Apparent Nutrient Digestibility and Carcass Yield of Broiler Chickens Fed Cooked Shea Nut Cake Diets of Different Fermentation Periods

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APPARENT NUTRIENT DIGESTIBILITY AND CARCASS YIELD OF BROILER CHICKENS FED COOKED SHEA NUT CAKE DIETS OF DIFFERENT FERMENTATION PERIODS

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ABSTRACT

Cake of Shea nut is an agroforestry by-product and residue after fat extraction from Shea nuts for fat with no economic value and its increasing output has become an environmental issue lately. A 30-day study was conducted to investigate the apparent nutrient digestibility and carcass yield of broiler chicken fed cooked cake of Shea nut diets of different fermentation periods. A total of 144 unsexed Arbor Acres Plus day-old broiler chickens were divided into four dietary treatments with four replicates of nine birds each in a completely randomized design. The results showed that fermentation enhanced the nutrient profile of cake of Shea nut meal especially concerning crude protein and crude fibre as compared to raw cake of Shea nut meal. The treatment values for crude protein and crude fibre digestibility showed significant (p < 0.05) differences amongst the dietary treatments while other nutrient parameters measured were not significantly (p > 0.05) different. There was no significant (p > 0.05) difference amid the treatment means for the control (carcass, breast and liver yield) and the carcass, breast and liver yield of broiler chickens fed diets containing different periods of fermented-cooked cake of Shea nut meal.

Keywords: Shea nut cake, digestibility, carcass yield, broiler chickens, fermentation.

INTRODUCTION

Chicken (Gallus gallus domesticus) is a globally essential domestic animal due to its nourishing meat that is consumed as food (Unang, 2003), income generation and food security for rural families (Dieye et al., 2004). Smallholder poultry business is a mutual practice in most rural and certain urban regions in the developing world, where the demand for the fowls is increasing due to the boost in population numbers, expanding urban areas and snowballing incomes (Schneider and Polnick, 2010).

Technical constraints and high production costs are major challenges faced in West African poultry sector, especially in Nigeria (Schneider and Polnick, 2010). The total cost of production books for seventy to eighty percentage of feed (Ademola and Farinu, 2006) while stanching unswervingly from their rivalry with human staple is the great price of the conventional poultry feedstuff (Esonu et al., 2001; Orogun, 2010). On the total feed cost, ninety-five percent of it is expended to meet protein and energy requirements, four percent is used up for major minerals, trace minerals and vitamin requirements while two percent is exhausted on other different feed additives (Ravindran, 2013).

The existing developments in contemporary poultry production have boosted rivalry for conventional feed materials amongst humans, distillers, confectioneries and livestock commerce (Bolu and Adakeja, 2008). The poultry feed industries deeply rely on grains like millet, sorghum and maize. Likewise, the industries are also dependent on oilseed resources like cakes and meals from palm kernel, soybean, groundnut and cottonseed in Nigeria (RMRDC, 2003). To lessen the
present pressure on human food supply, it has thus become imperative to search other replacements for the feed industry. An important agroforestry species in Africa, predominantly in Nigeria is the Shea tree (Vitellaria paradoxa, Gaertn.). The Shea tree yields fruits that are valued and widely consumed by humans and animals. Shea butter is taken out from the processed nuts of the fruits. The cake of Shea nut is the spin-off and filtrate (Dei et al., 2008).

The cake of Shea nut is an agroforestry offshoot and residues once the oil is withdrawn from Shea nuts. The economic worth is valueless. Its incremental volume produced lately has turned out to be a cause for environmental distress (Dei et al., 2008; Zanu et al., 2012; Aguhie et al., 2017). Abdul-Mumeen et al. (2013) concluded that the general nutritional value of Shea butter cake was high during their examination on its proximate composition analysis (with thirteen percent crude protein, twenty three percent crude fat, four percent ash, nine percent crude fibre, fifty nine percent carbohydrates and four hundred and forty-eight kilocalories metabolizable energy per kilogram). They also indicated that it is rich in minerals such as magnesium, potassium and calcium. Its composition depends on the methods used in the withdrawal of the oils which could either be by an industrial or a traditional procedure. Up till now, the industrial process is more effectual in the removal of oils (Dei et al. 2007).

Cake of Shea nut is well-thought-out as a latent feed material and also as a standby for diet maize in poultry portion which was grounded on its conformation (Dei et al., 2008; Zanu et al., 2012, Aguhie et al., 2017). The presence of anti-nutritive factors, principally the tannins, is a significant nutritive constraint of Shea nut meal for poultry which is within the array of ninety-eight grams per kilogram to one hundred and fifty-six grams per kilogram (Annongu et al., 1996; Agbo and Prah, 2014). The characteristic adverse effects on feed intake and nutrient utilization are related to the biological significance of tannins in poultry nutrition (Armstrong et al., 1974; Smulikowska et al., 2001).

To decrease the quantity of tannins in poultry diet, fermentation may be utilised. However, much is not known regarding the mechanism of eliminating the components (Reddy and Pierson, 1994). Through the fermentation process, microbes such as Aspergillus, Bacillus, Candida, Corynebacterium, Fusarium, Klebsiella and Penicillium are produced and break down the tannins (Reddy and Pierson, 1994). Hydrolysable tannins in both aerobic and anaerobic environments are more than the microbial degradation of reduced tannins (Bhat et al., 1998). Reichert et al. (1980) submitted that, for the duration of development, tannins may perhaps act in response to form complex oligomeric polymers that are readily insoluble in water consequently are much likely not to inhibit proteins and digestive enzymes.

Fermentation is an exceptional procedure with abundant potential for reusing certain agro-industrial by-products to be used as animal feeds in developing countries. It has been used to advance the nutritious worth of certain feed materials like guar meal (Nagra et al., 1998), soya-beans (Chah et al., 1975; Mathivanan et al., 2006) and Koji feedstuff (Yamamoto et al., 2007) in the poultry industry. The nutrient availability (Hong et al., 2004) and acceptability by birds (Ravindran, 2013) is also affected by physiognomy of the fermented merchandise. Hence, fermentative micro-organisms are used at length on the enhancement of agrarian by-products by its activities on substrates like proteins, non-starch polysaccharides and varying the anti-nutritive factors (Ong et al., 2004; Hong et al., 2004; Aderemi and Nworgu, 2007).

The likely surge in populace growth in developing countries will beyond doubt affect the livestock industry
as added animal protein will increase in demand (Singh and Makkar, 2000). Much of the increase in global demand for poultry products is centred in developing countries such as Nigeria. Over the years, the demand has steadily amplified and it is anticipated that it will continue (Ravindran, 2013). Consequently, the need for increased animal protein consumption of the Nigerian rural and urban populace, in the face of inflation of prices and increasing population has resulted in the upsurge in cost of conventional animal protein sources (Agbogidi and Okonta, 2011). The high demand for feed and raw materials is influenced by the rapid growth in the poultry industry (Ravindran, 2013). However, a major challenge to poultry farmers and nutritionists is the absolute feeding of birds in their early days of production (Plumstead et al., 2007).

Maize is not a cheap feed material for fowl feeding for the reason that it is used up by man. Notably, its incessant usage in fowl diet had amplified the poultry outputs’ cost of production (Aguihe et al., 2017). Therefore, the need to strive for other sources that are affordable, obtainable and low-priced may help lower the competition for consumption and minimize the costs in the poultry production industry. The cake of Shea nut is an alternative by-product that has such potential. Its consumption is constrained by the presence of anti-nutritional factors specifically tannin and low digestibility. However, there is a need for improving its nutritional potential for efficient utilization through an effective processing approach, for instance, cooking and fermentation. Thus, this study investigated the apparent nutrient digestibility and the carcass yield of broiler chicken fed cooked cake of Shea nut diets of different fermentation periods.

MATERIALS AND METHOD

Study Area

The research was carried out at the Poultry Unit of Aduke-Diamond Agricultural Services/Farms and the Animal Nutrition Laboratory, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The former is located on Latitude 7º 13’ N., Longitude 3º 30’ E with an elevation of 412 feet and high altitudes of 610 feet while the latter is on Latitude 7º 13’ N., Longitude 3º 26’ E with an elevation of 473 feet and high altitudes of 1141 feet (Alade, 2018). It is located in the rainforest vegetation zone which has a humid climatic condition with a mean annual rainfall of 1,037 mm, a mean temperature of 34.7 °C and the humidity of the location is on the average at 83 %.

Collection and Processing of Shea Nut Cake Meal

The cake of Shea nut used for this study was obtained fresh from the local Shea butter processing plants in Borgu Local Government Area, Niger State, Nigeria. The fresh cake of Shea nut was cooked for 30 minutes and thereafter divided into three batches. Each batch of a cooked fresh cake of Shea nut was fermented for 48 hours (2 days), 72 hours (3 days) and 96 hours (4 days) respectively. Consequently, the treated cakes of Shea nuts were properly air-dried for 168 hours (7 days). They were thereafter milled using a hammer mill to obtain fermented-cooked cake of Shea nut meal (FCSNCM) before its incorporation as a constituent in the preparation of the experimental diets.

Experimental Design

One hundred and forty-four (144) unsexed Arbor Acres Plus day-old broiler chickens were used for this experiment. The broiler chickens were allocated to four (4) experimental treatments per four
The broiler chickens were randomly selected and housed in a deep litter system using wood shavings as litter material in a standard open-sided poultry facility. Birds were fed daily and given access to clean water ad libitum throughout the experimental period of 30 days. Medication, vaccination and other prophylactic measures were appropriately observed.

**Experimental Diet**

Isonitrogenous and isocaloric diets were formulated according to the nutritional recommendations of the National Research Council, 1994. The experimental diets formulated were isocaloric and isonitrogenous for starter (23 percent crude protein and 3000 kcal/kg ME) to contain four dietary treatments. Diet 1 was a maize-soybean meal-based control having a zero percent SNM while diets 2, 3 and 4 contained 48 hours, 72 hours and 96 hours of fermented SNM respectively which replaced maize at twenty percent inclusion level.

**Experimental Layout**

The experimental layout was arranged as follows:

- $T_1 =$ Control diet (0% SNM)
- $T_2 =$ Two day-fermented SNM
- $T_3 =$ Three day-fermented SNM
- $T_4 =$ Four day-fermented SNM

**Apparent Nutrient Digestibility Evaluation (Metabolic cage)**

In the latter part of the feeding trial, two broiler chickens per replicate were selected randomly and taken into the metabolic cage. The broiler chickens were observed for an adaptation period of 48 hours (2 days). They were fed known quantities of feed for 72 hours (3 days). Their daily faecal excretion was collected and observed. The faecal samples were collected using sheets of aluminium foil. They were stored in a fly-free area at room temperature and were pooled together in replicates for proximate composition analysis. This procedure was carried out to avoid the contamination of the faecal samples. The faecal samples collection was done in the metabolic cage. The apparent nutrient digestibility was calculated thus:

$$Nutrient\ Digestibility = \frac{(Feed\ Nutrients-Faecal\ Nutrients)}{(Feed\ Nutrients)} \times 100$$

**Carcass and Organ Analysis**

On the 30th day, the experiment was terminated. Two broiler chickens of comparable live weights per replicate were selected. They were slaughtered after starvation of feed for 6 hours. They were eviscerated. Their carcass was weighed and the measured values were recorded. Thereafter, the measured values of the weights of their breast and liver were respectively recorded. The relative yield of the carcass, breast and liver was calculated as follows:

**Proximate Analysis**

Dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract formed the proximate composition of the experimental diets and faecal samples analysed. The analysis was done following the Association of Official Analytical Chemist (AOAC, 2006) guidelines.

**Statistical Analysis**

The data from the study was subjected to One-way analysis of variance (ANOVA) (Daniel, 1995) using IBM SPSS Statistics Version 23 Software (SPSS, 2015). The significant means were separated at five percent level of significance using Duncan’s multiple range test as described by Steel and Torrie (1980).
Table 1: Gross composition of experimental diets containing fermented-cooked Shea nut cake meal (FCSNCM)

| Ingredients          | T<sub>1</sub> Diet | T<sub>2</sub> Diet | T<sub>3</sub> Diet | T<sub>4</sub> Diet |
|----------------------|--------------------|--------------------|--------------------|--------------------|
| Maize                | 51.0               | 40.8               | 40.8               | 40.8               |
| Soya beans meal      | 35.8               | 35.8               | 35.8               | 35.8               |
| Shea nut cake        | 0.0                | 10.2               | 10.2               | 10.2               |
| Fish meal            | 4.0                | 4.0                | 4.0                | 4.0                |
| Soya oil             | 3.0                | 3.0                | 3.0                | 3.0                |
| DCP                  | 1.5                | 1.5                | 1.5                | 1.5                |
| Bone meal            | 1.5                | 1.5                | 1.5                | 1.5                |
| Limestone            | 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        | 0.3                | 0.3                | 0.3                | 0.3                |
| Lysine               | 0.3                | 0.3                | 0.3                | 0.3                |
| Threonine            | 0.3                | 0.3                | 0.3                | 0.3                |
| Total                | 100.0              | 100.0              | 100.0              | 100.0              |

Calculated nutrients

|                  | T<sub>1</sub> Diet | T<sub>2</sub> Diet | T<sub>3</sub> Diet | T<sub>4</sub> Diet |
|------------------|--------------------|--------------------|--------------------|--------------------|
| 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               |

T<sub>1</sub>: Control Diet - 0% SNCM Diet, T<sub>2</sub>: Two day - FCSNCM Diet, T<sub>3</sub>: Three day - FCSNCM Diet, T<sub>4</sub>: Four day - FCSNCM Diet

RESULT AND DISCUSSION

Proximate Composition

The proximate and tannin composition of raw and fermented SNCM is presented in Table 2. The result revealed that raw cake of Shea nut meal contained 5.9% moisture content, 20.6% ash, 4.1% crude fibre, 12.8% crude protein, 10.6% crude fat, 45.3% nitrogen-free extract and 0.25 (g/kg) tannin. The results further showed that fermented cake of Shea nut meal contained 8.6% moisture content, 30.0% ash, 4.0 percent crude fibre, 15.8% crude protein, 9.4% crude fat, 32.7% nitrogen-free extract and 0.0 (g/kg) tannin.

The result revealed that fermentation enhanced the nutrient profile of SNCM especially concerning crude protein and crude fibre compared to raw SNCM. This is in corroboration with previous reports (Mutayoba et al., 2011) where fermentation sustained heightening of nutrient composition of feed materials. The tannin content of the processed cake of Shea nut meal was reduced from 0.3 g/kg to 0.0 g/kg as obtained in the raw cake of Shea nut meal. This result was in tandem with previous studies (Dei et al., 2008; Mutayoba et al., 2011; Agbo and Prah, 2014). They indicated that high temperature conduct and zymolysis are efficient strategies for reducing the level of toxicity of feed materials.
Table 2: Proximate Analysis of the raw and fermented-cooked Shea nut cake meal

| Nutrients in %       | Raw SNCM | Fermented CSNCM |
|----------------------|----------|-----------------|
| Moisture             | 5.9      | 8.6             |
| Ash                  | 20.6     | 30.0            |
| Crude Fibre          | 4.1      | 4.0             |
| Crude Protein        | 12.8     | 15.8            |
| Crude Fat            | 10.6     | 9.4             |
| NFE                  | 45.3     | 32.7            |
| Tannin               | 0.3      | 0.0             |

SNCM – Shea nut cake meal; CSNCM – Cooked Shea nut cake meal

**Apparent Nutrient Digestibility**

Table 3 showed the results of the apparent nutrient digestibility of broiler chicken fed diets containing different periods of fermented-cooked cake of Shea nut meal. The treatment means for crude protein and crude fibre digestibility showed significant differences (p < 0.05) amongst the dietary treatments while other nutrient parameters measured were not significantly different (p > 0.05).

Crude protein and crude fibre digestibility in broiler chickens fed the T4 diet was compared satisfactorily with that of the control group. Its outcome was significantly higher (p < 0.05) than that fed T2 and T3 diets. The increased protein digestibility was an indication of a better protein quality in the T4 diet. This could be due to the cooking of cake of Shea nut followed by a lengthier period of fermentation, which improved the protein quality of the sample. It appropriately reduced the anti-nutritional factors particularly, tannin which has been reported to create and bond complexes with the dietary proteins and enzymes in the animals’ gastrointestinal tract, inhibiting the digestibility of proteins in the digestive system (Smulikowska et al., 2001; Iji et al., 2004; Alade, 2018).

Iyayi and Taiwo (2004) reported an increase in protein quality due to an efficient fermentation process, possibly due to the bio-conversion ability of soluble carbohydrate into single-cell proteins by the micro-organisms. Likewise, it could also be due to the discharge of the polysaccharide-bound proteins which made the substrate nutritionally enhanced. Additionally, the increased crude fibre digestibility of the broiler chickens fed T4 could be an indication that extended period of fermentation adds more value to the crude fibre content which could lead to a better digestibility, unvaryingly improving animals’ palatability and proper utilization of feed materials by the animals. This was in line with the report of Agbo and Prah (2014) who observed improvement in the nutritional value of Shea nut meal at an extensive period of eight days of fermentation of Shea nut meal. Correspondingly, Aluyor et al. (2009) suggest that degradation of polymeric linkage cellulose of Shea nut meal by anaerobic micro-organisms is connected to the enhancement in the digestibility of crude fibre.
Table 3: Apparent nutrient digestibility of broiler chickens fed diets containing different periods of fermented - cooked Shea nut cake meal

| Parameters (%) | T<sub>1</sub> | T<sub>2</sub> | T<sub>3</sub> | T<sub>4</sub> | SEM | LOS |
|----------------|--------------|--------------|--------------|--------------|-----|-----|
| Crude protein  | 83.44<sup>a</sup> | 62.61<sup>b</sup> | 68.86<sup>b</sup> | 82.21<sup>a</sup> | 2.63 | *   |
| Crude fibre    | 74.73<sup>a</sup> | 66.01<sup>b</sup> | 66.46<sup>b</sup> | 75.78<sup>a</sup> | 1.97 | *   |
| Crude fat      | 57.77         | 58.12        | 58.44        | 58.22        | 1.02 | NS  |
| Ash            | 66.02         | 66.22        | 65.01        | 65.87        | 0.78 | NS  |
| NFE            | 72.04         | 71.20        | 70.85        | 71.64        | 3.54 | NS  |

Table 3: Apparent nutrient digestibility of broiler chickens fed diets containing different periods of fermented - cooked Shea nut cake meal

<sup>ab</sup> Means with the different letters are significantly different (p < 0.05)

SEM: Standard Error of Mean

Carcass and Organs Analysis

Table 4 showed the results of carcass, breast and liver yield of broiler chickens fed diets containing different periods of fermented-cooked cake of Shea nut meal. The result showed that there was an insignificant (p > 0.05) difference amid the treatment means for the control (carcass, breast and liver yield) and the carcass, breast and liver yield of broiler chickens fed diets containing different periods of fermented-cooked cake of Shea nut meal. All the treatment means had a high carcass yield. The insignificance in the differences amidst the treatment means for the control and the treatments may imply that the nutritive sufficiency of the diets sustained the carcass yield. Hence, it is reasonable to believe that zymolysis and use of heat did lower significantly the anti-nutritional elements in the cake of Shea nut, thus making the protracted anti-nutritional element similar to tannin not to have an ostensible effect (Dei, et al., 2008).

Table 4: Carcass, breast and liver yield of broiler chickens fed diets containing different periods of fermented - cooked Shea nut cake meal

| Parameters (%) | T<sub>1</sub> | T<sub>2</sub> | T<sub>3</sub> | T<sub>4</sub> | SEM | LOS |
|----------------|--------------|--------------|--------------|--------------|-----|-----|
| Carcass yield  | 96.65        | 96.19        | 96.21        | 96.36        | 1.77 | NS  |
| Breast yield   | 11.26        | 10.27        | 10.51        | 10.68        | 3.13 | NS  |
| Liver yield    | 2.51         | 2.52         | 2.42         | 2.38         | 0.88 | NS  |

<sup>ab</sup> Means with the different letters are significantly different (p < 0.05).

SEM: Standard Error of Mean

Carcass and Organs Analysis

Table 4 showed the results of carcass, breast and liver yield of broiler chickens fed diets containing different periods of fermented-cooked cake of Shea nut meal. The result showed that there was an insignificant (p > 0.05) difference amid the treatment means for the control (carcass, breast and liver yield) and the carcass, breast and liver yield of broiler chickens fed diets containing different periods of fermented-cooked cake of Shea nut meal. All the treatment means had a high carcass yield. The insignificance in the differences amidst the treatment means for the control and the treatments may imply that the nutritive sufficiency of the diets sustained the carcass yield. Hence, it is reasonable to believe that zymolysis and use of heat did lower significantly the anti-nutritional elements in the cake of Shea nut, thus making the protracted anti-nutritional element similar to tannin not to have an ostensible effect (Dei, et al., 2008).
CONCLUSION

This study revealed that fermented-cooked cake of Shea nut meal is a valuable and potential alternative source of protein and energy as compared to maize and thus can be integrated into the diets of poultry animals. Furthermore, the broiler chickens fed four-day fermented-cooked cake of Shea nut meal diets likened satisfactorily with the control diet by having better crude fibre digestibility and crude protein, thus, the diets were sufficiently ample to a better carcass growth yield sustenance. However, following studies on extended periods of fermented-cooked cake of Shea nut at a much higher inclusion level are suggested for future research.

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