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Growth performance, haemetological and serum biochemical indices of broiler finisher birds fed fermented bambara groundnut meal (*Vigna subterranean(L) VERDC*)

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An experiment was conducted to determine the effect of fermented bambara groundnut meal on the performance, haematological and blood biochemical indices of broiler finisher birds. Bambara groundnut seeds were fermented, dried and milled into fine powdery fermented bambara groundnut meal (FBGM). It was then analyzed for proximate and phytochemical composition. The meal was then used to formulate four broiler finisher diets at 0.0, 5.0, 10.0 and 15.0% inclusion levels respectively, which were then used to raise 4 groups of 30 broiler finisher each for 4 weeks. At the end of the 4 weeks (28 days) trial, 3 birds were selected from each group and used for the determination of blood indices. The daily feed intake, average daily weight gain and feed conversion ratio did not show any significant ($P > 0.05$) difference. The packed cell volume, red blood cell and white blood cell were significantly affected ($p<0.05$) by treatment, decreasing significantly at 15.0% dietary levels. Total proteins, creatinine, urea, and cholesterol decreased significantly ($p<0.05$) as the fermented bambara groundnut meal increased. The results of this trial showed that broiler finisher chicken can be fed with fermented bambara groundnut meal up to 15.0% inclusion level in their diets as a partial replacement for soya bean meal without any detrimental effects on the performance and blood indices.

Keywords: Fermented, bambara groundnut, performance, haematology, blood biochemistry

INTRODUCTION

It is very obvious that Nigeria produce animal protein in sub optimal quantity leading to shortage of animal protein and consequent sub optimal consumption below the recommended value. FAO, (2010) reported that out of the 53 g of protein per caput per day, Nigeria obtains 10 – 15 g per caput per day from animal source as against the recommended 35 g per caput per day. This challenge is as a result of high cost of production attributable to animal feed. When less is produced less is consumed and vice versa. Feed ingredients especially energy and protein sources are very expensive such that it influences the production cost greatly. Protein sources such as soya bean is being utilized by man as food, by industries to produce various soya drinks, food and milk and also by feed industries for animal use. This has made the product soya bean scarce, competitive and costly. It is therefore, necessary to investigate into some other leguminous grains that are rich in protein but underutilized for the purpose of substituting them partially or wholly in place of soyabean. Bambara groundnut has been reported by Abiodun and Adepeju, (2011) to contain 24% crude protein and cheaper than most other leguminous grains. Dri yao *et al.* (2015) reported the nutrient composition of Bambara groundnut to contain 18.8% crude protein, 1.4%

fat, 50.2% starch and 10.3% fibre. Bambara groundnut has also been reported to contain anti-nutritional factors such as tannins, and anti-trypsin factors (Tibe *et al*., 2005). This study therefore was aimed at evaluating the growth performance, haematological and serum biochemical indices of broiler finisher birds fed fermented bambara groundnut meal.

MATERIALS AND METHODS

Experimental site

This experiment was carried out at the poultry unit of teaching and research farm, Imo State University Owerri, which is located within the South-Eastern agro-ecological zone of Nigeria. Owerri lies between latitude 5°29'North and longitude 7°20'East. It is about 91 m above sea level with annual rainfall, temperature and humidity ranging from 1,500 mm to 2,200 mm, 20.0 – 27.5°C and 75 – 90%, respectively (Accuweather, 2015).

Source and processing of fermented bambara groundnut meal

The bambara groundnut seeds were bought from a reputable source in Afo Oru market in Ahiazu Mbaise LGA of Imo State. The seeds were soaked in water for 72 h to allow it to ferment. Thereafter it was washed and sun dried for 7 days. The sun dried seeds were milled in a hammer mill to obtain a fine powdery fermented bambara groundnut meal (FBGM). Samples of the meal were subjected to proximate and phytochemical analysis according to AOAC (2010).

Experimental diets

Four finisher broiler diets were compounded, incorporating fermented bambara groundnut meal (FBGM) at 0%, 5.0%, 10.0% and 15.0% inclusion levels respectively, partly replacing soya bean in the control diet. The diets were thus designated as $T_{1.0}$, $T_{5.0}$, $T_{10.0}$ and $T_{15.0}$ respectively. The ingredient and calculated nutrient composition of the diets are shown in (Table 1).

Experimental birds and design

One hundred and twenty (120) 4-week old Marshal breed bought from a reputable dealer in Owerri were used for the trial. The birds were randomly divided into four groups of 30 broilers and each group randomly assigned to one of the four treatment diets in a completely randomized design (CRD). Each group was further subdivided into three replicates of 10 broilers each and each replicate housed in a deep litter compartment measuring 1×1.5 m. Feed and water were provided *ad libitum*. The trial lasted for 28 days.

Data collection

The birds were weighed at the beginning of the experiment to obtain their initial body weights and weekly, thereafter. Daily feed intake was determined by subtracting the weight of leftover feed from the weight of the feed given the previous day. Data were collected on feed intake, body weight changes and feed conversion ratio. Feed conversion ratio was calculated by dividing the average daily feed intake by average daily weight gain.

Haematology and blood biochemistry

At the end of the 28 day feeding trial, blood samples were collected from 3 birds from each treatment and 2 mls of blood placed in the specimen bottles with Ethylene diamine tetra acetic acid (EDTA) and 5 mls of blood placed in the specimen bottle without EDTA for haematological and blood biochemical indices, respectively. Blood was analyzed within 3 h of collection for red blood cell (RBC) count, haemoglobin concentration (HB), white blood cell count (WBC), packed cell volume (PCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular volume (MCV) and differential WBC counts as outlined by Ochie and Kolhatkar, (2000). Blood biochemical indices analyzed included total protein, cholesterol, urea, creatinine, enzymes and the electrolytes sodium, potassium, carbonate and chloride (Ochie and Kolhatkar, 2000).

Statistical analysis

Data collected were subjected to analysis of variance using the SPSS software (2012). Where analysis of variance indicated significant treatment effects, means were compared using Duncan's New Multiple Range Test (DNMRT) (SPSS, 2012).

RESULTS AND DISCUSSION

Proximate composition of fermented bambara groundnut meal (FBGM)

The proximate composition of the fermented Bambara groundnut meal is shown in (Table 2). The crude protein content (18.8%) was close to the values (18.25), 18% and 16.2 – 18.2g/100g reported by Anhwange and Atoo,

Table 1. Ingredient composition of the experimental diets (kg).

	Dietary levels of FBGM (%)			
Ingredients	**T_1 (0%)**	**T_2 (5.0%)**	**T_3 (10.0%)**	**T_4 (15.0%)**
Maize	55	55	55	55
Soya bean	25	20	15	10
Fermented bambara groundnut meal	0	5	10	15
Palm oil	1.0	1.0	1.0	1.0
Fish meal	2.0	2.0	2.0	2.0
Blood meal	2.0	2.0	2.0	2.0
Palm kernel cake	7.0	7.0	7.0	7.0
Wheat offal	4.0	4.0	4.0	4.0
Bone meal	3.0	3.0	3.0	3.0
Salt	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25
DL-Methionine	0.25	0.25	0.25	0.25
L-lysine	0.25	0.25	0.25	0.25
Calculated nutrient composition of the experimental diet (%DM)				
Crude protein	20.65	19.39	18.13	17.00
Crude fibre	4.35	4.57	4.80	5.02
Ether extract	4.93	5.10	5.28	5.45
Ash	3.29	3.04	2.79	2.53
Phosphorus	0.95	0.92	0.89	0.86
Calcium	1.94	1.93	1.92	1.91
Lysine	1.34	1.39	1.57	1.93
Methionine	0.62	0.59	0.56	0.53
ME (kcal/kg)	2928	2964.69	3001.38	3038.08

Table 2. Proximate composition of fermented and raw bambara groundnut.

Parameters	Fermented Bambara groundnut	Raw Bambara groundnut
Moisture	8.95	10.20
Ash	0.95	0.65
Crude fibre	11.0	11.02
Protein	18.8	17.2
Lipid	6.98	7.05
NFE	53.32	55.82
ME (kcal/kg)	3153.84	3113.88

(2015), Mazahib *et al*. (2013) and Amarteifio and Moichubedi, (1997) respectively. The value of the protein falls within the range of protein content of most legumes between 17 – 30% (Anhwange *et al*., 2006). The protein value was higher than the value 11.*05* – 11.56 by Aremu *et al*. (2006) but lower than the value 22.2% reported by Ferao *et al*. (1987) on bambara groundnut. The crude fat percent compares to the value 5.82 to 6.31%, 6.5%, 4.10 to 6.72% and 6.0% of bambara groundnut meal as reported by Anhwange and Atoo, (2015), Mazahib *et al*. (2013), Aremu *et al*. (2006) and Elegbede (1998) respectively. The carbohydrate content of the fermented Bambara groundnut compares to the value 52.80 -56.01 reported by Anhwange and Atoo, (2015) but lower than the value 73.30–73.87 reported by Aremu *et al*. (2006). The crude fibre content of the FBGM was higher than the values 4.58–5.50 and 2.07 – 4.07 reported by Anhwange and Atoo, (2015) and Aremu *et al*. (2006) respectively. The values of the nutrient composition shows that Bambara groundnut is rich in protein and carbohydrate and could be a good alternative of immense nutritional value to both humans and animals.

Performance of finisher broilers fed fermented bambara groundnut meal

The data on the performance of the experimental finisher broilers fed fermented bambara groundnut meal are shown in (Table 3).There were no significant difference ($p > 0.05$) on the average daily weight gain, average daily feed intake and feed conversion ratio. It is possible that fermentation was able to reduce the tannin and anti-trypsin factor to a tolerable limit where the body could

Table 3. Performance of finisher broilers fed fermented bambara groundnut meal.

Parameters	Dietary levels of FBGM				
	T_1 (0.0)	T_2 (5.0)	T_3 (10.0%)	T_4 (15.0%)	SEM
Average initial body weight (g)	800.00	802	806	804	8.550
Average final body weight (g)	2150.00	2188.00	2186. 00	2176.60	76.94
Average body weight changes (g)	1350.00	1386.00	1380.7	1372.60	50.11
Average daily weight gain (g)	48.21	49.5	49.31	49.02	3.581
Average daily feed intake (g)	150.5	151.2	151.5	151.8	4.101
Feed conversion ratio	3.12	3.05	3.07	3.10	0.320

Table 4. Haematological indices of broilers finisher fed fermented bambara groundnut meal.

Parameters	Dietary levels of FBGM				
	T_1	T_2	T_3	T_4	SEM
Hemoglobin (g/d) (HB)	13.10	13.00	12.67	12.06	0.14
Packed cell volume (PCV) (%)	4.67^{a}	41.00^{a}	39.67^{ab}	38.00^{b}	1.03
White blood cell (x10^{9}/l) (WBC)	12.40^{ab}	12.64^{a}	12.64^{b}	12.14^{b}	0.12
Neutrophil (%)	50.00	50.30	50.67	51.00	0.9
Eosinophil (%)	1.33	1.69	1.03	1.33	0.20
Basophil (%)	0.00	0.00	0.00	0.00	0.00
Lyphocyte (%)	45.00	44.58	44.60	44.67	0.81
Monocytef (%0	1.65	1.65	1.88	1.89	0.20
Red blood cell(RBC) (x10^{12}/l)	12.90^{a}	12.93^{a}	12.31^{ab}	11.89^{b}	0.27
Erythrocyte sedimentation rate (ESR) ($MM^3/1^{ST}$/h)	13.33	13.33	12.20	13.30	0.28
Mean cell volume (MCV) (fl)	31.70	31.00	32.40	32.53	0.71
Mean cell haemoglobin (MCH) (Pg)	30.17	30.03	30.20	30.14	0.13
Mean cell haemoglobin concentration (MCHC) (g/dl)	30.83	31.80	32.10	31.37	0.57

ab means within the same row with different superscript are significantly different.

utilize it for effective and efficient performance. The protein of bambara groundnut is rich in lysine. Lysine aids the synthesis of carmitine which converts fatty acids into energy. The high content of lysine in the bambara group may have been responsible for its comparable performance to the control. The feed conversion ratio was similar statistically. The value for the feed conversion ratio was lower than 3.87 to 4.19 for broiler finisher birds fed raw and toasted Bambara groundnut meal (Ironkwe and Esonu, 2004). However these values were more than the reference value of 1.7 to 2 for broilers. This difference could be due to the strain of the birds, environmental factors and climate change. The inclusion of fermented Bambara groundnut meal in broiler diet up to 5 – 15% level has no deleterious impact on the performance of the broiler finishers.

Haematological and serum biochemical indices of broiler finisher birds fed bambara groundnut meal

Data on the haematological and serum biochemical indices of broiler finishers fed fermented bambara groundnut meal are presented in (Tables 4 and 5). Result showed that packed cell volume, red blood cell and white blood cell were significantly affected ($p<0.05$) by treatment. The haemoglobin, white blood cell differentials and red blood cell differentials did not show any significant treatment effect ($p>0.05$). Haemoglobin is an important determinant of anaemia (Wikivet, 2013e). Low values of RBC and HB could be a sign of anemia (Mohammed and Oloyede, 2009). The values for HB were within the normal reference ranges (7.0 – 13.0) (Banerjee, 2013). It implies that there was adequate protein and iron for hemoglobin synthesis and oxygen transport to the tissues. Adequacy of iron will produce a normal concentration of serum haemoglobin (Okonkwo and Esiegwu, 2018). The values obtained for HB (12.06 – 13.10g/dl) were higher than the values (7.10 – 10.10g/dl) reported by Aguihe *et al*. (2014) and within the normal ranges (11.60–13.68g/dl) reported by Wikivet (2013). The packed cell volume were 42.67, 41.00, 39.67 and 38.00 respectively for T_1 (0.0), T_2 (5.0%), T_3 (10.0%) and T_4 (15.0%). At 15.00% dietary level, the packed cell volume was significantly decreased ($p<0.05$) compared to the control and 5.0% dietary level. The values obtained from this study (38.00 – 42.67) were higher than the values 32.66–36.33% and 23.32– 32.33% reported by Okonkwo and Esiegwu, (2018) and Odetola *et al*. (2015) respectively for broiler finishers and within the normal range (35.9 to 41.00%) (Merck, 2012 and Wikivet, 2013). Demoranville and Best, (2013) reported that a reduction

Table 5. Serum biochemical indices of broiler finishers fed fermented bambara groundnut meal.

Parameters	Dietary levels of FBGM				
	T_1(0.0)	T_2(5.0)	T_3(10.0)	T_4(15.0)	SEM
Urea (mmol/l)	8.32[a]	7.68[b]	6.98[c]	6.22[d]	0.15
Creatinine (mmol/l)	56.67[a]	52.66[a]	54.01[ab]	52.02[b]	1.18
Cholesterol (mmol/l)	9.50[a]	8.88[b]	8.57[bc]	8.30[c]	0.14
Total protein (g/dl)	67.00[a]	63.30[ab]	62.67[b]	61.00[b]	1.18
Albumin (g/dl)	26.00	22.30	23.30	22.30	1.19
Globulin (gldl)	41.00	41.30	39.30	38.67	1.38
Potassium (mmole/l)	1.47	1.33	1.40	1.30	0.06
Sodium (mmole/l)	46.00a	43.30b	43.30b	42.30b	0.65
HCo_3 (mmol/l)	10.92ab	10.42	11.32	10.98	0.65
Chloride (mmol/l)	21.00ab	19.30ab	22.30a	23.70a	0.82
SGOT	12.12	11.66	11.96	11.76	0.24
SGPT	7.00	6.80	6.87	7.07	0.15
Alkaline phosphatase (mmol/l)	1.28	1.14	1.21	1.28	0.10

Abcd Means within the same row with different superscripts are significantly different.

in PCV below the normal value was a sign of liver and kidney disease, vitamin B12 and folic acid deficiencies. The values for the PCV showed sign of no toxicity. The red blood cell (RBC) was significantly decreased ($p<0.05$) at 15% dietary level compared to the control and 5% level. The values for the red blood cell were higher than the normal values 7.0 x 12.0um reported by Banerjee, (2013).

This implies that the birds were neither anaemic nor short of blood supplies. The erythrocyte sedimentation rate (ESR) did not show any significant difference ($p > 0.05$) which implies that the health status of the birds were intact. ESR is used to evaluate the health of an animal and increases in acute general infection, in the presence of malignant tumors in inflammatory conditions in hypothyroidism, and also in pregnancy (Swenson, 2004). The mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration did not show any significant treatment effect ($p>0.05$). However, the MCHC were within the normal reference values 26.0 – 35.0% (Banerjee, 2013). The MCH were above the values (25 – 27 pg) reported by Swenson, (2004). The values of the red blood indices MCV, MCH and MCHC were an indication of a strong immune system. The white blood cell decreased significantly at 10 and 15% dietary levels with the values falling within the normal range 9– 31 x 10^3/mm (Banerjee, 2013). The white blood cell differentials, the neutrophil, eosinophil, basophil, lymphocyte and monocyte did not differ significantly ($p>0.05$) in all the treatments. This implies that there was no invasion of the chicken by any foreign matter arising from the test feed.

Biochemical indices showed that total proteins, urea, creatinine and cholesterol decreased significantly at 15% dietary level. Serum protein was significantly decreased ($p<0.05$) compared to the control at 10 and 15% dietary levels. Decreased serum protein suggests insufficient protein availability in the tissues and cells. Bolu and Balogun, (2009) reported that decreased serum protein concentration is a pointer to interference on normal protein metabolism and utilization. The significant reduction in serum protein of birds on dietary treatments could be attributed to amino acid imbalance due to anti-nutrients such as tannins, saponins, Alkaloids, etc. that is capable of inhibiting proper nutrient utilization especially protein and iron necessary for red blood cell formation (Esiegwu *et al*., 2017). The non-significant effect ($p>0.05$) of the serum albumin and globulin was an indicator of good health status of the birds. Kostow, (2009) reported low albumin concentration to be a sign of poor health whereas increased serum globulin was implicated in liver damage, chronic infections and kidney dysfunctions (Sanchez – Monge *et al*., 2004). Serum urea decreased significantly as the inclusion level of the Bambara groundnut increased. Serum urea is used to measure the protein quality. Nwogu *et al*. (2007) reported that high level of urea was an indication of low protein quality. Significant reduction in the serum urea level as Bambara groundnut meal increased was indication that the diet had no deleterious effect on the protein quality. Serum creatinine decreased significantly at 15% dietary level. Ross *et al*. (1978) reported that high blood creatinine implies muscle wastage which means the animal was surviving at the expense of body reserves which results in weight loss. Similarly, Ogunbode *et al*. (2016) reported that increase in blood creatinine could be as a result of excess breakdown of blood proteins. Significant reduction in values of creatinine was an indication of no muscle wastage as a result of inadequacy of protein in birds. Serum cholesterol decreased significantly as the bambara groundnut meal increased. The low serum cholesterol implies that bambara groundnut meal did not give room for normal fat metabolism and utilization as a result of anti-nutrients. Bambara groundnut may have a

hypocholesterolemic action. The reduction in cholesterol suggests that Bambara groundnut meal has anti-cholesterol action. Bush, (1991) reported that low level of cholesterol was an indication of fat malabsorption in the body and in the blood. The liver enzymes, serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) and alanine amino transferase (ALT) did not show any significant treatment ($p>0.05$) effect. Ukpabi *et al*. (2015) reported that serum enzyme activities are used for checking toxicity as well as monitoring protein quality, assess toxicity and damages done to the liver. The enzymes ALT, SGOT and SGPT were statistically the same. Non significant differences of the liver enzymes were a sign that the diets were not toxic and had no damaging effect to the blood and liver of the birds.

Conclusion

The results of the trial have shown that fermented bambara groundnut meal can serve as feed ingredient to broiler finisher birds up to 15% inclusion level. It has also shown that at this level of inclusion of fermented bambara groundnut meal there was no adverse effect of the diet on the blood indices of broiler finishers. It is therefore concluded that fermented bambara groundnut meal could be included in broiler finisher ration up to 15% level without any adverse effect.

Authors' declaration

We declared that this study is an original research by our research team and we agree to publish it in the journal.

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