DIETARY PROTEIN REQUIREMENT FOR GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY OF FUNAAB ALPHA BROILER CHICKENS

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ABSTRACT

A thirteen-week trial was carried out at the Teaching and Research Farm of the Federal University of Technology, Minna Nigeria to determine dietary protein requirement for growth performance and nutrient digestibility of FUNAAB Alpha broiler chickens. A total of one hundred and twenty (120) day-old of FUNAAB Alpha chicks was used for the study. The chicks were grade and randomly allocated to four varying dietary protein levels of 14, 17, 20 and 23 % CP and were tagged CP14, CP17, CP20 and CP23, respectively. The birds were allocated to the four treatments using a Completely Randomized Design (CRD). Each treatment group was replicated thrice with ten birds per replicate. The birds were housed in deep litter system where they received uniform care and management. The experiment lasted for thirteen weeks. Light was provided 24 hours daily, while feed and clean cool drinking water were given *ad libitum.* Data on feed intake, daily weight gain, FCR and nutrient digestibility were collected and subjected to one-way analysis of variance where differences occurred, they were separated using Duncan multiple range test. There were no differences (P>0.05) in all the growth parameters measured. Digestibility results indicated that dietary treatments had effect (P<0.05) in all the parameters measured. The birds on CP 14 % had better (P<0.05) DM (89.82 %), CF (81.90 %) and ash (70.17 %) digestibility than all the other treatments. It was thus, concluded and recommended that CP level of 14 % is adequate for FUNAAB Alpha chickens since there were no significant difference between this level and other higher protein levels used. This level also gave the highest DM, CF and ash digestibility.

KEYWORDS: Protein, FUNAAB Alpha, Performance, Digestibility

INTRODUCTION

The poultry industry is one of the most important sectors of the Nigerian economy contributing substantially to the nation's Gross Domestic Product (Ambali *et al*., 2003). In 2005 the population of poultry was estimated to be about 190 million (Orajaka, 2005) comprising of 8.0 % exotic breeds and over 90 % indigenous species (Nwanta *et al.,* 2006). Local chickens play an important role as household food supply in rural areas of developing countries (Zaman *et al.,* 2008). It is also a means of providing additional income to the generally resource-poor small holder farmers (Gueye, 2003), thereby helping to alleviate poverty.

Despite the fact that more than 90 % of the Nigeria poultry production system consists of local chickens, their contribution to human nutrition, gross domestic products and export earnings are disproportionately low. These problems are poor growth rate (reaching maturity at 3-4 months, laid few eggs), genetic makeup and environmental management (King'ori *et al.,* 2003). In all this nutrition plays a major role. One of the major nutrients is protein. Protein is one of the most important dietary macronutrients for animals, and as the key component of cells, plays an important role in the process of life.

Various authors have work on the dietary protein requirement for indigenous chickens. Chemjor (1998) reported that a dietary protein level of 13 % was adequate for indigenous chickens aged between 14 and 21 weeks. King'ori *et al.* (2003) observed that indigenous chickens require a protein level of 16 % to optimize feed intake and growth between 14 and 21 weeks of age. Furthermore, Ndegwaet *al.* (2001) reported that indigenous chickens fed diets containing 17 to 23 % CP had similar growth rates and feed intakes, suggesting that a 17 % CP diet was sufficient for these chickens. King'ori *et al.* (2003) compared the effect of varying crude protein levels of 100, 120, 140, 160 and 180 g/kg DM on the feed intake, feed conversion ratio and live weight of growing indigenous chickens raised intensively between 14 and 21 weeks of age. Results from this study indicate that feed intake per bird increased with increasing dietary protein levels. Similarly, live weight gain increased with increasing protein levels while feed conversion ratio decreased with increasing dietary protein levels. The results from literature on dietary protein requirement varies and thus inconclusive.

FUNAB alpha is an indigenous broiler breed developed through crossbreeding and intensive selection over many generations; this bird was developed at the Federal University of Agriculture of Agriculture, Abeokuta, Nigeria for improved meat and egg production without compromising the adaptation to tropical climate and diseases. There are limited studies on the protein requirement of this breed of chicken. This study was carried out to determine the dietary protein requirement of growth performance and nutrient digestibility of FUNAAB Alpha broiler chickens.

METHODOLOGY

The study was carried out in the poultry section of the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Gidan Kwano Campus, Minna, Niger State. Minna is located between latitude 4º 30 and 9° 37 North and longitude 6°33 and 06º45 East with an altitude of 1475 m above sea level (Niger State Agricultural Development Project; NSADP, 2009). The area falls within the Southern Guinea Savannah vegetation zone of Nigeria with average annual rainfall of between 1100 and 1600 mm and a mean temperature of between 21º and 36.5º C (Ovimap, 2016). Minna experiences two distinct seasons (dry, from November to March, and wet or rainy season from April to October). The study was conducted between May and September, 2018. The experimental ingredients (Table 1) used for the research were obtained from Minna UltraModern Market, Minna Niger State. FUNAAB Alpha chicks were obtained from Federal University of Technology Abeokuta, Ogun State, Nigeria.

A total of one hundred and twenty (120) day-old of FUNAAB Alpha chicks was used for the study. The chicks were grade and randomly allocated to four varying dietary protein levels of 14, 17, 20 and 23 % CP and were tagged CP_{14}, CP_{17}, CP_{20} and CP_{23}, respectively.The birds were allocated to the four treatments using a Completely Randomized Design (CRD). Each treatment group was replicated thrice with ten birds per replicate. The birds were housed in deep litter system where they received uniform care and management. The experiment lasted for thirteen weeks. Light was provided 24 hours daily, while feed and clean cool drinking water were given *ad libitum*

Data Collection

On arrival, the initial live weights of chicks were taken at the commencement of each experiment. Thereafter, average live weights per bird were measured at weekly intervals by weighing the chickens in each pen and the total weight was divided by the total number of birds in each pen. These live weights were used to calculate body weight gain of the chickens. Weekly mean feed intakes were determined until termination of the experiment. These weights were used to calculate daily mean feed intake.

Feed intake: A known quantities of feed were offered every morning and the left over were measured the next morning. The difference between the feed offered and the leftover was considered as feed intake. This was carried out daily.

Body weight gain: This were measured weekly per bird. The current body weights were subtracted from the weight of the previous week to obtain the weekly weight gain.

Feed Conversion Ratio (FCR)

Feed conversion ratio was computed as the ratio of feed intake to weight gain (g).

Feed Conversion Ratio (FCR)
=Average weekly feed intake/ Average weekly weight gain (Egbewande, 2009)

Nutrients Digestibility

A total collection method was used. This was determined when the chickens are between 84 and 91 days old. Two birds per replicate were randomly selected from each replicate were transferred to specially construct metabolic cages. They were allowed three days acclimatization, thereafter, fasted overnight and the feed and water were served *ad-libitum* to the chickens. Their total droppings were collected for four days. The total feacal collected were bulked and oven at 85 ^{0}C until a constant weight was gotten. Proximate composition of the feed and droppings were analyzed in the Animal Production Laboratory according to the methods and procedure of AOAC (2013). The nutrients digestibility was determined using the formula below.

Digestibility coefficient = Nutrient in Feed Intake – Nutrient in dropping voided/ Nutrient in Feed Intake
(Aduku and Olukosi, 1990)

Statistical Analysis

All data collected on feed intake, body weight gain, digestibility, growth rate, feed conversion ratio, live weight and apparent nutrient digestibility of the chickens were analyzed by one-way analysis of variance (ANOVA) in a Completely Randomized Design (SAS, 2012) and where there were mean differences, they were separated using Duncan's Mutiple Range Test (SAS 2012).

RESULTS AND DISCUSSION

The results of the growth performance of FUNAAB Alpha chickens fed different levels of dietary crude protein are presented in Table 2. All the growth parameters measured were not influenced (P>0.05) by the dietary treatments. The might imply that CP level of 14 is adequate for FUNAAB Alpha broiler chickens. The results obtain from this study is similar to those reported by Aftab (2009) who did not observed differences in the feed intake of broiler chickens at day 21 and 35 when the birds were fed diets containing different ME and protein concentrate. The CP 14 observed in this study is lower than NRC (1994) recommendation of 23, 20 and 18 % dietary protein levels for the broiler chickens during the starter, grower and finisher phases respectively, for optimal growth and maximum productivity. Furthermore, it is lower than those of Tadelle and Ogle (1996) who observed that the protein requirement of growing indigenous chickens varies between 16 and 18 % during the growing phase for optimal performance. The results observed in this study is close to the 13 % recommended by Chemjor (1998); who reported that a dietary protein level of 13 % was adequate for indigenous chickens aged between 14 and 21 weeks.

The apparent nutrient digestibility on FUNAAB Alpha chickens fed different levels of dietary crude protein results are presented in Table 3. Unlike the growth performance results all the parameter measured were influenced (P<0.05) by the dietary treatments. There was a negative relationship in the dry matter, crude fibre and ash contents digestibility. As the dietary crude protein increased the dry matter, crude fibre and ash contents digestibility decreased. This might imply that high in, crude fibre and ash contents digestibility inclusion levels of dietary protein are wasted by the birds since they are not well digested. This might be the reason that it was observed that CP level of 14% was adequate for the performance of FUNAAB Alpha broiler chickens.

CONCLUSION AND RECOMMENDATIONS

It was thus, concluded and recommended that CP level of 14 % is adequate for FUNAAB Alpha chickens since there were no significant difference between this level and other higher protein levels used. This level also gave the highest DM, CF and ash digestibility.

Table 1. Ingredient Composition of Experimental Diets (g/Kg)

INGREDIENT	CP14	CP17	CP20	CP23
Maize	71.90	61.00	51.00	48.00
GNC	1.20	2.35	2.20	12.00
Full fat soya	9.50	18.00	27.80	26.00
Maize bran	10.20	12.00	12.80	7.50
Fish meal	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00
Methionine	0.25	0.25	0.25	0.25
Lysine	0.75	0.75	0.75	0.75
Premix	0.50	0.50	0.50	0.50
Salt	0.25	0.25	0.25	0.25
Total	10.00	100.00	100.00	100.00
Calculated CP (%)	14.14	17.33	20.47	23.25
Calculated Energy (Kcal/kg)	3124.11	3104.62	3101.02	3054.10
Ether Extract	5.12	4.15	5.24	6.24
Crude Fiber	5.86	5.47	4.77	4.88

CP_{14} = Crude Protein 14, CP_{15} = Crude Protein 15, CP_{16} = Crude Protein 16, CP_{17} = Crude Protein 17

Table 2. Growth Performance of FUNAAB Alpha Chickens fed Different Levels of Dietary Crude Protein

Parameter	CP14	CP17	CP20	CP23	SEM	SIG
Initial Weight	604.33	608.33	618.33	627.00	6.86	0.24
Final Weight	2133.33	2366.67	2366.67	2300.00	80.21	0.40
Feed intake	60.30	72.73	62.81	62.81	3.11	0.34
Weight Gain	1529.00	1758.33	1748.33	1673.00	80.78	0.42
Daily Weight Gain	23.01	28.17	28.17	27.38	1.12	0.15
Feed Conversion Ratio	2.64	2.54	2.23	2.37	0.09	0.19
Protein Efficiency Ratio	1.90	1.83	2.13	1.90	0.07	0.20

CP_{14} = Crude Protein 14, CP_{15} = Crude Protein 15, CP_{16} = Crude Protein 16, CP_{17} = Crude Protein 17

Table 3. Apparent Nutrient Digestibility on FUNAAB Alpha Chickens fed Different Levels of Dietary Crude Protein (%)

PARAMETRS	CP_{14}	CP_{17}	CP_{20}	CP_{23}	SEM
Dry Matter	89.02^{a}	88.53^{b}	83.41^{c}	82.58^{d}	0.88
Crude Protein	87.28^{a}	87.28^{a}	81.31^{b}	80.15^{c}	1.00
Crude Fiber	81.90^{a}	78.37^{b}	73.65^{c}	66.78^{d}	1.71
Ether Extract	80.30^{b}	80.13^{b}	68.53^{c}	82.88^{a}	1.68
Ash	70.17^{a}	61.52^{b}	56.44^{c}	42.76^{d}	3.00
Nitrogen Free Extract	94.98^{a}	94.92^{a}	92.12^{b}	91.94^{b}	0.45

abcd : mean with different superscripts along the row are significantly different at $p<0.05$
CP_{14} = Crude Protein 14, CP_{15} = Crude Protein 15, CP_{16} = Crude Protein 16, CP_{17} = Crude Protein 17

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GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY OF BROILER CHICKENS FED WOOD ASH BASED DIETS AT BOTH STARTER AND FINISHER PHASES

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ABSTRACT

An eight-week study was conducted to determine the effect of different firewood ash-based diets growth performance and nutrient digestibility of broiler chickens at both the starter and finisher phases. A total of 120 broiler chickens were randomly allocated to four treatments in the completely randomized design. Treatments 1, 2, 3, and 4 are No ash (control), NTA (Neem tree ash), SBA (Shea butter ash) and LBA (Locust bean ash), respectively. Each treatment was replicated three times with ten birds per replicate. Data on feed intake, daily weight gain, FCR and nutrient digestibility were collected and subjected to one-way analysis of variance where differences occurred, they were separated using Duncan multiple range test. Starter phase results shows that dietary treatments had effect on final weight, body weight gain and feed intake. Birds on STA having higher (366.00 g) weight, body weight gain (173.71 g) and feed intake (546.03 g) than the control. At the finisher phase, dietary treatments had effect on the final weight with birds on NTA having the highest final weight (1238.15 g), daily weight gain with birds on SBA having the highest daily weight gain (32.88 g), FCR with birds on SBA having better conversion FCR (2.84). The digestibility results indicated birds on LBA diet had the highest crude fibre (79.87 %) and ash content (69.56 %). It is recommended that any of the wood ash could be use, as they had similar effects in terms of final weight, daily weight gain, FCR, crude fibre digestibility and ash content digestibility and birds on the wood ash treatments performed better than the control.

KEYWORDS: wood ash, performance, digestibility

INTRODUCTION

Broiler production plays a major role in food security for the rapidly increasing human population. Their short production cycle, high feed efficiency and high biomass per unit of agricultural land are particularly attractive for the production systems (Talpur *et al.*, 2012). The present broiler chicken has been genetically selected for rapid growth, increased muscle mass and heavier breast weight (Garner *et al.*, 2002). These genetic potentials cannot be fully utilized or expressed if the right or optimal nutrient is not provided, it implies that animals should be adequately provided with the right kind of nutrients for the maximum expression of their genetic endowment. Modern broiler strains have very rapid growth for which their requirement for oxygen, nutrients, enzymes, hormones, and growth factors has increased in comparison to earlier strains (Onimisi *et al.*, 2014). Additionally, the supportive systems are challenged to maintain structure, function, and to satisfy demands of tissues during growth. Thus, it is extremely important that their metabolism and bones support the increasingly heavier body weight and muscle mass that are obtained in younger ages as genetic selection for growth progresses.

Mineral imbalance, particularly of calcium (Ca) is one of the problems responsible for economic losses to poultry industry (Talpur *et al.*, 2012). Maintenance of calcium and phosphorus (P) ratio at 1:0.5 is essential for performing various functions in the body. Generally, minerals are responsible for proper osmo-regulation in addition to maintaining nervous and muscular coordination and blood coagulation in the animal's body (Adamu *etal*, 2012).

Calcium is the mineral with the highest concentration in the body of poultry, consisting of 1.5 % of its body weight (Pelicia *et al.*, 2011). Calcium plays two important physiological roles in the poultry. First, it provides the structural strength of the poultry skeleton by the formation of calcium salts. Second, it plays vital roles in many of the biochemical reactions within the body via its concentration in the extracellular fluid (Vahid *et al.*, 2014). Deficiency of calcium, for instance, leads to development of rickets, tibial dyschondroplasia (TD), increased chick's mortality and reduced body weight in older birds (Underwood and Suttle, 2001).

Supplying diets with adequate calcium levels is essential for bone formation to support high growth rates in broilers (Costa *et al.*, 2009). Supporting muscles and protects delicate organs and tissues, including the bone marrow, but is also jointed to allow movement, and is malleable to allow growth.

There are several studies in literature on the calcium requirements of broilers (Alveset *al.*, 2002; Araujo *et al.*, 2002; Sa *et al.*, 2004; Santos *et al.*, 2011; Tancharoenrat and Ravindran, 2014), out of which some have evaluated calcium sources, such as calcium bicarbonate (Alveset *al.*, 2002), calcium citrate-malate (Henry and Pesti, 2002), and calcitic and dolomitic limestone (Saet *al.*, 2004). However, there are limited studies on the use of firewood ash as a calcium source for broilers at the finisher phase. The objective of this study was to evaluate effect of firewood ash-based diet on the performance and nutrient digestibility of broilers.

METHODOLOGY

The study was carried out in the poultry section of the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Gidan Kwano Campus, Minna, Niger State. Minna is located between latitude 4º 30 and 9° 37 North and longitude 6°33 and 06º45 East with an altitude of 1475 m above sea level (Niger State Agricultural Development Project; NSADP, 2009). The area falls within the Southern Guinea Savannah vegetation zone of Nigeria with average annual rainfall of between 1100 and 1600 mm and a mean temperature of between 21º and 36.5º C (Ovimap, 2016). Minna experiences two distinct seasons (dry, from November to March, and wet or rainy season from April to October). The study was conducted between May and July, 2017.

Origin and Managements of Birds and Other Ingredients

Broiler birds used in the experiments were purchased from Globus Resources Limited in Ijesha- Tedo, Lagos State, Nigeria. Other ingredients used in the formulation of the feed were purchased from the Minna Central Market (Kure), Niger State. Fresh *Azadirachta indica* (Neem), *Parkia biglobosa* (African Locust bean) and *Vitellaria paradoxa* (Shea butter tree) woods were collected from within the Gidan Kwano campus. This was because of their abundance, availability and accessibility. The woods including the barks collected were broken into pieces to hasten the drying process and sun dried before burning to ashes. The woods were separately burnt in open air. Ashes produced were collected in plastic bags and taken to the laboratory for storage and subsequent analysis to determine their mineral contents. Use of fuel for burning was avoided to minimize contamination. Four experimental diets were formulated and designated as Control, NWA, The initial live weights of the birds were taken at the beginning of each experiment and at weekly intervals thereafter. Feed intake, weight gain and feed conversion ratio were determined according to the procedures of McDonald *et al.* (2011).

This was conducted on the 23rd and 49th day of the experiment using total collection technique according to the procedure of Aduku and Olukosi (1990). Two birds were randomly selected from each replicate and kept in the constructed metabolic cages. Activities involved feeding the broilers with known quantity of feed after allowing three days of acclimatization, followed by four days total faecal collection from each replicate. Faeces were bulked thoroughly mixed and sub-sample taken at the end of the faecal collection. The faeces were weighed and oven dried at 85 ^{0}C until a constant weight was obtained, followed by grounding to a size that could pass through a 2 mm sieve for proximate analysis. The difference between the nutrients in the Feed and faecal sample multiply by 100 gives the apparent digestibility coefficient of the feed in feed

Digestibility coefficient = Nutrient in Feed Intake – Nutrient in dropping voided/ Nutrient in Feed Intake (Aduku and Olukosi, 1990)

Chemical Analysis

Feed and faecal sample of the diet were oven dried until a constant weight is attained. Both the diet as well as the faeces collected from each animal per replicate was chemically analysed according to AOAC (2000) procedure.

Statistical analysis

All data collected on growth performance and SWA and LWA, respectively. Diet 1 was designated as the control without wood ash while diets 2, 3 and 4 contained 2 % NWA, SWA and LWA, respectively. The wood ash in diets 2, 3 and 4 were used to replace limestone and bone meal which were used in the control diet. The diet compositions of the two phases of the work are shown in Table 1. nutrient digestibility were subjected to one-way analysis of variance (ANOVA) using SAS version 9.2(SAS, 2013). Where means were significantly different at 5% ($p<0.05$), they were separated using Duncan Multiple Range Test.

RESULTS AND DISCUSSION

The results showed that at the starter phase the dietary treatment had effect on the final weight, body weight gain and feed intake (Table 2). The wood ash treatments showed superior results that the control diets with the birds on STA diet performed better ($P<0.05$) than the control treatment.

The present results indicate that the final weight has no trend. The results showed that the final weight is higher in birds fed STA compared to other treatment, it also indicates that all experimental treatments had similar value compare to the control. However, birds on STA diet had the highest final weight gain. The present result is in agreement with the findings reported by Atuhene (1998) who reported that inclusion of Shea Butter Cake (SBC) up to 2.5% in growing broiler diet have no adverse effect on the growth performance.

Feed intake have similar trend with to the body weight gain. The results indicate that birds on STA had higher performance in term of feed intake, and weight gain. However, all dietary treatments performed better than the control. The high weight gain recorded could be as a result of feed intake. That decreased in weight gain in the control diet could be attributed to the fact that weight gain in broiler is directly related to feed intake, the quantity of feed as well as how efficiently the bird utilized it. The differences between the experimental diets and the control may be attributed to different source of mineral and the medicinal properties of the wood-ashes. The higher good performance of the experimental diets is in agreement with report of Saccomani *et al.* (2016) who started that firewood ash may be employed as calcium source in replacement of limestone in broiler diet at starter phase (1 to 21 days of age) as it promotes similar performance and bone development as limestone.

Similarly, at the finisher phase, dietary treatments had effect ($P<0.05$) on the final and daily body weight gain. However, unlike the starter phase, dietary treatment had effect on the feed conversion ratio (Table 3). All the birds on the wood ash-based diets had similar results. Their results were better than those of birds on the control diet. The better performance might be attributed to better absorption of the mineral present in the wood ashes. Okoli *et al.* (2014) indicated that minerals in the ash are easily absorbed by the animal. Contrary to the finding in the present study, Onimisi *et al.* (2014) observed no difference in the growth performance of birds fed different calcium sources. This might be because the authors worked on only calcium and not with the other minerals present in the wood ash such as phosphorus, potassium, aluminium, magnesium, sodium, boron, copper, molybdenum, sulphur and zinc. (Theo Van Kempen, 2002). Furthermore, the similarity in the results of the different wood ashes used might implies that any of the ashes can be substitute for the other and they contained similar minerals. From FCR results, birds on shea butter ash had the highest FCR, the reasons is not well known; it, however, could be due to the fact that shea butter tree is rich in saturated and unsaturated fatty acids with a large fraction of unsaponifiable triglycerides, oleic acid, triterpene alcohols, vitamin E, provitamin A, allantoin (Hall *et al.*, 1996). The results of FCR agree with that of Okoli *et al.* (2014), who reported very high feed efficiency in pullets fed plantain ash supplemented diet.

In term of nutrient digestibility, birds on control, NTA, and LTA diets had higher ($P<0.05$) dry matter, ether extract digestibility compared to birds on STA diet at the starter phase. However, at the finisher phase birds on locust bean ash had better crude fibre and ash content digestibility, it might be due to the fact that locust bean tree is very rich in protein, vitamin C, retinol, calcium, crude fibre (Gernah *et al.* 2005; Ogundun, 2007). It could be because of the elevated mineral content present in locust bean wood ash as compared to shea butter wood ash (Alves *et al*. 2002).Storage, handling, processing procedure and anti-nutritional factor, combustion system and handling of the wood may also be contributing factors (Okoli *et al.* 2014). The results of growth performance showed that the wood ash based diets had effect on the daily weight gain, final weight and feed conversion ratio (FCR) of broiler chickens at finisher phase with birds on the wood ash diets performing better than the control. Wood ash based diets had effect on ash and crude fibre, with the birds of locust bean ash having high digestibility.

CONCLUSION AND RECOMMENDATIONS

From the results of this study, it can be recommended to both small and large scale farmers that any of these wood ash sources (neem tree, shea butter tree and locust bean tree) could be an effective substitute for feed lime stone and bone meal in supplying minerals in poultry diets since wood ash is rich in calcium and easily absorbed, it can be used also to supplement deficiencies in diets that contain ingredients known to be deficient in calcium.

Table 1. Ingredients and chemical composition of experimental diet

Ingredients	Starter phase				Finisher phase			
	Control	**NWA**	**SWA**	**LWA**	**Control**	**NWA**	**SWA**	**LWA**
Maize	50.00	50.00	50.00	50.00	62.00	62.00	62.00	62.00
Maize bran	9.00	9.00	9.00	9.00	5.00	5.00	5.00	5.00
GNC	26.00	26.00	26.00	26.00	20.00	20.00	20.00	20.00
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
SBM	8.00	8.00	8.00	8.00	6.00	6.00	6.00	6.00
Bone meal	2.00	1.00	1.00	1.00	2.00	1.00	1.00	1.00
Limestone	2.00	1.00	1.00	1.00	2.00	1.00	1.00	1.00
Wood ash	0.00	2.00	2.00	2.00	0.00	2.00	2.00	2.00
Methionine	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
Premix	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
Total	100	100	100	100	1 00	100	100	100
CP (%)	22.35	22.35	22.35	22.35	19.39	19.39	19.39	19.39
ME (Kcal/Kg)	2934.00	2934.00	2934.00	2934.00	2939.00	2939.00	2939.00	2939.00

NTA: Neem tree ash LTA:

Locus beans tree ash STA:

Shear butter tree ash

Table 2. Effects of wood-ash based diet on growth performance of broiler chicken at starter phase.

Parameters	Control	NTA	STA	LTA	SEM
Initial weight	57.67	61.00	62.00	63.00	1.18
Final weight	283.67^{b}	330.00^{ab}	366.00^{a}	318.67^{ab}	12.29
BWG	129.33^{b}	153.90^{ab}	173.71^{a}	144.52^{ab}	6.67
Feed intake	447.27^{b}	535.42^{a}	546.03^{a}	498.95^{ab}	15.62
FCR	3.46	3.48	3.27	3.50	0.08
Mortality	1.11	0.00	4.44	4.44	0.83

ab : mean with different superscripts along the row are significantly different at $p<0.05$

NTA: Neem tree ash; LTA: Locus beans tree ash; STA: Shear butter tree ash; SEM: Standard mean error

BWG: Body weight gain; FCR: Feed conversion ratio

Table 3 Growth performance of broiler chicken fed diets containing different wood ash based diets at the finisher phase

Parameter	NOA	NTA	SBA	LBA	SEM
Initial weight (g)	286.33	330.00	276.67	316.67	11.43
Final weight (g)	959.17[b]	1238.15[a]	1197.38[a]	1155.95[a]	37.86
Daily Weight gain (g)	24.03[b]	32.43[a]	32.88[a]	29.97[a]	1.27
Average daily Feed intake (g)	88.41	95.04	92.63	93.76	2.24
FCR	3.68[b]	2.93[a]	2.84[a]	3.13[a]	0.12
MORT (%)	13.33	13.33	16.67	16.67	3.59

ab=means on the same row bearing different superscript are significantly different ($p<0.05$) NOA=No ash (control)

NTA=Neem tree ash SBA=Shea butter ash LBA=Locust bean ash NFE=Nitrogen free extract FCR=feed conversion ratio

MORT=Mortality SEM=Standard error of mean

Table 4. Effects of wood-ash based diets on nutrient digestibility of broiler chicken at starter phase.

Parameters	Control	NTA	STA	LTA	SEM
Dry matter	64.53[a]	65.03[a]	55.96[b]	65.73[a]	1.71
Ether extract	76.45[a]	75.59[a]	57.41[b]	70.23[b]	3.18
Ash	15.69	20.73	4.29	19.15	3.86
Crude protein	66.42	63.72	53.83	64.56	2.42
Crude fibre	23.63	28.15	20.90	23.33	1.64
NFE	76.47	75.62	80.55	78.86	0.88

ab: mean with different superscript are significantly different ($p<0.05$) NTA: Neem tree ash LTA: Locust bean tree ash STA: Shea butter tree ash

Table 5. Nutrient digestibility of broiler chickens fed diets containing different wood ash-based diets at the finisher phase

Parameter	NOA	NTA	SBA	LBA	SEM
Dry matter (%)	90.74	90.88	90.79	91.44	0.21
Crude protein (%)	91.04	93.12	92.46	90.94	0.62
Crude fibre (%)	38.62[c]	58.81[b]	53.79[b]	79.87[a]	5.63
Ether extract (%)	92.63	92.59	92.11	93.59	0.67
Ash content (%)	65.80[ab]	64.05[ab]	52.13[b]	69.56[a]	2.96
NFE (%)	97.61	95.35	96.90	96.65	0.44
Gross energy (%)	92.26	91.51	91.72	91.81	0.35

abc=means on the same row bearing different superscript are significantly different ($p<0.05$) NOA=No ash (control)

NTA=Neem tree ash

SBA=Shea butter ash

LBA=Locust bean ash

NFE=Nitrogen free extract

CP=Crude protein EE=Ether extract

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