GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS FED WITH DIFFERENTLY COOKED BAMBARA NUTS

Egbewande, Olufemi Olubunmi* and Oluwabiyi, Temitope Victor
Department of Animal Production, Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, PMB 11, Niger State, Nigeria.
*E-mail: femi2015.ooe@gmail.com

Abstract
This study was conducted to investigate the effect of cooked Bambara groundnut (Vigna subterranean L.) on the growth performance and carcass characteristics of broiler chickens. One hundred and fifty (150) day-old chicks were randomly allotted into five treatment groups of thirty birds each and were replicated thrice in a completely randomized design (CRD). Five diets were formulated in such a way that cooked Bambara groundnut was used to replace 25% groundnut cake. Control diet contained no Bambara while diets 2, 3, 4 and 5 contained Bambara groundnut cooked for 30, 60, 90 and 120 minutes respectively. The study lasted for 8 weeks during which data were obtained on performance indices and carcass characteristics. At the end of the study, six birds per treatment were randomly selected, starved overnight, weighed and slaughtered by severing the jugular vein. Results showed that there were no significant (P>0.05) differences among the treatment means of the performance indices. Birds fed control had the highest final weight (1.977kg), followed by those fed diet 5 (1.837kg) and closely followed by birds fed diet 4 (1.833kg), while diet 3 recorded the lowest (1.700kg). There were no significant (P>0.05) differences in the cut-up parts and visceral organs. This study showed that cooking Bambara groundnut before incorporating into poultry diets has a beneficial effect on the birds.

Keywords: growth performance, bambara groundnut, carcass characteristics, broiler

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1. INTRODUCTION

Low intake of animal protein in developing countries could be attributed to high cost of animal products which is directly related to high cost of both energy and protein feedstuffs. The ever–increasing cost of the feedstuffs shows that there is need to explore the use of alternative feed ingredients that are cheaper and locally available (Teguia *et al.*, 2011). One of such ingredients is Bambara groundnut (*Vigna subterranean* L.).

The distribution of wild Bambara groundnut is known to extend from Jos Plateau and Yola in Nigeria, to Garoua in Cameroon (Goli, 2007). Yao *et al*. (2005) reported that Bambara groundnut plays a key role in the traditional food and culture of peoples in the western and northern parts of Côte d'Ivoire. Bambara groundnut is now widely distributed in the semi-arid zone of Sub-Saharan Africa (SSA), and according to Mkandawire (2007), it is the third most important food legume after cowpea *(Vigna unguiculata)* and groundnut (*Arachis hypogaea*). It is a low growing crop with its pods containing the seeds beneath the soil. FAO (2004) gave the world production of the legume to be 58,000 tons in 2003, lower than 330,000 tons reported by Courdet (1982) in 1982. Fru *et al.* (2004) reported that the low production recorded in 2003 was probably due to its low demand.

Bambara groundnut is important for smallholders and their households because the nuts are important source of food security, nutritious and high in protein. Although Bambara is deficient in sulphur-containing amino acids (Azam-Ali *et al.*, 2001), some genotypes contain higher amounts of methionine and lysine than is found in other legumes (NRC, 2006). Bambara groundnut yields well under conditions which are too arid for groundnut, maize and even sorghum (Adama *et al.*, 2007). According to Pfetter *et al.* (2012), the valuable quality of Bambara groundnut has accorded the wide usage it has been associated with in both the livestock and poultry industry. Just like other legumes,

Bambara groundnut contains anti-nutrients like polyphenols, trypsin inhibitor (Omoikhoje, 2008), tannin, phytic acid and oxalate. This study was therefore designed to reduce the anti-nutritional factors and thus assess the growth performance of broiler birds fed such processed Bambara groundnut meal.

2. MATERIALS AND METHODS

2.1 Experimental Location

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria. Lapai is situated between Latitude 9°31 and 9°45, east of equator (Usman, 2013). The area falls within the Southern Guinea Savannah Vegetation Zone of Nigeria with mean rainfall ranging from 1100 to 1600mm, and mean temperature between 21°C and 36.5°C (Usman, 2013).

2.2 Source and Processing of Feed Ingredients

Fish meal, blood meal, bone meal, limestone, salt, premix, lysine, methionine and groundnut cake were purchased from Animal Care Retailer Shop, Gidan Matasa, Okada road, Minna, Niger State. Bambara nut (*Vigna subterranean*) was obtained from Lapai market. Bambara nut was processed by cooking to reduce or remove totally the anti-nutritional factors which are tannin, polyphenols, phytic acid, trypsin and oxalate. It was cooked in boiling water (100°C) for 30, 60, 90 and 120minutes. The cooked Bambara nuts were sundried and milled to grit. Proximate analysis on the Bambara nuts was carried out.

2.3 Proximate Analyses

Nutrient contents of the test ingredients were analyzed on dry matter basis (DM), and these are moisture, crude protein, crude fibre, ash, ether extract and nitrogen free extract (NFE).

Determination of moisture

2 grams of each processed bambara nut was weighed in duplicates into different petri dishes and dried in an oven overnight for 12 hours at 105°C using the method described by Osborne and Voogt (1978). The samples were cooled in desiccators, weighed and the average dry matter content was calculated and expressed in percentages.

Determination of crude protein using Micro-Kjeldhal Method

A gram of Bambara nut boiled for 30 minutes was placed into a 100cm^3 Kjeldhal digestion flask. A selenium catalyst tablet and 10cm^3 of H_2SO_4 were added into the flask, and the mixture was boiled until frothing ceased and the digested sample became clear. The content in the flask was cooled to room temperature. Then, 10ml aliquot solution, 20ml of 40% NaOH solution and distilled water (filled to mark) were added into a distillation flask (50cm^2) containing the digested sample and steamed distilled. The ammonia liberated was collected over 50ml 4% Boric acid-mixed indicator solution, cooled and titrated with standard 0.01N H_2SO_4 solution to obtain nitrogen content. Crude protein was then calculated by multiplying the percentage nitrogen obtained by a factor (6.25) according to A.O.A.C. (1995). That is: %CP = %Nitrogen x 6.25. The procedure was carried out for the remaining test ingredients (BB60Mins, BB90Mins and BB120Mins)

Determination of total ash

Total ash was determined by incineration of 2 grams of each processed bambara nut in a crucible placed in a Muffle furnace at 550°C for 4 hours according to Pearson, 1976). The residue was weighed and expressed as percentage total ash content.

Determination of crude fibre

2 grams of each processed bambara nut was put in a conical flask of 1 litre capacity as W_0, and 200ml of 1.25% H_2SO_4 was added to each sample and boiled for 30 minutes. Each mixture was filtered through a muslin cloth stretched over a 9cm Buchner funnel and rinsed well with hot distilled water. Each filtered material (residue) was scraped (using spatula) into a 50cm^3 round bottom flask, and was added 200ml of 1.25% NaOH, allowed to boil gently for 30 minutes, filtered and the residue washed with hot distilled water. Then each residue was rinsed once with 10% HCL, twice

with industrial methylated spirit, and thrice with petroleum ether (boiling point of 40-60°C). After each residue was allowed to drain dry, it was then scraped into a crucible and later dried overnight in a hot air oven at 105°C. It was cooled in desiccators and weighed as W_1, ashed at 550°C for 90 minutes in a Muffle furnace, and finally cooled in desiccators and weighed as W_2. Percentage crude fibre was calculated as:

% Crude Fibre = $[100 (W_1 – W_2)] \div W_0$

Determination of lipid by Soxhlet extraction method

2 grams of each processed bambara nut in duplicates were weighed into porous thimble blocked clean white cotton wool free of fat. This was placed in an extraction chamber, which was suspended by a retort stand. Above is a weighed receiving flask containing 200ml petroleum ether and below is a condenser. Extraction was done for six hours, the thimble was carefully removed, and the petroleum ether was collected in the top container. After the extraction, the receiving flask was disconnected from water bath when it was almost free of the reagent, oven dried at 105°C for 30 minutes, cooled in desiccators and weighed.

Determination of Nitrogen Free Extract (NFE)

This was determined by subtracting the sum of crude protein, crude lipid, crude fibre and ash from 100% (A.O.A.C., 1995). That is:

% NFE = 100 – (%crude protein + %crude lipid + %crude fibre + %ash)

2.4 Experimental Diets

The experimental diets used were compounded using Bambara nut to replace groundnut at 25% inclusion level as source of crude protein (Tables 1 and 2). Five diets were compounded which are;

Diet 1 (T_1) contained groundnut as major plant protein source.

Diet 2 (T_2) contained groundnut + Bambara (Boiled for 30 minutes, BB30Mins)

Diet 3 (T_3) contained groundnut + Bambara (Boiled for 60 minutes, BB60Mins)

Diet 4 (T_4) contained groundnut + Bambara (Boiled for 90 minutes, BB90Mins)

Diet 5 (T_5) contained groundnut + Bambara (Boiled for 120 minutes, BB120Mins)

Table 1: Gross composition of experimental broiler starter diets

Ingredient (%)	Control	BB30Mins	BB60Mins	BB90Mins	BB120Mins
Maize	51.50	55.50	51.50	51.50	51.50
GNC	26.00	19.50	19.50	19.50	19.50
CBNM	-	6.50	6.50	6.50	6.50
WO	9.00	9.00	9.00	9.00	9.00
Fish Meal	5.00	5.00	5.00	5.00	5.00
Blood Meal	5.00	5.00	5.00	5.00	5.00
Bone Meal	2.00	2.00	2.00	2.00	2.00
Limestone	0.80	0.80	0.80	0.80	0.80
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00
Calculated:					
%CP	24.04	23.73	23.80	23.66	23.77
ME(Kcal/kg)	2842.10	2892.87	2921.14	2894.76	2886.73

*****Flomix Mineral-Vitamin premixes of 0.25kg contains vitamin A 10,00mg, Vitamin D3, 2,000mg, Vitamin B1 500mg, Vitamin B2 5,000mg, Vitamin B6 300mg, Vitamin B12 10,000mg, Pantothenic Acid 10,000mg, Niacin 25,000mg, Folic Acid 1,000mg, Biotin 100,000mcg, Choline 150,000mg, Antioxidant 125,000mg and minerals such as Manganese 10,000mg, Zinc 50,000mg, Cobalt 250mg, Iron 40,000mg, Copper 6,000mg, Iodine 500mg and Selenium 100mg

Key: GNC = Groundnut Cake, CBNM = Cooked Bambara Nut Meal, WO = Wheat Offal, CP = Crude Protein ME = Metabolizable energy, BB30Mins. = Bambara nuts cooked for 30 minutes, BB60Mins. = Bambara nuts cooked for 60 minutes, BB90Mins. = Bambara nuts cooked for 90 minutes, BB120Mins. = Bambara nuts cooked for 120 minutes.

Table 2: Gross composition of experimental broiler finisher diets

Ingredient (%)	Control	BB30Mins	BB60Mins	BB90Mins	BB120Mins
Maize	54.40	54.40	54.40	54.40	54.40
GNC	25.40	19.05	19.05	19.05	19.05
CBNM		6.35	6.35	6.35	6.35
WO	10.50	10.50	10.50	10.50	10.50
Fish Meal	3.00	3.00	3.00	3.00	3.00
Blood Meal	3.00	3.00	3.00	3.00	3.00
Bone Meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00
Calculated:					
CP (%)	22.46	21.44	21.05	21.03	21.41
ME(Kcal/kg)	2965.21	2886.36	2914.20	2888.21	2880.92

*****Flomix Mineral-Vitamin premixes of 0.25kg contains vitamin A 10,00mg, Vitamin D3, 2,000mg, Vitamin B1 500mg, Vitamin B2 5,000mg, Vitamin B6 300mg, Vitamin B12 10,000mg, Pantothenic Acid 10,000mg, Niacin 25,000mg, Folic Acid 1,000mg, Biotin 100,000mcg, Choline 150,000mg, Antioxidant 125,000mg and minerals such as Manganese 10,000mg, Zinc 50,000mg, Cobalt 250mg, Iron 40,000mg, Copper 6,000mg, Iodine 500mg and Selenium 100mg
Key: GNC = Groundnut Cake, CBNM = Cooked Bambara Nut Meal, WO = Wheat Offal, CP = Crude Protein ME = Metabolizable energy, BB30Mins. = Bambara nuts cooked for 30 minutes, BB60Mins. = Bambara nuts cooked for 60 minutes, BB90Mins. = Bambara nuts cooked for 90 minutes, BB120Mins. = Bambara nuts cooked for 120 minutes.

These were formulated to contain 24.04 and 22.461% CP and, 2842.10 and 2965.21 kg/ME for starter and finisher diets respectively.

2.5 Experimental Birds and Management

One hundred and fifty (150) day old broiler chicks of mixed sexes were used for the experiment. The chicks were randomly assigned into five dietary treatments in a completely randomized design (CRD). Each treatment was replicated thrice with ten chicks per replicate. The pen was washed and disinfected 2 weeks prior to the arrival of the chicks with litter materials (wood shavings) spread on the floor. On arrival, feed and water mixed with anti-stress (glucose) were served immediately and the temperature of the brooding room was under control. Chargeable lamps were used as the source of the lighting and charcoal as source of heat. Litters were changed fortnightly. Vitalyte® was administered to the birds after every vaccination and weighing. Feed and water were supplied *ad-libitum*. Feed intake and the body weight of the birds were recorded on weekly basis. Embazin forte® and antibiotics were administered in water and all the vaccines (Lasota and Gumboro) were administered as at when due.

2.6 Data Collection

Feed intake was carried out on weekly basis. It was the total amount of feed consumed by the birds within the week and it is given as; Feed offered (kg) – left over (kg)
Body weight gain: The birds were weighed on weekly basis. The initial weight was subtracted from the final weight to get the body weight gain. Feed conversion ratio: This was done at the end of each week and calculated as:

$$\text{Feed conversion ratio} = \frac{\text{feed consumed (g)}}{\text{weight gained by birds (g)}}$$

Carcass evaluation:
This was carried out at the end of the experiment. Two birds per replicate were randomly selected, starved (of water) overnight and slaughtered by severing the jugular vein with a knife. The dead birds were immersed in warm water to pluck the feathers manually. Each bird was cut into parts and the visceral

removed carefully. The visceral organs (Liver, spleen, kidney, heart, gizzard, abdominal fat, and pancreas) and cut up parts (breast, back, drum sticks, thighs and wings) were weighed.

2.7 Economic Analysis

Veterinary care and miscellaneous (variable cost): This was calculated as the total amount of money spent on vaccines, drugs, day old chick and other expenses divided by the number of the birds.

Average body weight (kg): This was the final body weight of the birds before slaughtering.

Feed cost: This was the cost of feed used in producing a bird and it is given as:

Feed intake (kg) × price per kg feed ÷ quality of feed produced.

Price per feed: This was calculated by taking into consideration the individual ingredients used in compounding the diet. This is calculated by:

Price per (kg) feed = cost per (kg) of the diet

Total investment: was the total amount of money spent during the cause of production.

Gross returns: this was the live weight gain multiply by the price of chicken per kg.

Gross profit: this was the profit realized after the sales of the bird. It is given as gross return - total investment. Benefit cost ratio: was the ratio of the gross profit and total investment.

2.8 Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA), according to the procedure of Gen stat (2014).

3. RESULTS AND DISCUSSION

3.1 RESULTS

3.2 Proximate Composition of the Test Ingredients

The proximate compositions of Bambara groundnut boiled at different boiling durations were shown in Table 3.

3.3 Performance Characteristics of Broilers Fed Test Ingredients

Table 4 showed the results of feeding four different processed Bambara nut on the performance characteristics of broiler chickens. The final weight gain was not significant ($P>0.05$) difference in all the treatment with T_1 having the highest final weight gain (1.98kg) and weekly body weight gain (0.93kg), followed by T_5 (1.84kg) and weekly body weight gain of (0.87kg).

Table 3: Proximate composition of test ingredient

Parameter (%)	BB30Mins.	BB60Mins.	BB90Mins.	BB120Mins.
Dry matter	94.40	94.38	94.11	94.67
Crude protein	14.94	15.75	14.06	20.00
Crude fibre	4.04	4.12	3.98	4.06
Ether extract	1.17	1.22	1.84	1.67
Ash	3.50	4.08	4.20	4.40
Nitrogen free extract	76.35	74.83	75.92	69.87

BB30Mins. = Bambara nuts cooked for 30 minutes, BB60Mins. = Bambara nuts cooked for 60 minutes, BB90Mins. = Bambara nuts cooked for 90 minutes, BB120Mins. = Bambara nuts cooked for 120 minutes.

Table 4: Performance characteristics of broiler chickens fed test ingredient.

Parameter	Control	BB30Mins	BB60Mins	BB90Mins	BB120Mins	±SEM
Initial weight (g)	50.00	50.00	50.00	50.00	50.00	-
Final weight (kg)	1.977	1.760	1.700	1.833	1.837	-
Exsanguinated weight (kg)	1.913	1.687	1.627	1.727	1.737	0.108
Dressed weight (kg)	1.717	1.527	1.517	1.567	1.627	0.094
Weekly body weight gain (kg)	0.937	0.840	0.828	0.833	0.865	0.047
Weekly feed intake (kg)	0.683	0.643	0.577	0.624	0.593	0.031
Weekly FCR	1.41	1.36	1.51	1.40	1.51	0.060
Mortality (%)	3.33	-	6.67	-	-	-

BB30Mins. = Bambara nuts cooked for 30 minutes, BB60Mins. = Bambara nuts cooked for 60 minutes, BB90Mins. = Bambara nuts cooked for 90 minutes, BB120Mins. = Bambara nuts cooked for 120 minutes.

Table 5: Cut-up parts of broiler chickens fed test ingredients

Cut-up Parts (g)	Control	BB30Mins	BB60Mins	BB90Mins	BB120Mins	±SEM
Head	49.01	45.93	45.90	44.41	47.53	4.60
Neck	76.22	70.43	56.43	74.51	75.50	9.64
Wings	154.83	124.51	121.35	150.33	168.29	26.20
Drumsticks	184.22	155.16	153.43	168.50	199.98	15.20
Thigh	202.40	164.78	144.86	186.03	15.20	26.52
Back	273.14	200.60	196.53	227.17	276.65	28.90
Breast	251.15	222.48	198.22	228.22	259.39	54.23

BB30Mins. = Bambara nuts cooked for 30 minutes, BB60Mins. = Bambara nuts cooked for 60 minutes, BB90Mins. = Bambara nuts cooked for 90 minutes, BB120Mins. = Bambara nuts cooked for 120 minutes.

Table 6: Visceral organs of broiler chickens fed test ingredients.

Visceral organ (g)	Control	BB30Mins	BB60Mins	BB90Mins	BB120Mins	±SEM
Liver	35.93	34.80	33.07	33.06	37.84	3.22
Kidney	12.68	12.76	10.51	10.09	9.91	1.66
Heart	8.29	8.29	8.50	7.99	8.40	0.89
Spleen	1.93	2.20	2.07	1.41	1.73	0.36
Pancreas	4.28	3.44	3.45	3.12	6.99	1.70
Gizzard	50.73	49.65	51.53	48.12	54.56	6.24
Abdominal fat	26.65	25.20	27.68	29.15	36.98	7.25
Proventiculus	9.30	9.33	7.95	8.74	10.10	0.10
Intestine	128.13	121.22	120.46	143.73	131.40	9.05

BB30Mins. = Bambara nuts cooked for 30 minutes, BB60Mins. = Bambara nuts cooked for 60 minutes, BB90Mins. = Bambara nuts cooked for 90 minutes, BB120Mins. = Bambara nuts cooked for 120 minutes.

Next to it is T_4 with final weight gain of (1.83kg) and weekly body weight gain of (0.83kg). For the weekly feed intake of the birds, T_3 was the lowest (0.58kg) but there was no significant ($P>0.05$) differences in their level of feed intake.

The feed conversion ratio (FCR) value was low for all diets, although birds on T_2 (cooked Bambara for 30 minutes) had the best FCR (1.36), followed by T_4 (cooked Bambara for 90minutes) which is 1.40, T_3 and T_4 recorded the lowest value of FCR (1.51) followed by T_1 (1.41).

Birds fed T_3 recorded the highest percentage of mortality at (6.67%) followed by T_1 (3.33%) while those fed T_2, T_4 and T_5 recorded no mortality.

3.4 Cut-up parts of broilers fed test ingredients.

Table 5 showed the result of the cut-up parts (head, neck, wings, drumsticks, thighs, back, breast and shank) which were not significantly ($P>0.05$) affected by the levels of cooking of the test ingredient (Bambara nut).

3.5 Visceral organs of broilers fed test ingredients

In Table 6, the results of relative organ weight of broiler chickens presented were not affected by the levels of cooking of Bambara nut. All the visceral organs were not significantly ($P>0.05$) affected.

3.6 Economic analysis of feed cost

Table 7 showed the result of the economic analysis of feed cost in local currency, Naira (₦) where T_1 recorded the highest amount of feed consumed (₦489.95) while the least cost of feed consumed was recorded by T_3 (₦364.65). T1 had the highest gross return (₦ 1782.00) and gross profit (₦843.05), followed by T_5 with gross return and profit of ₦1656 and ₦751.43 respectively.

3.7 DISCUSSION

Table 3 shows the proximate composition of the test ingredients of Bambara nut cooked for 30 minutes, 60 minutes, 90 minutes and 120 minutes (T_2, T_3, T_4 and T_5 respectively).

Table 7: Cost benefit for broiler chickens fed with processed bambara nuts as replacement for groundnut cake

Parameters	Control	BB30Mins	BB60Mins	BB90Mins	BB120Mins
Cost of day old chicks (₦)	135.00	135.00	135.00	135.00	135.00
Final weight gain (kg)	1.98	1.76	1.70	1.83	1.84
Cost of feed (₦ /kg)	109.11	92.00	93.50	95.00	96.50
Total Feed consumed (kg)	4.49	4.25	3.96	4.38	4.41
Total cost of feed consumed	489.95	391.00	364.65	416.10	425.57
Variable cost (₦)	314.00	314.00	314.00	314.00	314.00
Total investment (₦)	938.93	840.00	813.65	865.10	874.57
Cost of bird /Kg (₦)	900.00	900.00	900.00	900.00	900.00
Gross return (₦)	1782.00	1584.00	1530.00	1647.00	1656.00
Gross Profit (₦)	843.05	744.00	716.35	781.90	781.43
Cost benefit ratio	2.12	1.89	1.88	1.90	1.89

BB30Mins. = Bambara nuts cooked for 30 minutes, BB60Mins. = Bambara nuts cooked for 60 minutes, BB90Mins. = Bambara nuts cooked for 90 minutes, BB120Mins. = Bambara nuts cooked for 120 minutes.

The highest crude (20.00%) protein was recorded at T_5, followed by T_3 (Crude protein of 15.75%) and T_2 was next with the crude protein content of 14.94% and the least was T_4 with 14.94% crude protein content. The diet with the highest crude fibre content was T_3 (4.12%) and the least was T_4 with 3.98% crude fibre content, T_3 had 4.12% and T_5 had 4.06%.

The nitrogen free extract contents are 76.35, 74.83, 75.92 and 69.87% for T_2, T_3, T_4 and T_5 respectively. The variation in this composition may be due to effect of cooking on amino acid composition. Similar observation has been reported by Olaofe and Akintayo (2000), and Adeyeye and Afolabi (2004). The result obtained was higher than that of Okonkwo and Opara (2010). There was no much difference in Dry matter after processing of Bambara groundnut seeds. The Ash content increased as the time of cooking increased which agrees with the findings of Nwambe *et al.* (2011); Abdulsalami and Sheriff (2010); and Enujiuha and Ayodele (2003). The observed differences may have resulted from varieties of Bambara nut used. Therefore, there were no wide variations in the proximate compositions of the experimental diets as they were formulated to be iso-energetic and iso-nitrogenous.

Table 4 revealed the performance characteristics of broiler chicken fed test ingredient. There were no significant differences (P>0.05) among treatment in average body weight, feed intake, feed conversion ratio, dressing weight and exsanguinated weight. The role of anti-nutritional factors in growth depression and reduction in feed intake, carcass weight in broiler birds as a result of low nutrient availability had been earlier documented by Oyeleke *et al.* (2012). Depression in weight gain and feed intake in Treatment 3 (T_3) could be attributed to low availability of nutrient, particularly amino acid and presence of Polyphenols that could not be effectively removed by the cooking hours. This agrees with the report of Ocheme and Chinma (2010). The feed conversion ratio of broiler fed processed Bambara nut have no significant difference (P<0.05). Birds fed T_2 (1.36) had the best FCR followed by T_4 (1.40) then T_1 (1.41), T_3 and T_5 have the same Feed conversion ratio of (1.51). Treatment 3 (T_3) recorded the highest mortality rate at 6.67% followed by treatment 1 (T_1) with mortality rate of 3.33%. Treatments 2, 4 and 5 recorded no mortality.

The cut-up parts of broiler chicken fed the test ingredient is presented in Table 5. There were no significant (P>0.05) differences recorded on the cut up parts for all the treatments. Visceral organ weights are presented in Table 6 and there were also no significant (P>0.05) differences for all the treatments. The proportion of visceral organs (kidney, intestine, abdominal fat, heart, pancreas, liver and spleen) were not affected by anti-nutritional factors which if not removed effectively according to Tankou *et al.* (2013), can cause metabolic stress or toxicity. Since there were no significant (P>0.05) differences among treatment groups as far as the visceral organs

are concerned, it indicates that the experimental diets with test ingredients were free from toxin. Similar results were previously reported by (Defang *et al.*, 2014)

Cost benefit for broiler chickens fed test ingredient is shown in Table 7. The cost of producing 1kg live weight gain was lower in experimental diets than control diet. Although growth performance was not effectively improved, the inclusion of processed Bambara at 25% in broiler diet was of economic advantage and also cheaper than the control diet. This supports the findings of Pfetter *et al.* (2012).

4. CONCLUSIONS

It can be concluded that cooking Bambara nut at varied time especially 90 and 120 minutes can be used to replace groundnut cake at 25% without any detrimental effect on growth performance, carcass characteristics and feed utilization.

Recommendation

Since there were no significant differences observed among the birds fed different diets, it is recommended that the time differences used in cooking test ingredient (Bambara nut) should be increased for better performance.

5. ACKNOWLEDGEMENTS

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