Effects of raw and toasted *Daniellia oliveri* Rolfe seed meal as replacement for groundnut meal on the performance of broiler chickens

Efectos de la harina de semillas de *Daniellia oliveri* (Rolfe) cruda y tostada sobre el comportamiento de pollos de engorde

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ABSTRACT

Two hundred and ten one-day-old Arbor Acres broiler chicks were used to assess different level of introduction of raw and toasted *Daniellia oliveri* seed meal (DOSM) on the performance, haematological, and some biochemical indices on chicks. Seven dietary treatments that contained 0% (Control), raw DOSM (2.5, 5.0 and 7.5%) and toasted DOSM (2.5, 5.0 and 7.5%) were assigned to seven groups of 30 birds each, replicated thrice with 10 birds per replicate in a completely randomized design. Chemical analysis indicated that raw DOSM contained 26.50% crude protein (CP), 6.02% crude fibre (CF), 4.30% ether extract (EE), 4.06% ash and 47.47% carbohydrate contents. The results indicated that toasting DOSM reduced ($P < 0.05$) the CF to 3.19%, ash to 2.8% and nitrogen free extracts (NFE) to 40.51% while, CP (28.60%) and EE (7.85%) contents increased. The raw DOSM contained some anti-nutritional factors (ANF) such as tannin (2.23 mg/100 g), phytic acid (30.39 mg/100 g), oxalate (20.02 mg/100 g), hydrocyanide (6.05 mg/100 g) and saponin (2.08 mg/100 g). Toasting the raw DOSM was shown to eliminate ($P < 0.05$) the ANF almost completely. Performance data indicated that body weight gain (BWG) and feed conversion ratio (FCR) were significantly ($P<0.05$) better in broiler chicks fed on 0 and 2.5% raw DOSM and all levels of toasted DOSM diets than those fed on the 5.0 and 7.5% raw DOSM-based diets. The results of the packed cell volume, red blood cell count, white blood cell count, haemoglobin, serum protein, albumin, glucose and cholesterol of birds fed on the 0 and 2.5% raw and all three levels of toasted DOSM diets were similar ($P > 0.05$) but, better ($P < 0.05$) than those fed on 5.0 and 7.5% raw DOSM. The inclusion of 5.0 and 7.5% raw DOSM significantly ($P<0.05$) decreased BWG, FCR, nutrient digestibility, haematological and biochemical indices. From the results, it was concluded that inclusion of 2.5% raw DOSM and up to 7.5% level toasted DOSM as a replacement for groundnut meal in broiler chicks' diet has no adverse effects on the performance, haematological and biochemical indices.

Key words: *Daniellia oliveri* seed, anti-nutrients, broiler chicks, performance, blood profile.

RESUMEN

Doscientos diez pollos de engorde Arbor Acre de un día de edad se utilizaron para determinar diferentes niveles de introducción de la harina de semilla cruda y tostada de *Daniellia oliveri* (HSDO) sobre el rendimiento, la hematología y algunos índices bioquímicos. Siete dietas de tratamiento que contenían 0% (Control); 2,5; 5,0 y 7,5% de HSDO cruda y 2,5; 5,0 y 7,5% de HSDO tostada, respectivamente, se asignaron al azar a siete grupos de 30 aves cada uno, repetido tres veces con 10 aves por repetición en un diseño completamente aleatorizado. El análisis químico indicó que la HSDO cruda tuvo: 26,50% de proteína cruda (PC); 6,02% de fibra cruda (FC); 4,30% de extracto etéreo (EE); 4,06% de cenizas y 47,47% de carbohidratos. Los resultados de la FC (3,19%), cenizas (2,8%) y extractos libres de nitrógeno (40,51%) se redujeron después del tostado, mientras la PC (28,60%) y el EE (7,85%) se incrementaron. La HSDO cruda tuvo algunos factores anti nutricionales (FAN) tales como: taninos (2,23 mg/100 g), ácido fítico (30,39 mg/100 g), oxalato (20,02 mg/100 g), hidrocianida (6,05 mg/100 g) y saponina (2,08 mg/100 g). El tratamiento de tostado eliminó casi por completo los FAN de las semillas. Los datos de rendimiento indicaron que la ganancia de peso corporal (GPC) y el índice de conversión alimenticia (ICA) fueron significativamente ($P < 0,05$) mejores en los pollos de engorde alimentados con 0,0 y 2,5% de HSDO cruda y en todos los niveles de las dietas con HSDO tostado que aquellos de las dietas basadas en 5,0 y 7,5% de HSDO tostado. Los resultados del hematocrito, recuento de glóbulos rojos, recuento de glóbulos blancos, hemoglobina, proteína sérica, albúmina, glucosa y colesterol de las aves alimentadas con 0 y 2,5% de HSDO cruda y en todos los niveles de las dietas con HSDO tostada no mostraron ningún efecto significativo ($P > 0,05$) entre sí, pero difirieron ($P < 0,05$) respecto a aquellas de 5,0 y 7,5% de HSDO cruda. La inclusión de HSDO cruda a 5,0 y 7,5% significativamente ($P < 0,05$)

disminuyó la GPC, el ICA, la digestibilidad de los nutrimentos y los índices hematológicos y bioquímicos. A partir de los resultados, se puede concluir que la inclusión de HSDO cruda a 2,5% y de HSDO tostada hasta 7,5% como un reemplazo de la harina de maní en la dieta de pollos de engorde no tiene efectos adversos sobre el rendimiento y los índices hematológicos y bioquímicos.

Palabras clave: Semillas de *Daniellia oliveri*, factores anti nutricionales, pollos de engorde, rendimiento, perfil sanguíneo.

INTRODUCTION

The feed industry is faced with enormous challenges, not only regarding the availability of feed ingredients but also the ability to produce high quality products in a cost-effective manner (Chauynarong *et al*., 2009). Less developed countries, including, Nigeria are facing serious competition between humans and animals (especially, the monogastric animals) for available conventional foodstuffs (Muriu *et al.*, 2002; Teguia and Beynen, 2005). This problem is exacerbated by the high cost of feeding, and consequently, the resulting animal products (Opara, 1996). Increased competition for available conventional feeds and scarcity of food have both led to nutritionists, scientists and agriculturists having the need for research into the use of unconventional feedstuffs with no competition with man, that could meet the nutritional needs of livestock and possibly substitute more expensive protein (groundnut cake and soybean meal) and energy sources (maize) in the future (Onyimonony and Onukwufor, 2003). Legumes are rich sources of nutrients especially amino acids and minerals (Ragab *et al*., 2010). Incorporation of some processed wild legume seed meals such as *Detarium microcarpum, Parkia biglobosa* and *Afzelia africana* into broiler diet have been investigated with positive results on performance (Obun and Ayanwale, 2006; 2007; Obun, 2007; Ayanwale *et al*., 2007).

Daniellia oliveri is commonly known as Copaiba balsam, 'Maje' in Hausa, 'iya' in Yoruba, 'Ozabwa' in Igbo and belongs to the family of Fabaceae (subfamily Caesalpinioideae). It is an evergreen plant that grows abundantly in bush fallows, secondary bushes and marginal lands in most of the savannah zones of Nigeria. Different parts of the plant are used for different purposes including mulching and fodder (leaves and twigs), firewood and ethno-medicine (stem and root) (Adekunle and Oyerinde, 2004; Hassan *et al*., 2008; El-Mahmood *et al.*, 2008). The seeds have very low preference as a human food value or in industrial use till now and could, therefore, form an alternative feed ingredient for livestock production. Some previous studies (Hassan *et al*., 2008; El-Mahmood *et al.*, 2008) concentrated on the nutrients and anti-nutrients of the seeds. Nutritionally, *D. oliveri* on dry matter basis have been reported to contain 57.84% carbohydrate, 0.60% crude fibre, 27.74 % crude protein, 9.67% lipid and 4.17% ash (Hassan *et al*., 2008). However, the presence of anti-nutritonal substances such as phytate, oxalate, hydrocyanide, tannin and nitrate in the seeds hinder animals from benefitting from it nutritionally (Hassan *et al*., 2008; El-Mahmood *et al.*, 2008). Different traditional processing methods such as roasting, toasting, cooking and fermenting were pronounced that they reduce anti-nutritional factors and raise nutrients bioavailability (Ragab *et al*., 2010). Generally, there is a very limited number of documentation on the utilization of *D. oliveri* seed meal by poultry. Thus, this study was embarked upon to investigate the effects of feeding graded levels of raw and toasted *D. oliveri* seed meal on broiler chicks' performance, haematological and biochemical indices.

MATERIALS AND METHODS

Study site

This study was conducted at the Poultry Unit of the Teaching and Research Farm, Federal College of Wildlife Management (FCWM), New Bussa, Niger State, Nigeria. The poultry building is an open sided type that permits adequate ventilation in the house, with a concrete floor and zinc-roofing sheet. New Bussa is located between latitudes 7°31' and 10°00'N and longitude 4°30' and 4°33'E (Adewetan *et al*., 1980) in the savanna area of the Kainji Lake Basin. The climate of the area is tropical with monthly average temperature of 34 °C and mean annual relative humidity of 60%.

Source and processing of seed

D. oliveri seeds were obtained from the Reserved Estate College which dropped naturally after maturity between April and June, 2011. The seeds were cleaned of dirt and shared into two portions. One portion was ground raw to form raw *D. oliveri* seed meal (RDOSM). The second portion was toasted using fire wood with iron pot mixed with sand

and seeds in a ratio 1:2 weight for weight. The seeds were turned while, still on fire until the seeds cracked open and the white endosperm turned crispy brown after about 30-35 minutes of toasting. The toasted seeds were cleaned of dirts, decorticated and ground in a hammer mill (Model W-6-H, Buffalo NY 14206) to pass through a 0.02 mm sieve particle size as the toasted *D. oliveri* seed meal (TDOSM).

Experimental diets

The raw and toasted *D. oliveri* seed meals (DOSM) were used to replace groundnut cake (GNC) at 0, 2.5, 5.0, and 7.5 % levels in broiler chicks' diets on protein equivalent basis and presented as diets 1 (0% as control), 2, 3, 4, 5, 6 and 7 (Table 1).

Experimental design and management of birds

A total of 210 one-day-old Arbor-Acres broiler chicks were used in this study. The 210 broiler chicks were, randomly, allotted into seven treatment groups in a completely randomized design. Each treatment group consisted of 30 broiler chicks, replicated three times with 10 birds comprising each replicate. The birds were managed in deep litter poultry house with dimensions of 2.5 x 2.0 m each for eight weeks experimental period. Body weight, feed intake and mortality were recorded on weekly basis for each replicate while feed conversion ratio was obtained as a ratio of feed intake: weight gain. Feed and water were provided *ad libitum.* Newcastle disease vaccinations were administered at weeks 1

Table 1. Composition and calculated composition of broiler starter (S) and finisher (F) diets made from graded levels of raw and toasted *Daniellia oliveri* seeds as replacement for groundnut meal

	Control		Raw seed meals						Toasted seed meals					
Diets	1		2		3		4		5		6		7	
Ingredients (%)	S	F	S	F	S	F	S	F	S	F	S	F	S	F
Maize	53.0	55.0	52.0	55.0	52.0	55.0	52.0	55.0	52.0	55.0	52.0	55.0	52.0	55.0
Wheat offal	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Groundnut cake	30.0	28.0	27.5	25.5	25.0	23.0	22.5	20.5	27.5	25.5	25.0	23.0	22.5	20.5
D. oliveri seed meals	0.0	0.0	2.5	2.5	5.0	5.0	7.5	7.5	2.5	2.5	5.0	5.0	7.5	7.5
Fish meal	3.0	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0	2.0
Bone meal	3.0	4.0	3.0	4.0	3.0	4.0	3.0	4.0	3.0	4.0	3.0	4.0	3.0	4.0
Lysine	0.25	0.25	0.25	0.25	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	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	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	0.25	0.25	0.25	0.25	0.25	0.25
Calculated analysis (% dry matter)														
Crude protein	22.45	19.63	22.56	19.56	22.10	19.52	21.60	19.45	22.90	19.50	22.20	19.47	21.70	19.40
Crude fibre	3.44	3.75	3.48	4.20	3.50	4.20	3.50	4.20	3.41	4.20	3.40	4.21	3.29	4.20
ME (kcal/kg)	2873	2872	2880	2870	2892	2856	2881	2860	2870	2840	2893	2854	2876	2825
Analyzed composition (% dry matter)														
Dry matter	87.32	89.60	86.20	90.34	86.00	90.20	88.00	89.70	86.40	89.50	89.00	90.04	89.00	89.63
Crude protein	22.03	19.50	22.17	19.30	22.00	19.52	22.08	19.34	22.33	19.28	22.05	19.11	21.88	19.00
Crude fibre	3.50	4.40	3.54	4.60	3.56	4.62	3.60	4.67	3.57	3.98	3.48	4. 23	3.64	4.36
Ash	3.20	3.44	3.44	3.65	3.28	4.00	3.48	3.90	3.45	3.75	3.30	3.88	3.46	3.85
Ether extract	4.65	4.76	4.60	3.91	4.54	3.57	3.77	3.80	4.50	4.00	4.32	4.14	4.07	3.98

ME: Metabolisable energy

† Premix for S diets provided per kg diet: Vitamin A 15,000 I. U., Vitamin D_3 3,000 I. U., Vitamin E 15 I.U., B_{12} 0.013 mg, Vitamin K 4 mg, Riboflavin 10 mg, Folic acid 2 mg, Nicotinic acid 44 mg, Pantothenic acid 13 mg, Biotin 0.064 mg, Vitamin B_1 2.2 mg, Vitamin B6 5.5 mg, Choline Chloride 350 mg, Copper 6.25 mg, Iodine 1.5 mg, Zinc 62.5 mg, Manganese 62.5 mg, Selenium0.1 mg, BHT (Antioxidant) 100 mg, Zinc Bacitracin 10 mg.

‡ Premix for F diets provided per kg: Vit. A 10000 IU, Vit. B 2000 IU, Vit. E 13000 IU, Vit. K 1500mg, Vit. B_{12} 10mg, Riboflavin 5000mg, Pyridoxine 1300mg, Thiamine 1300mg, Panthothenic acid 8000mg, Nicotinic acid 28000mg, Folic acid 500mg, Biotin 40mg, Copper 7000mg, Manganese 48000mg, Iron 58000mg, Zinc 58000mg, Selenium 120mg, Iodine 60mg, Cobalt 300mg, Choline 27500mg

and 2 while infectious bursa disease vaccination was given at 2 weeks of age.

Nutrient retention trial

The study on apparent nutrient digestibility was carried out at the end of the 8th week of the experimental period. Three birds per replicate were, randomly, selected and transferred to metabolic cages for four days adaptation period and four days total collection of the droppings. The droppings were oven-dried, bulked and representative samples were taken for chemical analysis. The percentage of the nutrients (DM, crude protein, crude fibre, ash and ether extracts) were estimated according to the procedures described by McDonald *et al.* (2002) as shown below:

$$\text{Digestibility coefficient} = \frac{\text{Nutrient intake} - \text{Nutrient in faeces}}{\text{Nutrient intake}} \times \frac{100}{1}$$

Haematological and biochemical indices

About 5 mL of blood sample was collected from the jugular vein of each slaughtered chicken and put into two sets of seven sterilized glass tubes/bottles containing Ethylene Diaminetetra-acetic Acid (EDTA) for the haematological study. On the other hand, blood samples meant for serum biochemical studies were collected into plain vacutainers (without anticoagulant) to enhance serum separation. Serum was obtained by centrifugation and the harvested serum samples were used for analysis. The packed cell volume (PCV), red blood cells (RBC), haemoglobin (Hb), and white blood cells (WBC) were analyzed according to Schalm *et al*. (1975) methods. The blood serum was also used to determine serum total protein (STP) following the Kjeldahl method as described by Kohn and Allen (1995). Albumin was determined using the BCG (bromocresol green) method as described by Peters *et al.* (1982). Glucose and cholesterol were analyzed using Sigma assay kits as described by Coles (1986).

Chemical analysis

Samples of *D. oliveri* seeds, experimental diets and faecal droppings were analyzed, on dry matter basis, for proximate composition according to A.O.A.C (1990) procedures. The raw and toasted seeds were analyzed for tannin using the modified Vanillin assay (Price *et al*., 1978), oxalate by Day and Underwood (1986) procedure, phytate by Reddy and Love (1999) method, saponin by Hudson and El-Difrawi (1979) and hydrogen cyanide by AOAC (1990) method.

Statistical Analysis

Data obtained were subjected to analysis of variance procedures and treatment means were compared by Duncan's Multiple Range Test at 0.05 probability level (Duncan, 1955) using SPSS 10.0.

RESULTS

The results of the chemical analysis indicated that raw DOSM contained 26.50% crude protein, 6.02% crude fibre, 4.30% ether extract, 4.06% ash and 47.47 % carbohydrate on dry matter basis. After toasting, the crude fibre (3.19%), ash (2.8%) and nitrogen free extracts (40.51%) were reduced while, the crude protein (28.60%) and ether extract (7.85%) increased ($P < 0.05$). The raw DOSM contained tannin (2.23 mg/100 g), phytic acid (30.39 mg/100 g), oxalate (20.02 mg/100 g), hydrocyanide (6.05 mg/100 g) and saponin (2.08 mg/100 g) while toasting treatment eliminate almost completely the anti nutritional compounds in the seeds (Table 2).

Feed intake did not significantly differ ($P > 0.05$) among the treatment groups (Table 3). However, birds fed on the 5.0 and 7.5% dietary inclusion of raw DOSM had lower feed intake compared to those fed on 0 and 2.5% raw DOSM and all levels of toasted DOSM (2.5, 5.0 and 7.5%). The growth rates and feed conversion ratio of the birds on 0 and 2.5% raw DOSM and toasted DOSM diets were

Table 2. Proximate composition and anti-nutrients of raw and toasted *Daniellia oliveri* seed meals.

Fraction (%)	Raw	Toasted
Dry matter	88.00	82.95
Crude protein	26.15	28.60
Crude fibre	6.02	3.19
Ether extract	4.30	7.85
Ash	4.06	2.80
Nitrogen free extracts	47.47	40.51
Calcium	1.44	1.21
Phosphorus	0.37	0.22
Metabolites (mg/100 g)		
Phytic acid	30.39	0.01
Oxalate	20.02	-
Saponin	2.08	-
Hydrocyanide	1.05	-
Tannin	2.23	-

not significantly differ (P > 0.05) and significantly better (P < 0.05) when compared to those fed on 5.0 and 7.5% raw DOSM diets. Mortality increased (P < 0.05) with increasing levels of raw DOSM in the diets.

The nutrient retention of dry matter, crude protein, crude fibre, fats and ash contents of birds fed on 5.0 and 7.5% raw DOSM decreased with increasing inclusion levels while, other diets were similar (P > 0.05) to the control diet (Table 4).

Data on haematological and biochemical indices are presented in Table 5. The obtained results showed that only for diet 2, PCV (30.21%), RBC (2.76×10^6 mm^3), Hb (10.21g/dL) and WBC (20.00×10^6 mm^3) values did not statistically differ (P > 0.05) with those of the Control group and toasted DOSM groups but differed significantly (P < 0.05) from the other groups. Total protein, albumin, cholesterol and glucose of birds fed on 1, 2, 5, 6 and 7 diets were not significantly differ (P > 0.05) but differed significantly (P < 0.05) superior compared to those fed on 3, 4 and 5 diets which were depressed.

DISCUSSION

The proximate composition of raw *D. oliveri* seeds for dry matter (88%), crude protein (26.15%) and ash (4.06%) is similar to values reported by Hassan *et al.* (2008) but disagrees with their lower value of 0.6% crude fibre and high values of 9.67% for fats. However, the nitrogen free extracts values of 47.47 and 40.51% for raw and toasted seeds are lower compared to the value of 57.84% reported by Hassan *et al.* (2008). The variations in values of some chemical compositions may be attributed to differences in processing methods, geographical location and the conditions under which the *D. oliveri* trees were grown.

The high feed intake with increase in dietary level of toasted DOSM up to 7.5% inclusion could be due to better detoxification of the anti-nutrients by thermal (toasting) processing of the seeds. However, the significant decline in feed intake at 5.0 and 7.5 % dietary inclusion of raw DOSM could be attributed to the presence of some anti-nutritional factors (ANF), which are thought to be prevalent in most raw legume

Table 3. Performance of broiler chicks fed graded levels of raw and toasted *Daniellia oliveri* seed meals (DOSM) as replacement for groundnut meal.

	Diets							
Parameters	1	2	3	4	5	6	7	SEM
Initial body weight (g)	40.03	40.00	40.01	40.00	40.00	40.02	40.00	0.00
Final body weight (g)	2102^a	2066^a	1573^c	1308^d	2087^a	2068^a	2065^b	121.10
Body weight gain (g)	2062^a	2026^a	1533^d	1268^e	2047^a	2028.0^a	2025^b	121.10
Daily weight gain (g)	36.8^a	36.2^a	27.4^b	22.6^b	36.6^a	36.2^a	36.2^a	2.17
Feed intake (g/day)	80.54^a	80.14^a	76.30^b	71.43^c	80.25^a	79.46^a	79.82^a	1.26
Feed conversion ratio	2.19^a	2.20^a	2.78^b	3.16^c	2.19^a	2.20^a	2.20^a	0.15
Mortality (%)	3.33	-	16.67	26.67	-	-	6.67	-

Means with different letters on the same row differ per P < 0.05

Diets: 1 (0%); 2, 3 and 4 (2.5, 5.0 and 7.5% raw DOSM, respectively) and 5, 6 and 7 (2.5, 5.0 and 7.5% toasted DOSM, respectively).

Table 4. Nutrient retentions of broiler chicks fed graded levels of raw and toasted *Daniellia oliveri* seed meals (DOSM) as replacement for groundnut meal (% DM basis).

	Diets							
Parameters	1	2	3	4	5	6	7	SEM
Dry matter	89.2^a	84.6^a	75.0^b	72.6^b	86.1^a	86.1^a	85.3^a	2.38
Crude protein	81.4^a	78.0^a	67.1^b	61.0^b	80.0^a	79.6^a	79.0^a	3.00
Crude fibre	78.0^a	70.6^a	64.2^b	62.0^b	77.3^a	77.0^a	74.0^a	2.47
Fats	77.0^a	71.1^a	63.8^b	60.0^b	76.9^a	77.0^a	73.0^a	2.59
Ash	69.0^a	68.4^a	57.5^b	52.1^b	70.0^a	71.2^a	69.7^a	2.82

Means with different letters on the same row differ per P < 0.05

Diets: 1 (0%); 2, 3 and 4 (2.5, 5.0 and 7.5% raw DOSM, respectively) and 5, 6 and 7 (2.5, 5.0 and 7.5% toasted DOSM, respectively).

Table 6. Haematological and some serum biochemical indices of broiler chicks fed graded levels of raw and toasted *Daniellia oliveri* seed meals (DOSM) as replacement for groundnut meal.

	Diets							
Parameters	1	2	3	4	5	6	7	SEM
Packed cell volume (%)	31.3[a]	30.2[a]	26.7[ab]	25.1[b]	31.7[a]	31.0[a]	29.0[a]	0.96
Haemoglobin (g/dL)	11.0[a]	10.2[a]	7.5[b]	6.3[b].	10.9[a]	10.5[a]	10.3[a]	0.70
White blood cells ($\times 10^6$ mm^3)	19.3[b]	20.0[b]	25.1[a]	28.5[a]	19.0[b]	19.2[b]	19.0	1.43
Red blood cells ($\times 10^6$ mm^3)	2.87	2.76	2.40	2.31	2.88	2.78	2.89	0.91
Total protein (g/dL)	5.0[a]	5.0[a]	3.6[b]	3.3[b]	4.9[a]	4.9[a]	4.9[a]	0.29
Albumin (g/dL)	2.9[a]	2.8[a]	2.2[b]	2.1[b]	2.7[a]	2.7[a]	2.66[a]	0.11
Cholesterol (mg/dL)	130.0[a]	127.2[a]	94.1[b]	82.4[b]	129.5[a]	128.8	126.4[a]	7.52
Glucose (mg/dL)	176.3[a]	171.0[a]	150.0[b]	142.2[b]	170.0[a]	172.0[a]	168.5[a]	4.86

[a,b]Means on the same row with different superscripts are significantly different (P<0.05)
Diets: 1 (0%); 2, 3 and 4 (2.5, 5.0 and 7.5% raw DOSM, respectively) and 5, 6 and 7 (2.5, 5.0 and 7.5% toasted DOSM, respectively).

feedstuffs (D'Mello, 1982). The low feed intake could, probably, be caused by an astringent taste induced by tannins in raw DOSM as reported by Van Soest (1994). The decrease in body weight and weight gain with increase levels of RDOSM diets (5.0 and 7.5%) could be attributed to the low feed consumption and poor feed utilization by the birds. Tannins and other phytochemical compounds such as saponins, oxalates and phytates could have played a role in depressing growth of birds (Zdunczyk *et al*., 1997).

The high mortality observed in birds fed 5.0% and 7.5 % raw DOSM is in line with earlier reports by Osagie (1998) who noticed that, prolonged effects of consumption of ANF sometimes are capable of precipitating deleterious effects in man and animals, with manifestable toxicity ranging from severe reduction in feed intake and nutrient utilization to profound neurological effects culminating in death.

The enhanced nutrient digestibility in broilers fed TDOSM compared to diets 3 and 4 containing5.0% and 7.5 % raw DOSM is an indication that toasting the seeds improved the quality of the meals making them non-toxic, digestible and absorbable. The reduction in nutrients utilization in birds on the 5.0 and 7.5% RDOSM may be ascribed to the presence of anti-nutritional substances in the diets. This finding is in agreement with an earlier report by Ihekoronye and Ngoddy (1985) who mentioned that some of these active principles interfere with digestive processes thereby preventing efficient utilization of the legume protein.

The observed decrease in PCV, haemoglobin and RBC values for the birds fed diets 3 and 4 compared with the others might indicate an immunological response to the presence of ANF in the feeds and a poor protein utilization (Apata, 1990). The higher values of WBC for birds on the 5.0 and 7.5% RDOSM when compared to other diets might be attributed to the immune system of the birds attempting to detoxify the ANF in the feed. Anti-nutritional factors have been reported to exert negative effects on some haematological parameters. Saponin is known to cause erythrocyte haemolysis and reduction of blood (Cheeke, 1996). The low score in the vale of erythrocytes of broilers fed the 5.0 and 7.5% RDOSM, therefore, confirms the report by Tacon (1992) who found that nutritionally deficient diets cause decrease in haemoglobin concentration, heamatocrit and red blood cell counts. Hackbath *et al.* (1983) reported that increased RBC values are associated with high quality dietary protein and disease-free animals, as observed in the control, 2.5% RDOSM and all three levels TDOSM diets.

The low values of total protein, albumin, cholesterol and glucose recorded by birds on the 5.0 and 7.5% RDOSM diets attested to the nutritional inadequacy of RDOSM in meeting the protein needs of broilers. These low values are in agreement with earlier findings by Onifade and Tewe (1993) who found that the quality of dietary protein influenced their values. Similarly, the low cholesterol and glucose concentration indicates the possibilities of birds having anorexia, liver dysfunction and mal-absorption of fat, which are some of the symptoms of

abnormal glucose and cholesterol metabolism in the body as well as their levels in the blood (Bush, 1991).

CONCLUSION

It can be concluded that broiler chickens could tolerate up to 2.5% raw and up to 7.5% toasted DOSM in the diets without any adverse effect on palatability, survivability, performance and blood profiles. Further research is therefore recommended on higher inclusion levels.

LITERATURE CITED

Adekunle, V. A. J. and O. V. Oyerinde. 2004. Food potentials and some indigenous wild fruits in low land rainforests ecosystem of south west Nigeria. J. Food Technol. 2: 125-130.

Adewetan, T. A.; A. E. Onyeanusi and M. E. Osakwe. 1980. The study of flora and fauna at the Federal College of Wildlife Management, New Bussa. Unpublished Research Paper, Forestry Research Institute of Nigeria. 27 p.

A. O. A. C. 1990. Official methods of analysis. 15th Edition Association of Official Analytical Chemists, Washington DC.

Apata, D. F. 1990. Biochemical, nutritional and toxicological assessment of some tropical legume seeds. PhD Thesis, University of Ibadan, Nigeria.

Ayanwale, B.A.; C. O. Obun and A. V. Ayanwale. 2007. Effect of raw and roasted wild *Afzelia africana* seed meal based diets on broiler chickens. Int'l J. Poultry Sci. 6 (1): 27-30.

Bush, B. M. 1991. Interpretation of laboratory results for small animal clinicians. Blackwell Scientific Publications. London, United Kingdom p. 32-67.

Chauynarong, N.; A. V. Elangovans and P. A. Iji. 2009. The potential of cassava products in diets for poultry. World Poultry Sci. J. 65 (1): 23-26.

Cheeke, P. R. 1996. Biological effects of feed and forage saponins and their impacts on animal production. *In*: Saponins used in Food and Agriculture (Editors, G. Waller and K. Yamasaki.). Plenum Press, New York, USA. p. 377-385.

Coles, E. H. 1986. Veterinary clinical chemical pathology. 4th edition. W.B. Saunders Co. Philadelphia, USA. p. 10-97.

Day, R. A. and A. L. Underwood. 1986. Quantitative analysis. 5th Ed. Prentice-Hall publication, New Delhi, India. 701 pp.

D'Mello, J. P. F. 1982. Toxic factors in some tropical legumes. World Rev. Anim. Prod. 4: 41-46.

Duncan, D. E. 1955. Multiple range and multiple F-tests. Biometrics 11: 1- 42.

El-Mahmood, A. M.; J. H. Doughari and F. J. Chanji. 2008. *in vitro* antibacterial activities of crude extracts of *Nauclea latifolia* and *Daniella oliveri.* Scientific Res. Essay 3 (3): 102-105.

Hackbath, H.; K. Buron and G. Schimansley. 1983. Strain difference in inbred rats: Influence of strain and diet on haematological traits. Lab. Anim. 17: 7-12.

Hassan, L.G.; S. M. Dangoggo, K. J. Umar, I. Saidu and F. A. Folorunsho. 2008. Proximate, minerals and anti nutritional factors in *Danellia oliveri* seed kernel. Nig. J. Basic Applied Sci. 18: 31-35.

Hudson, B. J. and E. A. EL-Difrawi. 1979. The sapogenins of the seeds of four lupin species. J. Plant Food 3: 181-186.

Ihekoronye, A. and P. Ngoddy. 1985. Proteins: food quality control. *In*: Integrated Food Sciences and Technology. 3rd Ed, Macmillian Publishers, London, UK. 28: 155-193.

Kohn, R. A. and M. S. Allen. 1995. Enrichment of proteolytic activity relative to nitrogen in preparations from the rumen for *in vitro* studies. Anim. Feed Sci. Technol. 2 (1): 1-14

McDonald, P.; R. A. Edward and J. P. D. Geenhalgh. 2002. Animal Nutrition. 6th Ed. Longman Sci. and Technical Company, England. p. 154-176.

Muriu, J. I.; E. U. Njoka Njiru, J. K. Tuitock and J. N. Nanya. 2002. The effect of substituting maize with varying levels of high tennin sorghum in the diet on feed intake, digestibility, average gain and feed conversion efficiency for growing rabbits. Agri. Trop. Subtrop. 35: 149-155.

Obun C. O. 2007. Performance and some haematological response of finisher broilers fed graded levels of fermented locust bean (*Parkia biglobosa*) seed meal. Asian J. Agric. Res. 1 (3): 125-130.

Obun, C. O. and B. A. Ayanwale. 2006. The possibility of using *Afzelia africana* seed meal in the diets of starter chicks. Trop. J. of Anim. Sci. 9 (1): 55-61.

Obun, C. O. and B. A. Ayanwale. 2007. Chemical composition and growth performance of finisher broilers fed differently processed *Detarium microcarpum* (Guill and Sperr.) seed meal. Trop. J. Anim. Sci. 10 (1-2): 311-316.

Onifade, A. A and O. O. Tewe. 1993. Alternative tropical energy feed performance in rabbit diets: growth performance, diets digestibility and blood composition. World Rabbits Sci. 1:17–24.

Onyimonony, A. E. and J. O. Onukwufor. 2003. Effects of toasted bambara waste (TBW) on performance of growing pullets. *In*: Proc. of the 28th Ann. Conf. of Nig. Soc. for Anim. Prod. (NSAP). p. 237-239.

Opara, C. C. 1996. Studies on the use of *Alchornia cordifolia* leaf meal as feed ingredient in poultry diets. MSc Thesis, Federal University of Technology, Owerri, Nigeria.

Osagie, A. U. 1998. Anti-nutritional factors. *In*: Nutritional quality of plant foods. Ambolk Press. Benin City, Nigeria 21: 244.

Peters, T.; G. T. Biamonte and B. T. Doumas. 1982. Protein (total protein) in serum. *In*: Selected methods of clinical chemistry. (G. W. R. Faulkner and S. Mcites, Eds). American Association of Clinical Chemistry. p. 100-115.

Price, M. L.; S. Van Scoyoc and L. G. Butler. 1978. A critical evaluation of the vanillin reaction as an assay for tannin in sorghum grain. J. Agric. Food Chem. 26:1214-1218.

Ragab, H. I.; C. Kijora, K. A. Abdel Ati and J. Danier. 2010. Effect of traditional processing on the nutritional value of some legumes seeds produced in Sudan for poultry feeding. Int'l. J. Poultry Sci. 9 (2): 198-204.

Reddy, M. B. and M. Love. 1999. The impact of food processing on the nutritional quality of vitamins and mineral. Adv. Exp. Med. Biol. 459: 99-106.

Schalm, O. W.; N. C. Jain and E. J. Carrol. 1975. Veterinary haematology 3rd Ed. Lea and Fabinger, Philadelphia, USA.

Tacon, A. G. R. 1992. Nutritional fish pathology. Morphological signs of nutrient deficiency and toxicity in farmed fish. FAO Fish Technical Paper. No. 330. Rome, FAO. 75 p.

Teguia, A. and A. C. Beynen. 2005. Alternative feedstuffs for broilers in Cameroon. Livestock Res Rural Dev., 17 (3). Art. 34. http://www.lrrd.org/lrrd17/3/tegu17034.htm (Last visit: 04/25/2012).

Van Soest, P. J. 1994. Nutritional ecology of the ruminants. Cornell University Press, Ithaca, NY, United States America.

Zdunczyk, Z.; J. Juskiewicz, S. Frejnagel and K. Gulewicz. 1998. Influence of alkaloids and oligosaccharides from white lupin seeds on utilization of diets by rats and absorption of nutrients in the small intestine. Anim Feed Sci Tech., 72: 143-154.