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Impact of Raw Tallow *Detarium microcarpum* (Guill and Sperr) Seed Meal on Performance and Blood Parameters in Broilers

Research Article

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ABSTRACT

The nutritive and anti-nutritive components of raw *Detarium microcarpum* seed meals (DSM), and its' impact on performance and blood constituents were investigated in broilers. Day-old broilers (n=225) were randomly assigned to five treatments at graded levels of 0, 5, 10, 15 and 20% DSM in a completely randomized design. Feed and water were given *ad libitum* till 56 days. The analyzed DSM contained 26.5% crude protein, 11.1% crude fibre, 15.2% ether extracts, 3.5% ash and 33.1% NFE. Anti nutritional components of DSM contained 13.1% tannin, 9.6% saponins, 16.4% oxalate, 25.5% phytic acid and 5.1% hydrogen cyanides. Weight gain and FCR were linearly decreased with increased inclusion of DSM. Haematological and serum biochemical indices of birds fed 10, 15 and 20% diets were decreased (P<0.05) compared with those fed 5% and control diets. Inclusion of 5% DSM in broiler chicks' diet had no adverse effect on blood constituents. DSM needs processing to improve inclusion levels beyond 5% in broilers' diets.

KEY WORDS anti nutritive, broilers, raw detarium seeds.

INTRODUCTION

Detarium microcarpum tree is a drought-resistant uncultivated annual plant with fruit yields estimated at 50-75 kg/stand/annum (Obun *et al*. 2009). The inclusion of alternative feedstuffs in animal diets may provide advantages on economic basis (relative price, feed quality), but information on their nutritive value is lacking. The plant seeds have been reported to contain 18.0 to 37.2% crude protein, 39.0 to 65.8% carbohydrate, 9.5 to 17.0% fat, 2.9 to 3.5% crude fibre and 2.7 to 3.0% ash (Anhwange *et al*. 2004; Obun *et al*. 2009; Uhebgu *et al*. 2009) which indicate that detarium seed might be a useful protein and energy source for domestic animals.

Various publications have reported negative effects of unusual ingredients on performance parameters of experimental animals due to factors such as nutrient imbalance, improper metabolism, presence of anti nutritional factors and toxic elements in the ingredients (Emenalom, 1996; Awosanya *et al*. 1997). Like every other legume seed, the Detarium seed contains some metabolites including phytic acid, oxalate, hydrogen cyanide, tannin and saponin (Anhwange *et al*. 2004; Umaru *et al*. 2007). The present experiment sought to determine the antinutrient constituents and evaluated the potential use of graded levels of raw Detarium seed meal on the production performance and blood biochemical indices of broiler chickens.

MATERIALS AND METHODS

Study Site

This study was conducted at the Poultry Unit of Teaching and Research Farm, Federal College of Wildlife Management, New Bussa, Niger State, Nigeria. New Bussa is lo-

cated between latitude 7° 31'-10° 00' N and longitude 4° 30'-4° 33' E (Adewetan *et al.* 1980) in the Savanna areas of the Kainji Lake Basin.

Source and processing of seed meal

After collection of the dry *Detarium microcarpum* fruits from New Bussa, the fruits were cracked and open mechanically. The obtained raw seeds were then cleaned and grounded raw using a 2 mm sieve hammer mill to form raw Detarium seed meal (DSM).

Diets formulation

Five dietary treatments were formulated;diet DM0 served as the control (no *Detarium microcarpum* seed meal) while diets DSM 5, DSM 10, DSM 15 and DSM 20 contained DSM at 5, 10, 15 and 20% inclusion levels respectively in starter and finisher phases (Table 1).

Housing of birds and experimental design

Two hundred and twenty five day-old broiler chickens (Sayed) of mixed sex were purchased from Amo farm, Ibadan, Oyo State, Nigeria and were randomly assigned to five treatment groups comprising 45 birds each. Each treatment group had three replicates of 15 birds in each in a completely randomized design. The birds were raised in a deep litter system using 2.5×2.5 m pen sizes. The chicken house was disinfected using Dazintol solution in water 2 weeks prior to stocking of the chicks.

Feed and water were supplied *ad libitum.* On the first day of birds' collection, vitalyte soluble powder was administered to prevent stress and loss of condition while on the second day; birds were vaccinated using New Castle Disease Vaccine (I/O).

Similarly, on day 7 and 14, birds were orally immunized against New Castle Disease (Lasota) and Infectious Bursal Disease (Gumboro), respectively by dissolving 200 doses of each vaccine in 2 litres of chlorine-free water. The birds were also prophylactically treated against bacterial infection in the second week using Terramycin (chick formula) soluble powder (50 g in 60 litres H_2O) and against coccidiosis using Embazin forte at 30 g per 50 litre water on the 18th day as recommended by Oluyemi and Roberts (2000). At the end of 28 days, birds were weighed and changed to a finisher diet and were fed for 4 weeks until day 56 (Table 1). Feed intake of each replicate was recorded on a daily basis and body weights were taken weekly. The feed intake and weight gain recorded were used to calculate feed to ratio.

Blood collection and analyses

Approximately 5ml of blood was collected from the jugular vein of slaughtered chickens into two sets of five sterilized glass bottles at the conclusion of the feeding trial (56 days). For haematology, the blood samples were collected into a set of five sterilized bottles containing ethylene diamine-tetra-acetic acid (EDTA).

Table 1 Composition of experimental diets

Ingredient	Starter phase					Finisher phase				
	DSM 0	DSM 5	DSM 10	DSM 15	DSM 20	DSM 0	DSM 5	DSM 10	DSM 15	DSM 20
Maize	55.0	52.0	50.0	49.0	47.5	59.5	55.0	53.5	50.0	47.5
Wheat offal	7.5	7.5	7.5	7.5	7.5	10.0	10.0	10.0	10.0	10.0
GNC	27.0	25.0	22.0	16.0	15.0	22.0	18.0	17.0	15.5	13.0
DSM	0.0	5.0	10.0	15.0	20.0	0.0	5.0	10.0	15.0	20.0
Fish meal	3.0	3.0	3.0	3.0	3.0	2.5	2.5	2.5	2.5	2.5
Blood meal	2.0	2.0	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5
Bone meal	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Oyster shell	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Premix*	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Methionine	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Lysine	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Calculated analyzes (Oluyemi and Roberts, 2000)										
Crude protein	21.8	21.8	21.3	21.4	21.3	20.4	20.3	20.0	19.9	19.8
ME (MJ/kg)	12.2	12.3	12.4	12.4	12.4	12.5	12.4	12.5	12.6	12.6
Analyzed proximate composition (% DM)										
CP	22.1	21.5	21.9	21.6	21.2	19.8	19.1	19.1	19.9	19.6
CF	3.1	4.3	5.4	5.6	5.8	4.1	4.1	5.3	5.4	6.6
Ash	3.5	3.5	3.6	3.5	3.6	3.4	3.4	3.9	3.5	3.7
EE	4.6	4.7	4.7	5.0	5.2	4.0	4.2	4.4	4.7	4.9

* To provide the following per kg of feed: vitamin A: 100000 IU; vitamin D_3: 2000 IU; viamin B: 0.75 mg; Nicotinic acid 25 mg; Calcium panthothenate: 12.50 mg; vitamin B_{12}: 2.5 mg; vitamin K: 2.5 mg; viamin E: 2.5 mg; Cobalt: 0.4 mg; Biotin: 0.50 mg; Folic acid: 1 mg; Cholinchloride: 25 mg; Cu: 8 mg; Mg: 64 mg; Fe: 32 mg; Zn: 4 mg; I: 0.80 mg; Flavomycin: 100 mg; Spiramycin: 5 mg; DL-methionine: 50 mg; Se: 0.16 mg and L-lysine 120 mg.
GNC: groundnut meal; DSM: raw detarium seed meal; ME: metabolizable energy; CP: crude protein; DM: dry matter; CF: crude fibre and EE: ether extracts.

Blood samples for serum biochemical studies were collected into plain sterile bottles (i.e. without anticoagulant) for serum separation, Packed cell volume, red blood cells count, haemoglobin concentration, white blood cell count and differentials leukocyte count (lymphocytes, neutrophils and eosinophils) were analyzed according to the methodology of Schalm *et al*. (1975). Serum total protein (STP) was determined by the Kjedahl method as described by Kohn and Allen (1995). Serum albumin was determined using a BCG (bromocresol green) method.

Creatinine concentration was determined using a commercial kit (Creatinine Liquicolor, Germany). Serum glucose, nitrogen urea and cholesterol constituents were determined spectrophotometrically (Thermo Fisher Scientific Inc., Madison, Wisconsin, USA) using commercial reagent kits (United Diagnostic Industry, Dammam, Saudi Arabia). Serum hepatic enzymes namely, Aspartate aminotransaminase (AST), Alanine aminotransaminase (ALT) and Alkaline phosphatase (ALP) were determined using appropriate commercial kits (Randox Laboratories, United Kingdom) as described by Reitman and Frankel (1957) with modifications.

Chemical assay

Proximate analysis of raw Detarium seed meals and the diets (n=3 each) were determined as described by AOAC (2006). Nitrogen was multiplied by 6.25% to obtain crude protein content. Total oxalate was determined according to Day and Underwood (1986).

Phytate was determined using the method of Reddy and Love (1999). Saponin was determined using the method of Birk *et al*. (1963) as modified by Hudson and El-Difrawi (1979). Tannin was determined using the method of Trease and Evans (1978). Hydrogen cyanide was determined by the method of AOAC (2006).

Statistical analysis

Data were subjected to analysis of variance as described by Steel and Torrie (1980). Treatment means were compared by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Results of the chemical composition of the experimental diets are presented in Table 1. The raw detarium seed meal contained 26.5% CP, 11.1% CF, 15.2% EE and 3.5% ash (Table 2). The crude fibre and fat contents of the diets increased with increasing levels of *Detarium microcarpum* seed meals (DSM) which could be attributed to the increased graded levels. Anti-nutritional factors (ANF) of raw Detarium seed meals are presented in Table 2. The ANF values of 9.6% for tannin, 13.1% for saponin, 25.5% for

phytic acid, 5.1% for hydrogen cyanide (HCN) and 16.4% for oxalate obtained in this study were higher compared with earlier reports by Anhwange *et al*. (2004) and Umaru *et al*. (2007) probably due to environmental differences and analytical methods used. The nutritional importance of a given feed depends on its nutrient and anti-nutritional constituents (Aletor *et al*. 1994). Phytate and oxalate affect the bioavailability of the composite nutrients as both form complexes with divalent ions like Ca^{2+}, Mg^{2+}, Fe^{2+} and Zn^{2+} making them unavailable especially for monogastric animals (Pallauf and Rimbach, 1997). Tannin is capable of imparting a bitter taste when presented in legumes alongside other anti-nutritional factors like antho cyanins and phytates.

Growth performance and total feed intake were significantly (P<0.05) different among the treatment groups (Table 3). The final weight, feed intake and weight gain of the birds decreased as the quantity of raw Detarium seed meal increased in the diets. This could be attributed to the relatively high crude fibre and anti nutritional factors present in the raw DSM. The poor growth performance as the quantity of raw Detarium seed meal increased in the diets in accordance with the findings of Akinmutimi *et al*. (2008) who reported a similar trend in a closely related legume, sword bean (*Canavalia gladiata*). There are many factors that are believed to be involved in the poor growth performance of the birds with increasing inclusion levels of DSM. High dietary fibre level has been shown to depress feed acceptability and consequently nutrient intake in animals (Kass *et al*. 1980). Olomu (1995) reported that saponin impairs growth performance of host due to irritating effect on oral and intestinal mucosae in addition to its bitter taste. Tannin imposes an astringent taste that affects palatability, reduce feed intake and consequently body growth. It also decreases the activities of various digestive enzymes by binding them (Bagepallis *et al*. 1992; Aletor, 1993; Sotelo and Flores, 1995).

The poor growth performance of the birds with higher inclusion levels of DSM meal could be due to the accumulative or chronic effects of the anti-nutritional factors (ANF) in the diets. Similar observations were observed when broilers were fed raw jack bean diets (Leon *et al*. 1991; Ologhobo *et al*. (1993). The superior (P<0.05) FCR of birds fed on the control and 5% DSM diets compared to the other groups suggests more nutrients were available for the host besides ANF. High mortality of birds on 15 and 20% diets (Table 3) may be an indication of toxicity due the presence of ANF in the raw seeds.

The haematological parameters are presented in Table 4. There was a significant (P<0.05) decreased in blood chemistry values for test diets exceeding 5% DSM when compared with the control diet.

Table 2 Proximate composition and anti-nutritional factors of *Detarium microcarpum* seeds

Component	Tannin	Saponin	Phytic acid	HCN	Oxalate	CP	CF	EE	Ash
(%)	9.6	13.1	25.5	5.1	16.4	26.5	11.1	15.2	3.5

HCN: hydrogen cyanide; CP: crude protein; CF: crude fibre and EE: ether extracts.

Table 3 Growth performance and cost/benefits of experimental birds fed the *Detarium microcarpum* seed meal diets (0-8 weeks)

Parameters	Inclusion levels (%)					
	DSM 0	DSM 5	DSM 10	DSM 15	DSM 20	SEM
Initial body weight (g/bird)	40.1	40.0	40.0	40.1	40.0	0.00
Final body weight	1820.0[a]	1775.0[b]	1336.0[c]	1104.3[d]	924.4[e]	22.0
Body weight gain (g/bird)	1778.0[a]	1735.0[b]	1296.0[c]	1064.3[d]	884.4[e]	20.67
Feed intake (g/bird)	3225.7[a]	3148.2[b]	2754.3[c]	2460.2[d]	2380.8[e]	3.12
Feed conversion ratio (FCR)	1.8[d]	1.8[d]	2.1[c]	2.3[b]	2.7[a]	0.11
Mortality (%)	2.2[d]	2.2[d]	8.9[c]	11.1[b]	15.56[a]	0.02

DSM: raw detarium seed meal and SEM: standard error of the means.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).

Table 4 Haematological and biochemical indices of finisher broilers fed graded levels of detarium seed meal

Items	Inclusion levels (%)					SEM
	DSM 0	DSM 5	DSM 10	DSM 15	DSM 20	
PCV (%)	32.5[a]	29.7[a]	25.6[b]	23.6[c]	21.7[c]	1.07
RBC ($\times 10^6$/mm^3)	2.9[a]	2.8[a]	2.5[b]	2.2[c]	2.2[c]	0.09
Hb (g/dL)	9.4[a]	8.7[a]	7.7[b]	7.0[c]	6.5[d]	0.30
WBC ($\times 10^6$/mm^3)	30.2[a]	28.8[a]	25.8[b]	24.3[c]	22.1[e]	0.85
Neutrophil (%)	30.1[b]	31.4[a]	26.8[c]	24.5[d]	22.6[e]	0.97
Basophils (%)	4.9[a]	3.6[a]	3.3[b]	3.2[c]	3.2[c]	0.08
Lymphocytes (%)	59.4[a]	56.7[a]	54.6[b]	51.3[c]	46.7[d]	1.18
Eosinophils (%)	7.3[a]	7.1[a]	6.5[b]	6.2[c]	6.0[c]	0.14
Biochemical indices						
Total protein (g/dL)	5.3[a]	5.1[a]	4.9[b]	4.8[c]	4.7[d]	0.08
Albumin (g/dL)	2.9[a]	2.8[b]	2.67.0[b]	2.6[c]	2.4[d]	0.08
Glubolin (g/dL)	2.4[a]	2.3[b]	2.2[b]	2.3[b]	2.3[b]	0.04
Creatinines (mg/dL)	1.0	1.1	1.2	1.3	1.3	0.15
Urea nitrogen (mg/dL)	3.3[d]	3.5[d]	3.7[c]	3.9[b]	4.0[a]	0.09
Cholesterol (mg/dL)	136.7[a]	134.5[a]	126.8[b]	104.3[c]	101.2[c]	3.98
Glucose (mg/dL)	160.6[a]	153.9[b]	152.3[b]	149.9[b]	141.9[c]	2.15
Aspartate transaminase (AST, IU/L)	165.7[a]	161.3[b]	158.2[b]	154.2[c]	152.2[c]	1.56
Alanine transaminase (ALT, IU/L)	24.3[d]	24.6[c]	24.9[b]	24.9[b]	25.1[a]	0.31
Alkaline phosphatase (ALP, IU/L)	33.2[d]	33.7[c]	34.0[b]	34.5[a]	34.6[a]	0.24

DSM: raw detarium seed meal and SEM: standard error of the means.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).

The decreased in values obtained from birds fed 10, 15 and 20% DSM inclusion levels is an indication of poor protein quality in the diets (Awoniyi *et al.* 2000) due to the residual toxicants such as HCN, tannins, oxalate, saponin and phytic acid in the tested ingredient. The low values of RBC for the test diets could also be partly due to spleenic disease. Ubosi *et al.* (1990) reported that spleen produces a humoral factor containing erythropoiesis, leading to a decrease in the value of RBC as a result of spleenic disease. The decrease in WBC observed in diets exceeding 5% DSM may mean that the diets mildly suppressed haemopoietic tissues with resultant production of lower body immunity which could be confirmed by recorded mortalities at 10, 15 and 20% dietary birds. This result is similar to findings of Szabo *et al.* (2005) and Lloyd and Gibson (2006) who reported that PCV and haemoglobin concentration are good indicators of the nutritional status of the subject.

This study also supports the finding of Olorode *et al.* (1995) who reported that dietary influence on haematological parameters is very strong. The differential leukocyte counts (neutrophils, lymphocytes, eosinophil and basophil counts) of the birds on 10, 15 and 20% DSM were lower (P<0.05) compared with those fed the control and 5% diets which could be due to the accumulative toxic effect of high DSM levels in the diets.

Broiler birds fed the control and 5% diets had higher total protein values of 5.3 and 5.1 g/dL compare with the other groups (10, 15 and 20%) with values of 4.9, 4.8 and 4.7 g/dL, respectively (Table 4). Serum total protein consists of albumin and globulins. Changes in the nutritional status of an animal are easily detected in the albumin, which are about two-thirds of total protein. Information regarding nutritional status and malnutrition is often obtained from the total protein (Allison, 1995).

Decrease in serum protein (SP) concentration with increasing DSM inclusion levels suggests alteration of normal protein metabolism due to interference of protein utilization. The serum creatinine value for the control (1.0 mg/dL) was lower compared with DSM based diets which increase linearly with increasing DSM levels (5% DSM (1.1 mg/dL) diets 10% (1.18 mg/dL), 15.00% (1.22 mg/dL) and 20% (1.25 mg/dL) in the diets. This implies low nutritional protein quality of diets, since the higher the value of serum creatinine, the lower the protein quality of the test ingredient (Aletor *et al.* 1998). The globulin values for the birds on the control diet were higher ($P<0.05$) compared with other dietary treatments.

The serum urea significantly ($P<0.05$) increased at 10, 15 and 20% levels of DSM inclusion. The increase values may be attributed to the poor quality of protein utilization which is indicated by the low total protein recorded in this group of birds as earlier reported by Akinola and Abiola (1990). This agrees with the findings of Eggum (1970); Iyayi and Tewe (1998) and Esonu *et al.* (2001) who reported that serum urea and total protein contents depend on both the quantity and quality of the protein in the diet. The serum cholesterol and glucose concentrations of birds fed the control and 5% diets were similar ($P>0.05$) before a marked decrease ($P<0.05$) at 10, 15 and 20 diets. This may be due to the metabolites (ANF in DSM). Saponins in diets have been known to reduce the uptake of certain nutrients like glucose and cholesterol, and so may help in lessening the metabolic burden that would have been placed on the liver (Price *et al.* 1987).

Saponin has also been reported to reduce body cholesterol by preventing the reabsorption of bile and suppresses rumen protozoan by reacting with cholesterol in the protozoan cell membrane thereby causing it to lyse (Awe and Sodipo, 2001).

Table 4 outlines the activities of the serum hepatic enzymes Aspartate transaminase (AST), Alanine transaminase (ALT) and Alkaline phosphatase (ALP). The observed AST values decreased while the ALT and ALP slightly increase with increased DSM levels in the diets.

The amino transferases are the most common indicators of cellular malfunction, they are found in small quantities in the serum, with higher values indicating a disease or malfunction in the liver (Rosenthal, 1977).

Although the values observed in this study were different for all the experimental diets, they were all within the normal range value for serum enzymes in chickens (Kerr *et al.* 1982). This could be as a result of the negative effect of antinutrients present in DSM.

This finding is in agreement with submission by Harper (1975) and Kaneko *et al.* (1997) that when ALP and ALT values are higher than control, there is ANF in the diets, an indication that the animals suffered heart, kidney and / or liver infection due to cellular destruction.

CONCLUSION

In conclusion, Detarium seeds can be included in the broiler diet upto 5% level without affecting the feed acceptability and haematological and biochemical indices of broilers.

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