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Research Article

Impact of Fermentation Period on Heat-Treated Shea Butter Cake Meal in Diet of Broiler Chickens on Haematobiochemical Indices

Aguihe PC[1]*, Halidu SK[2], Chikezie J[2], Joshua DA[3], Adedeji EO[2] and Samuel KU[4]

[1]*Department of Animal Production and Health Technology, Federal College of Wildlife Management, New Bussa, Niger state, Nigeria*

[2]*Department of Wildlife and Ecotourism, Federal College of Wildlife Management, New Bussa, Nigeria*

[3]*Department of Basic Science, Federal College of Wildlife Management, New Bussa, Nigeria*

[4]*Department of Agricultural Science, College of Education, Ikere-Ekiti, Ekiti state, Nigeria*

***Corresponding Author**: Aguihe PC, Department of Animal Production and Health Technology, Federal College of Wildlife Management, New Bussa, Niger state, Nigeria.

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Abstract

Shea butter cake is produced as a by-product from shea butter production. The cake was processed by cooking in boiling water for 30 minutes and undergone fermentation at different periods of 3, 6 and 9 days, thereafter air-dried and milled to obtained cooked-and-fermented shea butter cake meal (CFSBCM). A 21-d feeding trial was conducted to evaluate the haematological and serum biochemical response of broiler chicks fed differently CFSBCM. A total of one hundred and forty four (144) Arbor Acre strain broiler chicks were randomly allocated to four treatments with four replicate of nine (9) birds each in a completely randomized design. The control diet (T1) had only maize meal without CFSBCM while others contained maize being substituted at 20% by 3, 6 and 9-days CFSBCM in T_2, T_3 and T_4 respectively. Feed and water were provided *ad-libitum.* At 28d, 2 birds per replicate were selected and blood were collected through the jugular vein into different labeled bottles with or without anti-coagulant (EDTA) for haematological and serum biochemical indices respectively. Fermentation and cooking improved the nutritive quality of the test ingredient by increasing the crude protein and reducing crude fiber and its tannin concentration. The results showed that there is no significant difference ($p < 0.05$) in all haematological parameters measured except for MCV and MCH concentrations. The blood biochemistry of the birds showed significant ($p < 0.05$) effect of the dietary treatments on serum glucose, total protein, uric acid, creatinine and triglycerides while no significant difference ($p > 0.05$) was recorded on serum albumin, alanine transaminase (ALT) and aspartate transaminase (AST). However, these values were within the normal range for broiler chickens. From the above, therefore, it can be concluded that longer period of CFSBCM at 20% inclusion is adequate in the diets of broiler chickens as replacement for maize without any adverse effect on their blood composition.

Keywords: *Shea Butter Cake; Fermentation; Haematology; Serum Biochemistry; Broilers*

Introduction

The rapid growth of human population has intensified the competition between humans and livestock for grains such as maize which is the major source of energy in poultry feeds. Cereals such as maize constitute more than one-third of the poultry feed and due to its high price is becoming more expensive to use at high level of inclusion in poultry feeds [1,2]. Hence, high cost of feeding poultry has necessitated the need to look for alternative energy feed source for poultry in order to reduce cost and limit dependence on maize [3,4]. Feed accounts for 70 - 80% of the total cost of broiler production in Nigeria [5]. The ever increasing cost of livestock feed with an attendant increase in

the cost of livestock products such as meat, eggs and milk shows that there is need to adopt the principle of waste - to - wealth in livestock feeding. In view of this high cost of grain (maize) in poultry production, the use of Agro Industrial by Products that are not consumed by man and are available in cheap cost of substitute for maize in poultry diet is worthy of consideration.

Therefore, there is an urgent need for an alternative in livestock feeds, to reduce the current pressure on maize as staple food for man [6,7]. One of such alternatives for replacement is the processed shea butter cake, is an agro-forestry by-product obtained from the processing of nuts of the shea butter tree *(Vitellaria paradoxa)* for fat with no economic value and environmental issue [8,9]. Abdul-Mumeen*., et al.* [10] investigated shea butter cake for proximate quality, and reported its overall nutritional value to be high, containing 13.03, 23.38, 4.25, 8.71, 59.37% and 4485.86 kcal ME/kg of crude protein, crude fat, ash, crude fiber, carbohydrates and metabolizable energy respectively as well as rich in minerals like calcium, potassium and magnesium. Based on its composition, shea butter cake has been sampled as potential feed stuff as replacement for dietary maize in poultry ration [9,11-13]. However, the major nutritional setback of shea butter cake utilization for chicken is poor digestibility possibly due to the presence of anti-nutritional factors like saponins and most particularly tannins [14]. Despite the high nutritional value of SBC, its inclusion in mono-gastric diets is limited due to the present of some anti-nutritional factors (ANFs) that can hamper the animal health and performance. The major ANFs are tannin and theobromine [10,15]. 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.

Fermentation is a unique process with great potential for recycling some Agro-industrial by-products into useful animal feeds in developing countries. The process does not requires the use of chemicals and is easy manage in a local condition or on an industrial scale [16]. The characteristics of the fermented products include their acceptability by birds and nutrient availability [17]. The amounts of tannins and saponins in some foods can be reduced by fermentation, although the mechanism by which these components are eliminated is not fully understood [18]. However, the fermentation process can produce organic acids that break down saponins or tannins; or create conditions for the growth of native microbes that detoxify these components [19]. Fermentative microbes have been used extensively in the improvement of agricultural by-products through its action on substrates such as non-starch polysaccharides and proteins [20,21] or structurally modifying anti-nutritive factors [17]. Thus, the need to ascertain the implication of cooked-and-fermented shea butter cake meal (CFSBCM) on blood parameters of broiler chickens is necessary. This is because of the effect of such diet will reflect in their body system and can be scientifically investigated by studying the physiological and pathological state of the animal through observation of blood and its components [21]. Therefore, this study was carried out to determine the haematological and serum biochemical indices of broiler chicks fed different periods of CFSBCM.

Materials and Methods

Study site: The study was conducted in the Poultry Research Unit of Federal College of Wildlife Management, New Bussa, which can be located in the savanna areas of Niger Basin in Nigeria. It has a tropical humid climate with mean annual temperature of 34°C, 60% relative humidity and mean annual rainfall of 1040 mm.

Source and processing of test ingredient: The shea butter cakes (SBC) used for this study were obtained fresh from the local shea butter processing factories in Tunga Dan baba, Borgu Local Government Area of Niger State, Nigeria. The fresh shea butter cake was cook for 30 minutes at 70oC, thereafter divided into three batches and fermented differently at 3, 6 and 9 days and were all properly air-dried for 5 days. The cooked and fermented shea butter cakes (CFSBCM) were ground using a hammer mill before incorporation into experimental diets. The sample of raw and fermented SBC meals were subjected to proximate analysis according to (AOAC, 2010). The tannin composition was determined as described by the method of Orogun et al (2015).

Housing of birds and management: The birds were managed in an open-sided constructed poultry facility and raised in a deep litter system, using wood shavings as litter material. Experimental feed and water were supplied free choice. At first day of bird's arrival,

an anti-stress (Vitalyte®) soluble powder was given against stress and to burst energy while other medication, vaccination and other prophylactic measures were done as appropriate.

Experimental birds and design: A total of two hundred and eight (208) unsexed day old broiler chicks of Arbor Acre strain were used for this experiment. The birds were randomly allocated to four experimental treatments; each treatment was further divided into four replicates of thirteen birds each in a completely randomized design (CRD).

Experimental dietary treatment: Four isonitrogenous diets were formulated to provide 23% CP requirement of broiler chicks. Treatment 1 (T_1) was made to contain corn-soybean meal based diets as the control treatment. The cooked shea butter cake meal which was fermented at different periods of 3, 6 and 9 days were used to replace 20% corn in T_1 to give diet T_2, T_3 and T_4 respectively (Table 1).

Ingredients	T_1 (Control diet)	T_2 (3-d FCSBCM)	T_3 (6-d FCSBCM)	T_4 (9-d FCSBCM)
Maize	51.00	40.80	40.80	40.80
Soya beans meal	35.75	35.75	35.75	35.75
Shea butter cake	0.00	10.20	10.20	10.20
Fish meal	4.00	4.00	4.00	4.00
Soya oil	3.00	3.00	3.00	3.00
DCP	1.50	1.50	1.50	1.50
Bone meal	1.50	1.50	1.50	1.50
Lime stone	1.50	1.50	1.50	1..50
Salt	0.50	0.50	0.50	0.50
Vitamin premix	0.50	0.50	0.50	0.50
DL-Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Threonine	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated nutrients				
ME kcal/kg	2997.20	3020.66	3020.66	3020.66
CP (g/kg)	22.08	22.82	22.82	22.82
Calcium (g/kg)	1.54	1.53	1.53	1.53
Phosphorus	6.65	6.36	6.36	6.36

Table 1: *Ingredient composition of experimental diets.*

Blood collection: On the termination of the feeding trial on day 28, thirty-two chicks were selected randomly (eight chicks per treatment) and blood samples were collected from each through the ventral part wing. Thereafter, 2.5 ml of the collected blood was poured into a sterile bottle containing Ethylene Diethyl Tetra Acetic acid EDTA bottle for determination of haematological parameters and another 2.5 ml into a sterile plain bottle for serological indices respectively. The haematological indices were determined with the use of Wintrobes hematocrit, improved Neubauer haemocytometer as described by Dacie and Lewis [22], MCV, MCH and MCHC were determined according to the method of Jain [23]. Blood glucose was determined using Hexokinase method, total protein and albumin were determined by Biuret and Bromocresol Green method, respectively [24]. The creatinine and other liver enzymes were determined using the standard enzymatic method described by Bush [25].

Proximate analysis: The proximate composition of the raw and CFSBCM were analyzed according to the procedures of AOAC [26].

Statistical analysis: All blood data determined was analyzed using analysis of variance (ANOVA) using the Completely Randomized Design (CRD) according to GLM model of SAS statistical package [27]. Significant differences were separated using Turkey test.

Results and Discussion

The proximate and tannin composition of raw and fermented SBCM is presented in table 2. The result revealed that raw shea butter cake meal contains 5.67% moisture content (MC), 20.61% ash, 4.18% crude fiber (CF), 12.85% crude protein (CP), 10.67% crude fat (CF), 45.41% nitrogen free extract (NFE) and 0.22 (g/kg) tannin. The result also shows that fermented shea butter cake meal contain 8.50% moisture content (MC), 29.94% ash, 3.89% crude fibre (CF), 15.71% crude protein (CP), 5.36% crude fat (CF), 32.61% nitrogen free extract (NFE) and 0.04 (g/kg) tannin. This shows that fermentation enhanced the nutrient profile of SBCM especially with respect to crude protein and crude fiber compared to raw SBCM. The crude protein content increased from 12.85% to 15.71% and crude fiber reduced from 4.18 to 3.89%. This is in accordance with the reports of Mutayoba., *et al.* [28] that fermentation aids in improving nutrient composition of feed stuffs. The tannin content of the processed SBCM reduces to 0.04 g/kg from 0.22 g/kg obtained in the raw SBCM. This is in line with the findings of Reddy and Pierson [18] who reported that fermentation process can create conditions for the growth of microbes (*Bacillus, Corynebacterium, Klebsiella, Aspergillus, Penicillium, Fusarium* and *Candida*) and also produce organic acids that break down tannins. The observed crude protein (12.85%) was higher than those reported by Ugese., *et al*. [29] and Orogun., *et al*. [12] who observed 9.2% and 12.70% respectively and lower than value reported by Abdulmumeen., *et al*. [10], Atuahene [30] and Zanu., *et al*. [9] who reported 13.03%, 16.24% and 17.31% respectively. The crude fiber, nitrogen free extract and ash content was lower compared to the value 16.57, 59.37 and 18.83 observed by Abdulmumeen., *et al*. [10] respectively. The variation in the nutrient composition could be attributed to differences in location, varieties and efficiency of oil extraction of the cake.

Component	Raw SBCM	Processed SBCM
Moisture content %	5.67	8.50
Ash %	20.61	29.94
Crude fiber %	4.18	3.89
Crude protein %	12.85	15.71
Crude fat %	10.67	5.36
NFE %	45.41	32.61
Tannin (g/kg)	0.22	0.04

Table 2: *Proximate analysis of the raw and processed shea butter cake meal (SBCM).*

Table 3 shows the results of replacing maize with 20% inclusion level of CFSBCM of broiler chicks on haematology. The result revealed that there is no significant difference ($p < 0.05$) in all haematological parameters measured except for mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH). Birds fed control and T_4 diets were statistically similar and show higher ($p < 0.05$) mean values for MCV and MCH concentrations than birds fed T_3 and T_4 diets. All the haematological values obtained in this study were within the normal range and correlated with those reported by previous researchers who observed the normal haematological values for birds [31,32]. This study showed that the blood of chicks fed CFSBCM based diets had an appreciable oxygen-carrying capacity and it is an indication that nutrient transport was not impaired [21]. Moreover, the similar values obtained in this study are an indication of the quality of the test diets as haematological parameters are a reflection of the animal responsiveness to both external and internal factors which include feed and feeding.

Table 4 shows the result of replacing maize with 20% inclusion level of CFSBCM in diet of broiler chicks on serum biochemical indices. The values of total serum protein of birds fed CFSBCM diets obtained increased proportionally from T_2 to T_4 when compared to those on control group. This is an indication that fermentation of cooked shea butter cake at longer period of time improved the protein quality

of the diet and might have enhanced normal protein synthesis. Changes in the nutritional status of an animal are easily detected in the albumin because they are about two-thirds of total protein [33]. Broiler chicks fed CFSBCM did not have a reduced ($P > 0.05$) serum albumin which is usually said to be as a result of protein malnutrition owing to decreased synthesis, thus, they were not affected by any chronic diseases during this investigations [21]. The pattern recorded among the treatments on serum glucose showed higher ($p < 0.05$) concentration in birds fed control and T_4 diets than the birds on T_2 diets. This observation is an indication of enhanced energy utilization in birds fed diet containing longer period (9 days) of fermented shea butter cake meal. The values of serum triglycerides were significantly affected ($p < 0.05$) by inclusion of different period of CFSBCM in the diets and birds fed control and T_4 diets recorded a similar ($p > 0.05$) triglyceride concentrations but lower ($p < 0.05$) than those fed T_2 and T_3 diet. The results suggested that increase in period of fermentation caused a reduction in the triglyceride biosynthesis and favour the re-distribution of cholesterol among the lipoprotein molecules [21,34]. Serum uric acid had its highest ($P < 0.05$) value recorded in birds fed T_2 diet and the blood uric acid level of chicks decreases with increasing fermentation period of CFSBCM which indicates a higher utilization of protein according to Cetin [35], because uric acid is reported to be a product of protein, non-protein nitrogen and purines [36]. A significant variation ($P < 0.05$) was observed in the creatinine level between the control and CFSBCM based diets; birds fed at T_2 diet shown the higher value while those on control diet had the lowest value but did not differ ($p > 0.05$) with those on T_3 and T_4 groups. Serum creatinine is a measure of muscle mass, it shows the level of degradation of tissue creatinine phosphate and is also regarded to be a measure of amino acid economy *in vivo* [37]. Alanine transaminase (ALT) and Aspartate transaminase (AST) were observed to decreased ($p > 0.05$) as the period of fermentation of shea butter cake in the diet increased, indicating no toxic effect within the liver parenchyma of the experimental birds. Moreover, in the present study, all the blood parameters fell within the normal range as reported by Mitruka and Rawnsley [33], an indication that the health of the birds were not compromised.

Parameters	T_1	T_2	T_3	T_4	SEM	LOS
Pack cell volume (%)	25.51	23.40	22.70	22.27	2.08	NS
Haemoglobin (g/dl)	5.17	4.47	4.23	4.09	1.20	NS
White blood cell ($x10^3/mm^3$)	9.65	9.75	9.40	9.20	0.79	NS
Red blood cell ($x10^3mm^3$)	1.12	1.07	1.05	1.01	0.92	NS
Mean corpuscular volume (u^3)	139.06^a	125.77^b	121.06^b	122.28^b	2.11	*
Mean corpuscular haemoglobin (Fi)	46.38^a	41.93^b	40.36^b	40.765^b	1.45	*
Mean corpuscular haemoglobin concentration (%)	33.34	33.34	33.00	33.34	0.24	NS

Table 3: *Haematological indices of birds fed experimental diets containing different periods of fermentation on cooked shea butter cake meal.*

^{ab}: Means on the same row with different superscript are significant ($P > 0.05$) different.

T_1: Corn-soybean based control diet, T_2: 3-days fermentation period of cooked shea butter cake, T_3: 6-days fermentation period of cooked shea butter cake, T_4: 9-days fermentation period of cooked shea butter cake.

*SEM: Standard Error Mean; LOS: Least Significant Difference; ns: Not Significant; *: Significant.*

Parameters	T_1	T_2	T_3	T_4	SEM	LOS
Glucose (g/dl)	85.145^a	75.019^c	77.303^{bc}	81.19^{ab}	2.01	*
Albumin (g/l)	13.45	14.98	14.43	14.04	1.14	ns
Total protein (g/dl)	4.27^a	3.961^b	4.09^{ab}	4.18^a	0.85	*
Uric acid (Mmol/l)	0.67^c	1.18^a	0.96^{ab}	0.79^{bc}	0.12	*

Creatinine (Mmol/l)	48.12	52.25	49.50	48.87	1.21	
Triglycerides (mg/dl)	141.41^{c}	148.77^{a}	145.55^{ab}	143.19^{bc}	1.77	*
AST (iμ/l)	23.10	24.44	24.01	23.90	0.81	ns
ALP (iμ/l)	28.10	30.15	30.07	29.35	2.10	ns

Table 4: *Serum biochemical indices of birds fed experimental diets containing different periods of fermentation on cooked shea butter cake meal.*

^{ab}: Means on the same row with different superscript are significantly (P > 0.05) different.

T_1: Corn-soybean based control diet, T_2: 3-days fermentation period of cooked shea butter cake, T_3: 6-days fermentation period of cooked shea butter cake, T_4: 9-days fermentation period of cooked shea butter cake.

*SEM: Standard Error Mean; LOS: Least Significant Difference; ns: Not Significant; *: Significant.*

Conclusion and Recommendation

The result shows that cooking and fermentation could improve the nutrient value and decrease the tannin level in shea butter cake, thus making it a potentially valuable energy feedstuff. Incorporation of cooked shea butter cake at longer period (9 days) of fermentation in the diet of broiler chickens showed more promising influence on their blood composition without any adverse effect and is thereby recommended for poultry farmers. Further investigation should pay attention to the mechanism by which period of fermentation affects the blood profile of poultry birds.

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