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Abstract

Shea nut cake (SNC) is one of the agro-industrial by products that could be used as ruminants feed. Twelve West African dwarf (WAD) young bucks were used in a completely randomized design for an 84 day study to evaluate the blood profiles of goats fed diets of 0 % (T1), 10 % (T2) and 20 % (T3) shea nut cake. The results revealed that there were slight significant differences in few of the blood parameters measured among the treatments. The haemoglobin (Hb), packed cell volume (PCV) and red blood cell (RBC) ranged from 8.33-9.88g/dl, 20.95-22.05% and 6.51-7.06x10^6/l respectively. The concentrations of mean corpuscular volume (MCV) (21.83-22.17fl), mean corpuscular haemoglobin (MCH) (7.58-8.50pg) and mean corpuscular hemoglobin concentration (MCHC) (33.00-34.73%) varied significantly ($p<0.05$), white blood cell varied from 8.46-12.75µl and lymphocytes (%) ranged from 51.27 to 53.78. For serum biochemistry, values obtained for aspartate aminotransferase (AST) and Total protein (TP) were similar. Cholesterol, alanine amino transferase (ALT) and albumin varied significantly among the treatment groups. Since the parameters measured were within the normal range for goats' blood profile, hence, shea nut cake does not have any deleterious effect on the health of the animals. It was concluded that shea nut cake could be incorporated into the diet of goats up to 20% without posing health hazard on the animals.

Keywords: blood; haematology; serum; shea nut cake; West African dwarf (WAD) goats

Introduction

Goats play an important socio-economic role in the rural areas where most of the peasant farmers live (Anaeto et al*.,* 2009) and form an integral part of the cultural life and system of Nigeria's peasantry (Ajala, 2004). The role played by ruminants in improving the low animal protein intake by Nigerian and other developing countries cannot be over emphasized. Notwithstanding the importance of goats, its production is still hindered as a result of shortage of feed both in quantity and quality at some seasons of the year. Quality forage, which could have alleviated the problem of feed scarcity, declines during rainy season and convectional feedstuff such as grains and oil seeds which are available during this period are very expensive to be used as feed for ruminants

The challenges of availability and affordability of feeds have therefore push scientists to find alternative sources of feeds that are sustainable and are not consumed by human beings. Shea nut cake (SNC), which is an oilseed by-product, has been identified as one of such alternatives. Increasing world demand for shea butter as a cocoa butter substitute, as well as for cosmetics (Hall et al., 1996; Hatskevich et al., 2011) has increased the production of SNC as the by-product in sub-Saharan Africa. In Nigeria, the livestock feed industry is heavily dependent on, among others, oilseed resources such as groundnut cake, soybean cake, cotton seed cake and palm kernel meal (RMRDC, 2003).

Shea butter tree, *Vitellaria paradoxa* is one of the key agro forestry species in Africa. It covers a 500–700 km wide and 5000 km long stretch of African savanna from Senegal to Ethiopia and Uganda (Umali & Nikiema, 2002). In Nigeria, the major area of occurrence is the Guinea and Sudan savanna zones (Keay, 1989). On the global scale, the species has made remarkable contributions in the food and cosmetic industries because of its seed fat extract known as shea butter (Boffa et al., 1996). Locally, shea butter tree is invaluable in traditional medicine, provision of fuel wood and in the production of soap, candle and pomade (Awoleye, 1995). Its dietary importance at the local level is derived from the fat extract which is used for cooking as well as the fruit pulp which is consumed by humans and livestock (ICRAF, 2000). The protein-rich caterpillars of *Cirina butyrospermi* associated with the species are commonly found as a good delicacy among the Yoruba and Nupe (Ande, 2004) as well as the Tiv ethnic groups in Nigeria (Ugese et al., 2005). Although the seed fat extract of shea seed has helped to bring the crop to global limelight, not much seems to be known of the seed cake, a by-product of fat extraction being utilized by ruminants in Nigeria. The upsurge in the use of oilseeds and grains such as soybean, maize and wheat for biofuel is already taking its toll on global food security (Spore, 2008). It has therefore become imperative to explore other alternatives for the feed industry to alleviate the current poor food supply situation. Exploring the nutritional content of SNC in Nigeria, the world's leading producer of shea nuts (Umali & Nikiema, 2002; Umobong, 2006) and its utilization by ruminant animals will be a step in the right direction.

Nutritional studies should not be only focusing on the performance and intake by the said animals, as the effect of such feed on blood constituents of livestock is also very germane. Jackson and Cockcroft (2002) stated that clinical examination is necessary to identify the clinical abnormalities that are present and the risk factors that determine the occurrence of the disease in the individual or population. He went further to say that without a proficient clinical examination and an accurate diagnosis it is unlikely that the control, prognosis and welfare of animals will be

optimized. Aderinboye et al. (2009) further affirmed that blood examination is a good way of assessing the health status of animals as it plays a vital role in the physiological, nutritional and pathological status of animals. According to Animashaun et al. (2006) and Ojebiyi, et al. (2007), the use of haematological studies is very important in considering the health status of animals used in various feed trials. Olorode & Longe (1999) have reiterated that nutrition interferes with the metabolites and other constituents found in the blood. Haematology and serum biochemistry facilitates diagnosis of a disease condition, enhances prognosis and assessment of efficacy of therapy and toxicity of drugs and substances (Fajemisin & Adeleye, 2005). However, Benjamin (1991) also mentioned that laboratory study and tests on blood profile were important tools to detect any deviation from normal animal or human body.

However, the sourcing for safe, readily and locally available feed ingredients to enhance food production prompted this research which aimed at assessing the impact of SNC diets on the blood profiles of West African dwarf goats.

Materials and Methods

Site of the study

The experiment was conducted at the goat unit of Teaching and Research Farm of the College of Agriculture, Kwara State University, Malete, Nigeria.

Experimental design and diets

Twelve (12) growing West African Dwarf male goats weighing between 7-11kg, obtained from a local market were allotted into 3 treatments in a completely randomized design with 4 animals per treatment. The diets were compounded to include SNC at 0% (T1), 10% (T2), and 20% (T3) (Table 1). Other ingredients in the diets were corn bran, cassava peel, cowpea husk, and wheat bran. Shea nut cake was obtained from a local shea butter processing factory in Ilorin South Local Government Area, Kwara State, Nigeria. The SNC was sun dried for four days, ground into smaller particles before mixing with other feedstuffs.

Table 1: Composition of experimental diets

	Diets		
Ingredients (%)	T1 (Control, 0% SNC)	T2 (10% SNC))	T3 (20% SNC)
Shea nut cake (SNC)	0	10.0	20.0
Cassava peels	25	22.5	20.0
Corn bran	25	22.5	20.0
Cowpea husk	25	22.5	20.0
Wheat bran	25	22.5	20.0
Total	100	100	100

Management of animals

The goats were treated against ecto- and endo-parasite with Ivomec injection, anthelmintic drug (Albendazole) and oxytetracycline (broad spectrum antibiotics). The animals were weighed and allotted to different diets. Water was given *ad libitum* daily. The diets were offered to the animals daily at 8.00 hrs and 16.00 hrs. During the 84-days experimental period, quantities of feeds offered and that refused were measured daily to compute feed intake while weight changes of the goats were recorded weekly.

Hematological and serum analysis

Blood samples were collected from each goat by the jugular venipuncture at the end of the feeding trial. The animals were bled in the morning prior to feeding and average of 5ml blood was collected from each goat. The blood samples were transferred immediately into sterile sampled bottles containing ethylene diamine-tetra-acetic acid (EDTA) which was used for the hematological analysis and another 5ml into the non-heparinised bottle for serum analysis. Hematological analysis of packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC), the mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), total white blood cell (WBC) and the differential counts were measured as described by Jain, (1986) and various serum biochemistry such as total protein, albumin serum cholesterol, aspartate aminotransferase (AST), alanine amino transferase (ALT) were determine using methods of Jain (1986).

Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) to determine the significant of treatment effects following the methods described by SAS (2010). Significant differences between means were compared using the Duncan New Multiple Range test (DMRT) of the same package at 5% level of probability.

Results and discussion

Table 2 gives the chemical composition of the experimental diets prepared from different levels of SNC inclusion. Crude protein concentration of the formulated diets decreased as the SNC level increased. However, these values were within the range of crude protein concentration that could be sufficient for microbial activities in the rumen because it is higher than the minimum level of 7-8% DM required for optimum rumen function and feed intake in ruminant livestock (Van Soest, 1994). According to Paterson et al. (1996), feedstuffs with a CP content lower than 70 mg g−1 DM require a supplementation of nitrogen to improve their ingestion and digestion by the ruminants. It is an indication that the formulated diets could be a good supplement to poor forage

The haematological indices (Table 3) of goats fed experiment diets. In the present study there were slight significant differences ($P<0.05$) on the blood profile of the animals after the introduction of the experimental diets. The haemoglobin (Hb) content ranged from 8.30 (T2 and T3) to 9.88 g/dl (T1) among the treatment groups. This is within the normal ranges of 8.0 to 15.0 g/dl reported for normal blood functions by Blood et al.,2007 & Daramola et al., 2005). The Hb values showed that the experimental diets were adequate for the nutritional requirements, and the test diets did not pose any danger to the animals. The aim of estimating the Hb content is to assess the oxygen carrying capacity of the goat circulatory system. Having a low oxygen carrying capacity indicates that such animal can easily succumb to stress factors that may lead to respiratory problems, while those with high level of Hb content can be regarded as having high level of oxygen capacity and therefore, likely to withstand respiratory stress (Oni et al., 2012). Packed cell volume (PCV) concentrations were not significantly different ($P>0.05$) among the treatment groups. The PCV is the measure of the ratio of the volume occupied by the red blood cells to the volume of the whole blood in a sample of capillary or arterial blood. The PCV ranged

between 20.50 to 22.05%. These were however, within the value reported elsewhwere(Daramola et al., 2005; Swati and Varsha 2014). The results of the analysis showed that PCV values were within the normal range for goat (Jain, 1993). The low PCV values in the study could be as a result of the breed and locations at which the animals were sourced from (Jackson and Cockroft, 2002, Opara et al., 2010). Red blood cell counts ranged from 6.82-7.06 × 10^6/µl. This is within the normal range of 5-10 ×10^6/µl (Daramola et al., 2005 and Blood et al*.,* 2007). Since it is the red blood cells that carry the respiratory pigments (hemoglobin), a decrease in the quantity of the circulating RBC implies a decrease in the quantity of hemoglobin and thus decreases in the oxygen carrying capacity of the animal. Red blood cell among treatment effects was not significantly (P>0.05) difference between diets T1 (6.51x10^6/µl) and T3 (6.82x10^6/µl) but diet T2 (7.06x10^6/µl) was significantly (P<0.05) higher than diets T1 and T3. The highest RBC (numerically but not significant statistically) recorded in diet T2 corresponded with the high values of PCV concentration observed in diets T2 and T3, suggesting their superiority in terms of their capability of supporting high oxygen carrying capacity of the blood and absence of anaemia related diseases which might be due to iron deficiency. The values of RBC were comparable to the reported range of 7.38-13.62x10^{12}/l for West African goat by Aina and Akinsoyinu (1996). It also falls within the range reported by Aruwayo et al. (2011). The WBC plays a prominent role in disease resistance especially with respect to the generation of antibodies. White blood cell was significantly (P<0.05) highest in diet T2 (12.75x10^6/µl) and lowest in diet T1 and T3 (8.46-9.29x10^6/µl respectively). The WBC counts were higher than the value (5 x 10^6/dl to 11 x 10^6/dl) reported by Scott et al. (2006) for sheep but within the level reported for WAD goats (Daramola et al., 2005). This implies that goats on the diets remained clinically healthy as indicated by researchers (Kolan et al 2012) and that the animals will be able to fight against any foreign body in the circulatory system . The foreign bodies are likely to be pathogens that have built up due to compositional changes that occurred during the slow drying process which would have allowed build-up of microorganisms which may be pathogenic in nature.

The mean corpuscular volume (MCV) and MCH values obtained in this study did not vary significantly (P > 0.05) among the animals fed experimental diets. The values ranged between 21.83 and 22.18 fl and 7.58–8.50 pg, respectively. The MCV are indications of macrocytic (regenerative) anaemia emanating from increased destruction and subsequent enhanced erythropoiesis in the liver, spleen and kidneys (Jain, 1986). The mean cell volume (MCV) and the higher mean haemoglobin (MCH) values recorded in the present study compared well with the values reported elsewhere (Mitruka & Rawnsley*,* 1977). The MCHC of animals fed T2 and T3 diets were not significantly (*P*> 0.05) different from the value of control group. The concentrations obtained across the treatments for MCHC were within the 30.0-34.4% reported (Mitruka & Rawnsley*,* 1977) for clinically healthy animal. The MCHC values have been reported to be the most accurate and absolute values that indicate anaemic condition in animals (Ogbuewu et al*.,* 2010; Thompson et al., 2006). Lymphocytes use the blood to travel round the body but can wander freely in other types of tissues using the lymphatic channels. The lymphocytes also known to play key roles in the immune defense system as a function of the immune status. An increase in lymphocytes number is in response to viral, parasitic and bacterial infection of the animal's body (Coles, 1980). The concentrations of lymphocytes were not significantly different but the concentration in the group of animals fed SNC at 20% was the highest. However, the values reported in this study were at variance with the values reported

elsewhere (Tambuwal et al., 2002) but fell between the values (49-53%) reported by Belewu and Ojo-Alokomaro (2007) for normal blood profile of WAD goats.

Table 2: Chemical composition of the experimental diets (%)

Parameters	T1 (0%)	T2 (10%)	T3 (20%)	SEM
DM	92.42^{b}	93.03^{a}	92.90^{ab}	0.14
CP	11.37^{a}	9.84^{b}	9.18^{b}	0.33
EE	2.03^{b}	2.79^{a}	2.19^{b}	0.09
CF	17.20^{b}	16.84^{b}	19.54^{a}	0.20
ASH	9.63^{b}	11.24^{ab}	12.11^{a}	0.54
NDF	30.69^{c}	48.51^{a}	48.51^{a}	0.33
ADF	21.56^{c}	41.17^{a}	32.35^{b}	0.34
ADL	12.35^{a}	8.96^{b}	9.73^{b}	0.47

SEM = Standard error of mean, DM=Dry matter, CP=Crude protein, EE=Ether extract, CF=Crude fibre, NDF=Nuetral detergent fibre, ADF=Acid detergent fibre, ADL=Acid detergent lignin

Table 3: Hematological parameters of experimental animals fed graded level of shea nut cake.

Parameters	T1 (0%)	T2 (10%)	T3 (20%)	SEM
Hemoglobin (g/dl)	8.33	8.33	9.88	1.41
PVC (%)	20.59	22.05	21.97	0.53
RBC ($\times 10^{6}/\mu l$)	6.51^{b}	7.06^{a}	6.82^{b}	0.73
WBC ($\times 10^{9}/l$)	8.46^{b}	12.75^{a}	9.29^{b}	1.56
MCV (fl)	21.83	22.17	22.12	0.77
MCH (pg)	7.58	8.23	8.50	0.39
MCHC (%)	33.00^{b}	34.73^{a}	33.90^{b}	1.93
Lymphocytes (%)	51.27	51.85	53.78	1.27

a,b,c =means within the same row with different superscripts are significantly different ($P<0.05$), SEM = Standard error of mean, PVC=Packed Cell Volume, RBC=Red Blood Cell, MCV=Mean corpuscular volume (fl), MCH = Mean corpuscular hemoglobin, MCHC = Mean corpuscular hemoglobin concentration.

Table 4: Blood serum chemistry of West African Dwarf goats fed various levels of shea nut cake diets

Parameters	T1 (0%)	T2 (10%)	T3 (20%)	SEM
AST u/l	55.17	59.95	60.38	1.45
ALT u/l	9.90^{b}	12.95^{a}	11.95^{a}	0.34
TP g/dl	59.93	59.95	60.38	1.45
Cholesterol (mg/dl)	0.69^{b}	1.72^{a}	0.60^{b}	0.04
Albumin g/dl	26.33^{b}	30.47^{ab}	32.54^{a}	0.19

a,b,c=means with different superscripts on the same row are significantly different ($P<0.05$), SEM = Standard error of mean, AST=Aspartate Aminotransferase, ALT=Alanine Amino transferase, TP=Total protein.

Table 4 shows the serum biochemical parameters of WAD goats fed experimental diets. Serum parameters have been reported to be important in the proper maintenance of the osmotic pressure between the circulating fluid and the fluid in the tissue space so that the exchange of materials between the blood and cell could be facilitated (Isidahomen et al., 2012). Ikhimioya and Imasuen (2007) also found that serum proteins are important in osmotic regulation, immunity and transport of several substances in the body. Harper et al. (1979) also reported that serum biochemical analysis is used to evaluate the level of heart attack, liver damage and to estimate protein quality and amino acid requirements in animals. The concentrations for serum transaminases (ALT and AST) in the blood are reliable tests for liver damage. Therefore, the values obtained for AST, which is an indication of normal functioning of the liver, were not significantly ($P>0.05$) different among the groups of animals fed the experimental diets. The concentrations of ALT varied significantly ranging from 9.90-12.95u/l with T2 having the highest concentration. Nonetheless, the values were within the range of the normal animal blood indices (Olafadehan, 2011). This shows that the diets supported the health status of the animals. The value obtained for total proteins of all the treatments were not significantly ($P>0.05$) different from each other. There was no significant different in the value of cholesterol among the animals under treatments. The cholesterol levels were normal, indicating that the meat from the experimental animals was safe, and would not lead to cholesterol elevation in consumers. Esonu et al. (2001) and Igwebuike et al. (2008) reported that cholesterol in the serum is associated with the quantity and quality of protein supplied in the diet. It is therefore indicated that the protein provided by the SNC combined was enough and of good quality to meet the nutritional needs of the animals. The albumin range of 26.33-32.54 g/l was similar to 29.30-32.70 g/l reported by Babayemi et al. (2003) and Oloche et al. (2015). Albumin which is a very good indicator of health was observed to be normal in this present study. In the current study, the experimental goats did not show clinical signs of ill health or of any toxicity, such as head pressing, generalized depression, grinding teeth, foaming at the mouth and twitching and jerking (Odenyo et al*.,* 1997).

Conclusion

In conclusion, addition of the SNC up to 20% will not pose any health problem to the animals since t the parameters measured in the blood of the animals under the study conditions, were within normal blood range for a healthy animal. This therefore suggest SNC to be a good feedstuff for ruminant animals to mitigate dry season feed shortage due to its abundant and availability all the year round.

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Public interest

The inclusion of shea nut cake (SNC) in the diets of ruminants could be one of the strategies to ameliorate the dry season feeding problem in Nigeria. SNC is an agro-industrial by-product obtained after shea butter extraction. It is a colossal waste and constituting health problem to community where the industry is located because of its abundance. The results of the blood profile of the experimental animals indicated its safe consumption up to the 20 % inclusion level.

Dr Dupe O. Ogunbosoye

I had researched into the solving feed problems that has become perennial issue to ruminant production in Nigeria and tropical countries in general. Alternative feed resources utilization has been discovered to be one of the ways to ameliorate feed scarcity often encountered during lean period. Most of my publications in this area have been published in most of the peer review journals.

Dr. Abayomi AKINFEMI

My field of research interest is ruminant nutrition and main research focus is treatment of agricultural wastes and by-products to value-added-ruminant feed. Agricultural wastes and by-products such as maize cobs, Sorghum straw, Sorghum threshed tops etc. constitute environmental problems in Nigeria. My research work has been published in various journals.

Dr. David A. AJAYI

Exploration of alternative feed resources as a means of sustainable conservation of indigenous animal species with strong biases for small ruminants is the focus of my research activities with publications in peer reviewed journals and conference proceedings