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Clarion University of Pennsylvania, Clarion, Pennsylvania

EFFECT OF DIFFERENT PERIODS OF FERMENTATION ON COOKED SHEA BUTTER CAKE MEAL ON PERFORMANCE, APPARENT NUTRIENT DIGESTIBILITY, AND CARCASS YIELD OF BROILER CHICKS

Kehinde, Abiodun Solomon ,Aguihe,Pascal Chukwudi, Babatunde, Taiye Oluwasola, and Kehinde, Olujide Johnson

ABSTRACT

Shea nut meal is an agro-industrial by-product obtained from the processing of the nuts of the shea tree (Vitellariaparadoxa, Gaertn.) for fat.The cake was subjectedto cooking in boiling water for 30minutes and undergone fermentation for different periods of 2, 3 and 4 days, thereafter sundried and milled to obtained fermented-cooked shea butter cake meal (FCSBCM). A-28 d feeding trial was carried out to investigate the response of broiler chicksfed diets containing different FCSBCM replacing maize at 20% inclusion level on apparent nutrient digestibility and carcass yield. One hundred and fourty -four chicks were used in this study and randomly distributed to 4 experimental diets groups of 4 replicates with nine chicks each in a completely randomized design (CRD). The control diet (T1)containedmaize-soybean based diet while other diets contained maize being substituted at 20% by 2, 3 and 4-day FCSBCM in T_2, T_3 and T_4 respectively. Feed intake and weight gain were recorded weekly. At 28 d, 2 birds per replicate were selected for metabolic cage evaluation and another 2 birds of comparable live weights per replicate were selected, slaughtered and eviscerated to determine carcass, breast and liver yield. The results showed that treatment means for feed intake and feed:gain were affected ($p<0.05$) by the dietary treatments. Birds fed control and T4 diets recorded lower ($p<0.05$) feed intake and feed:gain than those on T3 and T2 groups. Cost per kg gain of birds was significantly ($p<0.05$) higher in control groups compared to lower mean values obtained in birds fed different FCSBCM diets.The result of the study showed that apparent digestibility of crude protein (CP) and crude fibre (CF) was significantly ($p<0.05$) affected by the dietary treatments. Birds fed Diet T4 compared favourably with the control group and gave higher ($p<0.05$) mean values for CP and CF digestibility than those in diet T2 and T4 groups. Treatments means for carcass, breast and liver yield did not differ significantly ($p>0.05$) among the dietary treatments. In conclusion, longer period of fermentation has the potential to improve nutritive value of shea butter cake as this was reflected in birds fed 4d-FCSBCM diets comparing favourably with the control group in having better crude protein and crude fibre digestibility and hereby is recommended.

Keywords: Shea Butter Cake, Fermentation, Nutrient Digestibility, Carcass, Broiler.

INTRODUCTION

The increasing surge in population growth has caused an increase in global demand for animal protein especially consumption of poultry meat in developing countries(Singh and Makkar, 2009). The need for increased animal protein consumption of the rural and urban Nigeria populace in the face of rising population and inflation has resulted in the increase in cost of conventional animal protein sources (Agbogidi and Okonta, 2011). Feed accounts for 75-80% of the total cost of poultry production in Nigeria and this is largely due to the high cost of conventional feed stuffs stemming directly from their high demands as staple food by humans (Esonu *et al*., 2001). In Nigeria, the poultry feed industry is heavily dependent on grains such as maize, millet and sorghum; and oilseed resources such as groundnut cake, soybean cake, cotton seed cake and palm kernel meal (RMRDC, 2003). It has therefore become imperative to explore other alternatives for the feed industry in order to reduce the current stress on human food supply, enhance production of food sustainability at least cost, without compromising the environment ,minimize hunger and malnutrition.

One of the key agro-forestry species in Africa, particularly Nigeria is the Shea butter tree, *Vitellariaparadoxa*syn. *Butyrospermumparadoxum*(Sapotaceae). The Shea tree produces fruits which is cherished and eaten by humans and animals; the nut of this fruit is processed to give Shea butter, while the residue or by product is the Shea nut cake (Dei *et al.,* 2008). The Shea nut cake is a by-product that is the residue after fat extraction from shea nuts (Vitellariaparadoxa, Gaertn.)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 e high, containing 13.03, 23.38, 4.25, 8.71, 59.37% and 4485.86kcal MEkg^{-1} of crude protein, crude fat, ash, crude fibre, 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*).* Base 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).The major nutritional limitation of shea nut meal for poultry is the presence of anti-nutritive factors, particularly tannins that are in the range of 98.7 to 156.4 g/ kg (Okai et al., 1995; Annongu et al., 1996).

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 require the use of chemicals and is easy to manage in on-farm conditions or on an industrial scale. Fermentation processes have been used to improve the nutritive value of some feedstuffs such as soybeans (Chah et al., 1975; Mathivanan et al., 2006), guar meal (Nagra et al., 1998), and koji feed (Yamamoto et al., 2007) for poultry. The desirable characteristics of the fermented products include their acceptability by birds (Nagra et al., 1998) and nutrient availability (Hong et al., 2004). Fermentative microbes have been used extensively in the improvement of agricultural by-products through its action on substrates such as nonstarch polysaccharides and proteins (Ong et al., 2007; Aderemi and Nworgu, 2007) or structurally modifying anti-nutritive factors (Hong et al., 2004). Therefore, the objective of this study was to determine the effect of different periods of fermentation of cooked shea butter cake meal in the diet of broiler chicks on performance, apparent nutrients digestibility and some carcass traits

MATERIALS AND METHOD

Study site:

This study was conducted at the Poultry Research Unit of Federal College of Wildlife Management, New Bussa, Niger State, Nigeria. New Bussa is located at a longitude $7^0 03^0$E and 10^0 00^0E and latitude 4.31^0Nand 4.33^0N (Abu, 2003) in the Savannah area of Niger basin. The period of feeding trial lasted for 4weeks covering broiler starter production phase.

Collection and Processing of Shea Butter Cake Meal

The Shea butter cake used in this study was obtained fresh from the local Shea butter processing factories in Borgu Local Government Area of Niger State, Nigeria. The fresh Shea butter cake was cook for 30minute, thereafter was divided into three batches and fermented for 2, 3 and 4 days. Consequently, the treated Shea butter cakes were properly sun-dried and milled using a hammer mill before incorporation into experimental diets.

Experimental birds and design:

One hundred and forty four (144) unsexed day old broiler chicks were used for this experiment. The birds were allocated to four (4) experimental treatments per four (4) replicates of nine (9) birds each in a completely randomized design (CRD).

Experimental Diet

The experimental diets were formulated be isocaloric and isonitrogenousat starter phase (23% CP and 3000kcal/kg ME) to contain four (4) dietary treatments. Diet 1 is maize-soybean meal based control having 0% SBCM while diet 2, 3 and 4 contained 2, 3 and 4-day fermented SBCM replacing maize at 20% inclusion level.

Apparent nutrients digestibility evaluation (Metabolic cage):

At the end of the feeding trial, two birds per replicate were selected randomly and taken into the metabolic cage. 2 days of adaptation period was observed and the birds were fed known quantity of feed for three days and daily faecal collection was observed. The faecal samples collected were pooled together on replicate basis for proximate composition analysis. The apparent nutrient digestibility was calculated as

$$Nutrientdigestibility = \frac{FeedNutrients - FeacalNutrienet}{Feednutrients} \times 100$$

Carcass, relative breast and liver yield evaluation:

On day 28, 2 birds of comparable live weights per replicate were selected, starved for feed for 6 hours and slaughtered. They were eviscerated and the carcass weights were taken; thereafter the breast and liver weights were equally taken and measured. The relative yield of the carcass, breast and liver were expressed as the ratio of the live weights.

Proximate analysis:

The proximate composition of the experimental diets and faecal samples were analysed for dry matter (DM), Crude Protein (CP), Crude Fibre (CF), Ether Extract (EE), Ash and Nitrogen Free Extract (NFE) according to Association of Official Analytical Chemist (AOAC, 2006)

Statistical analysis:

All data obtained were subjected to analysis of variance (ANOVA) using SAS statistical package software (SAS, 2006) and significant means were separated using Turkey test.

TABLE 1: Gross composition of experimental diets containing fermented-cooked Shea butter cake meal

Ingredients	**Control Diet**	**2d-FSBC Diet**	**3d-FSBC Diet**	**4d-FSBC Diet**
Maize	51.00	40.8	40.8	40.8
Soya beans meal	35.75	35.75	35.75	35.75
Shea butter cake	0	10.2	10.2	10.2
Fish meal	4	4	4	4
Soya oil	3	3	3	3
DCP	1.50	1.5	1.5	1.5
Bone meal	1.5	1.5	1.5	1.5
Lime stone	1.5	1.5	1.5	1..5
Salt	0.5	0.5	0.5	0.5
Vitamin premix	0.5	0.5	0.5	0.5
Di-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**	**100**	**100**	**100**
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

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 fibre (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. The result revealed that fermentation enhanced the nutrient profile of SBCM especially with respect to crude protein and crude fibre compared to raw SBCM. This is in accordance with the reports of Mutayoba*et al.,* (2011), that fermentation aids in improve 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 early report that heat treatment and fermentation are efficient in reducing their toxic effect (Dei *et al.,* 2008, Mutayoba*et al.,* 2011, Agbo and Prah. 2014)**.**

Table 2: Proximate analysis of the raw and fermented- cooked Shea butter cake meal

SBCM	Moisture %	Ash %	Crude fiber %	Crude protein %	Crude fat %	**NFE%**
FSBCM	8.498	29.942	3.888	15.708	9.355	32.610
Raw SBCM	5.993	20.613	4.184	12.853	10.668	45.411

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 growth performance. The result of performance showed that no significant difference ($p>0.05$) was recorded in final body weight, weight gain and PER while feed intake and feed gain were significantly ($p<0.05$) by the dietary treatments. Similar trends were observed in both feed intake and feed gain . Birds fed control diet did not differ ($p>0.05$) from those on 4d-FSBC diet in their feed intake and feed gain. Feed intake and feed gain of birds fed 2d-FSBC and 3d-FSBC diets were higher ($p<0.05$) than those fed 4d-FSBC and control diets. This observation showed among the birds on the test diets, 4d-FSBC diet was better utilized for muscle accretion indicating an improved feed efficiency. This explains that the longer the fermentation period, the better the nutritive quality of the test ingredient (SBCM). This is in accordance with the report of Agbo and Prah (2014) who reported that longer fermentation of shea nut meal improved nutrient profile and reduced considerably the tannin content. The better feed:gain of birds fed 4d-FSBC diet at lower feed intake could be attributed to low residual effect of tannin which could not have the ability to bind dietary nutrients and digestive enzymes into complexes for easy absorption (D'mello and Devendra, 1995, Jansman et al., 1995; Iji et al., 2004).

Table 3: Performance of birds fed experimental diets

Performance	**Control**	**T2(2d-SBCM)**	**T3(3d-SBCM)**	**T4(4d-SBCM)**	SEM
Average initial weight(g)	116.67	116.67	116.67	116.67	1.20
Average final weight(g)	669.17	652.06	648.02	645.98	13.50
Average feed intake(g)	1020.83[b]	1122.69[a]	1123.55[a]	1075.45[b]	23.20
Average weight gain(g)	552.50	536.39	531.35	529.31	12.34
Feed: gain	1.87[b]	2.09[ab]	2.11[a]	2.03[b]	0.13
PER	2.39	2.29	2.26	2.25	0.09
Cost/kg gain	133.74[a]	116.86[b]	114.44[b]	120.58[b]	6. 10

[ab] means on the same row with different superscript are significantly (P>0.05) different

Table 4 shows the result of replacing maize with 20% inclusion level of differently fermented shea butter cake meal based diet of broiler chicks on the cost indices. Results of the cost indices (Table 4) evaluated showed no significant difference ($p>0.05$) in all parameters measured except in cost/kg gain, where birds fed different days of fermented SBCM diets have lower ($p<0.05$) mean values compared to the control diet though there were no difference among the fermented SBCM diets. The decrease in cost/kg gain may be attributed to the lower feed cost of SBCM (Zanu*et al.*, 2012, Aguihe et al, 2017).

Table 4: The Apparent nutrient digestibility of broiler chicks fed diets containing different periods of fermented-cooked Shea butter cake meal.

Parameters	**CONTROL**	**(2d-FSBC)**	**(3d-FSBCM)**	**(4d FSBCM)**	**SEM**
Crude protein %	83.45[a]	62.62[b]	68.89[b]	82.20[a]	2.64
Crude fiber %	74.74[a]	66.02[b]	66.47[b]	75.79[a]	1.98
Crude fat %	57.78	58.11	58.45	58.21	1.01
Ash %	66.01	66.21	65.00	65.88	0.79
N F E %	72.05	71.21	70.84	71.65	3.55

[ab]Means with the different letters are significantly different (P<0.05).

Table 5 shows the results of replacing maize with 20% inclusion level of different periods of fermented shea butter cake meal based diet of broiler chicks on the apparent nutrient digestibility. The treatment means for crude protein and crude fibre digestibility showed significant differences(P<0.05) among the dietary treatments while other nutrient parameters measured were not affected (P<0.05). Crude protein and crude fibre digestibility in birds fed 4d-FSBC diet compared favourably with that of the control group and was higher (P<0.05) than those fed 2d-FSBC and 3d-FSBC diets. The higher protein digestibility is an indication of superior quality protein of the 4d-FSBC diet with respect to greater efficient utilization of dietary protein by the broiler chicks. This could be attributed to the fact that cooking of the cake followed by longer period of fermentation improved the protein quality of the test ingredient and sufficiently reduced the anti-nutritional factors especially the tannin which has been reported to form complexes with dietary proteins including enzymes in the gastro intestinal tract and thereby inhibit the digestibility of proteins (Jansman et al., 1995; Smulikowska et al., 2001; Iji et al., 2004). According to the report of Iyayi (2004), the increase in protein quality due to sufficient fermentation could be as a result of the bioconversion ability of soluble carbohydrate into single cell protein by the micro-organisms and also due to the release of polysaccharide bound protein which makes the substrate nutritionally better. Moreover, the higher crude fibre digestibility of the birds fed 4d-FSBC could be indication that longer period of fermentation adds value to the crude fibre content which could be lead to better digestibility, invariably improving palatability and utilization by animal. This is line with the report of Agbo and Prah (2014) who observed improved nutritional value of shea nut meal at longer period (8 days) of fermentation. Also, Alemawor et al., (2009) reported that degradation of polymeric lignocellulose of shea nut meal by anaerobic microbes has been associated to improvement in crude fibre digestibility.

TABLE 5: Carcass, breast and liver yield of broiler chicks fed diets containing different periods of fermented-cooked Shea butter cake meal.

Parameters					**SEM**
	Control	**(2d-FSBCM)**	**(3d-FSBCM)**	**(4d-FSBCM)**	
Carcass yield %	96.63	96.18	96.20	96.34	1.75
Breast yield%	11.25	10.26	10.50	10.69	3.12
Liver yield %	2.50	2.50	2.43	2.39	0.89

[ab]Means with the different letters are significantly different (P<0.05).

Table 4.3 shows the result of replacing maize with 20% inclusion level of different periods of fermented Shea butter cake meal based diet of broiler chicks on the carcass yield, breast yield and liver yield. There was no significant (p>0.05) difference between the treatment means both for the control and FSBCM diets for all the parameters. There was high carcass yield for all the treatment means. This non-significance implies that the nutritional adequacy of the diets supported the carcass growth. It is therefore probable that cooking and fermentation did reduce substantially the anti-nutritional factors in the shea butter cake, thereby causing the residual anti-nutritional factors like tannin not to have observable effects (Dei et al, 2008).

CONCLUSION

In conclusion, the result of this study has shown that SBCM is a potential and valuable alternative source of protein and energy comparable to maize and can be incorporated in the diets of poultry. Therefore, birds fed 4d-FCSBCM diets compared favourably with the control group in having better feed conversion ratio, crude protein and crude fibre digestibility and are adequate enough to support good carcass growth. Subsequent research on longer periods of fermentation on cooked shea butter cake at higher inclusion levelis recommended for future investigation to further guarantee:

i Environmental protection, by converting waste to wealth .

ii Evolve culturally compartible and cost effective ration.

iii Minimise hunger, poverty and malnutrition.

iv.Promote organic agriculture and sustainable poultry production with an assured future.

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ABOUT THE AUTHORS

Kehinde, Abiodun, Solomon, Research Director, Department of Wildlife and Ecotourism, Forestry Research Institute of Nigeria P.M.B 5054,Jericho Hill, Ibadan ,Oyo State ,Nigeria

. Aguihe Pascal Chukwudi ,Senior Lecturer ,Department of Animal Health Technology ,Federal College of Wildlife Management ,New Bussa, Niger State,Nigeria.

Babatunde, Taiye Oluwasola, Lecturer I, Department of Forestry Technology, Federal College of Forestry ,P.M.B 5087,Jericho Hill, Ibadan, Oyo State, Nigeria.

Kehinde, Olajide Johnson, Assistant Lecturer, Department of Wood and Paper Technology Federal College of Forestry, P.M.B 5087,Jericho Hill, Ibadan, Oyo State. Nigeria.

Corresponding e-mail:aguihepc@gmail.com