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POTENTIALS OF SHEA CAKE *(VITELLARIA PARADOXA)* AS SUPPLEMENT IN THE DIET OF LACTATING RUMINANTS

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ABSTRACT

Shea cake *(Vitellaria paradoxa)* as supplement in lactating ruminant diets was investigated. Shea cake was collected at four shea butter factories at four locations in the derived savannah area of Oyo State, Nigeria, to represent 4 treatments; TI, T2, T3 and T4, respectively. Samples were air dried. Dried samples were milled and bottled for laboratory analysis for chemical composition, mineral analysis (Calcium - Ca, Magnesium - Mg, Sodium - Na, Potassium - K, Iron - Fe, Zinc - Zn and Copper - Cu), amino acids (Threonine, Isoleucine, Leucine, Lysine), Fatty acids (Stearic, Oleic, Linoleic, Palmitic) and Anti-nutritional factors (Tannin, Phytate and Oxalate), using standard laboratory procedures. The results were significantly different ($P<0.05$). The crude protein values ranged from 8.00% (T2) to 9.75% (T3). There was no significant difference ($P>0.05$) between T1 and T2 for crude fibre. Ash values ranged from 4.30% (T4) to 5.05% (T3). Mineral composition were significantly different ($P<0.05$). T3 (mg/100g) recorded highest values of 127.15, 98.30, 14.00, 86.00, 4.15, 3.25, and 0.85, for Ca, Mg, Na, K, Fe, Zn and Cu, respectively. Amino acid was significantly different ($P<0.05$). Threonine (g/100g protein) varied from 0.55 (T4) to 0.90 (T1 and T3), Isoleucine (g/100g protein) varied from 1.15 (T4) to 2.05(T3). Leucine differed significantly ($P<0.05$) as T3 had highest value (1.85g/100g protein). Lysine showed no significant different ($P>0.05$) for TI and T2 as well as T3 and T4. There was significant difference ($P<0.05$) in fatty acids investigated, except Oleic acid ($P>0.05$). Stearic acid values ranged from 44.75mg/100g dm (T4) to 47.20mg/100g dm (T1), Linoleic and palmitic acids recorded higher values of 7.00mg/100g dm (T3) and 4.25mg/100g dm (T4), respectively. Tannin values were not significantly ($P>0.05$). Phytate (mg/100g/DM) differed significantly ($P<0.05$), between T1, T2 and T3, T4 with values range of 0.88(T2) to 1.00 (T3). Oxalate (mg/100g/DM) was not significantly different ($P>0.05$) among T1, T2 and T4. This study therefore presents shea cake as good supplement in in the diet of ruminants, especially, lactating does.

KEYWORDS

Shea cake, Proximate composition, Minerals, Amino acids and Fatty acids.

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INTRODUCTION

Farmers-herders crisis in most African countries have become nightmare, not only to citizens but government at all levels, owing to farm destructions and unwarranted clashes between and among cattle herders and crops farmers whose all year round

labour vanishes overnight when overrun by nomadic herders in their effort to feed their herd. To curtail persistent loss of farm produce and lives, alternative feed stuffs capable of supplying both maintenance and production nutrient required in the rations of ruminants, especially cattle should be developed and introduced to herders. The emphasis on cattle was because, aside meat production for humans consumption; cattle produces more milk quantity than other small ruminants. Performance of any breed of livestock is a function of its genetic composition and environment. However, environment in animal production and management is broad and encompassing. Prominent of all; aside housing is nutrition. Feeding of good diets with appropriate composition of nutrients ensures better performance in domestic animals. Unfortunately, cost of feed; especially in developing nations of the world is biting hard on livestock production and output. This in effect necessitates sourcing for locally available feed resources naturally rich in nutrients but unconventional and underutilized by livestock farmers to sustain production without uttering the genetic makeup and performance of the animals. Among these numerous feed resources are crop residues and agro-industrial by-products. Crop residues are mainly fibrous material that is by-products of crop cultivation. Due to the intensity of and emphasis on crop production in Africa and Asia, great amounts of several by-products are produced annually. While these feed resources, particularly cereal straws, provide the bulk of livestock feed, their nutritive value is often so low that farmers must supplement them with feed grains and other concentrates., most of which have, low crude protein level required for promoting voluntary feed intake and also deficient in fermentable energy and minerals (Ben Salem *et al*, 2004)[1]. Some multipurpose trees such as Baobab produces multi-nutrient fruits which falls in the category of unconventional feed resources with great potentials to supply nutrients and nutritional requirements of livestock (Okunlola *et al*, 2018)[2]. In the category of multipurpose trees is Shea tree (*Vitellaria paradoxa)* which produces shea nuts, from which shea butter is extracted.

The shea tree (*Vitellaria paradoxa*) is a small to medium-sized deciduous tree that grows mainly on open dry land, covering the Guinea and Sudan savannah areas as well as the lower Sahel regions of the Nigeria (Okullo *et al*, (2004)[3]. Fully grown shea tree has an average height of 15-25 m. Leaves are caducous and spirally arranged, mostly in dense clusters at the tips of branches. Fruit is a 1 or 2-seeded ellipsoid berry (4-8cm), weighing 10-50g, initially green but turning yellowish green or brown at maturity (Nikiema *et al*, 2007)[4]. Availability of shea tree in Nigeria puts its production at 425,000 Metric tones in 2004 ahead of other nearby nations (FAO, 2005)[5].

The main produce from shea tree is shea butter, an edible fat used for food and cosmetics. Although, shea nuts contains traces of anti nutritional factors (Gohl, 1981)[6], such small quantities in the diet are unlikely to have any deleterious effect (Hill, 2003)[7] especially in ruminants because their systems tolerates low levels of anti nutritional factors, unlike monogastric animals EFSA (2009)[8]. Processing methods further reduces the anti-nutritional factors to bearable levels by ruminants, especially, lactating does/cows.

Shea cake is the solidified effluents from the production of shea butter. Usually, it is channeled to earthen or concrete tank at various shea butter production sites as waste. This nutrient rich by-product has potentials to supply the nutritional requirements of lactating ruminants. Hence, the need to investigate its nutritional qualities to further enhance performance of ruminant animals, especially, the quantity and quality of milk produced by these animals.

MATERIAL AND METHODS

Collection of Shea Cake

Four locations with huge population of shea tree, namely, Ofiki, Ipapo, Saki/Ogbooro and Tede/Igbeti in the Derived Savannah Area of Nigeria were identified for the study. Centrally located medium sized shea butter processing factory where individual owners of processing units converges for shea butter production was identified in each of the areas of study. The facility was constructed such that conduit

for effluents from each unit was channeled to a central concrete tank where it solidifies and removed for disposal as waste. Samples were randomly collected within the surface area of the effluent reservoir at factories in each location of study for evenness. Samples collected were thoroughly mixed, milled and stored in a covered plastic container for laboratory analysis; following standard procedures.

Laboratory Analyses

Proximate composition, crude protein (CP), crude fibre (CF) and ether extract (EE) were determined as described by AOAC (2005)[9]. Selected major minerals, Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), and trace minerals, Iron (Fe), Zinc (Zn), and Copper (Cu), were digested using wet oxidation method of AOAC (1995)[10]. After digestion, Na and K were read using flame photometer. Ca, Mg, Fe and Cu, were read with atomic absorption spectrophotometer. Selected amino acid (Threonine, Isoleucine, Leucine and Lysine) were determined according to Dimova (2003)[11] and Gheshlaghi *et al*, (2008)[12], Using the high-performance liquid chromatography (HPLC) method. Fatty acids were determined by simplified method of Kang J.X and Wang J. (2005)[13]. Tannin (Burns, 1971[14], Makkar and Becker, 1997[15]), Phytate (Maga, 1983[16], Reddy and Love, 1999[17]), Oxalate (Munro and Bassir, 1969[18], Beutler *et al*, 1980[19]).

Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) using the procedure of (SAS, 2003)[20] package to determine the effect of dietary treatments on the various parameters studied. Significant means were separated using Duncan multiple range test of the same software.

RESULTS AND DISCUSSION

Table No.1 presents the proximate composition of shea cake in the Derived Savannah Area of Nigeria. Samples were taken from four locations to ensure evenness. Each location represents the treatments (T1 - T4). The dry matter value ranges from 87.02 - 89.65%; with the sample on T3 (Sample from Saki/Ogbooro) recording the highest value (89.65%). T2 (Ipapo) recorded the least dry matter of 87.02%. The least value recorded by T4 was just in comparison among samples from other location as its value (87.02%) and not of less quality for use in ruminant feed composition or formulation. The dry matter values across the treatment is an indication of good shelf life and storage value of shea cake. Crude protein (CP) values on the other hand recorded a value range of 8.00 (T2) - 9.75 (T3). This agreed with the findings of (Enaberue *et al*, 2014)[21] in a research on shea fruit pulp. The CP values recorded justified shea cake as a good feed resource in ruminant nutrition. The ether extract (EE) recorded was high across treatments. The values ranged from 19.20% (T4) - 22.00% (T2). This could be linked to the nature of shea tree (*Vitellaria paradoxa*); being an oil rich tree. Comparatively, Shea cake from T3 had best results among other treatments.

Table No.2 presents selected minerals (mg/100g) and amino acid composition (g/100g protein) of Shea cake in the derived savannah zone of Nigeria. The results were significantly ($P<0.05$) for the minerals invested. Ca value ranged from 122.20mg/100g (T2) to 127.15mg/100g (T3), Mg values recorded 80.15mg/100g (T4) to 98.30mg/100g (T3). Other minerals, Na, K, Fe, Zn and Cu were all significantly different across ($P<0.05$) treatments. The results recorded shows shea cake as potential feed resource capable of supplying the nutrient requirements of ruminant animal, especially, lactating ones. Feeding shea cake to lactating animals has great potentials to improve the quality of milk to be produced by target ruminant. Shea cake is solidified effluent from the extraction of shea butter from shea nuts. Eromosele *et al*, (1991)[22], Meganaonu *et al*, (2007)[23] in separate study on shea pulp and kernels composition recorded 426.00mg/100g and 215.20 for Ca, 129mg/100g for Mg (shea pulp) and 71.40mg/100g for P in shea pulp. This was greater than Ca, Mg and P values recorded in this study. This was due to the fact that greater quantity of nutrients which were still intact in the pulp and kernel had been extracted from shea cake in the process of shea butter manufacturing. Same trend goes for other minerals investigated. However, the nutrients values obtained in this study can adequately supply the nutrient requirement of ruminant animals. The values of Iron (Fe) recorded in the study (2.88mg/100g (T2) to 4.15mg/100g (T3)

is an indication of shea cake's ability to increase oxygen carrying capacity if fed of the animals, this in turn promotes good health and overall performance of the animals.

Amino acids are building blocks of proteins which is required for synthesis of hormones and every activities of the body. Amino acid content in this study showed that shea cake has appreciable quantity of essential amino acid. The choice of Threonine, Isoleucine, leucine and lysine in this study was due to the roles they play in body building. Thronine plays important roles in fat metabolism and immune function, Isoleucine functions in hemoglobin production and energy regulation, leucine helps in blood sugar regulation as well as production of growth hormones, while lysine is important in calcium absorption, as well as immune function and energy production. Presence of these valuable nutrients in shea cake makes it a choice of feed resource, especially for lactating ruminant, because milk synthesis and letdown during lactation requires good immunity and energy.

Table No.3 shows the fatty acids composition of shea cake meal. Stearic acid, Oleic acid, Linoleic acis and palmitic acid were investigated. The fatty acid values were significantly different ($P<0.05$) across treatments. In all, Stearic acid had the highest value range (44.75%) T4 – (47.20%) T1. Followed by Oleic (37.80%- 39%), with no significant ($P>0.05$) difference. Linoleic and Palmitic acids recorded value range of 6.50% (T1)-7.00% (T3), and 3.50% (T1) -4.25% (T4), respectively. The values obtained was in agreement with the report of Ugese *et al*, (2010)[24], in a research conducted on fatty acid profile of shea butter. Stearic acid is a saturated fatty acid, found in all animals and most vegetables, oil and fats. Oleic acid is an unsaturated fatty acid, with 18 carbon atoms and double bond. It is also found in vegetables and animal oil and fats. Linoleic acid is a polyunsaturated fatty acid, also with 18 carbon atoms but with double bonds, which is essential for human nutrition. Presence of all theses essential fatty acids in shea cake makes it an ideal feed resource which when incorporated into the diets of ruminants will not only enhance performance, but it will also improve quality of milk to be produced by lactating ones. The value range obtained in this study could be linked to the fat and oil content of shea, while the variations in other parameters could be traced to edaphic factors of locations where the feed resource was gathered. Handling and processing methods could also be responsible for the variation in fatty acids content.

Table No.4 presents anti-nutrient composition (mg/100g dm) of Shea Cake (SK) in the Derived Savannah Area of Nigeria. Generally, anti nutrients are known for inhibitory roles the play in nutrients availability to animals, especially when they are present in high quantity in feed or feed materials. Tannin among other anti nutrients has been reported to have inhibiting effects on microbial and intestinal functions (Brooker *et al*, 1999)[25]. But, ruminants can consume substantial amounts of condensed tannin without apparently reducing the flow of microbial protein to the small intestines. Ruminants ability to tolerate anti nutrients, especially; tannin has been documented (Arjona-Alcocer *et al*, 2012[26], Ruz-Ruiz *et al*, 2013[27]). Ramirez-Restrepo and Barry (2005)[28] reported that methane emission decreased when ruminants are fed tannin-rich forages. However, feed resource containing hydrolysable tannin is preferred by ruminants to condensed tannin rich feed (Derix, 2017)[29]. Phytate, unlike most anti nutrients is readily digested by ruminants. This is because rumen produces phytase, a microorganism which helps in phytate digestion. This natural endowment, couple with low level of phytate in shea cake (0.88mg/100g - T2 to 1.00mg/100g) recorded in this study makes shea cake a good feed supplement to ruminants. The values of anti-nutrients recorded by shea cake in this study posed no detrimental effect to ruminants health. It is therefore considered safe for inclusion in ruminant diet, especially, lactating ruminants, because of its numerous nutritional potentials to improve milk yield and quality.

Table No.1: Proximate composition of Shea Cake (SK) in the Derived Savannah Area of Nigeria

S.No	Parameters (%)	Ofiki (T1)	Ipapo (T2)	Saki/Ogbooro (T3)	Tede/Igbeti (T4)	SEM±
1	Dry matter	89.15^{b}	88.50^{d}	89.65^{a}	87.02^{c}	0.05
2	Crude protein	8.60^{b}	8.00^{c}	9.75^{a}	8.26^{ab}	1.00
3	Crude fibre	4.00^{b}	4.00^{b}	4.50^{a}	4.22^{ab}	0.05
4	Ether extract	20.00^{b}	22.00^{a}	21.50^{a}	19.20^{c}	0.05
5	Ash	4.55^{b}	4.60^{b}	5.05^{a}	4.30^{c}	0.02
6	Moisture	10.85^{b}	11.50^{b}	10.35^{c}	12.98^{a}	1.00
7	Nitrogen free extract	52.00^{a}	49.90^{b}	48.85^{c}	51.04^{a}	1.00

^{abcd} *Means within each row with different superscripts are significantly different (p<0.05*

Table No.2: Selected Minerals (mg/100g) and Amino Acid composition (g/100g protein) of Shea cake in the Derived Savannah zone of Nigeria

S.No	Location /Parameters	Ofiki (T1)	Ipapo (T2)	Saki/Ogbooro (T3)	Tede/Igbeti (T4)	SEM±
Minerals (mg/100g)						
1	Calcium (Ca)	123.50^{c}	122.20^{d}	127.15^{a}	125.02^{b}	2.00
2	Magnesium (Mg)	90.00^{b}	83.15^{c}	98.30^{a}	80.15^{d}	1.50
3	Sodium (Na)	11.85^{b}	10.98^{c}	14.00^{a}	12.10^{b}	1.20
4	Potassium (k)	79.00^{b}	75.50^{c}	86.00^{a}	68.80^{d}	1.05
5	Iron (Fe)	3.23^{b}	2.88^{c}	4.15^{a}	3.20^{b}	0.75
6	Zinc (Zn)	2.23^{c}	2.15^{c}	3.25^{a}	2.85^{b}	0.15
7	Copper (Cu)	0.75^{b}	0.70^{c}	0.85^{a}	0.66^{c}	0.02
Amino acids (g/100g protein)						
8	Threonine	0.90^{a}	0.75^{b}	0.90^{a}	0.55^{c}	0.15
9	Isoleucine	1.55^{b}	1.50^{c}	2.05^{a}	1.15^{d}	0.20
10	Leucine	1.13^{d}	1.25^{c}	1.85^{a}	1.66^{b}	0.10
11	Lysine	1.88^{b}	1.85^{b}	2.00^{a}	1.95^{a}	0.00

^{abcd} *Means within each row with different superscripts are significantly different (p<0.05)*

Table No.3: Fatty acid composition of Shea Cake (SK) in the derived Savannah area of Nigeria

S.No	Location/Parameters (%)	Ofiki (T1)	Ipapo (T2)	Saki/Ogbooro (T3)	Tede/Igbeti (T4)	SEM±
1	Stearic acid	47.20^{a}	45.00^{ab}	46.82^{b}	44.75^{c}	1.55
2	Oleic acid	39.00	38.50	37.80	38.00	1.00
3	Linoleic acid	6.50^{ab}	6.00^{b}	7.00^{a}	6.75^{a}	0.95
4	Palmitic acid	3.50^{c}	4.00^{a}	3.70^{ab}	4.25^{a}	0.88

^{abc} *Means within each row with different superscripts are significantly different (p<0.05)*

Table No.4: Anti-nutrient composition (mg/100g dm) of Shea Cake (SK) in the derived Savannah area of Nigeria

S.No	Location/ Parameters (%)	Ofiki (T1)	Ipapo (T2)	Saki/Ogbooro (T3)	Tede/Igbeti (T4)	SEM±
1	Tanin	1.87	2.00	2.05	1.98	0.50
2	Phytate	0.90^{b}	0.88^{b}	1.00^{a}	0.95^{a}	0.02
3	Oxalate	1.00^{b}	1.00^{b}	1.12^{a}	1.05^{b}	0.10

^{abc} *Means within each row with different superscripts are significantly different (p<0.05)*

CONCLUSION

The results from this study showed shea cake as good feed resource in ruminant animals, especially lactating ones. The nutrient composition, especially, minerals and amino acids makes it capable of supplying nutritional needs of ruminants, whether for meat or milk purpose. The infinitesimal composition of anti nutrient therein makes it free from initiating or encouraging health problems when fed to ruminants. Its use as supplement in ruminant production and management will reduce cost of production because of its availability at little or no cost. Efforts should therefore be made to ensure good storage and establishment of commercial silage centers for all year round availability of shea cake meal which would be funded by private sectors and government for mass production of shea cake meal for sale to cattle owners and herders, to curb and curtail incessant crop farmers-cattle herders crisis that usually lead to unwarranted loss of lives and destruction of crop farms in developing nations. Various experiments should be encouraged to explore its potentials as feed resource in ruminant animal production.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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