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RESEARCH PAPER

Sheanut *Vitellaria paradoxa* cake as ingredient in the diet of West African Dwarf Sheep *Capra ovis*

Ahaotu Emmanuel Obioha
Department of Animal Production and Health Technology, School of Agriculture and Agricultural Technology, Imo State Polytechnic Umuagwo - Ohaji, Nigeria. *Corresponding author's email: emmaocy@yahoo.com, eahaotu@imopoly.net

ABSTRACT

The aim of the study was to determine the effect of different levels of SNC on feed intake, digestibility and growth in West African Dwarf sheep. Sheanut cake (SNC) is a waste product from the process of extracting shea butter from shea fruits. Sheanut cake (SNC) is a waste product from the process of extracting shea butter from shea fruits. Many authors have investigated the importance of this waste to the ruminant livestock production industry. Sheanut cake (SNC) contained 122.4 - 189.0 g kg^{-1} of crude protein, 123.0 - 175.0 g kg^{-1} ether extract, 92.3 g kg^{-1} ADF, 100.7 g kg^{-1} NDF, 41.6-53.0 g kg^{-1} ash, 75.0-138.0 g kg^{-1} crude fibre, dry matter of 915.0 g kg^{-1} and a metabolizable energy of 7.12 MJ kg^{-1}. SNC also contained anti-nutritional factors (ANFs) (tannins, saponins, and theobromine) that reduced its use at a higher inclusion level in the diet of sheep. Varying levels of Sheanut cake (11.5 - 30%) were included in the diet of sheep to observe its effect on the performance of WAD sheep. It was observed that above 25% inclusion, feed intake, digestibility and average daily growth rate were depressed. No negative effect was reported in the haematology and blood biochemistry of sheep when SNC was included in the diet up to 25%. It has been established from this study that SNC contains appreciable levels of nutrient especially protein. However, the optimum inclusion level in the diet of WAD sheep is 25% beyond which feed intake, digestibility and growth is depressed.

Keywords: Sheanut cake, Anti-nutritional factors, West African Dwarf sheep, Fermentation

INTRODUCTION

Shea tree is a member of the family *Sapotaceae*, and this plant is native to Africa. The tree is found in semi - arid areas north of the humid forest zone and it can attain a height of 15 to 22m and the trunk diameter varies from 0.5 – 1m (FAO, 1998). Bark is conspicuously thick, corky, horizontally and longitudinally deeply fissured. It protects older trees against bush fires. It also has an extensive root system which is essential for its survival in the 5-7month dry seasons of savannah climates.

The leaves of Shea butter are used as medicine to treat stomach ache in children and its fruit contains protein at 0.7-1.3g, carbohydrate 41.3g -100g, iron 1.90-100g, calcium 34.4mg -100g and ascorbic acid 196.1mg -100g respectively. Shea butter contains vitamins A and E, as well as catechins and plant antioxidants (Masters, 2004). Ayeh (1981) also reported that Shea butter is extracted from the nuts and are increasingly used for livestock and poultry feed, leaves and young sprouts serve as forage while small ruminants such as sheep and goats eat the sugary pulp of ripe fruit that have fallen to the ground. Studies have shown that the extract from the leaves are used to relieve headaches and eye bath (Abidemi *et al.,* 2009).

Crop residues (straws and stovers) will remain important sources of feed for livestock production in most developing countries especially Nigeria. Apart from crop residues, agro-by-

products are useful sources of nutrition for ruminants owing to the development of small scale industries. One agro-by-product which needs to be examined for its role in ruminant nutrition is Shea nut cake (SNC).

The shea tree, *Vitellaria paradoxa* is a multi- purpose plant highly valued for the fat obtained from its seeds. The plant grows wild in the savannah zone of Africa. In Nigeria, shea trees are widely distributed in the Northern savannah zone (Maranz *et al.*, 2004) and produce about 135,000 tonnes of nuts per annum (Adomako, 1985). The tree is perennial, deciduous and occurs mainly on dry open slopes (Yidana, 2004). The shea tree attains heights of about 6.1 m and girths of 61 cm in the wild when it is often ravaged by bushfires (Mumeen *et al.*, 2013).

The primary product from the shea tree is the shea nut from which shea butter is extracted. There are two main methods of butter extraction. These are the traditional village method and mechanical method (Fleury, 2000). Similar processes are involved in shea butter extraction and these processes are: traditional method, cold press method and hexane/chemical method respectively (Agyente and Kwame. 2010).

Sheep are one of the most important ruminant animals for livelihood in Nigeria (Ahaotu *et al.,* 2009). West African dwarf sheep (*Capra ovis)* is the major native breed type of Nigeria. They are good grazing instinct and suitable for migratory system. Lamb meat (mutton) is an excellent protein source and provides important minerals such as iron and zinc (Ahaotu and Ijut, 2018). It is generally known that raising young animals on high concentrate diets results in higher daily gains, dressing percentage and carcass quality than on a forage system (Ahaotu *et al.,* 2017). The productivity of sheep can be improved by improving the nutrition either concentrate feeding or provision of additional forage. Feeding and management systems affect the productivity of animals.

Sheep production is an important component of Nigerian livestock industry. Sheep represent about 60% of the total grazing domestic livestock in Nigeria (Ahaotu *et al.*, 2009). These animals display a unique ability to adapt and survive in areas where they are found and consequently their wide geographical distribution in Nigeria. Sheep supplies meat, milk, wool, skin and other products and also serves as a flexible financial reserve for the rural population as well as play other socio-cultural roles in the customs and tradition of many Nigerian societies.

Although all nutrients are mostly derived from feed intake, the nutrients stored in body tissues are fundamental in specific production stages such as late gestation and early lactation, mainly supporting adequate development and performance of mammary gland. Throughout the year, sheep often show large variation of body reserves, with higher weight at the end of pregnancy, the last part of lactation and the dry period, and with lower weight in the first part of lactation (Ahaotu *et al.,* 2009).

MATERIALS AND METHODS

Experimental site

The experiment was conducted during the early rainy season (May 2017) at the goatery unit of Department of Animal Production Technology, Imo State Polytechnic Umuagwo, Nigeria. The site is situated between longitudes 7^{o} 0^{1} 06^{11}E and 7^{o} 03^{1} 00^{11} and latitudes 5^{o} 28^{1} 00^{11}N and 5^{o} 30^{1} 00^{11}N in the humid tropical West Africa (IMLS, 2009). The area is within the Guinea Savannah agro-ecological zone of Nigeria, and has a unimodal rainfall pattern, with rainfall amounts ranging between 1000 mm–1200 mm, distributed unevenly from April to October. The zone has a period of 4–6 months of dry season. Temperature distribution is uniform between 21^{0}C–34^{0}C. The relative humidity ranges between 53% and 80%. The area is characterized by natural vegetation and dominated by shrubs. The cold harmattan winds extend

from December to March, while a period of warm dry months extends from March to April. The dry season stretches from December to May (John *et al.*, 2011).

Preparation of experimental diet

Fresh shea butter leaves were collected within the farm premises and washed. It was later spread on a concrete floor for 6 days to dry. The dried leaves from the strands are removed and grinded with a hammer mill to produce the shea butter leaf meal. This was further sent for proximate analysis to determine the chemical composition of the leaves.

Experimental Design

The West African Dwarf Sheep were randomly allotted into five (5) treatment groups and replicated in a completely randomize design (CRD). They were allowed a pre - treatment period of two weeks to enable them acclimatize. Five different inclusion levels containing varying levels of shea nut (*Vitellaria paradoxa*) meal were formulated. Treatment 1 had 11.5% level of shea nut (*Vitelliria paradoxa*) meal. Treatment 2, 3, 4 and 5 had shea nut (*Vitellaria paradoxa*) meal included at 15 %, 23 %, 25 % and 30 % respectively (Table 2). Experimental diet and water were supplied *ad-libitum*. The left-over were collected, weighed and recorded daily. Normal management practices were employed during the study period.

Chemical Analysis

The proximate components of Shea butter leaves (Powder) and samples were determined by method of A.O.A.C (1990).

Statistical Analysis

All data collected were subjected to one way Analysis of variance (ANOVA) by Steel and Torrie (1980). Significant means separated by Duncan multiple range tests (Gordon and Gordon, 2004).

RESULTS

The proximate composition of the SNC is shown in Table 1. The crude protein reported is in the range of 122.4 - 189.0 g kg^{-1} with ether extract in the range of 123-175 g kg^{-1}. The ADF and the NDF were 92.3 g kg^{-1} and 100.7 g kg^{-1}, respectively. Ash and crude fiber were in the range of 41.6 - 53 g kg^{-1} and 75 - 138 g kg^{-1}, respectively. Metabolizable energy of 7.12 MJ kg^{-1} was reported (Table 1).

The effects of varying levels of Shea butter on feed intake, weight gain, digestibility, feed conversion and the mortality of West African Dwarf Sheep is shown in Table 2. where the higher weight gain was recorded at 25% of Shea butter. The results from the study showed differences in dry matter feed intake at different levels of inclusion in the diet of sheep (Table 2). The highest feed intake was reported in sheep that were fed diets containing 11.5% SNC with least reported in the 25% SNC diet. The trend of the results to a large extent shows a decrease in feed intake with increase in SNC.

Haematology and serum metabolites of West African Dwarf rams fed diet containing various levels of Sheanut cake is shown in Table 3. There were no significant differences in haemoglobin and PVCs contents among the treatments. The higher of serum total protein, albumin, globulin, eosinophils and cholesterol were found at inclusion level of 23%, while the higher of glocuse, basophils, and neutrophils were recorded at 11.5 %of inclusions.

Table 1. Proximate composition Sheanut meal obtained on dry matter basis

Nutrient (g kg^{-1})	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Dry matter	-	915.0	-	-	-	-	905
Crude protein	138	162	189	181	174.1	122.4	159
Ether extract	175	134	123	158	140.0		320
Crude fibre	138	95	75	107	109.4	84.2	-
Ash	53	42	48	48	63.2	41.6	-
Nitrogen free extract	496	567	565	506	509.8	-	-
NDF	-	100.7	-	-	-	-	570
ADF	-	92.7	-	-	-	-	450
Tannins	+	-	-	-	-	+	445.9
Saponin	-	+	-	-	-	+	0.45
Theobromine	-	+	+	-	-	-	-
ME (MJ kg^{-1})	-	7.12	-	-	-	-	7

Note: 1; Okai *et al.* (1994), 2; Atuahene *et al.* (1998), 3; Rhule (1999), 4; Olorede and Longe (1999), 5; Anto (2004), 6; Mumeen *et al.* (2013), 7; Oddoye *et al.* (2012), +; present.

Table 2. Effects of varying levels of Sheanut cake on intake, weight gain, digestibility, feed conversion ratio and mortality of sheep.

Parameters	1	2	3	4	5
Inclusion level (%)	11.5	15.0	23.0	25.0	30.0
Intake (g head^{-1} day^{-1})	572.9	424.1	522.8	190.4	258.6
Weight gain (g head^{-1} day^{-1})	31.2	29.2	37.7	71.4	6.3
Crude protein (CP)	-	-	-	-	-
Digestibility (g 100g^{-1})	56.7	-	-	-	19.9
Dry matter (DM)	-	-	-	-	-
Digestibility (g level 100g^{-1})	77.1	61.5	60.1	-	46.4
Feed conversion ratio FCR)	8.3	-	13.9	-	-

Note: 1; Annoh (2005), 2; Konlan (2010), 3; Ansah *et al.* (2012)

Table 3. Haematology and serum metabolites of West African Dwarf rams fed diet containing various levels of Sheanut cake

	Inclusion levels		
Parameters	11.5	23.0	25.0
Haemoglobin g/DL	10.53	10.53	10.40
PCV (%)	31.2	31.2	31.25
WBCs	8.37	9.3	-
Serum total protein g L^{-1}	59.50	61.50	-
Albumin g L^{-1}	19.67	21.17	-
Globulin g L^{-1}	39.83	40.17	-
Glucose Mmol L^{-1}	5.90	5.77	-
Basophils (%)	1.33	1.00	-
Eosinophils (%)	5.64	6.83	5.75
Cholesterol Mmol L^{-1}	1.10	1.23	-
Neutrophils (%)	41.3	38.7	46.20

Note: 1; Konlan *et al.* (2012), 2; Ansah *et al.* (2012)

DISCUSSION

The variations in the reported chemical composition of shea nut cake could be attributed to the extent of processing under each of the methods. The high percentage of fat extraction in the mechanical method could results in a lower ether extract reported in the Shea nut cake. Under the mechanical method, the heat used is often controlled whereas under the traditional village method, it is difficult to control. Exposing the paste to high heat has the tendency to destroy the protein through the formation of mallard products. When this occurs, the protein concentration will be lower in the traditional village method. Differences and errors in analytical methods and techniques may also be a cause of variation in the chemical constituents of the Shea nut cake (Dei *et al*., 2007). Varietal differences could also account for the differences in chemical composition. Davrieux *et al.* (2010) found differences in the chemical composition of the Shea butter from different cultivars and these differences could manifest in the Shea nut cake.

It was deduced that the decrease in feed intake reported by the authors in diets containing high levels of SNC was attributed to the presence of ANFs and the relatively high levels of ether extract in the SNC. When polyethylene glycol (PEG) was added to tannin-containing diets, and fed to ruminants, the feed intake was enhanced relative to ruminants that fed on the untreated tannin-containing diets (Barry and Duncan, 1984; Agyente and Kwame (2010), Waghorn and Shelton, 1997; Dawson *et al*., 1999). The reduction in feed intake due to increasing levels of tannins has been attributed to the astringent taste in the mouth of ruminants when such diets are consumed. The ANF, saponins has been found to cause an irritating effect on the membranes of the mouth and digestive tract which could lead to a reduction in feed intake (Alagbe *et al*., 2018). High levels of fat in the diets of ruminants slow down digestion rate and could also account for the reduction in feed intake (McDonald *et al*., 1995; Church and Pond, 1988).

There was a marked depression in weight gain when inclusion levels of SNC reached 30%. The observed reduction in weight gain when SNC was used up to 30% could be due to the influence of saponins and tannins, which could have acted as binding agents to protein. When these compounds bind to dietary protein, microbial protein degradation is minimized to levels that negatively affect the supply of nitrogen for microbial membrane synthesis in the rumen. The reduction in microbial synthesis has been found to significantly reduce carbohydrate digestion in the rumen (MaKeish, 2012 and Liener, 1990).

The lower weight gain reported at 30% inclusion was supported by the lower dry matter digestibility (Table 2) confirming that higher inclusion levels of SNC could negatively affect intake, digestibility and weight gain. Konlan (2010) observed that there were no haematological changes in the blood of animals when fed with SNC. Similar findings were also reported by Olorede and Longe (1999) in poultry fed graded levels of SNC. The percentage distribution of leucocytes was not also affected by the SNC in all the three dietary treatments offered to the sheep. The WBCs counts of all the treatment groups were similar and fell within the normal range (5 x 10^6/dl to 11 x 10^6/dl) reported by Scott *et al.* (2006). The serum metabolites values reported in the study by Konlan *et al.* (2012) were all within the normal range for sheep as reported by Pampori *et al.,* (2003). Serum cholesterol level did not show any significant difference between the various levels of inclusion. The values obtained in this study were within the normal range of 100 – 150 mg per 100 ml of serum reported by Pampori (2003). The concentrations of serum total protein, albumin and globulin reported suggest that dietary protein digestion and absorption was not negatively affected by the inclusion of SNC up to 25%.

CONCLUSIONS

It is an evident that SNC possessed appreciable levels of nutrients which could be exploited to meet the nutrient requirement of ruminant livestock. It can also be deduced that beyond 25 % inclusion of SNC, feed intake and weight gain were depressed.

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