factors. The use of fermentation as a method of detoxification however, reduced the concentration of

ANFs and increased the nutrient composition of Jatropha seed meal, but did not completely remove the ANFs in the seed.

Table 2 Proximate Composition of Raw and Fermented Jatropha Seed Meal

Parameter	Raw	Fermented
Dry matter	91.11	89.91
Crude Protein	30.11	43.67
Ether extracts	32.13	20.18
Crude fibre	4.06	2.41
Ash	7.13	9.13
NFE	17.68	14.52
Metabolizable Energy	4344.24	3765.83

Metabolizable Energy = ME (kcal/kg) = 37 x % CP + 81 x % EE + 35.5 x % NFE. Calculated according to the formula of Pauzenga, (1985)

Table 3 Anti-nutritional composition of raw and fermented Jatropha seed meal (mg/100g)

Parameter	Raw	Fermented
Phorbolesters	3.32	2.11
Trypsin inhibitors	20.45	8.67
Saponin	191.56	78.98
Tannins	278.67	87.89
Oxalates	94.67	56.45
Phytates	234.56	58.11

Growth Performance of rabbits fed fermented Jatropha seed meal

Table 4, showed the growth performance of rabbits fed fermented Jatropha seed meal. The final body weights and total weight gain were highly (P<0.001) influenced by the replacement levels of fermented Jatropha seed meal. Final body weight of rabbits fed T1 (2561.20g) recorded significantly higher (P<0.001) weight compared to those on jatropha seed meals among Jatropha seed meal based diets rabbit fed T2 recorded significant higher (P<0.05) final body weight 2021.50g. Total body weight gain and total feed intake varied from 203.00g/day in T5 to 1361.10g/day in T1 and 1212.40g/day in T1 to 4351.10g/day in T1 respectively. Feed conversion ratio also differed significantly (P<0.001) across the treatments. It was observed that the superior feed conversion was recorded T1 (2.19) followed by T2 (4.42) and the inferior value in T3 (5.25), T4 (5.06) and T5 (5.97) respectively. Rabbit fed T5 had significant (P<0.001) higher mortality (50.00%). It was observed from the study that rabbits fed T3, T4 and T5 diets recorded lower feed intake. This could be attributed to the residual effect of anti-nutritional factors in the fermented Jatropha seed meal which resulted to low palatability of diets. Ogbu *et al.* (2015) reported that anti-nutritional factors such as tannins and saponins decrease feed intake due to its astringent properties. Phytate also has been reported to reduce the bioavailability of divalent cations due to insoluble complexes formation during digestion and absorption of minerals (Weaver and Kanna, 2002). This showed that rabbits fed T3 (50%), T4(75%) and T5 (100%) inclusion levels of Jatropha seed meal could not efficiently absorb the dietary nutrients in the gastro-intestinal tract as a result of high concentration of antinutritional factors. Esonu *et al.* (2001) also reported that high trypsin inhibitors in the diet reduce protein digestibility resulting in poor utilization of available nutrients. The finding from this study confirmed the result of Abdel Shafy *et al*. (2011) who reported significant reduction in feed intake and growth rate of more than 30% as a result of residual phorbol esters in jatropha seed meal. Rabbit fed T5 diets recorded high percentage of mortality percentage this could be attributed to residual content of phorbolester. Agboola and Adenuga, (2015) reported high percentage of mortality of birds fed 10% inclusion of Jatropha seed meal

Table 5: Growth performance of rabbit fed graded levels of fermented *Jatropha curcas* seed meal

Replacement levels of fermented Jatropha seed meal

Parameter	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM
Initial body weight (g)	1200.10	1190.10	1180.02	12002	1198.30	27.09^{ns}
Final body weight (g)	2561.20^{a}	2021.50^{b}	1681.10^{c}	1500.10^{d}	1401.30^{e}	73.86***
Total weight gain (g)	1361.10^{a}	831.40^{b}	501.10^{c}	300.00^{d}	203.00^{e}	12.59***
Total feed intake (g)	4351.10^{a}	3676.20^{b}	2631.20^{c}	1520.20^{d}	1212.40^{e}	54.22***
Feed conversion ratio	3.19^{d}	4.42^{c}	5.25^{b}	5.06^{b}	5.97^{a}	0.07***
Mortality (%)	0.00	3.00	10.0^{b}	24.00	50.00	-

Means in the same row bearing different superscripts differ significantly (P<0.001), ns= not significant (P>0.05), SEM = Standard error mean

CONCLUSION

The study showed that fermented jatropha seed meal can replace soyabean up to 25% FJSM as a source of plant protein in formulating rabbit diets. It is therefore recommended that 25% fermented Jatropha seed meal can be used in compounding rabbit diet.

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PERFORMANCE AND COST BENEFIT OF REPLACING WHEAT OFFAL WITH XYLANASE-SUPPLEMENTED RICE OFFAL IN THE DIETS OF BROILER FINISHER CHICKENS

[1]Kawu, Y. U. and [2]Shuaibu, I.

[1]Department of Agricultural Technology, Federal Polytechnic, P.M.B. 1006, Damaturu, Nigeria. [2]Ministry of Agriculture & Natural Resources, Bauchi State.

Corresponding author: kawuyahya@gmail.com Phone no: 08065631979

ABSTRACT

Increasing cost of conventional feed ingredients used in the formulation of poultry diets has continued to be a great challenge for poultry producers in developing countries like Nigeria. Consequently, readily available and cheaper alternatives need to be explored. An experiment was conducted to evaluate the performance and cost benefit of finisher broilers fed Xylanase-supplemented rice offal (XSRO) based diets as replacement for wheat offal. Three hundred finisher broiler chickens were assigned to five diets in which XSRO replaced wheat offal at 0 (diet 1), 25 (diet 2), 50 (diet 3), 75 (diet 4), and 100% (diet 5) levels in a completely randomized design. Xylanase was suppplemented at 1g/10kg rice offal and the study lasted for 4 weeks. Daily feed intake, daily weight gain, feed conversion ratio, mortality rate, feed cost per kg, feed cost per kg gain and cost saving, were the main parameters studied. Results showed no significant difference in daily feed intake, daily weight gain and feed conversion ratio. However, feed cost per kg gain (₦) decreased with increased level of XSRO in the diet. It was therefore concluded that Xylanase-supplemented rice offal can completely replace wheat offal in the diets of finisher broilers without compromising performance. Also, the replacement of XSRO for wheat offal at 100% level resulted in a cost saving of ₦162.60.

Key words: Broiler, wheat offal, rice offal, Xylanase, Performance, cost.

INTRODUCTION

Ensuring higher returns on investment at minimum expenditure on feed, is the principal target of any poultry business. This could be achieved when costly, highly competitive conventional feed ingredients are replaced with those that are cheaper, less competitive and readily available. Accordingly, the use of cereal by-products as dietary fibre source to replace the conventional wheat offal in poultry diets has been advanced by researchers (Dafwang and Shwarmen, 1996; Ajighjigh *et al.,* 2017; Egbunu *et al.,* 2020). Cereal by-products arise from dry milling (to produce flour), wet milling (starch and glucose production) and brewing. Commonly available among these products is rice offal.

According to Wudiri, (1991), Nigeria had the potential to produce 200,000 metric tonnes of rice offal per year. This quantity must have increased greatly in recent years due to increased level of rice production and processing in the country. Rice offal or rice milling waste, is the by-product obtained from small-scale rice mills. It contains husk, bran, polishing and small quantity of broken rice (Akinusi, 1999). Its commercial value is very low and it has a proximate composition of 4.25% CP, 27.01% CF, 7.15% EE, 41.14% NFE and 0.38, 0.04% calcium and phosphorus respectively (Ajighjigh *et al.,* 2017). However, its profile and efficiency of utilization could be improved through processing techniques such as chemical treatment with urea or the addition of exogenous enzymes (Tiemako, 1994).

The use of fibrolytic exogenous enzymes in poultry diets to improve efficiency of nutrient utilization, has been studied (Anuradha and Barun, 2015). The positive nutritional effects achieved by the addition of these enzymes could be attributed to several mechanisms, one of which is, the reduction of intestinal viscosity. High intestinal viscosity results in reduced feed conversion ratio, reduced weight gain as well as wet droppings in poultry (Paloheimo *et al.,* 2011).

Against this background, the aim of this study was to evaluate the performance and cost benefit of utilizing rice offal supplemented with Xylanase as replacement for wheat offal in broiler finisher diets.

MATERIALS AND METHODS

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm, Abubakar Tafawa Balewa University, Bauchi. The study area is located within the GPS coordinates of 10°18‘ 50.9724‖ N and 9°50‘ 46.6152‖ E, with a mean annual rainfall of 1009 mm. (World Atlas, 2015). The test materials (rice offal, Xylanase) and other feed ingredients were procured from Muda Lawal market, Bauchi.

Five broiler finisher diets were formulated to contain 0, 25, 50, 75 and 100% Xylanase-supplemented rice offal (1g/10kg) as replacement for wheat offal. The diets were designated as 1, 2, 3, 4 and 5 respectively. Composition of ingredients in the experimental diets is presented in Table 1. A total of three hundred (300) finisher broilers weighing 852.00 - 940.31 g were randomly allotted to five diets in replicates of three, containing twenty birds each. Feed and water were served *ad libitum* and the study lasted for 4 weeks. Daily feed intake was measured as the differences between quantity of feed offered and left-over collected the following day. Body weight gain was determined as the difference between two consecutive weighing (1-week interval), while feed conversion ratio was calculated using the relationship of daily feed intake and daily weight gain. Mortality was recorded as it occurred. Financial benefit was computed using feed cost per kg, total feed intake and total weight gain. All data was subjected to analysis of variance (ANOVA) using the SPSS software version 25, and where significant differences were observed, Duncan‘s Multiple Range Test (Duncan, 1955) was used to separate them.

Table 1: Ingredients Composition (%) and Calculated Analysis of Xylanase-Supplemented Rice Offal Fed to Finisher Broilers

Diets

Ingredient 1 2 3 4 5 Maize 51.97 51.76 51.76 51.76 51.76 Full-fat soya bean 14.72 14.72 14.72 14.72 14.72 Groundnut cake 12.02 12.02 12.02 12.02 12.02 Wheat offal 15.00 11.25 7.50 3.75 0.00 Rice offal 0.00 3.75 7.50 11.25 15.00 Fish meal 5.00 5.00 5.00 5.00 5.00 Bone meal 2.50 2.50 2.50 2.50 2.50 Limestone 1.00 1.00 1.00 1.00 1.00 Salt 0.25 0.25 0.25 0.25 0.25 Premix* (Finisher) 0.25 0.25 0.25 0.25 0.25 Methionine 0.30 0.30 0.30 0.30 0.30 Lysine 0.20 0.20 0.20 0.20 0.20 **Total 100.00 100.00 100.00 100.00 100.00 Calculated analysis (%)**

ME (Kcal/kg)	3006.45	3018.11	3029.74	3042.03	3053.18
Crude Protein (%)	20.07	19.70	19.51	19.33	19.14
Crude Fibre (%)	3.88	3.97	4.11	4.22	4.33

RESULTS AND DISCUSSION

Results of growth performance showed no significant (P>0.05) effect of diet on daily feed intake (81.59 - 98.43 g) daily weight gain (35.39 - 39.67 g) and feed conversion ratio (2.23 - 2.71), while 1.67% mortality was recorded on diet 1. This agrees with Egbunu *et al.* (2020), but contradicts Isikwenu *et al.* (2000). However, due to the higher fibre content of the experimental diets, it is expected that at least feed intake would be significantly higher, since birds usually eat to satisfy their

energy needs. Energy availability in diets containing relatively higher levels of fibre is usually low. Hence birds consume more of the diet in order attain their energy requirement. The findings of this study could further be explained by the activity of supplemental enzyme which was shown to have the capacity to increase efficiency of digestion by helping to break down anti-nutritional factors, such as fibre and phytate (Alsersy *et al.,* 2015). In a recent study, Salami and Odunsi (2019) reported that performance of broiler chickens fed dietary crude fibre up to 8% would not be compromised when Roxazyme G® was supplemented at 200 mg/kg feed.

Total feed intake revealed that birds on diet 1 consumed more feed (2.76 kg) than those on other diets, with those on diet 4 consuming the least (2.28 kg). Feed cost per kg (₦) decreased from ₦118.11 on diet 1 to ₦87.72 on diet 5. This was due to the comparatively lower cost of rice offal. Total feed cost decreased steadily from ₦325.98 on diet 1 until ₦216.74 (diet 4) and later increased to ₦221.05 on diet 5. Feed cost per kg gain (₦) decreased from ₦428.93 on diet 1 to ₦266.33 on diet 5. This could be informed by the concomitant decrease in feed cost per kg gain (₦). The ability of supplemental enzyme to increase nutrient bio-availability and digestion could also be implicated in the reduction of feed cost (Felix *et al.,* (2018).

Table 2: Performance of Broiler Finisher Chickens Fed Diets Containing Xylanase-Supplemented Rice Offal

	Diets						
Parameters	**1**	**2**	**3**	**4**	**5**	**SEM**	
Initial weight (g)	919.11	852.73	940.31	939.94	908.35	61.94	NS
Final weight (g)	1682.88	1596.06	1773.38	1707.56	1735.13	107.79	NS
Total feed intake (g)	2756.04	2560.04	2481.36	2284.52	2518.32	159.38	NS
Daily feed intake (g)	98.43	91.43	88.62	81.59	89.94	8.25	NS
Daily weight gain (g)	36.37	35.39	39.67	36.55	38.85	2.37	NS
Feed conversion ratio	2.71	2.57	2.24	2.23	2.37	0.24	NS
Mortality (%.)	1.67	0	0	0	0	-	

NS= Not significant; SEM = Standard Error of Means

Table 3: Cost-Benefit of Finisher Broiler Chickens Fed Xylanase-Supplemented Rice Offal

	Diets				
Parameters	**1**	**2**	**3**	**4**	**5**
Total feed intake (kg)	2.76	2.56	2.48	2.28	2.52
Feed cost (₦/kg)	118.11	112.04	104.38	95.06	87.72
Total feed cost (₦)	325.98	286.82	258.86	216.74	221.05
Total weight gain (kg)	0.76	0.74	0.83	0.77	0.83
Feed cost per kg gain (₦)	428.93	387.60	311.88	281.48	266.33
Cost saving (₦)	-	41.33	117.05	147.45	162.60

CONCLUSION AND RECOMMENDATION

From the results obtained of this study, it was concluded that rice offal supplemented with Xylanase at 1g/10kg can completely replace wheat offal in broiler finisher diets without compromising performance. Furthermore, replacement of wheat offal with xylanase-supplemented rice offal at 100% resulted in 37.91% decrease in feed cost. The use of rice offal along with 1g/10kg Xylanase as main fibre source in broiler finisher diets is therefore recommended.

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PERFORMANCE AND COST BENEFIT OF REPLACING FISH MEAL WITH

BLOOD MEAL IN BROILER FINISHER DIETS

[1]Muhammad, B. A., [2]Kawu, U.Y., [3]Adepoju, A.A., [4]Doma, U. D.
[1]Ministry of Agriculture and Animal Husbandry, P.M.B. 0110, Gombe, Nigeria [2] Department of Agricultural Technology, Federal Polytechnic, P.M.B. 1006, Damaturu, Nigeria. [3] Department of Agricultural Technology, Federal College of Horticulture, Dadin Kowa,Gombe state [4]Department of Animal Production, Abubakar Tafawa Balewa University,
P. M. B. 0248, Bauchi, Nigeria,
Corresponding Author: *batukulma@gmail.com* Phone no. 08065520421

ABSTRACT:
Fish meal, an ingredientused in poultry feed formulation, is expensive and very often scarce in Nigeria. Consequently, this has contributed in the rising cost of poultry diets. There is therefore a need to identify other available and cheaper alternatives that can substitute fish meal in poultry rations. An experiment was conducted to evaluate the growth performance and financial benefits of finisher broilers fed diets containing blood meal as replacement for fish meal. Five diets were formulated in which blood meal replaced fish meal at 0, 25, 50, 75and 100% levels, designated as diets 1, 2, 3, 4 and 5 respectively. Three hundred finisher broiler chickens of the cobb strain weighing between 475.00 and 481.00 g were randomly allotted to five diets in replicates of four containing 15 birds each in a completely randomized design. Feed and water were provided *ad libitum* and the study lasted for twenty-eight days. Parameters studied include daily feed intake, daily weight gain, feed conversion ratio, mortality, feed cost per kg, feed cost per kg gain and cost saving (₦). No significant (P>0.05) difference was observed in daily feed intake (85.52 -90.55 g). However, daily weight gain (22.43 – 28.92 g) was higher (P<0.05) on diets 1 and 3. Similarly, feed conversion ratio (3.10 – 4.04) was better (P<0.05) on diets 1 and 3 and poorer on diet 4. Feed cost per kg was lower on diets containing blood meal (₦122.12 – 142.55) compared to diet 1 (₦152.52). Feed cost per kg gain was least on diet 4 (₦423.23) and highest on diet 2. (₦495.90). It was concluded that blood meal can replace fish meal in broiler diets up to 50% level without compromising performance and with a cost saving of ₦28.35.
Keywords: Finisher, Broiler, Blood meal, Performance, Cost

INTRODUCTION:
Poultry production is an enterprise that can be used to fight poverty and malnutrition. However, feed cost has been on the increase which constituted a major challenge for growth of the industry. Consequently, effective management of costs and benefits must be put in place in order to make profit and remain in business. Factors that affect profitability in poultry production include costs of inputs, rate of growth(weight gain), flock size, disease risks, general management, judicious use of inputs and disease control, among others (Jadhav and Siddiqui, 2010). Feed constitutes 60-70% of the total cost of poultry production (Adebambo *et al.,* 2010). In most tropical countries, fish meal, is very expensive and often scarce. Its scarcity has contributed in the rising costs of poultry feeds (Oluyemi and Roberts, 2013). Blood meal is a dark chocolate-coloured powder with characteristic smell. It contains about 65 – 85% protein. This variation could be due differences in processing methods (McDonald, 1992). It is one of the richest sources of lysine (NRC, 1994). Research findings have shown that the incorporation of blood meal at 1 – 45 level in poultry diets resulted in better growth (Ikram *et al.,* 1989). In a recent study, Ebuo *et al.* (2017), reported no significant difference when fish meal was replaced for blood meal at 3% level in broiler chicken diets. This study was therefore designed to determine the optimum replacement level of blood meal (BLM) in broiler finisher diets.

MATERIALS AND METHODS
The experiment was conducted at the Poultry Unitof the Teaching and Research Farm, Abubakar Tafawa Balewa University, Bauchi, Nigeria. The area lies within the coordinates; 10°18'37.2‖ N and 9°50' 38.0‖ E and islocated at an altitude of about 616 metres above sea level with average annual rainfall of 1009 mm and daily temperatures of 13 - 17° C (December – January) and 36 – 37° C (March – April) (Geodatos, 2019). Blood meal and other feed ingredients including fish meal, were

procured from different markets in Bauchi Metropolis. Proximate analysis ofBLM and fish meal (Table 1) were carried out to determine their nutrients content according to (AOAC, 2006). Five isonitrogenous, isocaloric diets were formulated in which blood meal replaced fish meal at 0, 25, 50, 75 and 100% levels designated as diets 1 (control), 2, 3, 4 and 5 respectively (Table 2). Ingredient composition (%) of the experimental dietsis presented in Table 2. A total of three hundred (300) broiler chickens of the cobb strain weighing between 475.00 and 481.00gwere used for the experiment. The birds were randomly allotted to five diets in replicates of four, containing fifteen birds each in a completely randomized design. Feed and clean drinking water were served *ad libitum* and the study lasted for 4 weeks. Daily feed intake was measured as the difference between quantity of feed offered and left-over collected the following day. Body weight gain was determined as the difference between two consecutive weighing (1-week interval) while feed conversion ratio was calculated using the relationship of daily feed intake and daily weight gain. Mortality was recorded as it occurred. Cost benefit was computed using the cost of dietary ingredients (₦/kg), cost of diet per kg, total feed intake and total weight gain. All the data collected were subjected to analysis of variance using the SPSS software, version 25, and where significant differences in means were observed, Duncan's Multiple Range Test (Duncan, 1955) was used to separate them.

Table 1: Proximate composition of fish meal and blood meal

Ingredient %DM %CP %EE %CF %Ash %NFE Fish meal 89.11 62.29 7.26 0.98 14.51 4.17 Blood meal(BLM) 88.16 73.19 0.54 0.72 3.88 8.93 DM; Dry matter, CP; Crude Protein, EE; Ether extract, CF; Crude fibre, NFE; Nitrogen free extract.

Table 2: Percentage Composition of broiler finisher diets in which blood meal replaced fish meal (5-8) weeks

Ingredients Diets

1 2 3 4 5

Maize 53.36 53.36 53.36 53.36 53.36 Full-fat soya bean 22.24 22.24 22.24 22.24 22.24 Fish meal 5.00 3.75 2.50 1.25 0.00 Blood meal 0.00 1.25 2.50 3.75 5.00 Wheat offal 15.00 15.00 15.00 15.00 15.00 Limestone 1.50 1.50 1.50 1.50 1.50 Bone meal 2.00 2.00 2.00 2.00 2.00 Salt 0.25 0.25 0.25 0.25 0.25 Premix* 0.25 0.25 0.25 0.25 0.25 Methionine 0.20 0.20 0.20 0.20 0.20 Lysine 0.20 0.20 0.20 0.20 0.20 **Total 100.00 100.00 100.00 100.00 100.00 Calculated Analyses**

CP (%) 19.23 19.57 19.83 20.06 20.27 ME (Kca/kg) 2824.00 2803.00 2809.00 2801.00 2793.00

RESULTS AND DISCUSSION:

The results for proximate analysis of blood meal and fish meal used in the study showed that blood meal has a crude protein content of 73.19%, ether extract 0.54%, ash 3.88% and NFE 8.93%. These values are lower than 83.12%, 1.00% 5.00% and 10.88% respectively reported by (Ebuo *et al.,* 2017). Results of growth performance showed that daily feed intake (88.25 – 90.55 g) did not significantly (P>0.05) differ among treatments and were slightly lower than 94.44 – 103.02g obtained by (Khawaja *et al.,* 2007). Daily weight gain (DWG) was however higher (P<0.05) in birds fed the control diet (28.92g) which was comparable to 26.28g for those on diet 3. Other treatments did not differ and were lower in DWG. This agrees with (Khawaja *et al.,* 2007) but contradicts (Ebuo *et al.,* 2017) who reported no significant (P>0.05) difference when methionine fortified blood meal replaced fish meal in broiler chicken diets. Feed conversion ratio was better (P<0.05) on diet 1 (3.10), poor and similar

on diets 3 (37), 4 (3.46) and 2 (3.50) and poorest on diet 5 (4.04). Total weight gain was higher (P<0.05) on diets 1 (0.81 kg) and 3 (0.74 kg) which were similar. Other diets had lower values (1.11 – 1.19 kg) which were also similar. Feed cost per kg was lower on diets containing blood meal (₦122.12 – 142.55) compared to the control (₦152.52). Feed cost per kg gain was lowest on diet 4 (₦423.23), followed by ₦444.28 (diet 3) and highest in diet 2 (₦495.90). Consequently, the highest cost saving of ₦49.40 was realizedon diet 4.

Table 3: Performance of finisher broiler chickens fed diets containing blood meal as replacement for fish meal

Parameters Diets

1 2 3 4 5 SEM

Initial weight (g) 480.0 475.00 477.80 481.00 477.00 1.67^{NS} Daily Feed Intake (g) 89.53 88.25 88.54 85.52 90.55 2.05 ^{NS} Daily Weight Gain (g) $28.92^{a}25.18^{b}26.28^{ab}24.71^{b}22.43^{b}1.51^{*}$ Feed Conversion Ratio $3.10^{a}3.50^{b}3.37^{b}3.46^{b}4.04^{c}0.10$ * Total feed intake (kg) 2.51 2.47 2.48 2.39 2.44 0.16 ^{NS} Final weight (kg) $1.29^{a}1.19^{b}1.22^{a}1.17^{b}1.11^{b}0.03$ * Total weight gain (kg) $0.81^{a}0.71^{b}0.74^{a}0.69^{b}0.63^{b}0.03^{*}$ Mortality (%) 1.66 0 0 1.66 1.66 - NS = Not significant, SEM= Standard Error of the Mean.

Table 4: Cost benefits of replacing fish meal with blood meal in broiler finisher diets

Parameter Diets

1 2 3 4 5

Total feed intake(Kg) 2.51 2.47 2.48 2.39 2.44 Feed cost ₦/kg 152.52 142.55 132.57

122.19 122.12
Total feed cost(N̶)/bird 382.83 352.09 297.97
328.77 292.03 3
Total weight gain(Kg) 0.81 0.71 0.74 0.69 0.63
Feed cost N̶/kg gain 472.63 495.90. 26 444.28 423.23 472.97
Cost saving (N̶) - -23.27 28.35 49.40 -0.34

CONCLUSION AND RECOMMENDATION

The results of this study showed that blood meal can replace fish meal up to 50% level in broiler finisher diets without compromising performance and with a cost saving of N̶28.35. The replacement of fish meal with blood meal at 50% inclusion level is hereby recommended in diets for finisherbroiler chickens. Further study on other classes of poultry such as layers, quails, turkeys, guinea fowl and ducks is also recommended.

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NUTRIENT DETERMINATION OF CASSAVA PLANT MEAL

[*]Adeyemi, M. A. and Akinfala, E. O.
[*]Department of Animal Production and Health, Olusegun Agagu University of Science and Technology, Okitipupa
Department of Animal Sciences, Obafemi Awolowo University, Ile-Ife Corresponding email: ade_maxwell@yahoo.com
Cell phone: +234 706 3055 036

ABSTRACT
The study assessed the nutrient profile in composite Cassava Plant Meal (CPM) with a view to enhancing its efficiency through bio-fortification. Three CPM products were developed from Tropical *Manihot* Species (TMS) 30572 harvested at 24 months. The sun-dried unpeeled cassava root meal, cassava leaf meal and tender cassava stem meal were mixed at ratios 2:1, 2.5:1 and 3:1 while the ratio of the leaves to tender stems was 5:1 across the three cassava plant meal products. The proximate composition, minerals, amino acids and vitamins contents of CPM and maize were determined. Results of proximate contents showed that CPM products had comparable crude protein and nitrogen free extract as maize. CPM products showed superiority (P <0.05) in calcium content over maize meal though maize meal was significantly higher (P <0.05) in phosphorus content compared to the three CPM products. All evaluated parameters of amino acids showed differences (P<0.05) although methionine contents were lower in all CPM products and maize. CPM products had significantly (P <0.05) higher values than maize in all evaluated vitamin contents. Based on the findings of this study, it can be concluded that CPM products had comparable nutrient profile as maize with CPM product 1 comparatively better in all evaluated nutrient profile.
Key words: Cassava plant meals, TMS 30572, maize, nutrients.

INTRODUCTION
Improving livestock productivity especially poultry and swine production require adequate supply of low-cost feeding ingredients. The cost of feeding has been reported to be 65 – 80 % of the total cost of production (Longe, 2006) with maize constituting 40 – 60 % of a balanced maize-soy based diet for poultry and swine. However, the seasonal feed deficit, ever rising cost of feeding ingredients and competition with human food consumption have consistently driven efforts towards the use of alternative dietary energy feed resources for monogastrics (Morgan and Choct, 2016). One of such alternative dietary energy feedstuff is cassava. Cassava and its components have enjoyed widespread patronage as potential energy source for animal production in Nigeria. It is cheap, widely grown with a yearly tuber production of 59.5 million tons and grows at an annual rate of + 4.0 %; the largest in the world (FAOSTAT, 2018). However, after harvesting the value-giving component, substantial proportion of the co-products (leaves and tender stems) are allowed to rot on farms and homesteads (Akinfala and Tewe, 2004). The incorporation of these cassava fractions to form composite cassava plant meal (unpeeled cassava tuber meal + cassava leaves and tender cassava stem meal) had been shown by previous studies to enhance performance of pigs (Adeyemi and Akinfala, 2018; Akinfala *et al.,* 2013) and poultry (Akinfala *et al.,* 2011; Akinfala *et al.,* 2002;). Similarly, studies have reported detailed information on the efficiency and nutrient profile of cassava flour (Ngiki *et al.,* 2014; Nagib and Sousa, 2007) or leaves (Iyayi and Losel, 2001) or peels (Iyayi and Losel, 2000) and its acceptability as energy source for livestock. Nevertheless, the detailed nutrient profile of CPM has not been widely documented. Detailed information on feed resource could support sustainable livestock production and offer wider feed options in livestock production system (FAO, 2018). The research was carried out to characterise the nutrients in cassava plant meal with a view to enhancing its efficiency through bio-fortification.

MATERIALS AND METHODS
Experimental location and preparation of test ingredients
The experiment was carried out at the Poultry Meat Laboratory of the Department of Animal Sciences Obafemi Awolowo University, Ile-Ife and the Laboratory of Animal Science, University of Ibadan,

Ibadan. The cassava variety of Tropical *Manihot* Species (TMS) 30572 aged 24 months were purchased from a commercial farm at Ile-Ife. The roots were lifted and soil was shaken off the roots while the cassava leaves were harvested from the plant stem and the tender stems were harvested at 5 cm, usually 6 to 7 nodes from the top of the plant. All the cassava components were harvested between June and November 2018. The fresh roots (unpeeled cassava root) were washed and chopped into small pieces, sun-dried on a concrete floor for an average of 5 – 6 days depending on the intensity of the sunlight, milled with 3 mm sieve mesh and packed into sacks. Also, the fresh cassava leaves and tender stems were sun-dried for about 3-4 days and about 5 days respectively after harvesting, milled and packed into separate sacks. The composite cassava plant meal products were mixed in line with the procedure of Akinfala *et al.* (2002) at three different ratios of 2:1, 2.5:1 and 3:1 represented as products 1, 2 and 3 respectively. The mixing ratio was in attempt to have comparable minimum crude protein content of 10 % as maize.

Nutrient determination

The nutrients determined in the cassava plant meal products include amino acids (essential and non essential amino acids), vitamins (fat and water soluble vitamins) and minerals (calcium, phosphorus, zinc and copper). The fat soluble vitamins were determined following the procedure outlined by Adams and Moss (1995). The amino acid profile was carried out using the spectrophotometric determination of Ninhydrin chemical reaction. Mineral (Ca, P, Zn and Cu) contents and proximate composition were determined following the methods of AOAC (2005).

RESULTS AND DISCUSSION

The three cassava plant meal (CPM) products had comparable values with maize in the crude protein, ether and nitrogen free extracts (Table 1). Although, significant difference (P <0.05) exists in the values obtained for the crude fibre and ash with maize having the lowest values while CPM product 1 had the highest. The ash content of the CPM products decreased with increased inclusion of unpeeled cassava root meal in the mix.

Table 1: Proximate composition of maize and cassava plant meal products

Proximate Composition (%)	Maize	CPM1	CPM2	CPM3	SEM	*p*
Dry Matter (DM)	88.05	90.18	90.17	90.06	0.36	0.15
Crude Protein (CP)	10.38	12.62	12.25	12.51	0.56	0.24
Crude Fibre (CF)	2.57^{d}	8.05^{a}	4.69^{c}	6.81^{b}	0.79	0.01
Ash	2.82^{c}	6.69^{a}	6.53^{a}	6.15^{b}	0.60	0.01
Ether Extract (EE)	4.53	5.38	3.12	3.33	0.37	0.30
Nitrogen Free Extract	67.75	57.44	63.58	61.26	0.07	0.28

^{a,b,c,d} means in the same row having different superscripts differ at p <0.05; SEM: Standard Error of Means Product 1 contained sun dried unpeeled cassava tuber meal + cassava leaf meal + tender cassava stem meal mixed at a ratio of 2:1 while the ratio of the leaves to tender cassava stems was 5:1 while Products 2 and 3 contained the same components but mixed at ratios 2.5:1 and 3:1 respectively.

The mineral contents of maize and cassava plant meal is shown in Table 2. The CPM products have significantly (P <0.05) higher values than maize for calcium but the values obtained for phosphorus content of CPM were lower than maize. The calcium and phosphorus contents of CPM increased significantly (P <0.05) across products 1 through 3. Lower calcium values (1.93 ppm and 0.28 ppm) were reported by Akinfala *et al.* (2011) who determined the mineral contents of CPM product 2 and maize. The minerals (zinc and copper) composition of CPM was comparable with maize. The variations observed in the mineral composition of CPM and maize may be due to variations in their ash and fibre contents.

Table 2: Mineral composition of cassava plant meal products

Minerals	Maize	CPM1	CPM2	CPM3	SEM	*P*
Calcium (%)	0.055^{b}	0.302^{a}	0.411^{a}	0.433^{a}	0.08	0.021
Copper (g/Kg)	0.018	0.025	0.022	0.024	0.03	1.00
Phosphorus (%)	0. 512^{a}	0.104^{b}	0.120^{b}	0.121^{b}	0.079	0.001
Zinc (g/Kg)	0.120	0.122	0.117	0.122	0.003	0.16

means having different superscript in a row differ significantly (p <0.05)

Significant differences (P <0.05) exist in all evaluated amino acid contents of maize and CPM (Table 3) except tryptophan. There was a steady decrease in the amino acid contents of CPM products from CPM 1 through 3. This may be due to the increasing levels of unpeeled cassava root meal across CPM 1 through 3. Unsurprisingly, CPM products and maize had lower tryptophan, methionine and cystine contents, which followed a decreasing order from CPM 1 through 3. The lower contents observed for these corroborates the findings of earlier studies (Kong *et al.,* 2016) that plant-based diets are poor sources of methionine, cystine and tryptophan and should be adequately supplied in diets for poultry and pigs for feed efficiency and growth.

Table 3: Amino acid composition of cassava plant meal products

Parameters (g/100 g)	Maize	CPM 1	CPM2	CPM 3	SEM	*P*
Leucine						

8.23^{a}7.59^{ab}7.18^{b}6.59^{b}0.22 0.03 Lysine 4.14^{b}4.61^{a}4.35^{ab} 4.08^{b}0.07 0.01 Isoleucine 3.08^{b}3.80^{a}3.54^{a}3.14^{b}0.10 0.007 Phenylalanine 4.43^{b}4.97^{a}4.61^{b}3.90^{c}0.12 0.001 Tryptophan 0.89 1.00 0.89 0.73 0.34 0.56 Valine 3.80^{b}4.21^{a}3.97^{ab} 3.27^{c}0.12 0.003 Methionine 1.23^{a}1.28^{a}1.20^{a}0.96^{b}0.04 0.08 Proline 4.47^{a}4.87^{a}4.06^{b}3.65^{c}0.15 0.001 Arginine 5.68^{b}6.19^{a}5.50^{b}5.16^{b}0.14 0.02 Tyrosine 3.44^{ab} 3.61^{a}3.44^{ab} 3.10^{b}0.07 0.04 Histidine 2.68^{b}2.87^{a}2.49^{c}1.98^{d}0.10 0.001 Cystine 1.33^{a}1.45^{a}1.39^{a}0.97^{b}0.06 0.01 Alanine 4.32^{b}5.23^{a}4.93^{a}3.72^{c}0.18 0.001 Glutamic acid 13.32^{c}14.53^{a}14.08^{b}12.87^{d}0.20 0.001 Glycine 3.37^{b}3.70^{a}3.61^{a}3.04^{c}0.08 0.001 Threonine 3.22^{c}3.77^{a}3.55^{b}2.94^{d}0.09 0.001 Serine 3.78^{c}4.43^{a}4.05^{b}3.89^{bc} 0.08 0.001 Aspartic acid 7.38^{c}8.56^{a}7.94^{b}7.07^{d}0.17 0.001 *means having different superscript in a row differ significantly (p <0.05)*

The values obtained for CPM products 1 and 3 were higher (p<0.05) in all evaluated vitamin contents compared to CPM 2 and maize. The CPM 1 showed superiority over maize and other CPM products in all evaluated parameters. CPM products have the most significantly higher values of vitamins A (retinol) and niacin. The lower values of vitamin contents reported in this study could be due to the large proportion of cassava root contained in the composite mix. Similar findings were reported by Bayata (2019) and Salvador *et al.* (2014) who evaluated the contents of whole cassava root, unpeeled cassava root meal and cassava root meal respectively and obtained lower values.

Table 4: Vitamins composition of cassava plant meal products

Vitamins Maize CPM1 CPM2 CPM3 SEM *p* A (µg/100g) 11.40^{d}15.17^{a}13.28^{e}14.40^{b}0.53 <0.001 D (µg/100g) 0.17^{d}0.29^{a}0.25^{c}0.26^{b}0.016 <0.001 E (µg/100g) 0.13^{d}0.19^{a}0.15^{c}0.16^{b}0.007 <0.001 K (µg/100g) 0.09^{d}0.12^{a}0.10^{c}0.11^{b}0.003 <0.001 C (mg/100g) 0.10^{d}0.18^{a}0.15^{c}0.17^{b}0.012 <0.001 Thiamin (mg/100g) 0.21^{d}0.24^{a}0.22^{c}0.23^{b}0.003 0.01 Riboflavin (mg/100g) 0.07^{d}0.10^{a}0.08^{C}0.09^{b}0.003 0.01 Niacin (mg/100g) 2.06^{d}2.28^{a}2.10^{c}2.17^{b}0.03 0.011 Pyridoxine (mg/100g) 0.29^{c}0.31^{a}0.30^{b}0.30^{b}0.003 0.002 Folate (mg/100g) 0.10^{c}0.12^{a}0.10^{c}0.11^{b}0.002 0.038 Cobalamin (mg/100g) 0.012^{d}0.028^{a}0.017^{c}0.022^{b}0.002 0.027 *means having different superscript in a row differ significantly (p <0.05)*

CONCLUSION AND RECOMMENDATION

Based on the findings of this study, it can be concluded that cassava plant meal products had comparable nutrient profile as maize with CPM product 1 comparatively better in all evaluated nutrient profile. It is therefore recommended that CPM be supplemented with ample quantity of phosphorus and methionine to enhance desirable performance of livestock.

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CARCASS TRAITS AND HAEMATOLOGY OF BROILER FINISHER CHICKENS FED DIETS CONTAINING MAIZE OFFAL SUPPLEMENTED WITH RAXOZYME G® AS REPLACEMENT FOR WHEAT OFFAL

[1]Shuaibu, I., [2]Kawu, Y. U., [3]Doma, U. D., [3]Mancha, Y. P. and [3]Sanusi, M. [1]Ministry of Agriculture & Natural Resources, Bauchi State.
[2]Department of Agricultural Technology, Federal Polytechnic, P.M.B. 1006, Damaturu, Nigeria.
[3]Department of Animal Production, Abubakar Tafawa Balewa University, P. M. B. 0248, Bauchi, Nigeria
Corresponding author: kawuyahya@gmail.com Phone no: 08065631979

ABSTRACT
A twenty-one days feeding trial was conducted to evaluate the carcass traits and haematology of finisher broiler chickens fed dietary levels of enzyme-supplemented (Raxozyme G 10g/kg) maize offal (ESMO) as replacement for wheat offal. Five diets were formulated in which ESMO replaced wheat offal at 0, 25, 50, 75 and 100% levels, coded as diets 1, 2, 3, 4 and 5 respectively. A total of three hundred finisher broiler chickens weighing between 922.27 and 1010.16g were randomly allotted to five treatments, replicated thrice in a completely randomized design. Each replicate contained 20 birds. Data was collected for carcass yield, organs' relative weights and haematological indices. Results showed that dressing percentage (69.31. 74.08%) was higher (P<0.05) on diets containing enzyme-supplemented maize offal. Similarly, organ weights as percentage of live weight, were significantly (P<0.05) affected for spleen (0.12 – 0.20%), abdominal fat (1.47 – 2.48%) and liver (1.37 – 1.67%). Values obtained for haematological parameters however, revealed that Packed Cell Volume (22.28 – 26.98%), haemoglobin (7.12 – 8.88g/dl) and Mean Corpuscular Volume (35.95 – 49.17 fl), were significantly (P<0.05) higher on diets 1 and 5. It was therefore concluded that replacing wheat offal with Raxozyme G-supplemented maize offal at 75% level in finisher broiler chickens improves dressing percentage without compromising haematological status.
Key words: Broiler, maize offal, Rozaxyme G®, Carcass, Haematology

INTRODUCTION
Broiler chicken meat constitutes a sizeable source of animal protein in the diets of many families in Nigeria. However, successful production of these birds requires adequate feeding which is estimated to stand at about 60 -80% of the total cost of production (Ojewola *et al.,* 2005). In order to reduce this cost so as improve farmers' profit margin and make available poultry meat at more affordable price, cheaper, readily available and less competitive, alternative feed ingredients need to be explored. The

use of maize offal with or without enzyme supplementation to replace dietary maize or wheat offal has been studied (Nnenna *et al.,* 2006; Doma, 2020). Exogenous enzyme supplementation of animal feeds has been practiced with success since the late 80‘s (Brufau *et al.,* 2006). The inclusion of feed ingredients containing anti-nutritional factors may adversely affect poultry performance. However, supplementation with synthetic enzymes can enhance the nutritional value of these ingredients. Antinutritional factors, especially non-starch polysaccharides, have the ability to bind large quantities of water and hence increase fluid viscosity. This constitutes some challenges in nutrients digestion (Giraldo *et al.,* 2008). However, studies have shown that supplementation with enzymes can mitigate this problem. Apart from improving nutrient digestibility and utilization, enzyme supplementation also helps in lowering nutrient excretion, particularly excess nitrogen, phosphorus, zinc and copper (Abd El-Hack *et al.,* 2017; Alagawany *et al.,* 2017) which pollutes the soil.

MATERIALS AND METHODS

The experiment was carried out at the Poultry Unit, Teaching and Research Farm, Abubakar Tafawa Balewa University, Bauchi, located within the southern guinea savannah on latitude 10.31 N and longitude 9.84 E. The area has a mean annual rainfall of 1009 mm. Maize offal, Raxozyme G and other feed ingredients were purchased in Bauchi. Five broiler finisher diets were formulated to contain 0, 25, 50, 75 and 100% maize offal fortified with 10g/kg Raxozyme G®. The diets were designated as 1, 2, 3, 4 and 5 respectively. ingredients percentage composition and calculated analysis of the diets are presented in Table 1. Three hundred (300) finisher broilers weighing between 922.27 and

1010.16g were randomly allotted to five diets in a replicate of three, containing twenty birds each. Feed and water were served *ad libitum* and the study lasted for 3 weeks. At the end of the study, thirty birds (2 per replicated) were selected for carcass and blood analysis. Blood (5 ml per/bird) for haematological assay was drawn from the left wing web of each bird and collected in labelled tubes containing EDTA. Thereafter, the birds were weighed and slaughtered. Carcass measurements were taken using a 10 kg- weighing scale, while a sensitive electronic balance was used for organ weights, which were later expressed as percentage of live weight. Data generated was subjected to analysis of variance (ANOVA) using the SPSS software version 25, and where significant differences were observed, the Duncan‘s post hoc option (Duncan, 1955) was used to separate them.

Table 1: Ingredients Percentage Composition (%) and Calculated Analysis of Dietary Levels of Maize Offal Supplemented with Raxozyme® Finisher Broilers

Diets

Ingredient 1 2 3 4 5 Maize 51.96 51.96 51.96 51.96 51.96 Full-fat soya bean 23.54 23.54 23.54 23.54 23.54 Wheat offal 15.00 11.25 7.50 3.75 0.00 Maize offal 0.00 3.75 7.50 11.25 15.00 Fish meal 5.00 5.00 5.00 5.00 5.00 Bone meal 2.50 2.50 2.50 2.50 2.50 Limestone 1.00 1.00 1.00 1.00 1.00 Salt (NaCl) 0.25 0.25 0.25 0.25 0.25 Premix* (Finisher) 0.25 0.25 0.25 0.25 0.25 Methionine 0.30 0.30 0.30 0.30 0.30 Lysine 0.20 0.20 0.20 0.20 0.20 **Total 100.00 100.00 100.00 100.00 100.00 Calculated analysis (%)**

Metabolizable energy (Kcal/kg) 3012.59 3015.21 3017.83 3019.46 3021.09 Crude protein 20.01 19.86 19.71 19.56 19.41 Crude fibre 3.61 3.74 3.87 4.00 4.13

RESULTS AND DISCUSSION

The carcass and organ characteristics of broiler chickens fed dietary levels of enzyme-supplemented maize offal are presented in Table 2. Except for dressing percentage, no carcass parameter was significantly (P<0.05) affected. Live weight, ranged from 1793.92 g (diet 4) to 1844.16 g (diet 1), plucked weight, 1665.61 g (diet 4) to 1714.04 g (diet 1), eviscerated weight, from 1473.32 g (diet 2) to 1513.34 g (diet 1) and carcass weight, from 1277.08 g (diet 1) to 1329.93 g (diet 4). However, birds fed diet 4 (74.08%) dressed higher (P<0.05) and compared favourably with those on diets 2 (71.43%), 3 (72.55%) and 5 (71.28%) while those on diet 1 (69.31%) dressed lower. Relative weight of organs expressed as percentage of live weight showed no significant influence (P>0.05) of diet for kidney and gizzard weights. However, weights of spleen, abdominal fat, liver and pancreas were significantly (P<0.05) affected. Spleen weight was higher on diet 3 (0.20%) which was similar to diets 1 (0.17%), 2 (0.14%) and 3 (0.18%) while diet 5 (0.12%) was lowest (P<0.05). Abdominal fat weight was also higher (P<0.05) on diets 2 (2.46%), 4 (2.48%) and 5 (2.38%) but did not differ from diet 3 (2.10%) while birds on diet 1 (1.47%) had a lower (P>0.05) value which was similar to diet 3. Liver weight was higher (P<0.05) on diet 5 (1.67%) and lower on diet 3 (1.37%). However, diets 1(1.45%), 2 (1.63%) and 4 (1.50%) did not differ from 3 and 5. The findings of this study agree with Hana *et al.* (2010) using multi-enzyme feed additive in broiler chicken rations. In a recent study, Oyeagu *et al.* (2019) reported a significantly (P<0.05) improved carcass yield when broiler chickens were fed diets containing brewers' dried grains fortified with synthetic enzyme. The significantly (P<0.05) higher dressing percentage obtained in this study for birds fed enzyme-supplemented maize offal based diets

at 75% level of substitution for wheat offal, is in agreement with a previous report by Aguihe *et al.,* (2016) using Maxigrain® in cassava peel based diets.

Haematological indices of broiler chickens fed diets containing enzyme-supplemented maize offal are presented in Table 3. Packed Cell Volume was higher (P<0.05) on diet 1 (26.98 %) which was similar to diet 5 (25.16%) and lower (P>0.05) on other diets. White Blood Cell count was not significantly (P>0.05) affected and varied between 6.74 to 7.10 x 10^3µl on diets 5 and 3 respectively. Red Blood Cell count was also not significantly influenced (P>0.05) by dietary treatment. Values which ranged from 5.52 to 6.40 x 10^6µl were obtained on diets 1 and 4 respectively. Haemoglobin concentration (Hb), however, differed significantly (P<0.05) among diets. Birds fed diet 1 (8.88 g/dl) had higher Hb which was comparable with those on diet 5 (7.95 g/dl), while values for those on diets 2 (7.12g/dl), 3 (7.69 g/dl) and 4 (7.53 g/dl) were the same and comparable with those on diet 5. Similarly, a significant influence (P<0.05) of diet was found on Mean Corpuscular Volume. The trend was similar to that of PCV and Hb. Diet 1 (49.17 fl) had a higher (P<0.05) MCV value which did not differ from diet 5 (42.46 fl), while diets 2 (35.95 fl), 3 (38.01 fl) and 4 (36.63 fl) were lower (P<0.05) and similar to diet 5. This result is in conflict with the report of Olowu *et al.* (2012) where no significant (P>0.05) differences among treatments were observed when broiler chickens were fed roxazyme G supplemented maize offal based diets. The authors also reported a lower range for RBC (1.87 – 1.93 x 10^6/µl) than 5.22 – 6.40 x 10^6/µl obtained in the present study. This, according to (Nanbol *et al.,* 2016) could be informed by the difference in climate of the study locations.

Table 2: Carcass and Organs Characteristics of Finisher Broilers Fed Dietary Levels of Enzyme- Supplemented Maize Offal

Diets

Parameters 1 2 3 4 5 SEM Live weight (g) 1844.16 1821.55 1809.72 1793.92 1820.64 18.43^{NS} Plucked weight (g) 1714.04 1699.38 1683.46 1665.61 1686.49 16.58 ^{NS} Eviscerated weight (g) 1513.34 1473.32 1497.89 1496.67 1513.65 16.91 ^{NS} Carcass weight (g) 1277.08 1301.04 1311.46 1329.93 1297.75 17.76 ^{NS}

Dressing (%) $69.31^b 71.43^{ab}$ 72.55^{ab} $74.08^a 71.28^{ab}$ 1.40* **Organ weights expressed as percentage of live weight**

Gizzard weight 3.01 3.07 2.84 3.33 3.12 0.17 ^{NS} Abdominal fat weight $1.47^b 2.46^a 2.10^{ab}$ $2.48^a 2.38^a 0.21^*$ Kidney weight 0.22 0.30 0.26 0.30 0.25 0.03^{NS} Spleen weight 0.17^{ab} 0.14 ^{ab} $0.20^a 0.18$ ^{ab} $0.12^b 0.02$* Liver weight 1.45^{ab} 1.63^{ab} $1.37^b 1.50^{ab}$ $1.67^a 0.09^*$

^{abc}Means bearing different superscripts within the same row differ; * = (P<0.05); NS= Not significant; SEM = Standard Error of Means

Table 3: Haematological Indices of Finisher Broilers Fed Graded Levels of Enzyme- Supplemented Maize Offal

Diets

Parameters 1 2 3 4 5 SEM Packed Cell Volume (%) $26.98^a 22.28^b 23.15^b 23.96^b 25.16^{ab}$ 0.98* White Blood Cell (x(10^3/µl) 6.84 6.78 7.10 6.85 6.74 0.71^{NS} Red Blood Cell (x(10^6/µl) 5.52 6.29 6.25 6.40 5.94 0.55^{NS} Haemoglobin (g/dl) 8.88^a 7.12^b $7.69^b 7.53^b 7.95^{ab}$ 0.32* Mean Corpuscular Volume (fl) $49.17^a 35.95^b 38.01^b 36.63^b 42.46^{ab}$ 3.26*

NS= Not significant, SEM= Standard Error of the Mean, ^{ab}Means bearing different superscripts within the same row differ; * = (P<0.05),

CONCLUSION AND RECOMMENDATION

Based on the findings of this study, it was concluded that Razoxyme-G-supplemented maize offal can completely replace wheat offal in broiler finisher diets without reduction in carcass yield and deleterious effect on haematological indices. The use of maize offal supplemented with Raxozyme G at 10g/kg as replacement for wheat offal in broiler finisher diets is therefore recommended.

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GROWTH PERFORMANCE OF BROILER CHICKENS FED DIETS CONTAINING LEVELS OF BOILED MORINGA (*Moringa oleifera*) SEED MEAL

[1]Rabiu, M., [2]Muhammad, U.R., [2]Idris, D.Y., [2]Alimi, H.M and [2]Madu, A.

[1]Department of Animal Science, Ahmad Bello University, Zaria, Kaduna State, Nigeria [2]Department of Animal Health and Production Technology, Federal College of Agricultural Produce Technology, Kano State, Nigeria

Corresponding author: mdrabiu@yahoo.com; +2348033002271

ABSTRACT
A feeding trial was conducted to evaluate the growth performance of broiler chickens fed boiled *Moringa oleifera* seed meal (MOSM) diets. Three hundred (300) ―Ross‖ unsexed day old broiler chicks with an average initial live weight of 38g were fed diets containing graded levels of MOSM. Five experimental diets (T_1, T_2, T_3, T_4, and T_5) were formulated and the inclusion levels of MOSM in the diets were 0.0, 2.5, 5.0, 7.5 and 10%, respectively. The treatments were replicated three times with twenty birds per replicate and a total of sixty birds per treatment in a completely randomized design. Parameters measured were initial weight, final weight, total weight gain, average daily weight gain, total feed intake and daily feed intake. Feed conversion ratio, feed cost of bird per kilogram and weight gain were computed. The mortality rate was recorded as they occurred. Data generated were subjected to analysis of variance (ANOVA) using the general linear model procedure of Statistical Analysis Systems and separated using Duncan Multiple Range Test Procedure. The result showed final body weight, weight gain, daily weight gain, total feed intake, average daily feed intake, feed conversion ratio and feed cost/kg gain were significantly ($P<0.05$) affected across the dietary treatments while mortality recorded were not significantly ($P>0.05$) different. Birds fed 7.5% MOSM had significantly ($P<0.05$) higher final weight (714.83g), weight gain (676.51g) and daily weight gain compared to other treatment groups. The finisher phase of the study revealed that MOSM in the diets of broiler chicken significantly ($P<0.05$) enhanced live weight, weight gain and daily weight gain respectively. The results from this study suggested that the inclusion of 7.5% MOSM in the diet of broiler chickens improved growth performance at finisher phases.
Key words: Broiler, Chickens, Moringa, Seed meal, Growth.

INTRODUCTION
The poultry industry in Nigeria have been plagued by a variety of problems which includes the search for feed ingredients for livestock which will not compete with man for utilization (Siyanbola and Amao, 2016). The rapid growth of human and livestock populations create increasing demands for food and nutrition security in the least developed countries, thus alternative feed resources must be identified and evaluated (Olugbemi e*t al.,* 2010). The most logical step to take in solving the shortage and dwindling raw material supply is to direct efforts towards utilizing plant by-products and wastes for feeding poultry birds (Banjo, 2012). The use of unconventional feedstuff in animal feeds had been recommended (Adeola and Olukosi, 2008).
There is need to determine the extent to which *Moringa oleifera* seed meal can be utilized by broiler chickens for improved performance. This study was carried out to evaluate the growth performance of broiler chickens fed diets containing levels of boiled *Moringa oleifera* seed meal.

MATERIALS AND METHODS
The study was carried out in the Poultry Unit of the Teaching and Research Farm, Department of Animal Science, Ahmadu Bello University, Zaria. The farm is located in the Northern Guinea Savannah zone of Nigeria, latitude 11^0 9‘ 14‘‘ N and longitude $7^0$38‘ 45‘‘ E and at an altitude of 610mm above sea level (Ovimaps, 2015).
Source and Processing of Moringa seeds
Moringa seeds used for this research were sourced at Giwa market, Zaria, Kaduna State. The dry Moringa seeds were sorted, remove from the pods and cleaned. The quantity of seeds used were weighed and then poured into a pot containing boiled water at 100^{o}C. The sample was allowed to boil

for about 60 minutes, after which the water was drained out and the sample was spread in aluminium metal trays to sun dry for 3 days (Edegbo, 2009).
Design and Management of Birds
A total of three Hundred (300) day old Ross strain of broiler chicks were purchased from Agrited Farm Limited, Ibadan, Oyo State, Nigeria. The chicks were randomly distributed into five treatment groups of 60 chicks each with three replicates of 20 chicks per pen in a completely randomized design (CRD). Five experimental diets (T_1, T_2, T_3, T_4, and T_5) were formulated and the inclusion levels of Moringa seed meal in the diets were 0.0, 2.5, 5.0, 7.5 and 10%, respectively. The birds were housed in a deep litter system and subjected to the same experimental and management conditions. Feed and water were given *ad libitum* throughout the period of the experiment.
Data Collection and Analysis
The chicks were weighed on arrival and weekly thereafter with the following parameters measured. Initial weight, final weight, total weight gain, average daily weight gain, total feed intake, daily feed intake. Feed conversion ratio, feed cost of bird per kilogram and weight gain were computed. The mortality rate was recorded as they occurred. The data obtained from the study were analyzed using

One-way ANOVA using the General Linear Model procedure of the Statistical Analysis System (SAS, 2003). Significant differences among the means were separated using Duncan's Multiple Range Test Procedure (Duncan. 1955).

RESULTS AND DISCUSSIONS

The result of the performance of broiler finisher chickens fed diets containing levels of Moringa seed meal (MOSM) is shown in Table 2. The study result revealed MOSM in the diets significantly ($P<0.05$) enhanced live weight, weight gain and daily weight gain of broiler chickens. Birds on 7.5% MOSM had the highest ($P<0.05$) final body weight (2509.87g), weight gain (1896.53g) and average daily weight gain (67.07g) when compared with the other treatment groups. The gain in body weight observed in this study may be attributed to the decrease in anti-nutritional factor of the boiled MOSM which enhanced palatability and easy digestion of the diet offered. The present result was not similar to those observed by Du *et al.* (2007) and Ferreira *et al.* (2008) who reported no significant effect of MOSM supplementation at 2.5%, 5% or 7.5% in the diets of broiler chickens on growth rate. The results of total feed intake (3309.87g), daily fee intake and feed cost/kg gain (420.23/kg) showed that birds on 10.0% MOSM diets had higher ($P<0.05$) values across dietary treatment groups. This agrees with the report of Ferreira *et al.* (2008) who revealed that higher levels of MOSM increased feed consumption by the broiler chickens. The numerical increase observed in the values of feed intake and feed cost/kg gain was due to increase in MOSM inclusion across treatments and as such feed cost is affected. The feed conversion ratio of the birds was significantly ($P<0.05$) improved in all the treatments and the inclusion of 7.5% MOSM in the diet showed better a feed conversion ratio across dietary groups.

CONCLUSION AND RECOMMENDATION

From the results of the feeding trial conducted, it can be concluded that boiled MOSM inclusion at 7.50% in the diet of broiler chickens improved growth performance by (1896.53g) at the finisher phase. However, it is recommended that more work should be conducted with other species of poultry birds and other classes of monogastric and ruminant animals as well.

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Table 1: Experimental Diets for Broiler Finisher with Moringa Seed Meal (MOSM) Ingredients (%) T1 T2 T3 T4 T5

Maize 59.35 58.35 57.35 56.05 55.05 MOSM 0.00 2.5 5.00 7.50 10.00 Groundnut cake 16.00 14.50 13.00 11.80 10.30 Soya bean meal 15.50 15.50 15.50 15.50 15.50 Maize offal 5.00 5.00 5.00 5.00 5.00
Salt 0.30 0.30 0.30 0.30 0.30 Bone meal 3.00 3.00 3.00 3.00 3.00 Limestone 0.20 0.20 0.20 0.20 0.20 Lysine 0.20 0.20 0.20 0.20 0.20 Methionine 0.20 0.20 0.20 0.20 0.20 *Vitamin-mineral premix 0.25 0.25 0.25 0.25 0.25

Total 100.00 100.00 100.00 100.00 100.00

Calculated Analysis
Energy (ME Kcal/kg) 2942.00 2961.00 2980.00 2997.00 3016.00 Crude Protein (%) 20.00 20.00 20.00 20.00 20.00 Crude Fiber (%) 3.74 4.01 4.28 4.55 4.82 Ether Extract (%) 5.65 5.91 6.27 6.64 6.99 Lysine (%) 1.05 1.04 1.04 1.04 1.04 Methionine (%) 0.52 0.52 0.53 0.53 0.54 Calcium (%) 1.20 1.21 1.23 1.25 1.26 Available-P (%) 0.80 0.81 0.82 0.82 0.83 Feed cost/kg (₦/kg) 141.60 163.40 185.30 207.00 228.80 *Bio-mix broiler starter premix per 2.5kg of diet: Vit A, 10,000 I.U; Vit D_3, 2,000 I.U; Vit E, 23,000mg; Vit K_3, 2000mg; Vit B1,(thiamine) 1,800; Vit B_2(riboflavin), 5,500mg; Niacin, 27,500; Panthonenic acid, 7,500; Vit B6(pyridoxine),3000mg; Vit B_{12}, 15.00; Folic acid, 750.00mg; Biotin H_2, 60.00mg; Cholin Chloride, 300,000mg; Cobalt, 200mg; Copper,3000mg; Iodine, 3,000mg; Iron, 1,000mg; Manganese, 40,000.00mg; Selenium, 40,000mg; Zinc, 200mg; Antioxidant,1,250mg . MOSM: Moringa Seed Meal, ME: Metabolisable Energy

Table 2: Growth performance of broiler chickens fed diets containing graded levels of boiled Moringa seed meal (5-8 weeks)

Parameters T1 T2 T3 T4 T5 SEM

Initial wt. (g/bird) 614.67 616.00 616.00 613.33 620.67 6.02 Final wt. (g/bird) 2097.97^{c}2242.90^{b}2325.63^{b}2509.87^{a}2427.43^{ab} 46.93 Total wt. gain (g/bird) 1483.30^{c}1626.90^{b}1709.63^{b}1896.53^{a}1806.77^{ab} 48.22

Avg. daily wt. gain (g/bird 52.97^{c}58.10^{b}61.07^{b}67.07^{a}64.53^{ab} 1.72 Total feed intake (g/bird) 2817.13^{c}2936.80^{c}3104.23^{b}3240.30^{ab} 3309.87^{a}48.84 Daily feed intake (g/bird) 100.57^{c}104.90^{c}110.87^{b}115.73^{ab} 118.20^{a}1.67 Feed conversion ratio 1.90^{b}1.81^{ab} 1.81^{ab} 1.71^{a}1.84^{ab} 0.04 Feed cost/kg gain (₦/kg) 269.5^{a}295.75^{b}336.01^{c}353.28^{c}420.23^{d}6.72 Mortality (%) 6.67 6.67 0.00 10.00 0.00 3.34 abc= Means with different superscripts in the same row are significantly different P< 0.05, Ave= Average, wt= weight, SEM= Standard Error of Mean

INFLUENCE OF GRADED LEVELS OF *ETANDA AFRICANA* SEED MEAL ON GROWTH PERFORMANCE OF BROILER CHICKENS

Ajibade, A. J^, *Makinde, O.J+> Adedeji, A.S^, Adetona, A^, Sulyman A^, Opoola, E#, Sikiru, A. B< and Okunade, S. A^

^ Federal College of Wildlife Management, New Bussa, Nigeria

+ Department of Animal Science, Federal University, Gashua, Nigeria

Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria.

<Department of Animal Production, Federal University of Technology, Minna. >*Universite de Kisangani, Faculte des Sciences, Department des Sciences Biotechnoloques Laboratoire de Microbiologie et Phytopathologie B.P. 2012, R.D. Congo.*

***Corresponding author:** johyinmak@yahoo.com

ABSTRACT

This study was conducted to evaluate the effect of graded levels of processed *Etanda africana* seed meal (EASM) on growth performance of broiler chickens. Five experimental diets were formulated to meet nutrient requirement standards of broilers. Diet 1 (0 % EASM) served as the control while diets 2, 3, 4 and 5 contained 5, 10, 15 and 20 % EASM respectively. A total of one hundred and fifty (150) day-old broiler chicks were randomly allotted into five treatment groups with three replicates of ten birds each. Each group was assigned to the five experimental diets in completely randomized design (CRD). Throughout the experimental period, feed and water were provided *ad libitum* for all treatment groups. The results of growth performance revealed that average body weight gain, average feed intake and FCR were not statistically (P>0.05) influenced by dietary treatments. It was concluded that up to 20 % EASM could be included in the diets of broiler chickens without adverse effect on growth performance of the birds.

Keywords: *Etanda africana,* processing, boiling, roasting, broilers, performance

INTRODUCTION

Entada africana belongs to the family *Fabaceae* which is popularly known as legumes and it is the third largest order of seed-plants containing about 600 genera with 12,000 species (Sharma and Kumar, 2013). It is a small tree which is mostly found in tropical and subtropical regions (Nielsen, 1992). In Nigeria, it is commonly known as ―Tawatsa‖ in Hausa Language and ―Ogurobe‖ in Yoruba (Burkill, 1995). It can be used as food, medicine and fibre. Nutritionally, the seed of *Entada africana* was reported to contain 39.81 % crude protein, 80.00 % dry matter, 15.50 % crude fibre, 17.50 % ether extract, 4.88 kcal/kg metabolizable energy, 39.00 % acid detergent fibre and 53.00 % neutral detergent fibre (Belewu *et al.,* 2008). The authors further reported the mineral contents of the seeds to be 7.66 % calcium, 0.20 % sodium, 45.42 % magnesium, 44.92 % potassium and 0.17 % iron. Similarly, Olanrewaju and Ahmed (2014) reported that *Entada africana* leaves contain 4.20 % moisture content, 13.30 % ash, 10 %crude lipid, 18.56 % crude fibre, 14.60 % crude protein and 38.44 % carbohydrate. Previous study on the potential of *E. africana* in livestock feed revealed that the seed meal can replace soybean meal in the diet of growing West African Dwarf goats without impairing performance (Belewu *et al.,* 2007). There is however, dearth of information on its use in poultry nutrition. This present study evaluated the influence of graded levels of processed *Etanda africana* seed meal on growth performance of broiler chickens.

MATERIALS AND METHODS

The experimental was conducted at the Poultry unit of the Teaching and Research Farm, Federal College of Wildlife Management, New Bussa, Niger State previously described by Okunade *et al.* (2015). About 600 g of *Etanda africana* seeds were obtained from the College Farm. The seeds were handpicked so as to eliminate all unwanted particles. The seeds were then air-dried for 48 hr at 25^{o}C and divided into 2 lots; (i) raw and (ii) boiled and roasted. About 300 g seeds were boiled at 100^{o}C at a seed: water ratio of 1: 10 w/v. for 10 min in an aluminium pot on a Gallenkamp thermostat hot plate (Makinde *et al.,* 2019). The water was drained and the boiled seeds were air-dried at 25^{o}C for 72 hr. The boiled seeds were further roasted in an open pan under the controlled temperature at 65^{o}C for 15

minutes. The seeds were continuously stirred until the seeds cracked and their endosperm turned brown with toasty sweet odour. All the seed samples (raw and processed) were ground to pass through a 2 mm sieve and taken to the laboratory for nutrient and anti-nutrient analysis.

Experimental Design and Management of Birds

One hundred and fifty day old unsexed broiler chicks were purchased from a reputable hatchery in Ibadan, Nigeria. The birds were raised on deep litter pen with wood shaving as litter material. They were fed on a common diet for the first (1) week of the study after which they were randomly allocated into five experimental treatments of thirty birds per treatment, while each treatment was replicated three times (10birds per replicate) in a completely randomized design (CRD). Feed and water were supplied *ad-libitum.* Management practices and vaccination programme were followed strictly. Data were collected on average daily weight gain, average daily feed intake and feed conversion ratio.

Experimental diets

Five experimental diets were formulated to meet nutrient requirement standards of broilers (NRC, 1994). Diet 1 (0 % EASM) served as the control while diets 2, 3, 4 and 5 contained 5, 10, 15 and 20 % EASM respectively. The gross composition of the experimental diets is presented on Table 1.

Data Analysis

Data generated were subjected to Analysis of variance (ANOVA) using the general linear model of statistical analysis system, Version 9.3 (SAS, 2015). Significance was accepted at $P < 0.05$.

Table 1: Dietary composition of experimental starter and finisher diets

	Starter					Finisher				
Ingredients	**T1**	**T2**	**T3**	**T4**	**T5**	**T1**	**T2**	**T3**	**T4**	**T5**
Maize	56.00	53.00	51.00	50.00	48.50	59.50	58.50	54.50	51.00	48.50
Wheat offal	6.50	6.50	6.50	6.50	6.50	9.00	9.00	9.00	9.00	9.00
GNC	27.00	25.00	22.00	16.00	15.00	22.00	18.00	17.00	15.50	13.00
**EASM*	0.00	5.00	10.00	15.00	20.00	0.00	5.00	10.00	15.00	20.00
Fish meal	3.00	3.00	3.00	3.00	3.00	2.50	2.50	2.50	2.50	2.50
Blood meal	2.00	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50	1.50
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Oyster shell	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100	100
Calculated nutrients										
CP (%)	22.95	22.90	22.87	22.80	22.76	20.86	20.75	20.71	20.64	20.58
Met. Energy (Kcal/kg)	2816	2811	2807	2805	2802	3024	3019	3015	3012	3005
CF (%)	3.56	3.62	3.74	3.75	3.77	3.95	3.99	4.05	4.09	4.11
Lysine (%)	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Methionine (%)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48

*Composition of vitamin premix per kg is as follows: Vitamin A, 8000 iu; Vitamin D_3, 1600 iu; Vitamin E 5 iu, Vitamin K 0.200 mg; Vitamins B, Thiamine B_1 0.5mg; Riboflavin B_2 4mg; Pyridoxine B_6 0.015 mg; Niacin 0.015mg; B_{12} 0.01mg; Pantothenic acid 0.5mg; folic acid 0.5mg and Biotin 0.020 mg; Chlorine chloride 0.02 mg; Anti-oxidant 0.125g and Minerals (Mn, Zn, Fe, Cu, I, Si, Co) 0.156g.*EASM=*Etanda africana* seed meal. CP=Crude protein. CF=Crude fibre

RESULTS AND DISCUSSION

The results of the effect of graded levels of *Etanda africana* seed meal on growth performance of broiler chickens (1-7 weeks), is presented in figure 1. The results show that body weight gain, average feed intake and FCR were not significantly (P>0.05) influenced by the dietary treatments. The observations on feed intake, body weight gain and FCR of broiler chickens in this study showed that inclusion of EASM up to 20% in broilers diet had no adverse effect on growth performance of birds.

The overall growth performance of birds fed EASM diets were similar to those fed the control diet. The similarities observed in most of the performance evaluation traits implied that there was no intake limitation when EASM increased in the diets from 0 to 20% and there was acceptability and palatability as well as better utilization of the feed by the birds.

ADWG, g/b/d ADFI, g/b/d FCR

100 80

93.59 91.37 93.2 90.47 94.33

60

41.37 43.68 40.01 40.42 44.36 40

20

2.26 2.09 2.33 2.24 2.13 0

0% 5% 10% 15% 20% Graded levels of processed Entanda africana seed meal

Figure 1: Growth performance of broilers fed processed *Entanda africana* seed meal (1-7 weeks)

This observation could be attributed to the reduction of anti-nutritional factors in the processed seed and the nutrient balance of the experimental diets at both the starter and finisher phases (Ari *et al.,* 2012). Our result confirms the assertion of Alagbaoso *et al.* (2015); Makinde *et al.* (2019) that heat treatment of seed is effective in reducing anti-nutritional factors inherent in most legumes. Also, Kanyinji and Sichangwa (2014) observed that there was no significant difference in the performance parameters (feed intake, body weight gain and FCR) of broilers fed finishing diets with processed cotton seed meal as partial replacement for soybean meal. Our results however differs from the report of Wafar (2013), who observed a significant difference in feed intake, body weight gain and FCR of broilers when toasted sorrel seed (*Hibiscus Sabdariffa)* meal as substitute for soybean meal increased to 20% in broilers diets. This variation may be attributed to the differences in the initial live weights, breed of broilers and nutrient content of seed and concentrates used for the study.

CONCLUSION AND RECOMMENDATIONS

It was concluded that up to 20 % EASM could be included in the diets of broiler chickens without adverse effect on growth performance of the birds. Further researches should be conducted to ascertain the optimum inclusion level of EASM in broilers diet.

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EFFECT OF FEEDING OVEN-DRIED *Canarium schweinfurthii* SEED MEAL ON CARCASS CHARACTERISTICS OF BROILER CHICKEN

[*]Adelowo, O.V[1]., Christy Agbi[2], Aka-Tanimo, H.A[1]., Banjo, A.A[2]
[1]Department of Animal Production, Federal College of Animal Health and Production Technology, N.V.R.I., Vom, Plateau State
[2]Chemistry and Biochemistry Laboratory, Federal College of Animal Health and Production Technology, N.V.R.I., Vom, Plateau State
[*]Corresponding author: olufisayo71@gmail.com (08030426283)

ABSTRACT

A feeding trial of six weeks duration was conducted to determine the performance and carcass characteristics of broiler chickens fed with oven dried *Canarium schweinfurthii* seed meal (ODCSM). Four dietary treatments containing 0% (control), 2.5%, 5%, and 7.5% of oven dried *Canarium* seed meal (ODCSM) respectively. One hundred and twenty (120) day old chicks were randomly allotted to four experimental diet, at thirty (30) per treatment in a completely randomised design. The parameters measured were live weight, bled weight, carcass weight, breast weight, thigh weight, drumstick weight, wings weight, neck weight, back weight, spleen weight, gizzard weight, liver weight, heart weight, lungs weight, abdominal fat weight. The results shows no significant difference in all the parameters measured across the treatments. Therefore, Oven dried *Canarium schweinfurthii* seed meal can be included in the diets of broilers chickens up up to 7.5%.
Key word: Oven dried, *Canarium schweinfurthii*, Carcass characteristics, Broiler chickens

INTRODUCTION

Poultry meat is a rich source of high quality protein, minerals and vitamins (Adelowo *et al.,* 2019a). Due to economic importance attached to chicken and their products gives rise to the need for food safety which is imperative in food production worldwide (Chisoro, 2015). Poultry production, especially broiler chickens remains one of the veritable ways of attaining sustainable and rapid production of high quality protein to meet the increasing demand of the Nigeria teeming populace, due to short generation interval of broiler chicken (Akinmutimi, 2004). One of the main challenges in poultry enterprise is high cost of feed which is estimated to be about 70% of the total cost of production (Ogundipe *et al.,* 2003). This high cost has been attributed to the over-dependence on the expensive conventional feed stuffs such as soybean and groundnut cake which is mainly used in poultry feed formulation (Apata and Ojo, 2002). A high demand for these feed ingredients has resulted in an increase in their prices and consequently, cost of poultry feeds and its products, this calls for a serious attention with regard to the quality of chicken meat available (Chisoro2015). This necessitates research into non-conventional feedstuffs (NCF) that are readily available, cheap and nutritionally safe such as *Canarium schweifurthii* seed meal. *Canarium schweifurthii* seed contained natural flavors, high fat content, pigments, moisture, nutritionally valuable minerals, vitamins and naturally occurring antioxidants (Ayoade, *et al.,* 2015). The seed also contains appreciable amount of nutritionally valuable minerals such as calcium, potassium, magnesium, sodium, phosphorous, iron, zinc and copper. Glutamic and aspartic acids dominated the amino acid profile of *Canarium schweifurthii* seed, it contained appreciable amount of essential amino acids which is more than fifty percent of total amino acid contents (Ayoade *et al.,* 2017, Adelowo *et al.,* 2019a). One of the major problems of legume utilization is the presence of anti-nutritional factors (Oke *et al.,* 2004). Removal of these anti-nutritive components is essential in order to improve the nutritional quality of the seeds and to effectively utilize their full potential as feeds (Akinmutimi, 2004). Heat treatment such as boiling, frying and drying are frequently used to improve the utilization of the nutrients in legumes by animals (Shaahu *et al.,* 2015). This study is therefore aimed at studying carcass characteristics of broiler chickens fed with oven dried *Canarium schweifurthii* (ODCSM) seed meal.

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research farm of the National Veterinary Research Institute (NVRI) Vom, Nigeria. Vom is located in Jos south local government area of plateau state. It is situated on the south east of Jos, the Plateau state capital which is located at $8^0$45

Easts and $90^0$43 North with a height of about 1,285meters above sea level. Vom has a remarkable cool climate, in December and January; the night may be extremely cold, the wet season from late April to middle October.

Experimental Birds and their Management

In a completely randomised design a total of 120 unsexed two weeks old broiler chicks were used for the study. The chicks were randomly alloted into four (4) dietary treatments containing 0% (control), 2.5%, 5% and 7.5% of oven dried *Canarium schweifurthii* seed meal, with each treatment having three (3) replicates of ten (10) birds each. The feed was presented in mash form and water was provided *ad libitum. T*he birds were raised on deep litter and were subjected to standard management and hygiene the recommended vaccines for broilers were administered accordingly. At the end of the six weeks feeding trials, two birds from each replicate were randomly selected, fasted for (12) hours and slaughtered by severing the throat with the aid of sharp knife. The birds were allowed to bleed for five minutes and defeathered manually by immersing in warm water. The parameters measured were the live weight, bled weight, carcass weight, breast weight, thigh weight, drumstick weight, wings weight, neck weight, back weight, spleen weight, gizzard weight, liver weight, heart weight, lungs weight, abdominal fat weight

Determination of carcass characteristics was done according to the method described by Oluyemi and

Robert (2002). The feathers were plucked and eviscerated to determine the dressed weight and weight of the carcass components (thighs, drumstick, breast, back, wings, and neck. The internal organs were; heart, lung, liver, gizzard, spleen, abdominal fat) were measured. The Carcass, organs, and gut were weighed with the aid of laboratory electronic scale (ACCULAB). The cut parts were expressed as percentage of live weight. The dressing percentage was calculated as a ratio of dress weight to live weight multiplied by hundred

Dressing percentage X 100

Data Analysis

Data obtained from the experiment were analysed using the statistical analysis of variance (ANOVA) procedure of SAS (2010) and significant level of p=0.05 was used. The treatment means were compared using the New Duncan multiple range test option of the same software.

Table 1: Composition of the experimental diet

Ingredient 0% 2.5% 5% 7.5% Maize 59.00 57.39 57.39 55.00 Soybean cake 19.00 18.50 16.00 15.89 G. cake 19.39 19.00 19.00 19.00 ODCSM 0 2.50 5.00 7.50 Bone meal 2.00 2.00 2.00 2.00 Methionine 0.10 0.10 0.10 0.10 Lysine 0.10 0.10 0.10 0.10 Premix 0.16 0.16 0.16 0.16 Salt 0.25 0.25 0.25 0.25 Total 100 100 100 100 Nutrient Analysis %

CP% 22.61 22.06 21.04 20.75 Energy 3023.14 2944.76 2877.04 2793.03 Calcium 0.79 0.79 0.78 0.78

Av phosphorus 0.50 0.49 0.48 0.48

Lysine 0.09 1.07 1.00 0.99 Methionine 0.42 0.42 0.40 0.40 Fibre 3.38 3.30 3.14 3.08 G.cake-Groundnut cake, C.P-crude protein, Av-available phosphorus

Table 2: Carcass characteristics of broiler finisher fed graded levels of oven dried *Canarium schweinfurthii* seed meal (ODCSM)

Parameters 0% 2.5% 5% 7.5% Live weight 1.78 0.03 1.83 0.02 1.76 0.06 1.68 0.03 Carcass weight 1.68 0.03 1.70 0.10 1.65 0.05 1.55 0.05 CarcassComponent % of live weight

Dressing % 1.25 0.05 1.30±0.01 1.18±0.03 1.13±0.03 Breast 0.35 0.05 0.28±0.02 0.38±0.02 0.29±0.02 Thigh 0.18 0.03 0.16±0.01 0.16±0.01 0.18±0.03 Drumstick 0.15 0.01 0.15±0.01 0.15±0.02 0.14±0.01 Wings 0.13 0.03 0.12±0.01 0.13±0.03 1.15±0.01 Neck 0.95 0.05 0.90±0.10 1.00±0.10 1.00±0.20 Back 0.14±0.02 0.16±0.01 0.19±0.01 0.18±0.02

Internal organs giblet

Spleen 1.50±0.50 2.00±1.10 2.00±0.10 3.00±0.10 Gizzard 31.00±2.00 40.00±1.00 43.50±4.50 42.50±1.50 Liver 33.50±0.50 33.50±1.50 33.00±6.00 34.00±4.00 Heart 9.50±1.50 9.00±1.00 9.50±1.50 11.00±2.00 Lungs 13.50±1.50 9.50±1.50 10.50±1.50 8.50±0.50 Abdominal fat 18.50±12.5 12.00±5.00 11.50±3.50 12.00±6.00

RESULTS AND DISCUSSION

The carcass characteristics of broiler finisher fed graded level of oven dried *Canarium schweinfurthii* seed meal were not significantly different (P>0.05) across the treatments, this result agrees with the findings of Adelowo *et al*., (2019b) that broiler chickens can tolerate roasted *Canarium schweinfurthii* seed meal up to 7.5% without affecting their performance. The live weight of the birds fed with 2.5% has the highest value of 1.83±0.02kg although, there was no significant variation in the values statistically across the treatments with the birds fed at 0% (1.78±0.03), 5% (1.76±0.06), and 7.5% (1.68±0.03) at P>0.05 respectively. The bled weight of the birds fed with 2.5% is 1.70±0.10 kg while those fed at 0% (1.68±0.03), 5% (1.65±0.05) and 7.5% (1.55±0.05) respectively also at P>0.05. The carcass weights of the birds are 2.5% (1.30±0.01), 0% (1.25±0.05), 5% (S1.18±0.03), and 7.5% (1.13±0.03) respectively. The breast weight of the birds are 5% (0.38±0.02), 0% (0.35±0.05), 2.5% (0.28±0.02), and 7.5% (0.29±0.02) respectively at P>0.05. Oven dried *Canarium schweinfurthii* seed meal can be included in broiler diet at all stages because the seed contained appreciable amount of nutritionally valuable minerals such as calcium, potassium, magnesium, sodium, phosphorous, iron, zinc and copper while glutamic and aspartic acids dominated the amino acid profile, also appreciable amount of essential amino acids which was more than fifty percent of total amino acid contents (Aigade *et, al.* (2017). The parameters measured were not statistically different at P>0.05, Although the values obtained at 2.5% inclusion levels was higher than control and 7.5% inclusion level but once the statistical analysis shows no difference therefore any of the inclusion level can be fed to the birds. This result agrees with the findings of Adelowo *et al*., (2019b) on the inclusion of roasted *Canarium* seed meal to 7.5% without affecting the performance of the broiler chickens.

CONCLUSION

Based on the result obtained, where there was no significant variation across the treatments, the seed can therefore be added to the diets of broiler chickens at any of the inclusion level without having a detrimental effect on the carcass of the birds.

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DIETARY SUPPLEMENTATION OF SILICON OXIDE ON CARCASS CHARACTERISTICS AND LITTER QUALITY OF BROILER CHICKENS

[*]Opoola, E., [**]Makinde, O. J., [***]Lawal, N.A and [***]Olaniyan, O
[*]Department of Animal Science, Ahmadu Bello University, Zaria. Nigeria.
[**]Department of Animal Science, Federal University, Gashua, Nigeria.
[***]Kabba College of Agriculture. Ahmadu Bello University.
Corresponding email: emmycom123@yahoo.com
Phone number: 07032217712

ABSTRACT
This experiment was conducted to evaluate the effects of different levels of silicon oxide on carcass characteristics and litter quality of broiler chickens. In total, 120mixed sex Abor Acre broiler chicks were distributed according to a completely randomized design. The control group was fed a diet without silicon oxide, while treatments 2-4 were fed diets supplemented with 10, 20 and 30g/100kg silicon oxide respectively. At the end of the starter (0-3 weeks) and finisher (4-7 weeks) phases, litter samples were collected at random from different locations from all the replicates and scored for litter quality test. Also at the end of the finisher phase three birds per replicate were selected on the basis of weights for carcass characteristic study. Silicon oxide supplementation improved broiler carcass characteristics, as shown by higher breast, back, thigh, drumstick, shank, and gizzard weights. Chickens fed silicon oxide supplemented diets had significantly ($p<0.05$) better carcass characteristics compared with those chickens fed diet without silicon oxide. Litter quality and abdominal fat were not influenced by the treatments. It was concluded that carcass characteristics of broiler chickens were better in birds fed 20g silicon oxide /100kg diet compared to chickens fed without silicon oxide.
Keywords: silicon oxide, carcass, broiler, litter, tropics

INTRODUCTION

One of the most important recent challenges in broiler production has been associated to skeletal disorders, particularly those affecting the legs (Manohar *et al*., 2015). This can be caused by intensive genetic selection, an increase in the nutritional quality of feed and the increased demand for poultry as a food source, leading to a drive for faster production rates (Bradshaw *et al*., 2002). Unfortunately, selection for large pectoral mass did not occur alongside selection for a stronger musculoskeletal support system, with an investigation by Robinson *et al*. (2007) revealing that high breast-yielding strains had reduced carcass frames. Silicon (Si) has been linked to the calcification of growing bone and deficiency in poultry diets has been shown to lead to a number of health and welfare issues, such as various skeletal weaknesses. Safaeikatouli *et al*. (2012) and Tauqir *et al*. (2001) reported that poultry performance was improved with the use of silicate minerals in broiler diets. However, in turkeys, body weight gain and feed conversion ratio (FCR) significantly improved with dietary Si dioxide supplementation (Tran *et al*. 2015). In addition, silica increase dissolved oxygen in water and therefore helps reduce ammonia in litter and manure (Scholey *et al*., 2018). There has been a gap in the revisions made in the Nutrient requirement of poultry (NRP) since 1994, the majority have focussed on macronutrient provision, with some updates to the provision of essential vitamins and minerals, but no changes (or additions) have been made to reflect the growing body of work surrounding trace and ultra trace elements like silicon oxide despite its importance in regard to bone mineralisation. Therefore, this experiment was conducted to review the effect of silicon oxide on carcass characteristic and litter quality of broiler chickens reared under tropical environment.

MATERIAL AND METHODS

Experimental site

The experiment was conducted at the Poultry Unit of livestock section Kabba College of Agriculture, Teaching and Research farm, Ahmadu Bello University. The study area is located within the Southern Guinea Savannah agro-ecological zone and the coordinate of the study area is Latitude 07° 51.128‘ N and Longitude 006° 04.273‘ E.

Experimental design, diets and management of birds

One hundred and twenty (120) one-day old Abor Acre broiler chickens of mixed sexes were assigned to four dietary treatment groups were distributed on the basis of equal weight into three replicates per treatment with 10 birds each in a completely randomized design. The birds were housed in deep litter pens and all necessary routine management practices were observed. Broiler starter and finisher diets were fed from 0 – 3 weeks and day 4-7 weeks, respectively. Water and feed were administered *ad libitum* for the 7 weeks' experimental period. The necessary medications and vaccinations were administered as at when due. The diets were isocaloric and isonitrogenous and formulated to meet the nutrient requirements of the broiler chicks during starter and finisher periods (Table 1) according to the National Research Council requirements (1994). A basal diet was formulated such that treatment 1 was without silicon oxide (control), treatment 2-4 had 10g, 20g and 30g silicon oxide/100kg diet respectively.

Table 1: Diets composition

Ingredients Basal diet (starter) Basal diet (finisher) Maize 52.80 60.50
Soyabean cake 28.00 22.00
GNC 13.74 12.14
Palm oil 1.20 1.30
Bone meal 2.80 2.70
Limestone 0.50 0.50
Common Salt 0.30 0.30
Methionine 0.18 0.15
Lysine 0.18 0.16
Vit-min-Premix[1] 0.30 0.25
Total 100.00 100.00
Calculated Nutrient
ME (Kcal/kg) 3010 2998
Crude Protein (%) 23.10 20.00
Crude Fibre (%) 3.73 3.73
Ether Extract (%) 5.84 5.84
Calcium (%) 1.27 1.27
Phosphorus (%) 0.83 0.83
Methionine (%) 0.86 0.86
Lysine (%) 1.28 1.28

[1]Vitamin mineral premix provide per kg of diet. Vit. A, 13,340 i.u; Vit. D_3, 2680 i.u; Vit. E, 10 i.u; Vit. K, 2.68 mg; Calcium pantothenate, 10.68mg; Vit. B_{12}, 0.022mg, Folic acid, 0.668mg; Choline choride, 400mg; Chlorotetracyline, 26.68mg; manganese, 13mg; iron, 66.68mg; Zinc, 53.34mg; Copper, 3.2mg; Iodine, 1.86mg; Cobalt, 0.268mg; Selenium, 0.108mg

Carcass characteristics

At the end of the 7th week of the feeding trial, three birds from each pen with approximate body weights equal to the mean weight of the birds in the pen were used. They birds were fasted overnight in order to allow for the emptying of the gastro-intestinal tract (GIT) and weighed. The selected birds were slaughtered for carcass analysis by severing the neck with a sharp knife and allowed to bleed completely. They were then defeathered and eviscerated. The liver and gizzard, and the thigh and breast were weighed and expressed as percentages of the live body weight and the carcass weight respectively. The intestinal length was measured in centimeters. The dressed weights were taken and the dressing percentages computed.

$$\text{Dressing percentage} = \frac{\text{Carcass weight}}{\text{Live weight}} \times 100$$

Litter quality

At the end of the experimental period litter samples were visually scored on a scale of 1 to 5 (1 driest to 5 wettest) adapted from Hooge *et al*. (2012) with some modifications, as follows: 1. Dry, friable material throughout the pen.
2. Predominantly dry material and mostly acceptable but with some areas of wet shavings. 3. Poor quality litter material with a large proportion of wet areas.

4. Unacceptable litter quality, wet but with a few areas of dry material remaining. 5. All litter wet and soggy, no dry areas left.

Data analysis

All data obtained from the two experiments were subjected to analysis of variance (ANOVA) using the General Linear Model Procedures (GLM) of the Statistical Analysis Software package. Significant difference between treatments means were separated using Duncan Multiple Range Test (SAS, 2002).

RESULTS AND DISCUSSION

The effect of varying level of silicon oxide supplemented diet on carcass characteristics of broiler chickens were as shown in Table 2. Dietary treatments had significant (P<0.05) effects on live weight (LW), carcass weight (CW), dressing percentage (DP), back, gizzard, breast, wings, thigh, drumstick and abdominal fat. It was observed that chickens fed diet supplemented with 20g/100kg silicon oxide had the best results in terms of LW, CW, and DP as compared to other treatments. Chickens fed 20g silicon oxide /100kg diet had the best results in terms of back, breast, gizzard, wing, thigh and drumstick. However, chickens fed 30g silicon oxide /100kg diet had the best result in terms of gizzard and spleen weights. Generally, it was observed that majority of the carcass parameters measured were higher for chickens fed silicon oxide compared to fed chickens without silicon oxide. This result disagrees with the findings of Aksu *et al*., (2010b) who reported that basal diets containing lower levels of trace minerals were similar in carcass weight than birds fed diets without trace minerals. Also, Ara´ujo *et al*. (2019) reported no significant difference in weight gain/carcass weight of birds diets supplemented with organic trace mineral diets. However, the explanation on this is still not clear as measurements of absorption and digestion of supplemental trace minerals are generally difficult to make because of the complexity of endogenous mineral excretion. Numerically abdominal fat pad was observed to be highest in birds fed diet without silicon oxide diet compared to the chickens fed diets supplemented. All the litter score values assessed were similar. This result disagrees with the findings of Tran *et al*. (2015) who reported no significant differences as the levels of silicon oxide in the diets of broiler chickens increased. However, it was observed that all the treatment groups had a good litter score. This may be as a result of the feed ingredient used and season of rearing which may have reduced litter pH which decreased the conversion of NH_4^+ to NH_3 thereby reducing nitrogen losses from litter.

Table2: Carcass characteristics of broiler Chickens fed varying level of silicon oxide in the diets

	Silicon oxide levels (%)				
Parameters	0.00	10	20	30	SEM
Live weight (g)	2386.37^{d}	2760.00^{b}	3346.70^{a}	2406.70^{c}	0.12
Carcass weight (g)	1900.00^{c}	2193.04^{b}	3120.47^{a}	1900.08^{c}	2.29
Dressing (%)	69.60^{b}	81.89^{a}	79.58^{a}	80.46^{a}	1.98
Prime cuts and organ weights expressed as % of dressed weight					
Breast	18.58^{c}	21.99^{b}	34.27^{a}	32.62^{a}	2.68
Wings	2.56^{c}	2.81^{c}	4.54^{a}	3.94^{b}	0.20
Thigh	2.43^{d}	4.42^{c}	6.92^{a}	5.80^{b}	0.36
Drumsticks	2.10^{d}	2.75^{c}	5.20^{a}	4.03^{b}	0.30
Back	9.23^{b}	14.66^{a}	14.98^{a}	13.36^{a}	1.36
Liver	0.94	1.03	0.99	0.91	0.08
Heart	0.56	0.52	0.54	0.51	0.05
Kidney	0.15	0.14	0.12	0.16	0.05
Gizzard	0.67^{b}	0.79^{ab}	0.75^{ab}	0.93^{a}	0.10
Abdominal fat	0.70	0.68	0.56	0.69	0.11
Spleen	2.11^{a}	1.22^{b}	1.11^{b}	0.80^{b}	0.22
Shank	1.23^{d}	2.41^{c}	3.30^{b}	4.40^{a}	0.23

a, b, c, d= Means with different superscript on the same row differ significantly (P<0.05)
SEM = Standard Error of Means

Table 3: Visual Scoring of Litter Quality at each Growth Phase

	Silicon Oxide (g/kg)				
Growth phase	0.00	10	20	30	SEM
Starter	2.66	2.42	2.32	2.50	1.96
Finisher	2.98	2.65	2.63	2.76	1.87

SEM = Standard Error of Means

CONCLUSION and Application

Dietary supplementation with silicon oxide may improve carcass quality and reduce moisture in litter. It was concluded that, under our study conditions, the feeding of 20g silicon dioxide /100kg diet offers potential economic benefits in terms of carcass characteristics and reduced moisture content in the litter of broiler chickens.

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CARCASS AND GUT CHARACTERISTICS OF BROILER CHICKENS FED DIFFERENT COMMERCIAL DIETS

[1]Usman, Y., [2]Hafizu R., [3]Magaji., I. M. and[4]Doma, U.D.

[1]Department of Animal Health Technology, College of Agriculture Bauchi.
2Ministry of Education Science and Technology, Dutse, Jigawa State, Nigeria.
[3]Department of Animal Science, Federal University Gashua, Yobe State, Nigeria.
[4]Department of Animal Production, Abubbakar Tafawa Balewa University, Bauchi. Corresponding Author: yakubuusman320@gmail.com; Phone no: 07039368989

ABSTRACT

An experiment was conducted to evaluate the response of broiler chickens to five different commercial diets. Two hundred and fifty day-old chicks were randomly allotted to five diets in replicates of three containing 16 birds each in a completely randomized design. Feed and water were supplied ad libitum and the feeding trial lasted for 42 days. Results for Carcass analysis revealed that diet B gave the highest ($P<0.05$) carcass weight of 2.06kg. Dressing percentage was higher on diets A (70.51%) and B (68.52%). It was therefore concluded that diet B gave better carcass yield at reduced feed cost, hence recommended for broiler chicken producers.

Keywords: Commercial diets, Broiler chickens, Carcass and Gut Characteristic

INTRODUCTION

The development of the poultry industry has been identified as the fastest way of bridging the animal protein deficiency gap. Although CBN (2019), has reported that the poultry industry is the most commercialized of all the Nigeria‘s agricultural subsectors with a current worth of about N1.6 trillion, it is yet to attain its full potentials in the country. The World Data Atlas (2017) revealed that in 2006, Nigeria produced 232,100 mt of poultry meat. However, this quantity decreased to 201,493 mt in 2017. A number of factors might be responsible for this decline. Notable among them is the increasing cost of poultry feed ingredients and that of finished commercial feeds that often contain sub-standard nutrient levels. Energy is a property of energy-yielding nutrients. Basically, it is produced when carbohydrates, lipids and proteins are oxidized during metabolism. According to Carre and Juin (2015) and Emmanuel *et al*. (2018), energy sources form the major single constituent (40 - 50 %.) in broiler chicken diets. Metabolizable energy (ME) which is measured in kilocalories is the standard measure used to describe the energy requirement of poultry (NRC, 1994). Dietary ME plays a central role in metabolic, maintenance and production processes. Poultry feeding programmes are established based on energy requirements to allow for optimization of production and economic targets (Sakomura *et al.,* 2014). Metabolizable energy levels are implicated in broiler feed intake regulation (Leeson and Summers, 2001; Emmanuel *et al.,* 2018). Ghaffari *et al*. (2007) reported that as dietary energy level increases, birds satisfy their energy needs by decreasing feed intake. Therefore, when formulating broiler diets, nutrient requirements have frequently been expressed per unit of dietary metabolizable energy. At the moment, there is limited literature on the response of broiler chickens to different commercial feeds sold in Bauchi metropolis. It is therefore the aim of this study to add to the body of knowledge in that area.

MATERIALS AND METHOD

Experimental Site

The study was carried out at the poultry farm, college of Agriculture, Bauchi, situated on latitude 10018‘ North, longitude 9050‘ and at an altitude of 590m above sea level. There are

two distinct seasons in the area. A rainy season, which starts in May and ends in October and dry season which starts from November to April. The mean annual rainfall is 1091mm (World Atlas, 2015).

Experimental Diets

Five different commercial diets available and commonly used by broiler chicken farmers in Bauchi metropolis were used in the study. For convenience, the feeds were designated A, B, C, D, and E.

Table 1: Composition (%) of different commercial starter and finisher diets.

	Diets				
Composition	**A**	**B**	**C**	**D**	**E**
Starter					
(ME Kcal/kg) (min)	2800	2850	2900	2900	2900
Crude Protein (min)	21.0	23.0	20.0	21.0	20.0
Crude Fibre (min)	5.0	3.0	4.5	4.8	5.0
Crude fat (min)	4.0	4.5	5.0	6.0	5.5
Finisher					
ME Kcal/kg) (min)	2900	2850	3000	3000	2900
Crude Protein (min)	18.0	18.5	18.0	18.0	18.0
Crude Fibre (min)	6.0	5.0	6.0	6.0	6.5
Crude fat (min)	5.5	6.0	5.0	6.0	5.8

Experimental Birds and their Management

A total of two hundred and fifty unsexed, day-old Cobb 500 broiler chicks obtained from a reputable hatchery were used for the experiment. Two weeks prior to the birds‘ arrival, the study pens were cleaned washed, disinfected and fumigated. Similar treatment was also made on the feeders, drinkers and other equipment. A week after, wood shavings were spread on the floor of the experimental pens to a depth of approximately 3 inches. Thereafter, adequate heating/lighting facilities, feeders, and drinkers were provided.

Brooding, which was done for a period of 7 days, commenced with the arrival of chicks. Two 200W electric bulbs were used to provide the necessary warmth needed in the brooding room while Vital super starter®, a commercial feed, wasted to the birds ad lib. Birds were also given the first dose of IBDV (Gumboro vaccine) at 7 days. Followed by an anti-stress Vitalyte® for two consecutive days. Another vaccine, New Castle Disease Vaccine NDCV

(LASOTA) was also administered on the 14th day.
Thereafter, the birds were randomly allotted to five commercial diets in replicates of 3 containing 16 birds each in a Completely Randomized Design (CRD). Diets and clean drinking water were offered ad libitum throughout the 42-day trial period. Birds were also given the second dose of Infectious Bursal Disease vaccine (Gumboro vaccine) (Booster) on the 21st day and another of NCDV a week after. All vaccines and drugs were orally administered.

Experimental Design

The experiment were conducted in a completely randomized design (CRD), (Steel and Torrie, 1980).

Data Collection

Carcass analysis

At the end of the finisher phase, thirty birds, two from each replicate, were randomly selected from the five treatments (15 replicates) and fasted for 12 hours before slaughter. Each bird was weighed and slaughtered. Weights of carcasses and internal organs were immediately

measured using an electronic balance calibrated in grams. Dressing percentage (DP) was obtained using the relationship.

Where DP= Dressing percentage, CW= carcass weight and LW= live weight.

RESULTS AND DISCUSSION

The results for carcass and gut characteristics of broiler chickens fed different commercial diets are presented in Table 2. All the carcass parameters considered in this study showed significant (P<0.05) influence of diet. This agrees with Sanusi *et al.* (2015) but was at variance with the report of Sogunle *et al.* (2009). In terms of dressing percentage, broilers in this research dressed lower than 79.31 – 81.09% reported by Sogunle *et al.,* (2009) but similar to 64.45 – 70.68% (Abdel-Raheem and Abd- Allah, 2011). The significant difference obtained in vital organs; liver, heart, and kidney disagrees with the findings of Sogunle *et al.* (2009) and Sanusi *et al.* (2015) in similar experiments. . Most of the parameters studied showed significant influence of diet. Live weight of birds was significantly (P<0.05) higher on diet B (3.00 kg) and lower on diet A (2.39 kg). However, diet D (2.84 kg) did not differ from diet B. similarly, diets C (2.84 kg and) and E (2.15 kg) were similar to diet A. Plucked weight was highest (P<0.05) on diets B (2.63 kg) and C (2.64 kg) and lowest on diet E (1.81 kg). eviscerated weight was also higher (P<0.05) on diet B (2.26 kg) which was similar to diet D (1.99 kg) and lower on diets A (1.79 kg), C (1.83 kg) and E (1.53 kg). in the same way, carcass weight was higher (P<0.05) on diet B (2.06 kg) which did not differ from diet D (1.77 kg) and lower on diets A (1.69 kg), C (1.68 kg) and E (1.41 kg). In terms of dressing percentage, all diets with the exception of diet D (61.59%) had significantly (P<0.05) higher mean values (65.35 – 70.51%). However, diet D was comparable to diets C and E. Head weight expressed as percentage of live weight did not differ among treatments (1.88 – 2.05%). Birds on diet A (3.76%) had heavier (P<0.05) shanks thank those on other diets (3.27 - 3.42%). Lung weights did not show any significant influence of diet (0.48 – 0.60%). The intestines of birds fed diet A (3.97%) were heavier (P<0.05) than that of birds fed other commercial diets (2.81 – 3.05%). However, no significant effect of diet was recorded on intestinal length (243.33 – 273.00%). Kidney weight was higher (P<0.05) on diet E (0.67%) which was similar to diets C (0.62%) and D (0.63%). On the other hand, liver weight was lower on diet E (1.43%) and higher on diet D (2.34%). Birds on diets A (1.93%), B (1.83%) and (1.96%), were similar. Relative weight of abdominal fat was higher (P<0.05) on diet E (0.87%) which compared favourably with diets C (0.74%) and D (0.78%). Birds on diets A (0.72%) and B (0.64%) had lower abdominal fat weights which were similar to diets C and D. Heart weight showed a significant (P<0.05) influence on diet. Diet D (0.50%) was higher than other diets (0.32 – 0.38%). Gizzard weight relative to live weight was significantly (P<0.05) higher on diets C (1.70%), D (1.55%) and E (1.69%) which were similar. Broiler chickens fed diet B (1.34%), had the lowest mean value which was lower than 1.53%

recorded on diet A. Caecal weight was higher (P<0.05) on diet A (0.48%) and lower on other diets (0.34 – 0.37%) which did not differ. Pancreas (0.19 – 0.21%) and spleen (0.17 – 0.25%) weights did not differ among diets.

Table 2: Carcass and Organs Characteristics of Broiler Chickens Fed Commercial Diets

Parameter	A	B	C	D	E	SEM
Live weight (kg)	2.39^{cd}	3.00^{a}	2.57^{bc}	2.84^{ab}	2.15^{d}	0.13*
Plucked weight (kg)	2.18^{b}	2.63^{a}	2.22^{b}	2.64^{a}	1.81^{c}	0.12*
Eviscerated weight (kg)	1.79^{bc}	2.26^{a}	1.83^{bc}	1.99^{ab}	1.53^{c}	0.11*
Carcass weight (kg)	1.69^{b}	2.06^{a}	1.68^{b}	1.77^{ab}	1.41^{b}	0.11*
Dressing percentage (%)	70.51^{a}	68.52^{a}	65.66^{ab}	61.59^{b}	65.35^{ab}	2.17*
Head, shank and visceral organs expressed as a percentage of live weight						
Head	2.03	1.88	2.05	2.02	1.93	0.06^{NS}
Shanks	3.76^{a}	3.42^{b}	3.32^{b}	3.31^{b}	$3,27^{b}$	0.09*
Lungs	0.60	0.60	0.55	0.53	0.48	0.04^{NS}
Intestinal weight	3.97^{a}	3.05^{b}	2.95^{b}	2.95^{b}	2.81^{b}	0.24*
Intestinal length (cm)	273.00	258.33	250.33	264.17	243.33	10.65^{NS}
Kidney	0.57^{b}	0.55^{b}	0.62^{ab}	0.63^{ab}	0.67^{a}	0.03*
Liver	1.93^{b}	1.83^{b}	1.96^{b}	2.34^{a}	1.43^{c}	0.13*
Abdominal fat	0.72^{b}	0.64^{b}	0.74^{ab}	0.78^{ab}	0.87^{a}	0.05*
Heart	0.34^{b}	0.37^{b}	0.38^{b}	0.50^{a}	0.32^{b}	0.03*
Gizzard	1.53^{b}	1.34^{c}	1.70^{a}	1.55^{ab}	1.69^{a}	0.05*
Caeca	0.48^{a}	0.36^{b}	0.37^{b}	0.34^{b}	0.36^{b}	0.03*
Pancreas	0.19	0.21	0.21	0.21	0.20	0.01^{NS}
Spleen	**0.21**	**0.17**	**0.19**	**0.25**	**0.19**	**0.03^{NS}**

~~b a, c, d~~ Means bearing different super scripts within the same row differ; * = (P<0.05); NS= Not significant; SEM = standard error of mean.

CONCLUSION AND RECOMMENDATION

Carcass analysis revealed a significant influence (p<0.05) of diet in favour of diet B due to Higher carcass yield that was obtained on diet B than other diets (A, C, D and E), therefore diet B is recommended for broiler chickens feeding

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UTILIZATION OF MAIZE OFFALS AS A REPLACEMENTTO WHEAT OFFALS AS DIETARY FIBRE SOURCES BY BROILER CHICKENS AT STARTER PHASE

[1] Shuibu Inuwa and 2 Usman Yakubu
[1]Ministry of Agriculture, Bauchi, Bauchi state, Nigeria

[2]Department of Animal Health, Bauchi State College of Agriculture. Nigeria
Corresponding Author: shu'ibu inuwa@gmail.com; Phone no: 08123729404

ABSTRACT
An experiments was conducted to evaluate the response of broiler chickens to dietary levels of maize offal as replacement to wheat offal. Using a completely randomized design, three hundred broiler chicks were used in the trial. Feed and water were supplied *ad lib* and the trial lasted for 4 weeks. In the experiments maize offal replaces wheat offal as diet 1,2,3,4 and 5 respectively, as 0 (diet 1), 25 (diet 2), 50 (diet 3), 75 (diet 4), and (diet 5)100% levels. The Results showed no significant influence (P<0.05) of diet on initial weight, total weight, final weight gain and feed conversion ratio. However, performance traits significantly (P<0.05) differ among the diets on total feed intake, daily feed intake, daily weight gain and week 4 weight gain respectively. It was therefore concluded that maize offal can replace wheat offal in broiler chicken diets without compromising performance.
Keywords: Commercial diets, Broiler chickens and performance.

INTRODUCTION.
Poultry‖ can be defined as domestic fowls, including chickens, turkeys, geese and ducks raised for the production of meat or eggs and the word is also used for the flesh of these birds used as food. Poultry also include other birds that are killed for their meat, such as the young of pigeons (known as squabs) but does not include similar wild birds hunted for sport or food and known as game. Poultry can be distinguished from ―game‖ defined as wild birds or mammal hunted for food or sport, a word also used to describe the flesh of these when eaten. Nowadays poultry production has developed and occupies a place of pride among the livestock enterprises due to its rapid monetary turnover (Kheravvi et al., 2018). This has made the enterprise attractive and popular among small, medium as well as large scale poultry farmers (Kheravvi et al., 2018). Fibre refer to fibre as cell walls of plant tissue that mostly consist of lignin, cellulose as well as hemicelluloses. (Mc Donald et al.,1994) The poultry industry has become a diverse industry with a variety of business interests such as egg production, broiler production, hatchery and poultry equipment business (Oluyemi and Roberts, 1999). Fibre is thought to decline chicken production and growth that is it decreases the effectiveness of feed utilization (Vantsawa, 2001). Maize is a stable food for millions of people in sub-Saharan Africa. Although white maize is more popular in most households, few know that yellow maize is more nutritious than white maize. maize is an excellent and most popular source of energy used in broiler diets (Aduku., 1993). Therefore, sorghum, millet, maize offal, rice bran and wheat offal, millet bran, spent sorghum grain and broken rice could be recommended as alternative sources of feed ingredients in poultry diets.(Medugu *et al*.,2011). Several workers have emphasized the need for utilizing alternative feed ingredients removed from human and industrial uses (Durunna et al., 1999; Fanimo *et al*., 2007; and Nsa *et al*., 2007).

MATERIALS AND METHOD
The experiments were carried out at the Poultry Unit, Teaching and Research Farm, Abubakar Tafawa Balewa University, Bauchi. The town, Bauchi, is located within the southern guinea savannah on latitude 10.31 N and longitude 9.84 E. It is 616 metres above sea level characterized a rainy season that commences in May and terminates in October and a dry season that starts in November and ends in April. Mean annual rainfall is 1009 mm, highest relative humidity 94% (August) and the lowest 35% (February). Temperatures are between 13-17oC (December – February) and 36 – 37oC (March – April) (World Atlas, 2015).

Experimental Diets
Experimental starter diets containing 23% CP. Diet 1 which served as the control contained 0% maize offal, while diets 2, 3, 4 and 5 contained 25, 50, 75 and 100% levels of maize offal as replacement for

wheat offal. The ingredients were measured out and mixed using a feed mill mixer to ensure homogeneity. Percentage composition of graded levels of maize offal for wheat offal in broiler starter are presented in Tables 1. A total of three hundred (300) day-old Cobb 500 broiler chicks obtained from a commercial hatchery were used for the experiment. Prior to the commencement of the experiment, the study pens were cleaned washed, disinfected and fumigated. Similar treatment was also made on the feeders, drinkers and other equipment. A week after, wood shavings were spread on the floor of the experimental pens to a depth of approximately 3 inches. Adequate heating/lighting facilities, feeders, and drinkers were also provided.
After brooding the chicks for 2 weeks, where all recommended vaccinations were also made. Feed and clean drinking water were served ad libitum throughout the 56-day trial period. Birds were also

given the second dose of Infectious Bursal Disease vaccine (Gumboro vaccine) (Booster) on the 21st day and another of NCDV a week after.

Table 1: Ingredients Composition (%) and Calculated Analysis of Dietary Levels of Maize Offal as Replacement for Wheat Offal Fed to Starter Broilers (1 – 4 weeks)

Diets

Ingredient **1 2 3 4 5**
Maize 46.50 46.50 46.50 46.50 46.50 Full-fat soya bean 34.00 34.00 34.00 34.00 34.00 Wheat offal 10.00 7.50 5.00 2.50 0.00 Maize offal 0.00 2.50 5.00 7.50 10.00 Fish meal 5.00 5.00 5.00 5.00 5.00 Bone meal 2.50 2.50 2.50 2.50 2.50 Limestone 1.00 1.00 1.00 1.00 1.00 Salt (NaCl) 0.25 0.25 0.25 0.25 0.25 Premix* (Starter) 0.25 0.25 0.25 0.25 0.25 Methionine 0.30 0.30 0.30 0.30 0.30 Lysine 0.20 0.20 0.20 0.20 0.20 **Total 100.00 100.00 100.00 100.00 100.00 Calculated analysis (%)**
ME (Kcal/kg) 2835.00 2847.68 2859.00 2872.14 2881.52 Crude Protein 22.85 22.75 22.65 22.55 22.45 Crude Fibre 3.70 3.78 3.87 3.96 4.05 Ether Extract 4.01 4.00 3.98 3.96 3.95 Calcium 1.80 1.79 1.79 1.79 1.79 Phosphorous 0.82 0.82 0.81 0.81 0.81 Methionine 0.66 0.66 0.66 0.66 0.66 Lysine 1.20 1.20 1.20 1.20 1.20 ME; Metabolizable energy.

Experimental Design
The birds were weighed to determine their initial weights and randomly allotted to five experimental diets in 3 replicates of 20 birds each in a completely randomized design (CRD). The experiment were conducted in a completely randomized design (CRD), (Steel and Torrie, 1990).

Data Collection
Feed consumption, weight gain, feed conversion ratio, and mortality were the performance parameters monitored during the study period. Initial live weights of chickens were taken at the beginning of each experiment, thereafter, weekly weights were determined. These were in turn used to calculate the daily weight gain (DWG). Daily mean feed intakes were also determined by subtracting the weight of left-over feed from the quantity offered the previous day. Feed conversion ratio on the other hand, was calculated from the relationship;

…………………………………………………………… *(3)*

Where FCR= feed conversion ratio, FI= feed intake and WG= weight gain. Mortalities were recorded for each treatment throughout the feeding trial.

RESULTS AND DISCUSSION.
The performance of broiler chickens fed dietary levels of maize offal as replacement for wheat offal is presented in Table 2.
Initial weights of birds used in this experiment which ranged between 207.66 (diet 3) to 226.66 g (diet 5), was not significantly different among diets. This agrees with Makinde and Sonaiya (2011). These authors however, did not report any significant difference in initial weight and daily weight gain in starter phase. However, body weight at 4 weeks was significantly (P<0.05) affected with birds on diet 5 (997.38 g) having higher weights while those fed diet 1 (888.43 g) had the lowest, The significant influence of diet on body weight gain obtained at the starter phase contradicts to the findings of Ajighjigh *et al.* (2017) and Ajighjigh *et al.* (2018) whose found no significance different on body weight gain at starter phase (671.34) and (678.46) for birds on diet 3 and 4 respectively, but concur with Makinde and Inuwa (2015) whose reported significance influence on body weight at starter phase. Diet 3 (852.35g) was intermediate and did differ from diets 2 (941.20 g) and 4 (903.17 g). Mortality of two birds was recorded on diets 2 and 3 during the starter phase.

Table 2: Performance of Broiler Chickens Fed Diets Containing Maize Offal as replacement for Wheat Offal

Diets

Parameters 1 2 3 4 5 SEM Productive performance
Initial weight (g) 211.33 220.00 207.66 215.00 226.66 10.91^{NS} Week 4 weight (g) 888.43^{c} 941.20^{ab} 852.35^{b} 903.17^{ab} 997.38^{a} 45.34* Total weight gain (g) 1099.76 1161.20 1060.01 1118.17 1224.04 102.73^{NS} **Starter phase (1 – 4 weeks)**
Total feed intake (g) 1199.52^{b} 1748.60^{a} 1695.40^{a} 1792.56^{a} 1994.16^{a} 176.45* Daily feed intake (g)

42.84[b]62.45[a]60.55[a]64.02[a]71.22[a]5.83* Daily weight gain (g) 15.97[c]25.76[ab] 23.02[b]24.58[ab] 27.52[a]2.30* Feed conversion ratio 2.69 2.43 2.65 2.61 2.59 0.24[NS] Mortality (No.) 0 1 1 0 0 -

[abc]Means bearing different superscripts within the same row differ; * = (P<0.05); NS= Not significant; SEM = Standard Error of Means

CONCLUSION AND RECOMMENDATION

Based on the results obtained in this study, it was concluded and recommended that; Maize offal can replace wheat offal in broiler starter chicken diets without compromising performance. There for maize offal can be recommended as a potential fibre source in broiler starter chicken diets.

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METABOLISABLE ENERGY VALUE AND ANTI-METABOLITES OF CASSAVA PEELS PRODUCTS IN POULTRY

[1,2] Oladimeji S. O., [1]Ogunwole O. A., [1]Adeyemi, A. A. and [1]Tewe O. O.
[1] Agricultural Biochemistry and Nutrition Unit, Department of Animal Science, University of Ibadan. [2] Animal Nutrition Department, Amo Byng Nigeria Limited, Awe, Oyo, Oyo State
Corresponding author: Oladimeji S. O. Email: oladimejioo@gmail.com; Phone: +2348062411299

ABSTRACT
The metabolisable energy value and antinutrient composition of cassava peel products were determined in this study. Four cassava peel products namely; coarse cassava peel mash (CCPM), fine cassava peel mash (FCPM), whole cassava peel mash (WCPM) and sundried cassava peel meal (SCPM) were processed from fresh cassava peels. The products were assessed for energy values and antimetabolites. Results showed that CCPM had significantly higher (P<0.05) gross energy (3577.20KKcal/Kg), while FCPM had the highest apparent metabolisable energy (2862.7) Kcal/Kg). The SCPM contained the highest (P<0.05) cyanide, oxalate, tannin, saponin and alkaloids which ranged from 14.52-20.63mg/100g (cyanide), 28.24-68.58mg/100g (Phytate), 6.15-9.13mg/100g (oxalate), 67.79-286.97mg/100g (tannin), 1.21-3.83mg/100g (saponin) and 5.97-10.08mg/100g (alkaloids). It was concluded that processing of cassava peels helped to reduce antinutrient composition of cassava peel products and increased metabolisable energy of cassava peel products.

Keywords: Nutrients, Chemical composition, Anti-nutritional factors, Agro-industrial by-products

INTRODUCTION
The increasing cost of feedstuffs has resulted in amplified search and use of alternative ingredients, particularly, as energy and protein sources. The increased search is largely caused by poor yield, reduced annual rainfall and increase cost of raw materials. Morgan and Choct (2016) have attributed increased drought and competitions between human and animal industry as contributors to high raw materials cost. Recently, the price of maize and soya increased by 78 and 100% in December 2020, from an initial price of 90 and 110 naira in January 2020, respectively.
The average usage of maize in commercial poultry feed is between 50-60% while soybean meal, between 20-30%. Significant saving would be made if the usage of maize is reduced. Cassava tuber and cassava peels are one of the products that could help reduce the consumption of maize (Morgan and Choct, 2016; Etuk *et al.,* 2017). Cassava peels are less competed for by human industry and is an Agro-Industrial By-products (AIBs) from cassava tuber processed for human industry.
Sundried cassava peels is the most common form of cassava peel presentation of cassava peel. However, authors have suggested that different processing methods such as fermentation, boiling and physical methods could help to reduce the antinutrients and microbial toxins (Okike *et al.,* 2015; Etuk *et al.,* 2017) level of the cassava peels. Okike *et al.* (2015) submitted that combination of physical processing methods using similar machinery for garri production could help to address the challenge. Three products named fine, whole and coarse cassava peel mash were developed from cassava peels. The new products need to compare with the conventionally known sundried cassava peel.
The usage and preference of any cassava peel products require adequate knowledge of metabolisable energy and anti-nutrients. There is therefore the need to determine the metabolisable energy of cassava peel products and anti-nutrient, which is the reason for this study.

MATERIALS AND METHODS
Test Materials
Four cassava peel products namely sundried cassava peel meal (SCPM), fine cassava peel mash (FCPM), coarse cassava peel mash (CCPM) and whole cassava peel mash (WCPM) were used for this study. Fresh cassava peels were obtained from garri processing plant. A fraction of the fresh cassava peel was sundried for 3-5 days, plate milled and named SCPM. The remaining cassava peels were grated, dewatered using hydraulic press overnight. The cake obtained was pulverised and sundried

was named WCPM. A fraction of the cake was also pulverised and sieved to obtain the coarse and fine fraction. Both fractions were then sundried to obtain CCPM and FCPM.

Experimental Site

The study was carried out at the Poultry Unit, Teaching and Research Farm, University of Ibadan, Ibadan. Laboratory analyses were undertaken at the Department of Animal Science Laboratories, University of Ibadan.

Determination of Antinutrients in Cassava peel products

The anti-nutrients determined were cyanide (Bradbury *et al.,* 1999; Egan *et al.,* 1998), phytate (Wheeler and Ferrel, 1991), oxalate (Oke, 1969), saponin (Harborne, 1984) and alkaloids of each cassava peel products in quadruplicate.

Apparent Metabolisable Energy of Cassava Peel Products Determination Apparent metabolisable energy determination of FCPM, WCPM, CCPM and SCPM were determined using 108, 21-day old Abor Acres broiler chicks; practical diet replacement method of Hills and Anderson (1958) as explained by Mandal *et al.* (2006) was employed in a completely randomized design.

Nine groups of broiler chickens were offered nine dietary treatments. They were replicated 6 times with 3 birds per replicate. Diet I was conventional reference grower diet, while diets II, III, IV, V, VI, VII VIII and IX had maize in reference diets replaced with 20% and 40% CCPM, FCPM, SCPM and WCPM.

The average feed intake was determined before feeding. The quantity consumed was used to calculate the average feed consumption during this period and the average feed to be consumed for the next three days of data collection.

Total excreta was collected and used. The excreta were oven-dried, the gross energy of feed, excreta was determined with e2K model of Oxygen bomb calorimeter. The metabolisable energy and dry matter of the seven diets were calculated.

Calculation of AME_N

The apparent metabolisable energy values of the diets were determined using the method of Hill and Anderson (1958) adopted by Mandal *et al.,* (2006). The apparent metabolisable energy values of the test cassava peel products were calculated using simultaneous equations: AME_n=0.80R+0.20T and 0.60R + 0.40T (where R is the AMEn of reference diet and AMEn of the Test ingredient is represented as T).

Statistical Analysis

The design was a completely randomized design. Data were subjected to analysis of variance using the procedure of SAS (2002).

RESULTS AND DISCUSSION

The anti-nutrients content and energy values of cassava peel products are presented in Tables 1 and 2. The results showed that anti-nutrients levels in cassava peel products were influenced. The SCPM had the highest ($P<0.05$) level of cyanide (20.63mg/100g), oxalate (9.13 mg/100g), tannin (86.97mg/100g), saponin (3.83 mg/100g) and alkaloids (10.28 mg/100g). Phytate (68.58 mg/100g) was highest ($P<0.05$) in WCPM. Anti-nutrients have been reported to influenced utilisation and absorption of nutrients with cyanide considered the most toxic anti-nutrients in cassava (Montagnac *et al.,* 2009). The cyanide levels of the cassava peel products were lower than European countries standard of less than 50mg/Kg of HCN (Okafor and Nwabuko, 2003).

The phytate levels obtained for all the cassava peel products were lower than value reported by Oboh (2006). The phytate levels were observed to be higher than cyanide levels in the products. Oxalates values reported for the cassava peel products were lower than 33mg/100g reported by Aro *et al.* (2010) and the values were lower than 100,000 mg/100g considered to be deleterious to animals (Matham and Sutherland, 1992). Higher tannin level has been reported to result in toxicity, poor nutrient utilisation and sometimes death (Garg *et al.,* 1992; Salinikowe *et al.,* 2001). Varietal differences could be responsible for the difference between anti-nutrient of the cassava peel products obtained to cassava peels figures reported by Aro *et al.* (2010).

Table 1: Anti-nutrients content (mg/100g) of cassava peel products

Parameters	Coarse cassava	mash	SEM
Sundried cassava	peel mash	Whole cassava	
peel meal	Fine cassava peel	peel mash	

Cyanide 20.63^{a} + 0.47 14.52^{d} + 0.18 19.25^{b} + 0.31 15.62^{c} + 0.24 0.76 Phytate 28.24^{d} + 1.35 43.09^{c} + 2.38 61.37^{b} + 0.9^{4}68.58^{a} + 2.46 4.78 Oxalate 9.13^{a} + 0.17 7.53^{c} + 0.26 6.15^{d} + 0.21

8.05[b] + 0.10 0.33 Tannin 86.97[a] + 0.29 67.79[d] + 0.33 74.64[c] + 0.06 81.35[b] + 0.42 2.17 Saponin 3.83[a] + 0.16 1.32[c] + 0.02 2.09[b] + 0.06 1.21[c] + 0.03 0.31 Alkaloid 10.08[a] +0.04 5.97[d] + 0.14 7.50[c] + 0.14 9.58[b] + 0.07 0.50 [abc] Means with the same superscripts in the same row are not significantly different (P>0.05)

Table 2 Energy content (Kcal/Kg) of cassava peel products

Parameters	Coarse cassava	mash	SEM
Sundried cassava	peel mash	Whole cassava peel	
peel meal	Fine cassava peel	mash	

Gross energy 3511.80[b]3577.20[a]3400.70[e]3377.30[e]24.89 AME 2581.84[b]2593.65[b]2862.70[a]2752.23[a]40.45 [abc] Means with the same superscripts in the same column are not significantly different (P>0.05) AME= Apparent metabolizable energy, SEM= Standard error of mean.

Saponin has been reported to prevent the absorption of cholesterol in the small intestine (Farell, 2013). Though, values obtained were lower than those reported by Aro *et al.* (2010) for cassava peel. Alkaloid contents were within the safety margin for consumption. McDonald *et al.* (2010) had reported that alkaloid content below 0.6g/kg was safe for consumption.
Energy indices are important tools in the measurement of available energy in feedstuffs. The cassava peel products studied has lower energy content compared to maize. The cassava peel products had lower gross energy compared to 3714Kcal/kg reported by Hoai *et al.* (2011) for cassava meal. The apparent metabolisable energy was highest in FCPM and was an indication that higher gross energy does not translate to higher metabolisable energy. This study also disagrees with Ravindran (2013) submission that 30% of ingested energy was lost as feaces. The lower apparent metabolisable energy obtained for SCPM could be due to the influence of higher anti-nutritional factors in it.

CONCLUSION AND RECOMMENDATION

Sundried cassava peel meal had the highest cyanide, oxalate, tannin, saponin and alkaloid content but phytate. The processing methods also improved the apparent metabolisable energy of the new products; FCPM recorded the highest apparent metabolisable energy.

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EFFECT OF GARLIC (*ALLIUM SATIVUM)* SUPPLEMENT ON PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS

Ibrahim *, H[1]., Egbewande, O.O., Aliyu, Z., Oluwawuni, T.B. and Awolola, G Department of Animal Production, Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai, Niger State, Nigeria.

*Corresponding Author : ihadiza080@gmail.com GSM No- 08036101761

ABSTRACT

The study was conducted to investigate the effect of garlic supplement on the growth performance and carcass characteristics of broiler chickens. One hundred and twenty day old chicks of mixed sexes were randomly allotted into four treatment groups, thirty birds per treatment and were replicated three times with ten birds per replicate in a complete randomized design. Four test diets were formulated and designated as Diet 1 for control, while Diet 2, 3, and 4 with inclusion levels of garlic powder at 0g/kg,10g/kg, 15g/kg and 20g/kg respectively. The study lasted for eight . The parameters investigated were performance Cut-up parts and Visceral organs. Data generated were subjected to analysis of variance and significant differences separated using Least Significant Difference. The results on performance showed that there were no significant (P>0.05) difference in the parameters measured except percentage dressed weight that showed significant difference with T1 having a higher value of 64.33% closely followed by T4 with 62.60% , T2 with 61.10 % and the least value was T3 with 54.53% , highest percentage of mortality were recorded on birds fed with T 1 (10.00%), followed by diet 2 (6.67%),T 3 (6.67%) and T4 recorded the least of percentage of mortality with the value (3.3%) results obtained for cuts off parts also showed non significant difference except wings and backs that were significantly different across the treatment groups. The same trend of non significant difference were observed in Visceral organs of broiler chickens fed garlic supplement except abdominal fat and intestine that were significantly different across the treatment groups. From the result obtained , Birds fed with inclusion rate of garlic at T4 had the lowest mortality rate, this may have great impact on production of the broilers chicken and can be recommended as the best diet to be fed to broiler chickens

Keywords: Supplements, Chickens, Carcass, Characteristics, Garlic

INTRODUCTION

Poultry that can efficiently solve the problem of animal protein shortage in most of the developing countries like Nigeria (Olabanji *et al*. 2009). Poultry industry in Nigeria occupies a prominent position as a important source of animal protein supply to the citizen. Over the years, the growth of poultry industry has followed a pattern closely dictated by the economic fortunes of the countries. The sector contributed about 25% of the agricultural domestic products of the Nigerian economy (FAO, 2009) Nigeria. Currently rated as the leading country in Africa with respect to egg production and fourth in broiler production, Garlic (*Allium sativum* L) is bulbous vegetable, well known spice and medicinal plant, which belongs to the family *Liliaceae* and genus *Allium* (Simon and Jenderek, 2003). The importance of garlic in recent years, has to a wide range of useful properties, it has been increasingly used as an additive in nutrition and health of farm animals (pigs, poultry, cattle, sheep). The objectives of the present study, therefore was to determine the effects of garlic supplement on growth performance and carcass parameters of broiler chickens.

MATERIALS AND METHODS

Location of experimental site: The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Department of Animal Production, Faulty of Agriculture, Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria.

Processing of Test ingredient (garlic)

Fresh garlic gloves were peeled and washed to remove adhering debris and cut/ sliced into small sizes after which they were dried for three days, and then ground into powdery form and finally in cooperated in to the starter and finisher diets for the birds.

Experimental birds and their management

One hundred and twenty (120) mixed sex day-old broiler chicks were bought from Karmadex Nigeria Plc, Ibadan and used for this experiment. They were allotted into four treatments of three replicate each containing ten birds. The birds were placed on the experimental diet on their arrival. The chicks were brooded on deep liter and heat was supplied using charcoal pot and kerosene lanterns as sources of heat and light. The birds were vaccinated against endemic diseases in the area via drinking water. Feed and water were supplied *ad-libitum.*

Experimental design

Experimental diets were formulated and fed at graded levels of inclusion of 0g/kg , 10g/kg, 15g/kg and 20g/kg of garlic powder respectively and designated as T1==0g/kg , T2== 10g/kg, T3==15g/kg and T4==20g/kg of garlic powder respectively (Table 1 and 2).

Table 1: Composition of experimental broiler starter diets

Ingredients (%) T1 T2 T3 T4

0kg 10kg 15kg 20g/kg

Maize 54.40 54.40 54.40 54.40 Groundnut 32.00 32.00 32.00 32.00 Wheat Offal 5.00 5.00 5.00 5.00 Fish Meal 5.00 5.00 5.00 5.00 Bone Meal 0.50 0.50 0.50 0.50 Premix 0.50 0.50 0.50 0.50 Limestone 2.00 2.00 2.00 2.00 Salt 0.50 0.50 0.50 0.50 Lysine 0.10 0.10 0.10 0.10 Methionine 0.10 0.10 0.10 0.10 Garlic g/kg 0.00 2.00 1.50 1.00

Total 100.00 100.00 100.00 100.00 Calculated Values

Crude Protein 23.10 23.10 23.10 23.10 ME Kcal/kg 2877.37 2877.37 2877.37 2877.37 Fibre 3.25 3.25 3.25 3.25 Key:ME =Metabolizable Energy, T1 = contained only feed ingredient without garlic powder (Control), T2 = contained feed ingredient with 20g/kg of garlic powder, T3 = contained feed ingredient with 15g/kg of garlic powder, T4 = contained feed ingredient with 10g/kg of garlic powder

Data Collection

Data were collected on growth performance as seen below ,

- Mean weight gain = Mean final weight(g) – mean initial weight(g)
- Mean daily feed intake = mean total feed intake / Number of days

Feed conversion ratio = mean of feed intake / Mean of weight gain by birds

The carcass characteristic was carried out at the end of the experiment. Three birds per treatment were randomly selected, slaughtered and dressed with hot water (scalding). After dressing, the visceral organs and the cut-up parts were weighed in grams. Statistical analysis: All data obtained from the experiment were subjected to Analysis of Variance (ANOVA) according to the procedure of Gen Stat, (2014)

Table 2: Composition of experimental broiler finisher diets

Ingredients (%) T1 0 T210 T3 15 T4 20 0g/kg 10kg 15kg 20kg

Maize 54.40 54.40 54.40 54.40 Groundnut 28.40 28.40 28.40 28.40 Wheat Offal 10.50 10.50 10.50 10.50 Fish Meal 3.00 3.00 3.00 3.00

Bone Meal 2.00 2.00 2.00 2.00 Premix 0.25 0.25 0.25 0.25 Limestone 1.00 1.00 1.00 1.00 Salt 0.25 0.25 0.25 0.25 Lysine 0.10 0.10 0.10 0.10 Methionine 0.10 0.10 0.10 0.10

Garlic powder g/kg 0.00 2.00 1.50 1.00 **Total 100.00 100.00 100.00 100.00**

Calculated Values

Crude protein 20.26 20.26 20.26 20.26 ME Kcal/kg 2917.04 2917.04 2917.04 2917.04 Fibre 3.65 3.64 3.64 3.64 Key:ME =Metabolizable Energy, T1 = contained only feed ingredient without garlic powder (Control), T2 = contained feed ingredient with 20g/kg of garlic powder, T3 = contained feed ingredient with 15g/kg of garlic powder, T4 = contained feed ingredient with 10g/kg of garlic powder

RESULTS AND DISCUSSION

The result on the effect of garlic supplementation on performance parameters of broilers chicken is presented in Table 3 . The results showed that broiler chickens fed diet supplemented with garlic powder were not significantly (P>0.05) different in all the parameters across the treatments groups except Dressing percentage that was significantly (P>0.05) different from T4 20g/kg (62.60) but having similar value with T1 0g/kg (64.33). This could be attributed to the high amount of garlic powder inclusion in the treatment diet and is not in accordance with the finding of Raeesi *et al* (2010), who reported that it is better to use garlic as growth stimulator periodically than continuously

Table 3: Performance characteristics of broiler chickens fed garlic supplement Parameter T1 T2 T3 T4 SEM LSD

0kg 10kg 15kg 20kg

Initial weight 0.037 0.036 0.034 0.038 0.002 NS

Final Body weight 1.03 1.10 1.06 1.06 0.12 NS Weekly body weight gain (kg) 0.12 0.13 0.13 0.13 0.01 NS Dressed weight (kg) 0.83 0.66 0.67 0.73 0.93 NS Percent Dressed weight 64.33[a] 61.10[a] 54.53[b]62.60[a]3.31 *

Feed Intake (kg) 0.53 0.45 0.45 0.49 0.04 NS FCR 0.24 0.30 0.29 0.27 0.04 NS Mortality (%) 10.00

6.67 6.67 3.33 **Means in the same row with different letters in superscript are significantly different (P < 0 05) Mean ± Standard deviation, FCR = Feed Conversion Ratio, SEM =Standard Error Mean, LSD = Level of Significant Difference**

Result of Internal organ weights of broiler chickens expressed as percent of live weight is presented in (Table 4) . The parameters considered here were not significant (P<0.05) affected in birds fed diets containing garlic powder as supplement except abdominal fat and intestine with T3 recorded highest value 4.25 and that could result from higher proportion of test ingredient in the inclusion

level in the diet and effect of garlic on increase of mass of internal organs as explained by Otunola *et al* (2010) which is not in agreement with the studies by Raeesi *et al* (2010), who reported that the consequences of adverse effect of garlic derive from its chemical composition, and intestine recorded similar values across the treatment groups

Table 4: Visceral organs or internal organs of broiler chickens fed garlic supplement

Visceral organ (g) T1 T2 T3 T4 SEM LSD 0kg 10kg 15kg 20kg
Liver 31.67 24.83 24.33 31.67 5.88 NS Kidney 9.50 8.10 5.83 8.10 1.55 NS Heart 7.33 6.67 6.17 7.17 1.01 NS Spleen 1.25 0.82 0.42 0.42 0.57 NS Pancreas 3.00 3.50 3.17 2.50 0.57 NS Gizzard 40.50^{a}35.67^{c} 40.83a 39.17^{b}4.49 NS Abdominal fat 2.83 4.25 2.50 2.25 0.94 * Proventriculus 7.83 7.50 8.10 9.00 1.38 NS Intestine 111.17^{a}104.33^{b} 106.00^{b} 108.67^{b}14.18 * **Means in the same row with different letters in superscript are significantly different (P < 0 05)Mean ± Standard deviation, SEM =Standard Error Mean, LSD = Level of Significant Difference**

Result of the Cut-up parts of broiler chickens fed garlic powder supplement is presented in Table 5 Cut up difference among the treatment groups except on the neck and back that were significantly (P<0.05) were not affected by the test ingredient. Stanacev *et al* (2010) and Raeesi *et al* (2010) also obtained similar result in their studies that revealed no significant different effect of garlic on cut up parts. Control treatment (zero inclusion) had a significantly higher proportion of back and wing compared with other treatment groups , which was in agreement with of results of these authors Stanacev *et al*. (2010).

Table 5 : Cut-up parts of broiler chickens fed garlic supplement

Cut-up Parts (g) T1 T2 T3 T4 SEM LSD 0kg 10kg 15kg 20kg
Head 43.17 37.00 36.67 38.33 3.00 NS Neck 51.67 40.33 42.33 47.83 4.60 NS Wings 98.00^{a} 81.81^{c} 91.00^{a}86.33^{b} 6.38 * Drumsticks 123.00 100.67 101.83 110.67 22.33 NS Thigh 141.50 114.83 117.33 117.00 14.91 NS Chest 193.16 161.00 170.83 175.33 22.70 NS Back 170.67^{a}133.83^{b} 126.83^{c}147.67^{b} 13.88 * Shank 55.17 49.50 51.59 52.50 5.46 NS Means in the same row with different letters in superscript are significantly different (P < 0 05)Mean ± Standard deviation, SEM =Standard Error Mean, LSD = Level of Significant Difference Error Mean, LSD = Level of Significant Difference

CONCLUSION

Based on results obtained in this trial, garlic Supplementation on performance and carcass characteristics of broiler chickens can be improved specially at T4 20g/kg of garlic. Carcass characteristics were not significantly (P > 0 05) influenced by the garlic dietary inclusion levels

RECOMMENDATION

From the above, it could be concluded that Birds fed with inclusion level of garlic at T4 20g/kg of garlic can be recommended as the best diet to be fed to broiler chickens

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UTILIZATION OF RICE OFFAL AS A RELPACEMENT FOR WHEAT OFFAL AS DIETARY FIBRE SOURCE BY BROILER CHICKENS

[1]Shuibu Inuwa and [2]Yakubu Usman
[1]Ministry of Agriculture, Bauchi, Bauchi State Nigeria
.[2]Department of Animal Health, Bauchi State College of Agriculture.
Nigeria Corresponding Author: shu‘ibu inuwa@gmail.com; Phone no: 08123729404

ABSTRACT
An experiment was conducted to evaluate the response of broiler chickens to dietary levels of Rice offal as replacement to Wheat offal, using a completely randomized design, A total of three hundred (300) day-old *Cobb 500* broiler chicks obtained from a commercial hatchery were used for the experiment. Feed and water were supplied *ad lib* and the trial lasted for 4 weeks. In the experiments. Rice offal replace Wheat offal as diet 1,2,3,4 and 5 respectively, as 0 (diet 1), 25 (diet 2), 50 (diet 3), 75 (diet 4), and (diet 5)100% levels. However, a synthetic enzyme, Roxazyme G, at 100g/kg feed was supplemented along with the offal. The Results showed no significant influence ($P<0.05$) of diet on initial weight, total weight, final weight gain and feed conversion ratio. However, performance traits significantly ($P<0.05$) differ among the diets on total feed intake, daily feed intake, daily weight gain and week 4 weight gain respectively. It was therefore concluded that Rice offal can replace Wheat offal with synthetic enzyme supplementation up to 100% level in broiler chicken diets without compromising performance.
Keywords: Commercial diets, Broiler chickens and performance.

INTRODUCTION
Poultry production is the management of some or other species of birds (as earlier enumerated) mainly for economic and nutritional purposes. These are domesticated birds reared for their flesh or meat. The production of table birds (broilers) has grown into a major industry in many advanced countries. However, it is more specialized than egg production (Oluyemi and Roberts, 2011). Hence, commercial table birds' industry is now largely based on broilers. These are fast growing birds which reach market weight of 1.8 to 2.0kg in eight or twelve weeks at most. They are referred to as meat chicken. Members of this group grow rapidly and attain market weight within two (2) to three (3) months of age. Depending on the size and age, a meat chicken can be further classified as fryer or a roaster. However, whether a fryer or a roaster, all meat chickens are generally called broilers. They are sold and eaten before they attain egg laying age. Alltech, (2018), also referred to castrated male chickens as capons.
Sorghum, millet, maize offal, rice bran and wheat offal, millet bran, spent sorghum grain and broken rice could be recommended as alternative sources of feed ingredients in poultry diets.(Medugu *et al*.,2011). Several workers have emphasized the need for utilizing alternative feed ingredients removed from human and industrial uses (Durunna et al., 1999; Fanimo *et al*., 2007; and Nsa *et al*., 2007).

MATERIALS AND METHOD
Experimental Site
The experiments were carried out at the Poultry Unit, Teaching and Research Farm, Abubakar Tafawa Balewa University, Bauchi. The town, Bauchi, is located within the southern guinea savannah on latitude 10.31 N and longitude 9.84 E. It is 616 metres above sea level characterized a rainy season that commences in May and terminates in October and a dry season that starts in November and ends in April. Mean annual rainfall is 1009 mm,

highest relative humidity 94% (August) and the lowest 35% (February). Temperatures are between 13-17oC (December – February) and 36 – 37oC (March – April) (World Atlas, 2015).
Experimental diets
Five experimental starter diets containing 23% CP were formulated. Diet 1 which served as the control contained 0% rice offal, while diets 2, 3, 4 and 5 contained 25, 50, 75 and 100% levels of rice offal as replacement for wheat offal. The ingredients were measured out and mixed using a feed mill mixer to ensure homogeneity. Percentage composition of graded levels of rice offal for wheat offal in broiler starter diets are presented in Tables 1.

Table 1: Ingredients Composition (%) and Calculated Analysis of Dietary Levels of Rice Offal Supplemented with Raxozyme® Fed to Starter Broilers (1- 4 weeks) **Diets**

Ingredient	**1**	**2**	**3**	**4**	**5**

Maize 47.90 47.90 47.90 47.90 47.90 Full-fat soya bean 19.23 19.23 19.23 19.23 19.23 Groundnut cake 14.37 14.37 14.37 14.37 14.37 Wheat offal 10.00 7.50 5.00 2.50 0.00
Rice offal 0.00 2.50 5.00 7.50 10.00 Fish meal 5.00 5.00 5.00 5.00 5.00 Bone meal 2.50 2.50 2.50 2.50 2.50 Limestone 1.00 1.00 1.00 1.00 1.00 Salt (NaCl) 0.25 0.25 0.25 0.25 0.25 Premix* (Starter) 0.25 0.25 0.25 0.25 0.25 Methionine 0.30 0.30 0.30 0.30 0.30 Lysine 0.20 0.20 0.20 0.20 0.20
Total 100.00 100.00 100.00 100.00 100.00 Calculated analysis (%)
ME (Kcal/kg) 2840.00 2851.00 2862.00 2873.00 2884.00 Crude Protein 22.98 22.83 22.72 22.61 22.50 Crude Fibre 3.62 3.72 3.82 3.92 4.02 Ether Extract 6.76 6.99 7.22 7.45 7.67 Calcium 1.61 1.60 1.59 1.58 1.57 Phosphorous 0.73 0.74 0.75 0.76 0.77 Methionine 0.64 0.65 0.66 0.67 0.68 Lysine 1.28 1.28 1.29 1.29 1.30 ME; Metabolizable energy

Experimental Design

The birds were weighed to determine their initial weights and randomly allotted to five experimental diets in 3 replicates of 20 birds each in a completely randomized design (CRD). (Steel and Torrie, 1990).

Experimental birds and their management

A total of three hundred (300) day-old Cobb 500 broiler chicks obtained from a commercial hatchery were used for the experiment. Prior to the commencement of the experiment, the study pens were cleaned washed, disinfected and fumigated. Similar treatment was also made on the feeders, drinkers and other equipment. A week after, wood shavings were spread on the floor of the experimental pens to a depth of approximately 3 inches. Adequate heating/lighting facilities, feeders, and drinkers were also provided.

After brooding the chicks for 2 weeks, where all recommended vaccinations were also made, the birds were weighed to determine their initial weights. Feed and clean drinking water were

served ad libitum throughout the 56-day trial period. Birds were also given the second dose of Infectious Bursal Disease vaccine (Gumboro vaccine) (Booster) on the 21st day and another of NCDV a week after. All vaccines and drugs were orally administered.

Data Collection

Performance parameters

Feed consumption, weight gain, feed conversion ratio, daily weight gain, initial weight and final weight were the performance parameters monitored during the study period. Initial live weights of chickens were taken at the beginning of experiment, thereafter, weekly weights were determined. These were in turn used to calculate the daily weight gain (DWG). Daily mean feed intakes were also determined by subtracting the weight of left-over feed from the quantity offered the previous day. Feed conversion ratio on the other hand, was calculated from the relationship;

Where FCR= feed conversion ratio, FI= feed intake and WG= weight gain. Mortalities were recorded for each treatment throughout the feeding trial

RESULTS AND DISCUSSION

The performance of broiler chickens fed dietary levels of rice offal as replacement for wheat offal were presented in Table 2. Results for productive performance did not reveal any significant influence of diet, except for body weight at 4 weeks. Initial weight of birds ranged between 233.33 g on diets 2 and 4 to 246.67 g on diet 5. Body weight of broiler chickens at the end of starter phase (4 weeks) was significantly ($P<0.05$) lower on diet 1 (645.13 g) than on all other diets (711.85 – 737.15 g) which were the same

During the starter phase, daily feed intake and daily weight gain were significantly ($P<0.05$) affected. Daily feed intake was higher on diets 3 (52. 45 g) and 4 (51.57 g) and lower on diet 1 (45.45 g). However, diets 2 (49.23 g) and 5 (49.91 g) did not differ from 1, 2 and 3. Daily weight gain was lower ($P<0.05$) on diet 1 (14.50g) and higher on other diets (17.08 – 17.52 g). Feed conversion ratio, 2.82 to 3.15 on diets 2 and 1 respectively, did not differ among diets, while mortalities of 2 (diet), 2 (diet 2), 1 (diet 3) and 1 (diet 5) birds were recorded during this growth segment. The significant ($P<0.05$) effect of diet on total feed intake, daily feed intake and daily weight gain obtained in this experiment, supports the findings of Supriyati *et al.* (2015) using fermented rice bran in broiler chicken diets. The decreased feed intake in the rice bran based diets could be attributed to the higher crude fibre content of the diet. According to Gonzalez-Alvarado *et al.* (2007), increased crude fibre content of the diet decreases feed consumption of broiler chickens.

Table 2: Performance of Broiler Chickens Fed Diets Containing Rice Offal as Replacement for Wheat Offal (g/bird)

	Diets					
Parameters	**1**	**2**	**3**	**4**	**5**	**SEM**
Productive performance						
Initial weight (g)	239.17	233.33	235.83	233.33	246.67	9.53 ^{NS}
Week 4 weight (g)	645.13^{b}	722.22^{a}	714.58^{a}	711.85^{a}	737.15^{a}	14.53*
Total weight gain (g)	884.30	955.56	950.41	945.18	983.82	98.03 ^{NS}
Starter phase (1 – 4 weeks)						
Total feed intake (g)	1272.60^{b}	1378.44^{ab}	1468.60^{a}	1443.96^{a}	1397.48b	57.31*
Daily feed intake (g)	45.45b	49.23ab	52.45a	51.57a	49.91ab	2.81*
Daily weight gain (g)	14.50b	17.46a	17.09a	17.08a	17.52a	1.00*
Feed conversion ratio	3.15	2.82	3.08	3.03	2.85	0.27^{NS}
Mortality (No.)	2	2	1	0	1	-

^{abc}Means bearing different superscripts within the same row differ; * = (P<0.05); NS= Not significant; SEM = Standard Error of Means

CONCLUSION AND RECOMMENDATION

Based on the results obtained in this study, it was concluded and recommended that; Rice offal can replace dietary wheat offal in broiler chicken rations without any deleterious effect on performance parameters. Rice offal supplemented with enzyme can replace wheat offal in broiler chicken diets up to 100% without adverse effect on performance, therefore Rice offal can be used in place of wheat offal in broiler starter ratios. Raxozyme G® enzyme is recommended at inclusion level of 100g/kg feed in broiler chicken diets at starter phase.

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EFFECT OF GARLIC (*ALLIUM SATIVUM*), GINGER (*ZINGIBER OFFICINALE*), AND THEIR COMBINATION ON THE PERFORMANCE OF BROILER BIRDS

Egbewande, O.O., Ibrahim, H.G., Idris, Y. and Kabiru, S.
Department of Animal Production, Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.
Corresponding Author: femi2015.ooe@gmail.com

ABSTRACT
This experiment was carried out to determine the effect of garlic (*Allium sativum*), ginger (*Zingiber officinale*), and their combination as immune booster on performance of broiler chickens. In a completely randomized design a total of one hundred and fifty (150) day old broiler chicks of Marshall Strain were randomly allotted into three replicates of 10 chicks/replicate (n = 30) used for the experiment. Four experimental diets were formulated in such a way that control diet (T1) contained neither ginger nor garlic. Birds in T2 were fed diet containing 2% garlic, while those in T3 were fed 2% ginger. Birds in T4 were fed combination of 1% of garlic and 1% ginger. Birds in T1 were administered vaccines (Lasota and Gumboro), while the rest treatments were not vaccinated. The experiment lasted eight weeks. Results showed that there were no significant differences in all the performance parameters measured except in feed conversion ratio (FCR). Birds fed in T4 had the best (1.82) feed conversion ratio, while the least (2.00) was recorded in birds fed garlic (T2). Birds fed combination of the test ingredients had the best (2003.21g) final body weight, followed by those fed control diet (T1) (1907.83g), while the least (1885.47g) was recorded in those fed garlic (T3). No mortality was recorded in birds fed combination of garlic and ginger while, those fed control diet had the highest. It can be concluded that the test ingredients improved the immune system of the birds.
Key words: Performance, garlic, ginger, immune, broiler

INTRODUCTION Antibiotic growth promoters (ABGPs) have been intensely used in broilers diets to improve their productivity. However, many countries have currently banned the use of these growth promoters (drugs and antibiotics) due to the side effects on animals and humans (Khachatourian, 1998). Search for alternatives to the growth promoters has arisen in animal production practices, especially in the use of additives of plant origin which are natural and safe to consumers (Soliman, 2003). Garlic and ginger can be used as natural growth promoters for their antimicrobial, antifungal, antibacterial, anti protozoal, immuno-modulatory, anti-inflammatory, hypoglycemic and cardiovascular protecting effects (Zhang *et al*., 2009). It was on the above that the study investigated the effect of garlic, ginger and their combination on the performance of broiler chickens.

MATERIALS AND METHODS **Experimental site** The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Ibrahim Badamasi Babangida University, Lapai Niger State. The area is located in the Guinea Savannah, Middle Belt of Nigeria. It lies on longitude 9.02^{o}N and latitude 6.3^{o}E of the equator with an average temperature range of 21^{o}C – 36.5^{o}C and a rainfall range of 1100-1600mm (Usman, 2013). **Source and processing of test ingredients**
Garlic and ginger were purchased at Kure Modern Market in Minna, Niger State. Garlic bulbs were peeled manually and both (ginger and garlic) were cut into smaller pieces after the removal of fibrous material (ginger) and dry scales (garlic). They were crushed using pestle and mortar, and later air dried. After drying, they were ground, passed through 1mm sieve and later mixed with other

ingredients.

Experimental diets

Four diets containing approximately 23 and 21% crude protein in starter and finisher diets respectively were formulated for the experiment (Table 1). The Metabolizable energy for both starter and finisher diets was 2877.37 and 2917.04kcal/kg respectively. The diets were formulated in such a way that control diet (T1) contained neither ginger nor garlic. Birds in T2 were fed diet containing 2%

garlic, while those in T3 were fed 2% ginger. Birds in T4 were fed combination of 1% of garlic and 1% ginger.

Table 1: Gross composition of broiler starter and finisher diets

Ingredient (%)	Starter				Finisher			
	Control	Garlic	Ginger	Combination	Control	Garlic	Ginger	Combination
Maize	54.40	52.40	52.40	52.40	56.40	54.40	54.40	54.40
Groundnut cake	31.90	31.90	31.90	31.90	26.40	26.40	26.40	26.40
Wheat offal	5.00	5.00	5.00	5.00	10.50	10.50	10.50	10.50
Fish meal	5.00	5.00	5.00	5.00	3.00	3.00	3.00	3.00
Bone meal	0.50	0.50	0.50	0.50	2.00	2.00	2.00	2.00
Limestone	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00
Premix	0.50	0.50	0.50	0.50	0.25	0.25	0.25	0.25
Common salt	0.50	0.50	0.50	0.50	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Garlic	0.00	2.00	0.00	1.00	0.00	2.00	0.00	1.00
Ginger	0.00	0.00	2.00	1.00	0.00	0.00	2.00	1.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated:								
Crudeprotein(%)	23.60	23.90	23.90	23.67	20.69	20.93	20.93	20.94
Metabolizable energy (kcal/kg)	2903.06	2893.94	2893.94	2878.07	2869.71	2859.91	2859.93	2860.34

T1 = control diet, T2 = diet + garlic, T3 = diet + ginger, T4 = diet + garlic + ginger

Experimental birds and management One hundred and twenty day old broiler chicks were used for the study. In a completely randomized design (CRD), the birds were divided into four treatments of 30 birds each and 10 chicks per replicate. Prior to the arrival of the chicks, the pens were washed and disinfected using Izal®solution and the floor of the pen was covered with wood shavings. The experiment lasted eight (8) weeks. On arrival, the chicks were served experimental diets and clean water containing anti-stress (Vitalyte®). The chicks were allocated into four treatments (T1, T2, T3 and T4). On the 10th day, chicks fed control (T1) were administered Infectious Bursal Diseases (IBD) (Gumboro) vaccine via drinking water, and on the 21st day, they were administered Newcastle Disease Vaccine (Lasota) via drinking water. On the 35th day, the infectious bursal disease vaccine was repeated. At the fourth week, Coccidiostat (Amprollium®) was administered for 3-5 days. The above vaccines were administered only to the chicks in T1.

Data collection

Feed intake was recorded on weekly basis. It was the total amount of feed consumed by the birds within the week minus the left over at the end of the week. The birds were weighed on weekly basis. Initial weight was subtracted from the final weight to get the body weight gain.
Feed conversion ratio was calculated at the end of each week as:

( )
( )

The number of birds that were alive at the expiration of the experiment was recorded and expressed as percentage (%) of the total number of stocked birds.

( )

Statistical analysis

Data collected were subjected to one-way analysis of variance (ANOVA) according to the procedure of Steel and Torrie (1980). The significant means were separated using Duncan's Multiple Range Test (Duncan, 1955) at 5% probability level.

RESULTS AND DISCUSSION Table 2 showed the results of the performance characteristics of broiler chickens fed garlic, ginger and their combination. Birds in T4 recorded no mortality while the highest mortality was recorded in T1. There were no significant (p>0.05) differences among the treatments in all the parameters studied in this trial except the feed conversion ratio (FCR). Birds in T4 had the best (1.82) feed conversion ratio, followed by those in T1 (1.95), T3 (1.96), and lastly by those in T2 (2.00) as far as this study is concerned. Birds in T4 had the highest (2003.21g) final weight gain and mean daily body weight gain of 35.77g, followed by birds in T1 (1907.83g) with mean daily body weight gain of 34.07g. Birds in T3 had the lowest mean final weight of 1885.47g with mean daily body weight gain of 33.82g. Birds in T2 had the highest (3778.91g) feed intake while, those in T4 had the lowest (3653.90g). The mean daily feed intake followed the same pattern as in feed intake.

Table 2: Performance characteristics of broilers fed test ingredients as immune booster

Parameter (g)	Control	Garlic	Ginger	Combination	*p* value
Initial body weight	37.00	36.00	35.00	34.00	0.69
Final weight	1907.83	1894.06	1885.47	2003.21	0.35
Mean daily body weight gain	34.07	33.82	33.67	35.77	0.44
Mean Feed intake	3721.79	3778.91	3686.56	3653.90	0.77
Mean daily feed intake	66.46	67.48	65.83	63.46	0.55
Feed conversion ratio (FCR)	1.95^b	2.00^c	1.96^b	1.82^a	0.04
Survival (%)	86.67	93.33	93.33	100.00	-

abc: Means with different superscripts are significantly (p<0.05) different. T1 = control diet, T2 = diet + garlic, T3 = diet + ginger, T4 = diet + garlic + ginger

The supplementation of garlic and ginger diets fed alone in the birds does not exert any significant effect on FCR as compared to control. Results obtained in this study for the final weight showed that combination of garlic and ginger (T4) improved the growth of the birds at the inclusion rate better than treatments where ginger and garlic were used singly. These results contradicted the findings of Aji *et al.,* (2011) who has reported non-significant effect of garlic on FCR. These results did not corroborate with the reports of Ademola *et al.* (2009) and Thayalini *et al.* (2011), who did not observe any significant improvement in the feed conversion ratio of broilers fed on a diet containing ginger powder as compared to the control group. The mean feed intake of the experimental birds showed no significant (p>0.05) differences. It showed that there was no effect of smell or taste of garlic and ginger on the palatability of feed in the broiler diets. Total body weight gain (g) of experimental birds fed with combination of garlic and ginger T4 showed higher value as compared to other treatments. Similar and slightly different results were reported by Zhang *et al*. (2009). Improvement in final weight and mean daily body weight gain of broiler chicks fed combination of garlic and ginger might be due to the active components in the test ingredient which stimulate digestive enzymes and improve overall digestion and thus led to increase of both parameters. Survival percent showed that the antimicrobial, antibacterial, antiviral, anti-protozoal and antifungal properties of both ginger and garlic were in action. These agreed with the reports of Rahman (2001) and Ogbuewu *et al*. (2019) that both ingredients lowered mortality and increase livability.

CONCLUSION AND RECOMMENDATION

It was concluded that the use of garlic, ginger and the combination of garlic and ginger can be used to improve growth performance of broiler birds at 20g/kg of feed, and reduced mortality rate. Though there were no statistically significant differences observed among the birds fed the different diets, but T4 (combination of garlic and ginger) recorded no mortality, and higher final weight compared to T1, T2 and T3, it is therefore, recommended that combination of garlic and ginger be used to improve broiler growth. However, further research work is recommended.

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PERFORMANCE OF GROWER CROSS BRED RABBITS OF FED FONIO (*DIGITARIA EXILIS*) OFFAL AS FIBRE SOURCE

[1]Sudik, S. D. and [2]Ajiji, I.

[1]Department of Animal Science, Federal University, Gashua, Yobe State, Nigeria

[2]Department of Animal Health and Production, College of Agriculture, Garkawa

Corresponding author‘s email: davidsudik@yahoo.com Mobile phone: +2348065633451

ABSTRACT

The over relying on wheat offal and in lesser cases maize or rice offal as fibre source in feed formulation particularly for mongastrics livestock threatens some locally available offals which perhaps could have provide alternatives. Therefore, to search for alternative, this study was conducted to determine the performance of grower rabbits of cross breed fed fonio (*Digitaria exilis*) offal as fibre source. Five diets (designated as T1, T2, T3, T4, and T5) were formulated. The content of wheat offal (WO) was replaced with fonio offal (FO) by 0%, 25%, 50%, 75% and 100%, respectively. The 0% (T1) served as control. Twenty five (25) grower rabbits of cross breed at 5 weeks old were used. They were distributed randomly into the five diets. Each diet had 5 rabbits and each rabbit represents a replicate. Rabbits fed on T5 had highest (p<0.05) total weight gain (TWG), daily weight gain (DWG) and best feed conversion ratio (FCR) than those fed on T4, T3, T2 and T1. Similarly, those fed on T4 and T3 had higher (p<0.05) weight gains and FCR than those fed on T2 and T1 while those fed on T2 had similar (p>0.05) with those fed on T1. Total feed intake and daily feed intake were similar (p>0.05) among treatments. There was no mortality. It may be concluded that FO can totally replace WO in grower rabbits' diet without negative effect performance. Therefore, FO is recommended as alternative for WO.

Keywords: fonio offal, Fibre source, Performance, Grower rabbits, Wheat offal.

INTRODUCTION

Rabbits consume many kinds of feeds satisfactorily including green feeds, dry roughages, and concentrate feeds (NAS, 2019; Owoleke *et al*., 2016). Rabbits have preference to the green feeds because of the high succulent and palatability but most green feeds (grasses and legume) are usually seasonal (NAS, 2019). A high carbohydrate concentrate added to roughages increases energy density while high protein supplement helps in meeting the recommended protein requirements (NAS, 2019). Like ruminants, the presence of fermentation vat in rabbits though distal the digestive tract make it possible to utilize high dietary fibre (Zsolt *et al*., 2011). Zsolt *et al*. (2011) reported that dietary fibre constitutes 40-50% of total diet of rabbits. The high proportion of dietary fibres in the diet and the lesser cost of fibre resources make cost of feed of rabbit lower in comparison to poultry and swine's feeds. Studying the potentials of locally available resources would provide more alternatives and sustain growing interest particularly in rabbit production. One of such locally ingredients is fonio offal. Fonio offal is a by-product of fonio (also known as hungry rice) grains (*Digitaria exilis*) obtained when producing fonio flour or preparing other fonio foods. Two varieties of fonio are found in Nigeria and are natively called ―acha‖ (*Digitaria exils*) and ―iburu‖ (*Dgitaria iburua*) (Gyang and Wuyep, 2005). Folio affal contains 11.02% crude fibre (Sudik and Gofwan, 2017) similar to 11% of wheat offal (USDA, 2012). An FAO e-conference on ‗food waste to animal feed' stressed the need to convert food wastes to animal feed (Thieme and Makkar, 2016). The aim of this study is; to determine the performance of grower rabbits of cross breed fed fonio (*Digitaria exils*) offal as dietary fibre source.

MATERIALS AND METHODS

The experiment was conducted at the Plateau State College of Agriculture, Garkawa. Garkawa is located in the Southern Zone of Plateau State, coordinated within latitude 8.8955^{o}N and longitude 9.4537^{o}E. It is characterized of Guinea Savanna climatic condition and vegetation patterns (Wikipedia, 2019).

The test ingredient was collected from fonio (acha) milling house in Bogoro town of Bogoro Local Government Area of Bauchi State, Nigeria. Five diets (T1, T2, T3, T4, and T5) were formulated. The

content of wheat offal (WO) in the diets was replaced with fonio offal (FO) by 0%, 25%, 50%, 75% and 100%, respectively. The 0% diet served as control. The diets were formulated to meet the nutrient requirements of grower rabbits described by Zsolt *et al*. (2011). Twenty five (25) grower rabbits of cross breed at 5 weeks old were purchased from a reputable Rabbit Farm in Jos, Plateau State. They were randomly divided into 5 treatments. Each treatment had 5 rabbits and each rabbit represent a replicate because each hutch could not accommodate more than one rabbit. The rabbits were individual housed in a 60 cm by 45 cm hutch equipped with feeder and drinker. They were served with their respective dietary treatments and drinking water *ad libitum*. They were dewormed with ivermetin in the first week of the experiment and coccidiostat was occasional administered as prophylactic against coccidiosis. The experiment lasted for 42 days.

At the beginning of the study the rabbits' weights were taken using a sensitive scale graduated in 0.001 to determine the initial weights and thereafter, at weekly interval to determine weekly live weight. The difference in weight between two conservative weeks gave the weekly weight gain. Daily weight gain was determined by dividing the cumulative weekly weights by 42. Feed intake was monitored daily using the same sensitive scale by subtracting the left-over from the quantity of feed supplied the previous day. Daily feed intake was determined by dividing the cumulative daily feed consumed by 42. Feed conversion ratio (FCR) was derived as the ratio of feed consumed to weight gain.

Data generated was analyzed using one-way analysis of variance (ANOVA) of the SPSS version 25.0 and significance of differences among treatments was determined using Duncan multiple range test of the same software.

Table 1: Composition and calculated nutrients (%) of experimental diets

Ingredients T1 T2 T3 T4 T5 Maize 32.50 32.50 32.50 32.50 32.50 Wheat offal 45.00 33.75 22.50 11.25 0.00 Fonio offal 0.00 11.25 22.50 33.75 45.00 Soybean 15.50 15.50 15.50 15.50 15.50 Groundnut cake 5.30 5.30 5.30 5.30 5.30 Limestone 1.70 1.70 1.70 1.70 1.70 Salt 0.50 0.50 0.50 0.50 0.50 Protein % 16.00 16.11 16.25 16.33 16.42 ME(kcal/) 2500.79 2510.47 2522.67 2536.36 2544.14 Crude fibre 10.00 10.08 10.10 10.12 10.13 Lysine 0.65 0.67 0.69 0.70 0.73 Methionine 0.45 0.45 0.47 0.48 0.50 Calcium 0.40 0.40 0.41 0.41 0.42 Phosphorus 0.22 0.23 0.24 0.25 0.25 ME = metabolizable energy.

RESULTS

Table 2 shows the performance of grower rabbits of cross breed fed fonio (*Digitaria exilis*) offal as fibre source. Rabbits fed on T5 and T4 ($p<0.05$) had highest final weights while those fed on T1 and T2 had lowest. Rabbits fed on T5 had highest ($p<0.05$) total weight gain (TWG) and daily weight gain (DWG) than those fed on T4, T3, T2 and T1. Similarly, rabbits fed on T4 and T3 had better ($p<0.05$) weight gains than those fed on T2 and T1 while those fed on T2 had similar ($p>0.05$) with those fed on T1. Total feed intake and daily feed intake were similar ($p>0.05$) among treatments. Also, rabbits fed on T5 had best ($p<0.05$) feed conversion ratio (FCR) than those fed on T4, T3, T2 andT1; those fed on T4 and T3 had better ($P<0.0$) than those fed T2 and T1 while those fed T2 had similar ($p>0.05$) with those fed on T1. There was no record of mortality.

DISCUSSION

The significant ($p<0.05$) superior performance of the grower rabbits fed on 100% FO in regard to weight gain and FCR is an indication that FO would completely replace WO without compromising

performance. This further indicates that FO may perhaps contain some nutrients that support growth and feed conversion ratio which are lacking in WO. This corroborated with the report of Sudik and Gofwan (2017) that FO contains higher level of sulfur amino acids (methionine and cysteine) than most cereal offals. Methionine helps liver to process fat and is a methyl donor capable of giving off its molecules needed for a wide variety of chemical and metabolic reactions inside the body, including the manufacture of the amino acid taurine (EFRT, 2000). Cysteine is a major constituent of the proteins, that make up hair, nails, and skin and is involved in major processes in the body (EFRT, 2000). The non-record of mortality buttressed that AO may be converted into feed without negative effect. This support the report of Thieme and Makkar (2016) and FAO (2015) that food wastes make excellent animals' feed resources.

Table 2: Performance of grower rabbits of cross breed fed acha offal as fibre source Parameters T1 T2 T3 T4 T5 Level of significant

Initial weight (kg) 1.81±0.07 NS
1.80±0.07 1.83±0.03 1.81±0.03 1.84±0.06

Final weight (kg) 2.85±9.14^{c}2.90±7.55^{c}2.94±6.99^{b}3.03±3.67^{a}3.09±4.28^{a}*
30.36±3.81^{a}* 6.30±0.15 6.33±0.21 6.31±0.22
Total weight gain(kg)
Daily weight gain (g)
Total feed intake (kg)
5.96±0.41 5.92±0.55 NS 150.10±10.12
Daily feed intake (g)
Feed conversion ratio
150.04±11.32 146.45±8.34 142.61±7.44
1.05±0.31^{c}1.07±0.51^{c}1.13±0.34^{b}1.19±0.26^{ab}
141.43±8.16 NS
1.28±0.18^{a}*
6.00±0.10^{a}5.76±0.13^{a}5.64±0.21^{b}5.01±0.13^{b}4.64±0.
25.00±3.53^{c}25.36±3.16^{c}26.79±4.12^{b}28.33±3.72^{ab}
17^{c}*

Means in the same column with different superscripts differed significantly, but similar superscripts did not differ significantly: * significantly ($P<0.05$); NS= Non- Significant ($P>0.05$).

CONCLUSION

In this study no problems were encountered by a total replacement of WO with FO in regards to the growth and feed conversion ratio of rabbits. Therefore, FO is recommended as alternative dietary fibre source in grower rabbit's diets.

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