



Blood Profile and Selected Organ Histopathology of Balami Sheep Fed Shea Cake (*Vitellaria paradoxa*) Meal

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The blood profile and histology of selected tissues (kidney, lungs, intestine, and epididymis) of Balami Sheep fed Shea Cake meal supplement was investigated. A total of thirty-two (32) sheep of the average weight range of 11.75-14.75kg comprising an equal number (16) of males and females were randomly allotted to four dietary treatments in a completely randomized experimental design with eight sheep per treatment for twelve weeks duration. Treatment 1 (T1) was a control diet and had zero inclusion level of Shea cake meal (SCM), while treatments 2,3, and 4 had 10%,15%, and 20% inclusion of SCM, respectively. At the twelfth week of the experiment, two blood samples of 5ml each were taken from each animal from the jugular vein. The first set was preserved in Ethylene Diamine Tetra Acetic Acid (EDTA) bottle for haematological parameters, while the second samples were preserved without EDTA for serum examination. Representative samples of tissues were

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randomly selected and slaughtered for gross microscopic examination. There was a significant difference ($P < 0.05$) at various levels of inclusion for parameters investigated. The white blood cell (WBC), Red blood cell (RBC), and Packed cell volume (PCV) recorded the highest values at T3 (15% inclusion level) ($13.42 \times 10^9/L$), $2.92 \times 10^{12}/L$, 3.75%, respectively). The serum parameters were significantly ($p < 0.05$) different among the treatments. Total protein ranges from 54.78(mg/dl) (T_1) - 60.51(mg/dl) (T_2), Cholesterol 70.15(mg/dl) (T_1) - 78.00(mg/dl) (T_4). Iron ranges from 58.15(ug/dl) (T_1) - 62.88(ug/dl) (T_3). The histopathology of tissues (kidney, lungs, intestine, and epididymis) showed no alteration across the treatments ($P = .05$) in the gross microscopic examinations. No lesion was observed in the lungs, kidney, epididymis, and intestine. The results showed that shea cake meal posed no health risk to Balami sheep and as such recommended as a good supplement in the diets of the sheep.

Keywords: *Shea cake meal; Blood profile; Histopathology; and Balami sheep.*

1. INTRODUCTION

Sheep are small ruminants that have special attributes over other livestock resources. They are more adapted to broad ranges of environment, have short generation cycles, and have a high reproductive rate which leads to high production efficiency and poor people can afford them with less cost [1]. These animals represent an important component of Ethiopia's livestock production system, providing 12% of the value of livestock products consumed at the farm level and 48% of the cash income generated [2]. There are four main breeds or races of sheep native to Nigeria, the Balami, Uda, Yankasa, and West African Dwarf (WAD) [3]. Nigeria has a population of about 8 to 13.2 million sheep out of which about 3.4 million are found in the southern/humid region and the larger proportion of the animal in the northern region of the country. Out of these four major breeds of sheep in the country, the WAD breed is common in the southern region against the widespread Balami, Uda, and Yakansa breeds in the Northern region of the country [4]. The need for animal protein by the ever-increasing human population requires domestication of non-common breeds such as Balami to other zones of the country to complement the population of native breed which is mainly West African Dwarf. Aside breed, quality of feed offered to domestic animals determines to a larger extent, the performance of such animal. In most African and Asian countries, cultivated forages, when available, are fed in priority to cattle. The diets for sheep and goats are based on native pastures or rangelands, crop residues, agro-industrial by-products and other non-conventional feed resources, mainly fodder shrubs and trees [5]. Shea nut is one of these non-conventional feed resources. Shea nuts are produced by Shea tree (*Vitellaria paradoxa*), 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 [6] and produce about 135,000 tonnes of nuts per annum [7]. The tree is perennial, deciduous and occurs mainly on dry open slopes [8]. The shea tree attains heights of about 6.1 m and girths of 61 cm in the wild. So, it is often ravaged by bushfires [9]. The main produce of Shea nuts is Shea butter which contains vitamins A and E, as well as catechins and plant antioxidants [10]. Ayeh [11] 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 has fallen to the ground. Studies have shown that the extract from the leaves are used to relieve headaches and eye bath [12]. The nutritional potentials of this feed resource necessitated its use in this study. Shea cake is the solidified effluent from the production of shea butter from shea nuts.

Since Haematological and serum biochemical values have been considered useful for the evaluation of body condition and the nutritional and immune status in an animal where other tissue related measurements are not available [13,14,15], and the effects of feed offered to livestock is observable on various tissues (Organs) in the body systems, this study, therefore, focuses examination of blood profile and histopathology of selected tissues of Balami sheep fed shea cake meal.

2. MATERIALS AND METHODS

Study site - The experiment was carried out at the Small Ruminant Unit and Laboratory of the

Ladoke Akintola University of Technology, Ogbomoso, Oyo State. The location is on longitude 4° 15' East of the Greenwich Meridian and latitude 8°17' North of the Equator in the derived savannah zone of Nigeria with a mean annual rainfall of 1247mm and mean annual temperature of about 27°C. Histopathological examination of selected tissues from representative male experimental animals was carried out by a certified pathologist at the Veterinary Medicine Department laboratory, University of Ibadan.

Preparation of Experimental Diets - Solidified effluent (Shea cake) was collected from the shea butter production factory in Saki, a popular community in the Oke-Ogun Area of Oyo State. The shea cake alongside cassava peels and palm kernel cake were milled separately and mixed with other feed components, namely, wheat offal, Di-calcium phosphate, ruminant premix, and salt. A diet-tagged shea cake meal (SCM) was formulated at the inclusion level of 0, 10, 15, and 20% of shea cake meal, respectively, as contained in the table of the gross composition of the experimental diets. Samples of the experimental diets were taken and stored in a covered plastic container for laboratory analysis, following the procedures of AOAC [16].

Experimental Animals Management: A total of thirty-two (32) growing Balami sheep comprising of 16 males and 16 females weighing between 11.75-14.75kg were used for the study. They aged between 5-6 months as dentition was used to estimate the age. The experimental animals were purchased from villages around Wukari town in the Taraba State of Nigeria. On arrival, animals were given prophylactic treatments, using the standard procedure of health management. They were introduced to the experimental diets two weeks prior to the commencement of the experiment and data recording after weight balance for even

distribution. Four experimental diets which included shea cake meal (SCM) at inclusion levels of 0,10, 15 and 20% were offered to the experimental animals in individual pens in a completely randomized design of 8 replicates per treatment. The experimental animals were allowed to graze on guinea grass paddock for 1 hour every day, followed by experimental diets at 5% of their body weight. The orts were weighed at 08:00 am every morning and deducted from the quantity offered for intake determination prior to serving new feed daily. The individual animal was tagged for the purpose of identification. The feeding lasted for 12 weeks.

Blood Profile examination: Hematological parameters were determined by drawing 10ml of blood from the jugular veins of each animal, 5 ml into a sample bottle containing anticoagulant, Ethylene Di-amine Tetra acetic Acid (EDTA), and 5ml into a sample bottle without EDTA. 5ml of these samples were used for the determination of Haematological parameters which include the packed cell volume (PCV), Haemoglobin (Hb) concentration, Red blood cell counts (RBC) and White blood cell counts (WBC). The total serum protein, Serum albumin, globulin, and blood glucose were determined in the blood serum, respectively. The serum was obtained by allowing the blood to coagulate in order to separate the serum and cells. Packed cell volume was measured for each animal using the micro haematocrit method. Haemoglobin concentration was also measured using the Sahl's (acid haematin) method Red blood cells were determined with the aid of Neubaur counting chamber (Haemocytometer). White blood cells (WBC) were determined using the improved Neubauerhaemocytometer after the appropriate dilution [17]. Serum samples were also taken and used in the determination of serum urea, total cholesterol, total protein and albumin.

Table 1. Gross composition of experimental diets

Component/Treatment	T1 (%)	T2 (%)	T3 (%)	T4 (%)
Shea cake	0.00	10.00	15.00	20.00
Salt	1.00	1.00	1.00	1.00
Ruminant premix	0.50	0.50	0.50	0.50
Di-calcium phosphate (DCP)	0.50	0.50	0.50	0.50
Palm Kernel Cake (PKC)	5.00	5.00	5.00	5.00
Wheat offal	18.00	18.00	18.00	18.00
Cassava peel	75.00	65.00	60.00	55.00
TOTAL	100.00	100.00	100.00	100.00

SCM-0: diet without Shea cake, SCM-10: diet with 10% Shea cake, SCM-20: diet with 20% Shea cake.

Histology examination: At the 84th day, representatives male animals were randomly selected and weighed before slaughter to collect selected tissue samples (kidney, lungs, intestine, and epididymis) for histopathological examinations.

Statistical Analysis: Data obtained were subjected to analysis of variance (ANOVA) using the procedure of SAS [18] to determine the effect of dietary treatments on the various parameters studied. Significant means were separated using Duncan's multiple range test of the same software at 0.05 significant levels.

3. RESULTS AND DISCUSSION

The chemical composition of experimental diets containing varying inclusion levels of shea cake meal (SCM) differed among the diets (Table 2). The Crude protein content of the diet slightly increases with the increasing level of SCM having the highest (11.85%) value in T3 and the lowest in T1 (6.25%). However, SCM helped to improve the crude protein values of the diet to attain recommendation within 9 - 12% crude protein for the moderate level required by ruminants for minimum growth performance as reported by Gatenby [19]. The high crude protein contents of the diets show that the feed will be able to meet the optimum microbial need in the rumen. Crude fibre content reported in this study negates the findings of Baiden et al., [20] who reported a higher (19.54%) crude fibre compare to the result of this study (5.68%). Baiden et al., [20] reported that microbial colonization of low fibre feed is more than that of higher fibre content as a high level of crude fibre could inhibit digestibility. The low concentration of ether extract in the experimental diets is an indication that the meat produced from the animals fed the diets will contain less fat.

When blood is examined (Table 3), it provides a good opportunity to clinically investigate the presence of several metabolites and other constituents in the body of an animal. Also, blood biochemical values are used in medical nutritional assessment for humans and animals. The results obtained in the study for haematology were significantly different ($P < 0.05$) across treatments as the result increased from T1 to T4. The PCV range of 26.08-31.75% obtained in this study was within the value (22.00-37.00%) reported by Sowande et al. [21] and Fajemisin et al. [22] for normal healthy sheep. Olayemi et al. [23] conducted a study to

determine the haematology of the West African Dwarf (WAD) sheep under intensive and extensive management systems in Nigeria. The intensively reared animals showed higher PCV, Hb concentration, and MCV than those under extensive management. Both groups of animals had similar MCH, MCHC, Red Blood Cell, (RBC), Total White Blood Cell, lymphocyte, neutrophil, eosinophil, and monocyte counts. In another study conducted by Olayemi et al. [23], on the influence of management on the haematology of the white Fulani cattle, the intensively reared animals showed higher Packed Cell Volume (PCV), Red and White cell counts but lower Mean Corpuscular Haemoglobin than those under extensive management [24]. The values recorded for PVC, WBC, and RBC in this experiment at various levels of inclusion show that Balami sheep tolerates and utilize shea cake meal for healthy performance.

The Hb value obtained in this study fell within the normal value recorded for healthy sheep (2), an indication that seemed to be capable of supporting high oxygen-carrying capacity in the animal. For RBC, the range of value of 2.44 to 2.92 obtained for this study fell within the range value of 2.40 – 4.20 reported by Sowande et al. [21]. The value for white blood cell (WBC) neutrophils (NEUT) and eosinophil (EOSI) were above normal reported for healthy sheep, while values for lymphocyte and monocyte were within the normal range reported by Mitruka and Rawnsley [25] for clinical healthy sheep. WBC in animals possesses phagocytic function [26], differentiate WBC use as an indicator of stress response and sensitive biomarkers crucial to immune function [27]. The higher WBC and differential counts reported in the study indicated that Balami sheep seem to possess a protective system providing a rapid and potent defense against any infectious agent. This probably is the physiological basis for the adaptation of this species to an ecological zone characterized by the high prevalence of the disease.

Furthermore, Coles [28] and Schalm et al. [29] reported that regardless of age, sex, and climate, sheep and goats reared under the traditional husbandry system have low haematological values compared to those reared under modern husbandry. The results of MCHC in this experiment were not significantly different ($P > 0.05$) at all levels of inclusion. This agreed with the findings of Okunlola et al. [30] in an experiment conducted on Red Sokoto goats. The results obtained in this study showed that SCM

was well utilized by the experimental animals and as such adjudged as a good feed supplement in the diet of the breed. The total protein level in this study ranged from 54.78mg/dl(T1) to 60.51 mg/dl (T2). The serum total protein of an animal is a direct index for measuring nutritional protein adequacy. The result shows good protein utilization by the experimental animal and this could be due to the genetic make-up of Balami sheep and nutrient adequacy of the test ingredients. The creatinine level in this experiment 0.78mg/dl (T1) – 0.85 mg/dl (T3) shows the healthy function of the kidney of the experimental animals. This agrees with the

findings of Prvulovic et al. [31] in a haematology experiment on pigs; where it was reported that creatinine level in serum had a direct correlation with muscle mass and kidney function. Biochemical analysis can be used to evaluate the level of heart attack, liver damage and also to estimate protein quality and amino acid requirement in animals. Therefore the value obtained for AST, indicates normal functioning of the liver. The concentration of ALT varied significantly ranging from 19.55 to 23.00 (U/l) with T3 having the highest concentration. Nonetheless, the values were within range of the normal animal blood indices.

Table 2. Proximate composition (%) of experimental diets

Nutrients (%)	T ₁ (SCM-0)	T ₂ (SCM-10)	T ₃ (SCM-15)	T ₄ (SCM-20)
Dry matter	91.62	88.98	90.39	88.96
Crude protein	6.25	7.88	11.85	9.63
Crude fibre	5.48	5.01	5.62	5.68
Ash	6.90	8.60	6.68	10.14
Moisture	8.38	11.02	9.61	11.04
Ether extract	2.98	4.08	3.70	4.94
Nitrogen free extract	70.01	63.41	62.54	58.57

Table 3. Blood Chemistry of Balami Sheep fed Shea Cake meal supplement

Parameters	Treatments				SEM
	T ₁ (SCM-0)	T ₂ (SCM-10)	T ₃ (SCM-15)	T ₄ (SCM-20)	
Haematology Index					
PCV (%)	26.08 ^b	29.43 ^{ab}	31.75 ^a	30.84 ^a	1.25
Hb (g/dl)	8.91 ^b	11.19 ^{ab}	13.30 ^a	13.82 ^a	0.77
WBC (x 10 ⁹ /l)	11.15 ^d	12.88 ^c	13.42 ^a	13.00 ^b	1.00
RBC (x 10 ¹² /l)	2.50 ^b	2.80 ^a	2.92 ^a	2.44 ^b	0.75
MCV (fl)	16.64 ^{ab}	16.44 ^c	17.00 ^a	16.72 ^b	1.50
MCHC (g/l)	32.00	33.00	32.48	33.00	1.00
MCH (pg)	7.75	8.05	9.50	8.00	0.70
Lymphocytes (%)	59.66	60.00	59.75	60.00	1.00
Neutrophils (%)	37.00	38.00	38.00	37.85	0.95
Monocytes (%)	1.85 ^a	1.70 ^{ab}	1.80 ^b	1.77 ^b	1.00
Eosinophils (%)	2.00	2.00	2.00	2.00	0.50
Basophils (%)	0.60	0.60	0.60	0.60	0.10
Serum Index					
Total protein (mg/dl)	54.78 ^c	60.51 ^a	58.84 ^b	54.80 ^c	1.55
Creatinine (mg/dl)	0.78 ^c	0.80 ^b	0.85 ^a	0.82 ^b	0.10
Cholesterol (mg/dl)	70.15 ^d	73.55 ^c	75.00 ^b	78.00 ^a	1.00
Iron (µg/dl)	58.15 ^d	60.00 ^c	62.88 ^a	60.75 ^b	2.00
Globulin (mg/dl)	33.44	36.17	34.66	31.34	0.95
Albumin (mg/dl)	21.34 ^c	24.34 ^a	24.18 ^b	23.46 ^b	0.50
Albumin/globulin ratio	0.64	0.67	0.70	0.75	0.15
AST (µ/l)	58.05 ^c	65.00 ^a	64.75 ^a	63.77 ^{ab}	1.05
ALT (µ/l)	19.55 ^c	21.00 ^{ab}	23.00 ^a	21.55 ^b	1.00

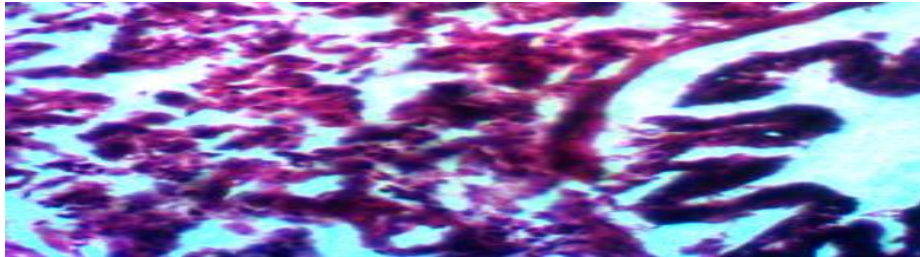
^{abc} Means within each row with different superscript are different (P<0.05)

SEM – Standard error of mean, AST- Aspartate aminotranferase , ALT- Alanine aminotransferase, SCM-0: diet without Shea cake , SCM-10: diet with 10% Shea cake, SCM-20: diet with 20% Shea cake.

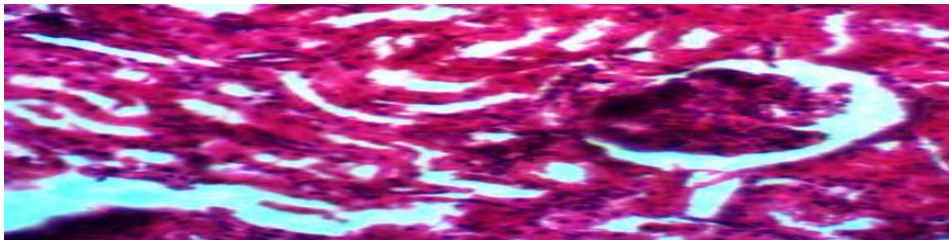
Based on gross macroscopic inspection (Fig. 1), there was no observable lesion on the lung which indicates the absence of respiratory diseases. The kidney, epididymis and intestine are free of infection by the pathological agent. Based on the macroscopic inspection, there is no observable lesion on the epididymis. There is patchy tubular epithelial necrosis and inflammation on the kidney which could later lead to acute renal failure and septic shock (as a result of low blood

pressure). Necrosis and loss of surface enterocytes were observed in the intestine which limits the absorption of nutrients and secretion of digestive enzymes. Also, no observable lesion was seen in the lungs of the intestine and epididymis. However, a patch of coagulation necrosis of tubular epithelial was observed in the kidney as there is a moderate interstitial reaction in the lung.

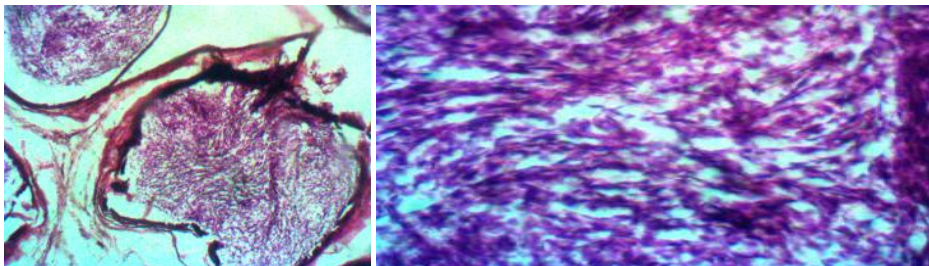
A1T4 (Animal 1 treatment 4)



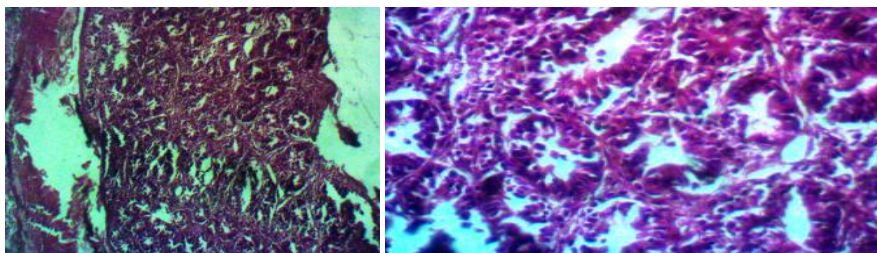
Lung- there is no observable lesion. HE x400



Kidney- there is no observable lesion. HE x400

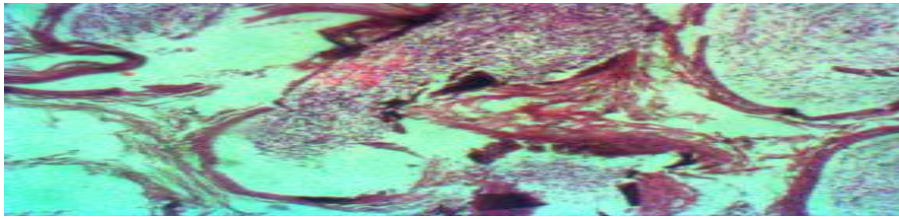


Epididymis- There is no observable lesion. HE x400



Intestine- there is no observable lesion. HE x400

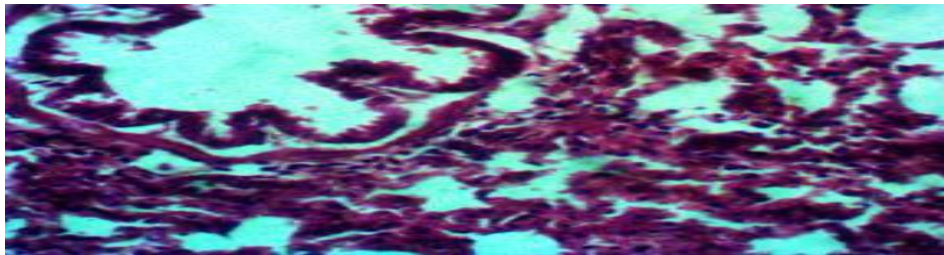
A3T1 (Animal 3 treatment 1)



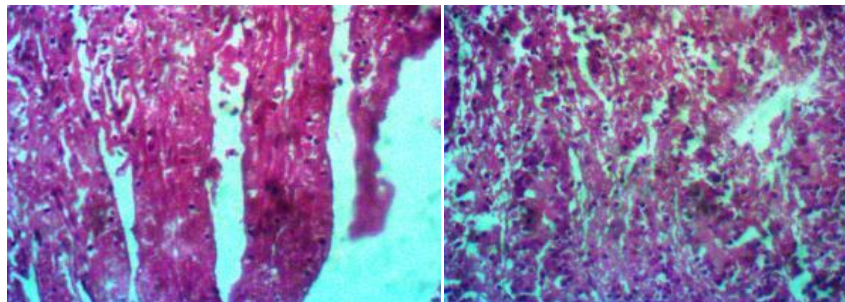
Epididymis - there is no observable lesion. HE x400



Kidney- there is patchy tubular epithelial necrosis and inflammation. HE x400

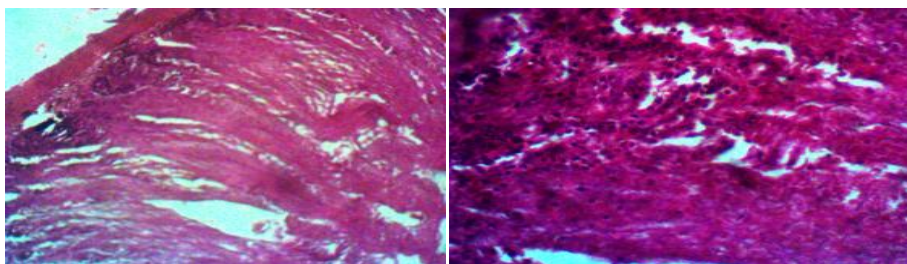


Lung- there is no observable lesion. HE x400

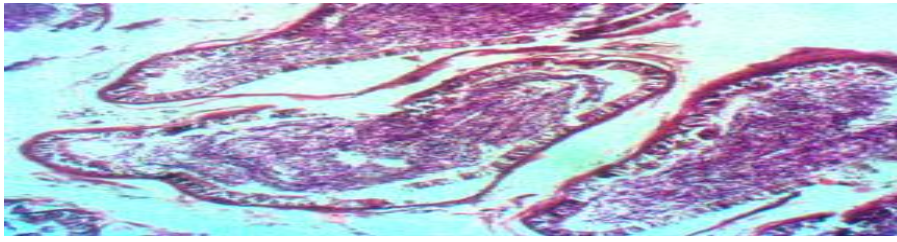


Intestine- There is necrosis and loss of surface enterocytes. HE x400

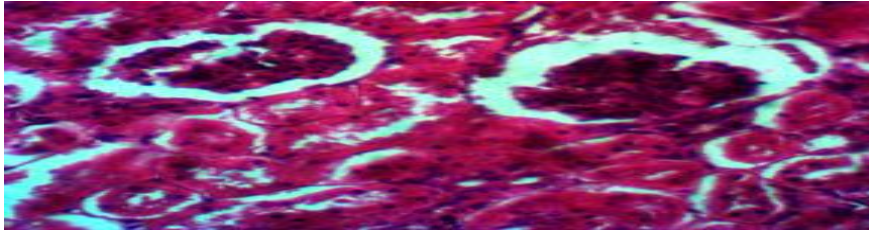
A4T3 (Animal 4 treatment 3)



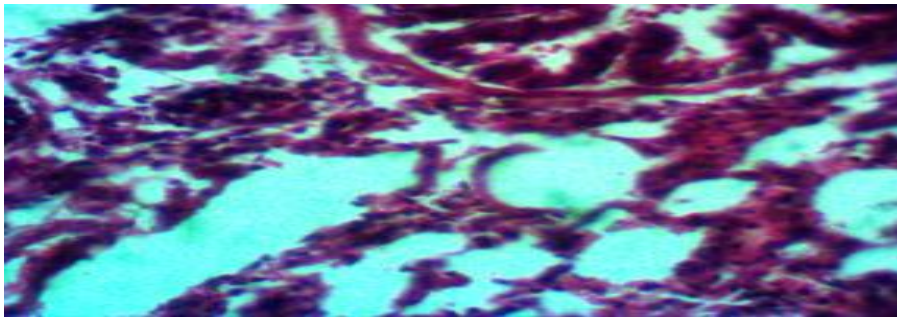
Intestine- there is no observable lesion. HE x400



Epididymis- there is no observable lesion. HE x400



Kidney- There is patchy coagulation necrosis of tubular epithelial cells.



Lung- There is moderate interstitial reaction. HE x400

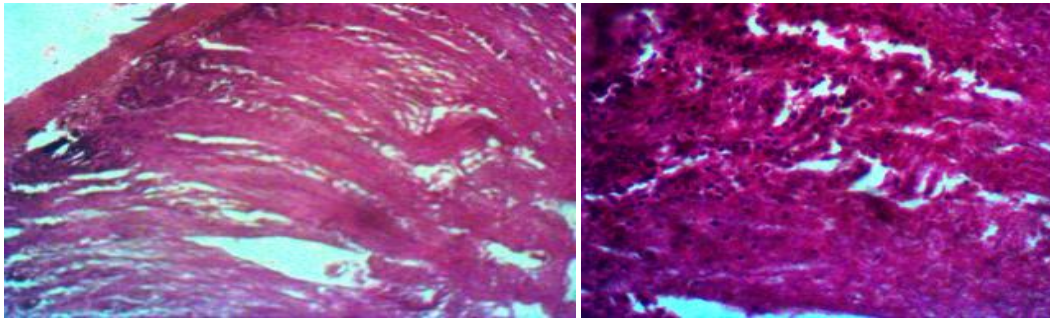
A2T2 (Animal 2 treatment 2)



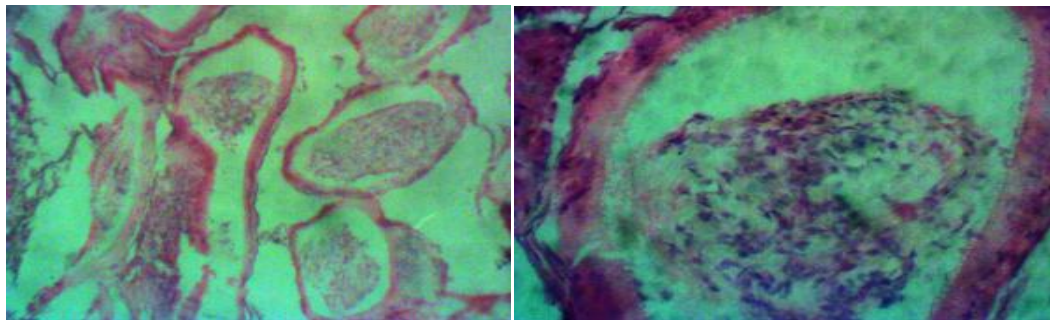
Kidney- there is no observable lesion. HE x400



Lung- there is no observable lesion. HE x400



Intestine- there is no observable lesion. HE x400



Epididymis - there is no observable lesion. HE x400

Fig. 1. Histology of selected organs (Tissue) of Balami Sheep fed Shea cake meal

4. CONCLUSION AND RECOMMENDATIONS

The findings from the study show that Shea cake is a good feed supplement for Balami Sheep. It has no deleterious effect on the performance of the experimental animals and as such promotes good quality of products which could have been hampered due to the declining nutritive value of available grass species mostly in dry season. The availability of Shea cake during the off-season makes it a good feed resource for ruminant production and management. Carcass analysis of Balami sheep on graded level of Shea nut cake meal as a feed supplement in the diets should be carried out to determine whether there is an unusual deposition of fat in the body that may threaten meat quality. Further research should be carried out at a higher shea nut cake inclusion level to determine the highest tolerable level of inclusion to improve the performance of the Balami Sheep.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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