Effect of Differential Fermented Periods of Cooked Shea Butter Cake on Hematological and Serum Biochemical Indices of Broiler Chicks

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ABSTRACT

Shea butter cake is produced as a byproduct from shea butter production. The cake was processed by cooking in boiling water for 30 minutes and underwent fermentation for different periods of 2, 3, and 4 days, thereafter sun-dried and milled to obtained fermented-cooked shea butter cake meal (FCSBCM).

A 21-day feeding trial was conducted to evaluate the hematological and serum biochemical response of broiler chicks fed differently fermented-cooked shea butter cake meal (FCSBCM). A total of one hundred and forty-four (144) Arbor Acrestrain broiler chicks were randomly allocated to four treatments with four replicates of nine (9) birds each in a completely randomized design. The control diet had only maize meal without FCSBCM while others contained maize being substituted at 20% by 2, 3 and 4-days FCSBCM. Feed and water were provided ad-libitum. At 28 d, 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 hematological and serum biochemical indices respectively.

Fermentation and cooking improved the nutritive quality of the test ingredient by increasing the crude protein reducing crude fiber and its tannin concentration. The results showed that there is no significant difference ($p<0.05$) in all hematological 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 and triglycerides while no difference ($p>0.05$) was recorded on serum total protein. However, these values were within the normal range for broiler chickens. From the above, therefore, it can be concluded that longer period of fermentation of cooked shea butter cake 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 periods, hematology, serum biochemistry, broiler)

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 (Annongu, et al., 2006; Mohammed, et al., 2009). 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 (Ojebiyi, et al., 2006).

Hence, the 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 (Esonu, et al., 2006; Wafar, et al., 2016). Feed accounts for 70-80% of the total cost of broiler production in Nigeria (Ademola and Farinu, 2006).

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 (Zulkifli, et al., 2000). 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 (Vitellariaparadoxa) for fat with no economic value and environmental issue (Dei, et al., 2008; Zanu, et al., 2012).

Abdul-Mumeen, et al., (2013) 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 4485.86kcal MEkg-1 of crude protein, crude fat, ash, crude fiber, carbohydrates, and metabolizable energy, respectively, as well as rich in minerals like calcium, potassium, and magnesium. This material has been shown to vary in composition depending on weather extraction of fat was by an industrial (expeller and sometimes solvent) or traditional cottage industry method, with the industrial methods tending to be more efficient at fat extraction (Dei, et al., 2007).

Based on its composition, shea butter cake has been sampled as potential feed stuff as replacement for dietary maize in poultry ration (Dei, et al., 2008; Zanu, et al., 2012, Aguihe, et al., 2017). 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 (Annongu, et al., 1996).

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 (Oddoye, et al., 2012; Abdulmumeen, et al., 2013). 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 byproducts 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 (Yamamoto, et al., 2007).

The characteristics of the fermented products include their acceptability by birds and nutrient availability (Hong, et al., 2004). 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 (Reddy and Pierson, 1994). However, the fermentation process can produce organic acids (Delaude, 1974) that break down saponins or tannins; or create conditions for the growth of native microbes (Yosioka, et al., 1966) that detoxify these components (Reddy and Pierson, 1994).

The microbial degradation (Bacillus, Corynebacterium, Klebsiella, Aspergillus, Penicillium, Fusarium, and Candida spp.) of condensed tannins is found to be less than hydrolysable tannins in both aerobic and anaerobic environments.

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 (Ong, et al., 2007; Aderemi and Nworgu, 2007) or structurally modifying anti-nutritive factors (Hong, et al., 2004). Therefore, this study was carried out to determine the hematological and serum biochemical indices of broiler chicks fed different periods of fermented-cooked shea butter cake meal.

MATERIALS AND METHOD

Study Site

The study was conducted in the Poultry Research Unit of Federal College of Wildlife Management, New Bussa, Niger State, Nigeria. New Bussa is located at a longitude 40 310E and 40 330E and latitude 7.30N and 10.000N (Abu, 2003) in the Savanna Areas of Niger Basin.

Source and Processing of Test Ingredient

The shea butter cake that was 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 70^{o}C, thereafter divided into three batches and fermented differently at 2, 3, and 4 days and were all properly sun-dried for 5 days. The dried processed shea butter cake was milled using a hammer mill before incorporation into experimental diets.

Housing of Birds and Management

The birds were raised in a deep litter system, using wood shavings as litter material. The chicken house with a foot dip, was disinfected using Dazintoland izal solution in water 2 weeks prior to stocking of the chicks. Feed and water were supplied free choice. At first day of bird's collection, Vitalyte® soluble powder and glucose® powder was given against stress and to burst energy. Medication, vaccination and other prophylactic measures were done as appropriate.

Experimental Birds and Design

One hundred and forty four (144) unsexed day old broiler chicks of Arbor Acre strain were used for this experiment. The birds were allocated to four (4) experimental treatments; each treatment was further divided into four (4) replicates of nine (9) birds each in a completely randomized design (CRD).

Experimental Dietary Treatment

Corn-soybean meal basal diets were used as the control treatment. Shea butter cake was fermented at different periods of 2, 3, and 4 days to replace 20% corn in treatment 2, 3, and 4, respectively.

Blood Collection

On day 21 of feeding trail, two birds per replicate were selected and bled through the jugular vein into two vaccutiner tubes, one containing ethylene diamine tetra acetic acid (EDTA) for hematological study and the other sterile plasticvaccutiner tubes without EDTA for serum biochemical analyses.

Hematological Indices

The Packed Cell Volume (PCV) was determined using Micro haematocrit as described by Kelly (1979). Red Blood Cell (RBC) and White Blood Cell (WBC) were determined using Neubauer haemocytometer after the appropriate dilution. Hemoglobin (Hb) concentration was determined by a cyanmethemoglobin method using Drabkins solution as diluents.

Serum Biochemical Parameters

Total protein was determined by Biuretic method using Erba® test kit as described by WHO, 2006 and International Federation of Clinical Chemistry (IFCC). Glucose and Triglyceride was measured based on principles described by Peters et al. (1982).

Proximate Analysis

The proximate composition of the raw and fermented-cooked SBCM was analyzed according to (AOAC, 2006).

Statistical Analysis

All data were analyzed using analysis of variance (ANOVA) by GLM model of SAS statistical package (SAS, 2012). Significant differences were separated using Turkey test.

RESULTS

Table 1 shows the gross composition of experimental diets with the control and three other diets. Control has no FCSBCM, while other three diets contained 2, 3, and 4 day FCSBCM. All diets were isocaloric and isonitrogenous.

Table 1: Gross Composition of Experimental Broiler's Diets Containing Different Periods of Fermented-Cooked Shea Butter Cake Meal.

Ingredients	Control Diet	2d-FSBC Diet	3d-FSBC Diet	4d-FSBC Diet
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)	23.08	23.82	23.82	23.82
Calcium (g/kg)	1.54	1.53	1.53	1.53
Phosphorus	6.65	6.36	6.36	6.36

Proximate Composition

The proximate and tannin composition of raw and fermented SBCM is presented in Table 2 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 contains 8.50% moisture content (MC), 29.94% ash, 3.89% crude fiber (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%.

TABLE 2: Proximate Analysis of the Raw and Fermented-Cooked Shea Butter Cake Meal.

	Moisture %	Ash %	Crude fiber %	Crude protein %	Crude fat %	NFE%	Tanin g/kg
Raw SBCM	6.29	20.61	4.181	12.851	10.661	45.411	0.22
2dFSBCM	8.52	29.94	3.88	15.70	9.35	32.61	0.04
3dFSBCM	9.00	3.00	3.50	15.90	9.10	32.50	0.03
4dFSBCM	9.10	31.50	3.35	16.00	9.00	31.05	0.02

TABLE 3: Hematological Indices of Birds Fed Experimental Diets Containing Different Periods of Fermentation on Cooked Shea Butter Cake (FSBC) Meal.

Parameters	Control Diet	2d-FSBC Diet	3d-FSBC Diet	4d-FSBC Diet	SEM	LOS
Pack cell volume (%)	25.51	23.40	22.70	22.27	2.08	NS
Hemoglobin (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 hemoglobin (Fi)	46.38^a	41.93^b	40.36^b	40.765^b	1.45	*
Mean corpuscular hemoglobin concentration (%).	33.34	33.34	33.00	33.34	0.24	NS

^{ab} means on the same row with different superscript are significant (P>0.05) different

Table 3 shows the results of replacing maize with 20% inclusion level of differently fermented shea butter cake meal-based diet of broiler chicks on hematology. The result revealed that there is no significant difference ($p<0.05$) in all hematological parameters measured except for mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH). Birds fed control and T4 diets were statistically similar and show higher ($p<0.05$) mean values for MCV and MCH concentrations than birds fed T3 and T4 diets.

Table 4 shows the result of the effect of replacing maize with 20% inclusion level of differently fermented shea butter cake meal-based diet fed to broiler chicks on serum biochemical indices.

The results obtained on the blood biochemistry showed significant ($p<0.05$) effect of the dietary treatments on serum glucose and triglycerides while no difference ($p>0.05$) was recorded on serum total protein. The pattern recorded among the treatments on glucose and triglyceride followed the same trend, having higher ($p<0.05$) concentration in birds fed control and 4d-FSBCM diets than the birds on 2d- and 3d- FSBCM diets.

Table 4: Serum Biochemical Indices of Birds fed Experimental Diets Containing Different Periods of Fermentation on Cooked Shea Butter Cake (FSBC) Meal.

Parameters	Control Diet	2d-FSBC Diet	3d-FSBC Diet	4d-FSBC Diet	SEM	LOS
Glucose(g/dl)	85.145[a]	75.019[c]	77.303[bc]	81.19[ab]	2.01	*
Total protein(g/dl)	3.375	3.961	4.09825	4.18	1.85	NS
Triglycerides(mg/dl)	141.41[b]	148.77[a]	148.55[a]	143.19[b]	1.77	*

[ab] means on the same row with different superscript are significantly (P>0.05) different
SEM – Standard of mean, LOS

DISCUSSION

According with the reports of Mutayoba, et al. (2011), fermentation aids in improving nutrient composition of feed stuffs. The tannin content of the processed SBCM reduces to 0.04g/kg from 0.22g/kg obtained in the raw SBCM, which agrees with the report of Delaude, (1974), that fermentation process produce organic acids that break down tannins. Also, this is in line with the findings of Reddy and Pierson (1994) who reported that fermentation process can create conditions for the growth of microbes (Bacillus, Corynebacterium, Klebsiella, Aspergillus, Penicillium, Fusarium, and Candida) that break down tannins.

The observed crude protein (12.85%) was higher than those reported by Ugese, et al. (2010) and Orogun (2014), who observed 9.2% and 12.70%, respectively, and lower than value reported by Abdulmumeen, et al. (2013), Atuahene (1998), and Zanu, et al. (2012) 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. (2013), respectively. The variation in the nutrient composition could be attributed to differences in location, varieties and efficiency of oil extraction of the cake.

All the hematological values obtained in this study were within the normal range and correlated with those reported by previous researchers who observed the normal hematological values for bird (Maxwell et al., 1990; CCAC, 1993; Mistruka and Rawsley, 1997; Wikivet (2013); NseAbasi, et al., 2014).

The similar values obtained in this study are an indication of the quality of the test diets as hematological parameters are a reflection of the animal responsiveness to both external and internal factors which include feed and feeding.
This observation is an indication of enhanced energy utilization in the diets of birds fed control and 4d-FSBCM. In this experiment, all the blood parameters fell within the normal range reported by earlier researchers (Mitruka and Rawnsley, 1977; Anon, 1980; Pampori, 2003). This observation suggests that the health of the birds were not compromised and could be related to the nutritional adequacy and safety of the diets. This is because according to Linsday (1977), the reduction or abnormal values of hematology parameters and serum biochemistry may indicate a low protein intake, liver damage, anemia, or parasitological infestation.

CONCLUSION AND RECOMMENDATION

The result shows that shea butter cake is potentially valuable energy supplement that can be included in diets of broiler chicks, replacing 20% of maize if cooked and fermented properly. Acceptability of the diet at 4 days of fermentation did not show any detrimental effect on hematological and serum biochemical parameters measured. Fermentation of the cake at longer periods should be further

investigated at level exceeding 20% inclusion to ascertain its utilization in poultry diet.

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