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Performance, haematology and serum biochemistry of broiler chickens fed differently processed shea butter cake meal

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Target Audience: *Poultry Farmers, Animal Nutritionists, Researchers and Extension agents*

Abstract

A 42-day study was conducted to determine the effect of feeding differently processed shea butter cake meal (SBCM) on performance and blood indices of broiler chickens. A total of 250 Arbor acre day old chicks were randomly allocated to five dietary treatments with five replicates of 10 birds each in a completely randomized design under deep litter system. The five diets were formulated such that T_1 is the control containing 0% SBCM while T_2, T_3, T_4 and T_5 contained 20% of raw, boiled, sodium hydroxide (NaOH)-treated and fermented SBCM respectively. Data obtained on performance, haematology and serum indices were subjected to one-way Analysis of Variance (ANOVA). The results showed that all performance parameters were significantly ($p<0.05$) affected by the treatments and birds fed processed SBCM diets compared favorably with the control group especially fermented SBCM than those fed raw SBCM diet. WBC, RBC, serum protein, glucose and creatinine were comparable among birds fed control and processed SBCM diets while lower ($P<0.05$) values were recorded in those on raw-SBCM. In conclusion, birds fed fermented-SBCM diets showed improved performance at lower fed and up to 20% inclusion can be tolerated without any deleterious health consequences.

Keywords: Shea butter cake, processing, performance, blood, broilers.

Description of Problem

In developing countries such as Nigeria, smallholder poultry rearing is a common practice in most rural and some urban areas where the demand for the birds is expanding as a result of population growth, increased urbanization, and rising incomes. The need for increased animal protein consumption of the rural and urban populace in the face of rising population and inflation has resulted in the increase in cost of poultry production [1]. Feed accounts for 70 - 80% of the total cost of poultry production in Nigeria [2], with the high cost of the conventional poultry feed stuffs stemming directly from their competition with human staple [3]. Recent advances in modern poultry production have further increased the competition for conventional feedstuffs between livestock industry, agricultural product-dependent industries and humans [4]. It has therefore become imperative to explore other alternatives for the feed industry in order to reduce the current stress on human food supply.

Shea butter cake (SBC) is a by-product obtained during the processing of shea nuts (*Vitellaria paradoxa*,) to produce shea butter. The SBC which is made available after extraction is a material that has been recommended as potential feedstuff for livestock [5, 6]. Chemical analysis of SBC indicated its overall nutritional value to be

high, containing a crude protein and metabolisable energy (ME) content of 13.03% and 3427.27 kcal/kg respectively, and also rich in minerals like calcium, potassium and magnesium [7]. Despite the high nutritional value of SBC, its inclusion in poultry diets is limited due to the present of some anti-nutritional factors (ANFs) especially tannin that can hamper the animal health and performance [8, 9]. Though, nutritionist and researchers have made efforts to reduce the level of the ANFs in order to improve its utilization as alternative energy source in poultry diet, hence, there is need to adopt efficient processing strategy in order to improve the nutritional potential of SBC. Therefore, this research was conducted to improve the nutritive value of shea butter cake through effective and efficient processing strategies in the diets of broiler chickens on growth performance and some blood indices.

Materials and Methods

Experimental site: The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of the Department of Animal Production Technology, Federal College of Wildlife Management, New-bussa, Niger State, Nigeria.

Source and processing of SBC: Large quantities of SBC were obtained from local shea butter processing factories in New-bussa, Nigeria, thoroughly mixed, air-dried for 5 days and divided into 4 different processing batches. Batch 1 was not subjected to any processing method. Batch 2 was soaked in water overnight and boiled for 30minues at 70^{o}C, thereafter, drained and sundried. Batch 3 was processed by applying 0.01M solution of sodium hydroxide (NaoH) to the samples until thoroughly wet and allowed to air-dry. Batch 4 was subjected to fermentation under anaerobic condition for three days. The SBC samples from the different processed batches were milled separately to produced raw, boiled, NaoH-treated and fermented SBC meal, and thereafter were analyzed for their proximate composition and tannin content [10].

Experimental diets: Five iso-nitrogenous and iso-caloric diets both for starter and finisher were formulated to meet the [11] recommendation with the differently processed SBC meal replacing 20% of maize in the control diet. The ingredient composition of the experimental basal diets is shown in Table 1.

Experimental birds, design and management: Two hundred and fifty (250) day old arbor acre broiler chicks used for the experiment were procured from a reputable commercial hatchery. The birds were weighed and randomly divided into five treatment groups of five replicates with 10 birds each in a completely randomized design (CRD). Feed and water were provided *ad-libitum* throughout the experiment that lasted for 42 days. The birds were raised in a deep litter system using wood shavings as litter material in an open sided poultry pen facility.

Data collection: The birds were weighed at the beginning of the study and subsequently weekly in order to measure average weight gain (AWG). A known quantity of feed was served to the chicks every week and left over was collected and weighed to determine feed intake (AFI). Feed conversion ratio (FCR) was calculated by dividing the AFI by AWG. The cost/kg weight gain was calculated according to the procedure of Ukachukwu and Anugwa [12]. At the end of the study, blood haematology and serum biochemistry were evaluated by randomly selecting 2 birds per replicate. The birds were sacrificed by severing their jugular veins and blood samples were collected into bottles containing EDTA (an anticoagulant) for haematological evaluation while another set of blood samples were collected into bottles without EDTA for blood chemistry evaluation. Blood constituent

parameters were determined as described by Dacie and Lewis [13].

Data analysis: All data collected were statistically analyzed using General Linear Model (GLM) of SAS [14] package and treatment means were separated using Duncan's New Multiple Range Test [15]. All levels of significance were set at 5% ($p<0.05$).

Table 1: **Ingredient composition of experimental broiler starter and finisher basal diets**

Feed ingredients	Starter phase		Grower phase	
	0% SBCM	20% SBCM	0% SBCM	20% SBCM
Maize	55.00	44.00	67.50	54.00
SBCM	0.00	11.00	0.00	13.50
Soybean meal	35.50	35.50	24.00	24.00
Fish meal	5.00	5.00	4.00	4.00
Di-calcium phosphate	2.50	2.50	2.50	2.50
Limestone	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated Nutrients				
Energy (Kcal ME/kg)	3021.76	3043.28	3104.60	3139.44
Crude Protein %	23.65	23.28	19.24	19.14

*Vitamin mineral premix provided (per kg of diet): Vitamin A, 5000 I.U., Vitamin D_3 1000,000 I.U., Vitamin E 15,000 mg; Vitamin K_3, 100 mg; Vitamin B_1, 1,200 mg; Vitamin B_2, 2,400 mg Biotin, 32 mg; Vitamin B_{12}, 10 mg; Folic acid, 400 mg; Choline chloride, 120,000 mg; Manganese, 40,000 mg; Iron, 20,000 mg; Zinc 18,000 mg; Copper, 800 mg; Iodine, 620 mg; Cobalt, 100 mg; Selenium 40 mg.

Table 2: Proximate composition of differently processed shea butter cake meal (SBCM)

Nutrients	RSBCM	BSBCM	NaOH-SBCM	FSBCM
Dry matter %	93.27	93.88	95.64	94.98
Crude protein %	14.60	13.53	14.47	16.23
Ether Extract %	15.21	13.38	15.52	12.63
Crude Fiber %	4.26	4.17	4.06	3.97
Ash %	14.43	13.97	14.38	14.87
Nitrogen Free Extract %	51.50	54.95	51.57	52.30
ME (Kcal/kg)	3601.98	3536.45	3624.80	3481.45

RSBCM: Raw shea butter cake meal; BSBCM: Boiled shea butter cake meal
NaOH-SBCM: Sodium hydroxide treated shea butter cake meal; FSBCM**:** Fermented shea butter cake meal

Results and Discussion

The result on proximate analysis (Table 2) shown that raw (14.60%), NaOH-SBCM (14.47%) and FSBCM (16.23%) have higher crude protein levels compared to earlier reports (5, 7) of below 14.36% CP. Among the differently processed SBCM, boiling gave the lowest level of CP of 13.53% and this may be attributed to the fact that heating enhances degradation of protein [16] and moreover, is

associated with solubilization and leaching of some nitrogenous compounds into the processing water [17, 18]. The NFE and ME values of SBCM obtained in this study were an indication that SBCM could be a potential alternative energy source to reduce dependence on maize. The variation in nutrient levels as observed in the proximate composition may be attributed to different processing methods adopted. There was a general reduction in the level of tannin due to the processing methods adopted (Table 3). Boiling, NaOH treatment and fermentation resulted in 86.36, 72.73 and 81.82% reduction in tannin content respectively. The highest reduction in the tannin content obtained in boiled SBCM confirms the report of previous authors that wet heat treatment reduces heat labile anti-nutrients [19, 20, 21]. The results of the average daily feed intake (ADFI), average daily weight gain (ADG), feed conversion ratio (FCR) and cost/kg weight gain are presented in Table 4. This result showed that all performance parameters were significantly affected ($p<0.05$) by the dietary treatments. The mean values recorded for ADG and ADFI were similar ($p>0.05$) among the birds fed control and processed SBCM based diets and significantly lower ($p<0.05$) in birds fed RSBCM diet. The comparable growth rate of birds fed control and processed SBCM diets is a clear indication that there was improved utilization of the nutrients in the cake meal by the birds due to the processing methods adopted in eliminating the barrier imposed by the anti-nutritional factors present in the SBC [5, 6, 22]. FCR were significantly ($p<0.05$) lower in birds fed control and FSBCM diets than those on RSBCM diet. The improved FCR of birds fed FSBCM diet suggests enhanced availability, digestion and absorption of the nutrients in the fermented cake meal by broilers. The marked improvement in the performance indices of birds fed processed SBCM diets comparable to those on the control diet may be due to enhanced nutritive value and significant reduction in the level of tannin. This confirms the report of earlier researchers who recommended that the detoxification of SBCM via the process of NaOH treatment [6], fermentation [23] and boiling [24] were very efficient and effective in reducing the adverse effect of ANF especially tannin thus improving its nutritional value as a potential feedstuff. On the other hand, the significant reduction in performance of the birds fed RSBCM diet could be a reflection of the stringent requirement for essential nutrient especially protein and energy due to the limitation caused by the presence of relatively high concentration of tannin in the cake meal [8, 7, 23, 25]. Tannins are known to inhibit the in vivo activities of some enzymes like trypsin, amylase and lipase by forming insoluble complexes with protein thereby reducing their absorption in the body [26]. Thus, the result of poor performance of birds fed RSBCM obtained in this study is in accordance with previous researchers who reported that high dietary tannins result in lower body weight gains and poor feed efficiencies in birds fed unprocessed shea butter based diets [27, 5, 28, 25]. This is as a result of the pronounced deleterious effect of tannin on protein and energy digestibility as well as bioavailability of amino acids [29, 30, 31]. Feed cost per kilogram gain was significantly ($p<0.05$) affected by the dietary treatments and was lower ($p<0.05$) in birds fed FSBCM than those on control, RSCBM, BSBCM and NaOH-SBCM diets. This implies that cost decreased with the inclusion of processed SBCM especially FSBCM, thus an indication that significant savings can be achieved with the use of processed SBCM in replacing maize up to 20% inclusion level. The higher demand and price for maize in the market were responsible for the higher feed cost per kg gain observed in the control diet.

Table 3: **Tannin content and percentage reduction of raw and processed shea butter cake meal (SBCM)**

Processing techniques	Tannin composition (mg/kg)	% reduction of tannin
Raw SBCM	0.22	----
Boiled SBCM	0.03	86.36
NaOH-treated SBCM	0.06	72.73
Fermented SBCM	0.04	81.82

Table 4: Performance of broiler chicks on the experimental diets

Parameters	Control	RSBCM	BSBCM	NSBCM	FSBCM	SEM
Daily Weight gain (g/bird)	53.75^{a}	35.98^{b}	51.71^{a}	51.28^{a}	52.01^{a}	1.75
Daily Feed intake (g/bird)	74.39^{a}	69.17^{c}	73.89^{b}	74.02^{a}	70.17^{a}	0.22
FCR	1.38^{bc}	1.92^{a}	1.43^{b}	1.44^{b}	1.35^{c}	0.03
Cost/kg gain (₦)	147.26^{a}	138.49^{b}	103.15^{c}	103.87^{c}	97.38^{d}	2.01

^{abc} Mean values on the row with different superscripts are significantly different ($p<0.05$).
RSBCM: Raw SBCM; BSBCM: Boiled SBCM; NSBCM: NaOH-treated SBCM
FSBCM**:** Fermented SBCM; SEM: Standard Error Mean.

Table 5: Haematological and serum biochemical indices of broilers on experimental diets

Blood indices	Control	RSBCM	BSBCM	NSBCM	FSBCM	SEM
Haematology						
PCV %	25.50	22.70	25.69	26.16	25.61	2.75
Hb %	8.52	7.44	8.59	8.72	8.54	0.93
WBC 10^3/L	28.25^{a}	24.96^{c}	28.36^{a}	27.98^{a}	28.29^{a}	1.31
RBC 10^6/L	3.81^{a}	2.30^{b}	3.59^{a}	3.32^{a}	3.73^{a}	0.55
Serum biochemistry						
Total protein g/dl	5.18^{a}	3.13^{b}	5.08^{a}	4.86^{a}	4.47^{a}	0.34
Albumin g/dl	3.47	2.17	3.90	3.53	3.38	0.69
Globulin g/dl	1.76	1.35	1.44	1.51	1.61	0.77
Creatinine mg/dl	2.21^{b}	4.83^{a}	2.38^{b}	2.63^{a}	2.33^{b}	0.62
Glucose mg/dl	206.52^{a}	186.98^{c}	204.76^{b}	210.01^{b}	208.88^{b}	2.84
Cholesterol mg/dl	163.33	154.94	162.60	161.41	162.77	12.65

^{abc} Mean values on the row with different superscripts are significantly different ($p<0.05$).
RSBCM: Raw SBCM; BSBCM: Boiled SBCM; NSBCM: NaOH-treated SBCM; FSBCM**:** Fermented SBCM; SEM: Standard Error Mean.

The result of haematological and serum biochemical parameter are presented in Tables 5. With the exception of white blood cells (WBC) and red blood cell (RBC), all other haematological parameters measured were not affected ($P>0.05$). The RBC count for birds fed RSBCM were lower ($p<0.05$) than those on control and processed SBCM diets. The lower RBC counts obtained in birds fed RSBCM diets may be ascribed to the higher concentration of tannin in SBCM diet. RBCs are responsible for the transportation of oxygen and carbon dioxide in the blood as well as synthesis of haemoglobin, therefore higher mean values obtained from birds on processed SBCM diets is an indication of a greater potential for this function and better state of health for the birds [32]. This shows that processed SBCM based diets are nutritionally adequate to meet the protein needs of the birds

since Hb concentrations decrease in animals on low protein intake [33]. This still confirms the good ability of the diets containing processed SBCM due to their lower level of tannin content to support blood formation and consequently leading to improve performance. WBC count for broilers on RSBCM diet was significantly lower ($p<0.05$) than those fed control diet and processed SBCM. This shows that the ability of birds fed RSBCM to fight against the foreign substance in the body was impaired but improved when fed processed SBCM due to proper detoxification in reducing the level of ANFs in the test ingredient. According to Oyawoye and Ogunkunle [34], haematological components of blood are valuable in monitoring level of toxicity in feed, with emphasis on feed constituents that affect blood formation. This implies that the feed value of the processed SBCM diets was adequate and the replacement of corn with processed SBCM in the experimental diet did not impair its nutritional quality. All serum biochemical indices examined except for the total protein, glucose and creatinine were not significantly affected ($P>0.05$) by the dietary treatment. Birds fed RSBCM diet recorded a lower ($p<0.05$) serum protein and glucose compared to other dietary treatments. The decreased ($p<0.05$) total protein and glucose observed in broilers fed RSBCM could be attributable to inhibition of protein and energy utilization due to the presence of tannin which has the ability to complex with protein, including enzymes in the gastro intestinal tract and thereby negatively inhibits the digestibility of protein and other essential nutrients. Thus, significant ($p<0.05$) reduction in total protein and glucose on RSBCM diet indicate inferior protein quality and nutrition as evidenced in the reduced growth rate and efficiency of feed utilization in the birds fed RSBCM. However, higher ($p<0.05$) serum protein and glucose obtained in birds fed processed SBCM attest to the nutritional adequacy of these diets in meeting the protein and energy needs of the birds. Serum creatinine of birds fed diet containing RSBCM was higher ($p<0.05$) than those on the control and processed SBCM diets. Thus, birds fed diets containing processed SBCM having comparable lower serum creatinine with those on control group is an indication of nutritional superiority of the protein quality of the processed diets, since the lower the value of creatinine, the higher the protein quality of the test feedstuff [35].

Conclusion and Application

The result of this study has revealed that

1. SBCM has good nutrient attributes that warrant its usefulness as a potential alternative energy ingredient source in poultry nutrition.
2. Adequate processing techniques such as boiling and fermentation effectively enhanced the nutritive value of SBCM by reducing the level of anti-nutritional factors especially tannin.
3. Inclusion of fermented SBCM at 20% replacement for maize has the potential of improving performance and reducing cost per kg gain of broilers without any negative impact on their health status.

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