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PHYSIOLOGICAL RESPONSE OF RED SOKOTO BUCKS TO GRADED LEVELS OF ENSILED AMMONIATED GROUNDNUT SHELL MEAL

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ABSTRACT: *The study assessed the physiological parameters of Red Sokoto Bucks as affected by diets containing graded levels of ensiled ammoniated groundnut shell meal (EAGNSM). Twenty (20) Red Sokoto Bucks used for the study were divided into five groups of four animals each, with an average weight of 9.80±2.30kg. The groups were randomly assigned to one of the five treatment diets designated as T1 (0 % EAGNSM), T2 (5% EAGNSM), T3 (10% EAGNSM), T4 (15% EAGNSM) and T5 (20% EAGNSM). The animals were offered the basal diet: 500 g of Fresh Maliana leaves (Gmelina arborea) every morning (9:00 a.m.); followed by the experimental diets based on 4% body weight of the animals in the afternoon (12:00 p.m.). Drinking water was provided ad libitum. Blood samples were collected from the jugular vein of the bucks at the beginning and 60th day of the feeding trial for determination of haematological and serum indices. The results reveal that packed cell volume (PCV) at the end of the study significantly (P < 0.05) improved over the initial values except for T5. The AST values which were significantly different at the beginning of the study increased and were not significantly different at the end of the experiment. Alanine transaminase (ALT), Total Protein, Albumin, Cholesterol, Creatinine and Urea, which were not significantly different at the beginning of the study, differed significantly at the end of the experiment. The difference between the initial and final values of AST, ALT, Cholesterol and Urea were significant (P < 0.05) across the treatments. However, the values obtained were within the normal reference range except for ALT which were above for goats. It could be concluded that inclusion of EAGNSM in the diet of Red Sokoto Bucks had no deleterious effect on the haematological and serum biochemistry parameters evaluated and could be included in their diets up to 20%.*

KEYWORDS: Ensiled, Ammoniated, Groundnut Shell, Haematological Indices.

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INTRODUCTION

Goat rearing offers a significant source of high biological value animal proteins as well as vital minerals and vitamins that are important in human diets (Gbolabo *et al*., 2015). However, in many regions, the availability of quality feed resources is limited, leading to the utilization of unconventional feedstuffs such as groundnut shell meal. Groundnut shell meal is a byproduct of the groundnut processing industry and is rich in fiber but low in protein and other essential nutrients. To enhance its nutritional value, ammoniation has been proposed as a potential treatment method. Ammoniation involves the treatment of feed with urea or anhydrous ammonia, which can improve its digestibility and nutrient utilization (Nwagu *et al*. 2019). Ochepo (2024) reported that ammoniation and ensiling of groundnut shell meal improved the performance of sheep. In a similar vein, urea and subsequent ensiling has been adopted as a processing strategy for crop residues, such as soybean haulms, that are hitherto nutritionally poor and fibrous for feeding (Ikyume *et al*., 2023). It is important to note that any strategy to improve nutrient utilization and performance of the animals must ensure the health and welfare of the animals consuming them. Numerous feed items, including groundnut shell meal, are given to animals without considering the potential health and physiological effects on them. Additionally, comparing blood samples and biochemical indicators with dietary intake may reveal that some nutrients in an animal's diet need adjustment or are not adequate (Aksoy *et al*., 2021).

According to Jiwuba *et al*. (2016), blood parameters are thought to be important indicators of a farm animal's physiological stage, demonstrating the link between diet and health. Balikci *et al*. (2007) observed that nutrition, breed, sex, age, and stress have all been found to have an impact on haematological and biochemical parameters, and are thought to play a crucial part in the differences in haematological and biochemical indices recorded between tropical and temperate animals (Opara and Fagbemi, 2009). Hematological indices, such as red blood cell count, hemoglobin concentration, and packed cell volume, provide information on the oxygen-carrying capacity of the blood. On the other hand, biochemical indices, including serum protein, albumin, and glucose levels, reflect the metabolic functions and nutritional status of the animals (Abdulahi *et al*., 2017). Serum total protein and albumin reflect the overall protein metabolism of the animals, while urea and creatinine levels serve as indicators of renal or kidney function. Alterations in these biochemical indices can provide valuable information about the effects of the graded levels of ammoniated groundnut shell meal on metabolic processes in the animals. Assessing the haematological and serum indices of animals to ascertain their health and physiological state in response to dietary feeding regime is therefore important for sustainable livestock production. This study was therefore carried out to determine the haematological and biochemical values of red sokoto bucks fed graded levels of ensiled ammoniated groundnut shell meal in supplementary diets.

MATERIALS AND METHODS

Experimental Site

The study was conducted at the sheep and goat unit of the Livestock Teaching and Research Farm of Joseph Sarwuan Tarka University Makurdi, Benue State, Nigeria located between latitude 8°50’ and longitude 11° 31’E in the southern Guinea Savanna zone of West Africa. The area has an annual rainfall between 6–8 months (March–October) and ranging from 1000

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to 1500 mm with an average minimum temperature range of 30°C and maximum temperature between 39.50 ± 2.20 % and 64.00 ± 4.80 % (T.A.C., 2011).

Processing Groundnut Shell

The groundnut shells (GNS) were obtained from the groundnut processing unit in Ujam Community, Makurdi. The GNS was grinded using a hammer mill fitted with a 2.5 cm screen. The GNS was ammoniated by dissolving 5 kg of urea grains in 95 liters of water and allowed to stand for 24 hours before use, as described by Omotoso *et al*. (2018). The GNS meal (100 kg) was soaked in the 5 % urea solution and thereafter decanted. The filtrates were ensiled for 21 days, dried and incorporated in five treatment diets as follows: T1 = no ensiled ammoniated groundnut shell meal (EAGNSM) control, T2 = contains 5% ensiled ammoniated groundnut shell meal (EAGNSM), T3 = contains 10% ensiled ammoniated groundnut shell meal (EAGNSM), T4 = contains 15% ensiled ammoniated groundnut shell meal (EAGNSM), and T5 = contains 20% ensiled ammoniated groundnut shell meal (EAGNSM). Other ingredients in the complete diets were maize offal, palm kernel cake (PKC), rice bran, brewers dried grain (BDG), bone ash and salt (Table 1).

Table 1: Percentage Composition of Experimental Diet

	Levels of inclusion (%)				
Ingredient	**T1**	**T2**	**T3**	**T4**	**T5**
UTGNSM	0	5	10	15	20
Maize Offal	20	15	10	5	0
BDG	20	20	20	20	20
Rice Bran	35	35	35	35	35
PKC	20	20	20	20	20
Bone Ash	4	4	4	4	4
Salt	1	1	1	1	1
TOTAL	100	100	100	100	100

UTGNSM = Urea Treated Groundnut Shell Meal, BDG = Brewers Dried Grain, PKC = Palm Kernel Cake, T1 = Treatment 1, T2 = Treatment 2, T3 = Treatment 3, T4 = Treatment 4, and T5 =Treatment 5

Experimental Animals and Management

A total of twenty (20) growing Red Sokoto Bucks aged between 6–7 months with an average body weight of 9.80 + 2.30 kg was used for this experiment. The animals were purchased from the livestock market in Lafia Local Government Area of Nasarawa State. The animals were screened for helminths and blood parasites, and quarantined for two weeks before the commencement of the experiment and were dewormed with Albendazole 5 ml/20 kg orally,

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injected with Oxytetracycine L.A 1 ml/10 kg (im), Ivomectine 0.3 ml/25 kg (sc) and Multivat 1 ml/10 kg body weight. The bucks were housed in demarcated individual pens with concrete floors. The basal diet: 500 g of Fresh Maliana leaves (Gmelina arborea) was offered to the animals every morning (9:00 a.m.) followed by the experimental diets offered at 4% body weight. Drinking water was also provided ad libitum. The basal diet and experimental diets were fed for the period of 60 days.

Data Collection

Homogenous samples of test diets were analyzed for proximate compositions, as outlined by AOAC (2005). Blood samples were collected from all the experimental animals at the beginning and on the last day of the study. About 5 ml of blood was collected at each of the sampling stages from each of the buck via the jugular vein, using needles and syringes, into properly labeled blood sample tubes. Two (2) mls of the blood were emptied into bottles containing Ethylene diamine tetra-acetic acid (EDTA) for haematological analysis. Haematological parameters were determined according to the method described by Baker and Silverton (1985) using the Sysmex System Haematology Analyser machine. The remaining 3 mls of the blood were emptied into sample bottles without EDTA and the serum was harvested for the determination of the various serum indices. Serum aspartate aminotransferase, serum alanine transferase and alkaline phosphatase were analysed using spectrophotometric linked reaction method (Cheesbrough, 2004). The blood urea nitrogen was assessed by the method of Tannins (1968), while Creatinine was determined according to the method described by Lamb (1991).

Statistical Analysis

Data on haematological and serum indices was analyzed through one-way analysis of variance (ANOVA) using SPSS (version 24) (SPSS, 2013). The treatment means were separated and compared using standard error of the mean (SEM), and Duncan's Multiple Range Test (DNMRT) as contained in the statistical tools.

RESULT

Proximate Composition of Experimental Diets

The results for proximate composition of experimental diets are presented in Table 2. Dry matter (DM) ranged from 91.61–94.29 %, crude protein ranged from 13.95–14.25 %, crude fiber ranged from 16.35–25.65 %, ash ranged from 15.24–23.74 %, while ether extract and nitrogen free extract ranged from 4.23–6.69 % and 26.13–35.28 %, respectively.

Haematological Indices of Red Sokoto Bucks in Response to Diets Containing Graded Levels of Ensiled Ammoniated Groundnut Shell Meal Diets

Presented in Table 3 is the haematological response of Red Sokoto Bucks to diets containing graded levels of ensiled ammoniated groundnut shell meal. The initial parameters measured—except for MCHC, Eosinophil and Monocytes—were not significantly ($P > 0.05$) different. The PCV values were 24.33, 23.67, 24.67, 25.33 and 23.00 % for T1, T2, T3, T4 and T5 respectively. RBC values at the beginning and the end of this study range from 12.83–

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13.47 x 10^12/L and 12.30–13.10 x 10^12/L respectively. The initial WBC values range from 5.30–6.00 x 10^9/L, while the values at the end of the study range from 7.66–10.50 x 10^9/L. The MCHC values at the beginning of the experiment ranged from 33.330–33.400, whereas the values at the end of the study range from 33.267–33.333 g/dl. Eosinophil and Monocytes values at the beginning of the experiment ranged from 2.33–3.67 and 4.33–6.00 %, whereas the values at the end of the study ranged from 3–4 % and 4–6 % respectively. The difference between initial values and the values obtained at the end of the study for the parameters measured were not significantly ($P > 0.05$) different except for PVC and Monocytes.

Serum Biochemical Indices of Red Sokoto Bucks in Response to Diets Containing Graded Levels of Ensiled Ammoniated Groundnut Shell Meal

Serum biochemistry results are presented in Table 4. It was observed that all the initial parameters measured except AST were not significantly ($P > 0.05$) different across the treatments. However, all biochemical indices measured at the end of the study—except AST, ALP and Glucose—differ significantly ($0<0.5$) across the treatments. The Total Protein (g/dl) values at the beginning and the end of the study were (4.61, 5.1, 4.63, 5.45 and 5.44) and (6.73, 6.42, 5.77, 6.63 and 7.2) for T1, T2, T3, T4 and T5 respectfully. Creatinine (mg/dl) were 0.6, 0.62, 0.71, 0.67 and 0.68 at the beginning and 0.57, 0.49, 0.45, 0.60 and 0.70 at the end of the study, while Urea (mmol/L) were 35.86, 36.26, 36.31, 36.26 and 35.56 for T1, T2, T3, T4 and T5 respectfully. Albumin (g/dl) was 3.5, 3.34, 3.0, 3.44 and 3.79; Creatinine (mg/dl) was 0.57, 0.49, 0.45, 0.6 and 0.7, while Urea (mmol/L) was 29.92, 27.02, 19.8, 28.43 and 36.85 for T1, T2, T3, T4 and T5 respectfully. Total Protein level was significantly ($P < 0.05$) higher in T5 compared to T1 (control diet) for the final blood samples. Creatinine levels in T1 and T5, which were not significantly different initially, were significantly ($P < 0.05$) different at the end of the study. The Urea levels, which were not significantly different initially for T1 and T5, were significantly different at the end of the study, with T5 having a higher value.

Table 2: Proximate Composition of Experimental Diet

Parameters	T1(0%)	T2(5%)	T3(10%)	T4(15%)	T5(20%)
DM	91.89	92.40	92.10	91.79	92.12
CP	13.95	14.03	14.10	14.13	14.25
CF	16.35	18.99	22.23	25.64	28.09
EE	5.36	4.23	6.69	5.79	5.94
Ash	23.74	19.87	15.24	15.39	17.71
NFE	32.49	35.28	33.84	30.84	26.13

DM = Dry Matter, CF = Crude Fiber EE = Ether Extract, NFE = Nitrogen-free Extract

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Table 3: Haematological Indices of Red Sokoto Bucks

Parameters	T1(0%)	T2(5%)	T3(10%)	T4(15%)	T5(20%)	SEM
PVC (%)						
Beginning	24.33	23.67	24.67	25.33	23.00	0.405
End	27.67^{ab}	33.00^{a}	26.00^{ab}	30.33^{ab}	23.00^{a}	1.418
Difference	3.34^{ab}	9.33^{a}	1.33^{ab}	5.00^{ab}	0.00^{b}	1.203
Hb (g/L)						
Beginning	8.11	7.89	8.17	8.44	7.67	0.134
End	9.22	10.50	8.67	10.11	7.66	0.465
Difference	1.11	2.61	0.50	1.67	0.01	0.397
WBC (10^9/L)						
Beginning	5.80	5.60	5.50	6.00	5.30	0.154
End	7.07	7.60	6.53	7.47	6.30	0.228
Difference	1.27	2.00	1.03	1.47	1.00	0.214
RBC (10^{12}/L)						
Beginning	12.97	12.83	13.30	13.47	12.80	0.149
End	12.67	13.10	12.30	12.83	12.27	0.137
Difference	(0.30)	0.27	(1.00)	(0.64)	(0.53)	0.118
MCV(fl)						
Beginning	18.71	18.42	18.37	18.79	17.86	0.167
End	21.57^{ab}	25.00^{a}	21.13^{ab}	23.50^{ab}	18.70^{ab}	0.873
Difference	2.86	6.58	2.76	4.71	0.84	0.877
MCHC(g/dl)						
Beginning	33.337^{ab}	$33,333^{ab}$	33.340^{a}	33.327^{b}	33.330^{ab}	0.002
End	33.333	33.300	33.267	33.327	33.267	0.019
Difference	0.004	(0.033)	(0.073)	(0.060)	(0.063)	0.014

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MCH(pg)						
Beginning	62.37	61.39	61.24	62.65	59.55	0.557
End	7.13^{ab}	8.30^{a}	7.00^{ab}	7.83^{ab}	6.20^{b}	0.294
Difference	55.24	53.09	54.24	54.82	53.35	0.566
WBC Differential						
Lymphocyte(%)						
Beginning	66.67	64.00	65.67	65.00	63.67	0.507
End	66.67	63.67	65.00	64.67	64.00	0.554
Difference	0.00	(0.33)	(0.67)	(0.33)	0.33	0.379
Neutrophils(%)						
Beginning	25.67	26.67	25.67	26.67	27.33	0.375
End	27.33	26.00	26.00	26.00	26.67	0.434
Difference	1.66	(0.67)	0.33	(0.67)	(0.66)	0.408
Eosinophils(%)						
Beginning	2.33^{b}	3.67^{a}	3.67^{a}	3.00^{ab}	3.00^{ab}	0.192
End	3.00	4.00	3.67	3.67	3.00	0.192
Difference	0.67	0.33	0.00	0.67	0.00	0.153
Basophils(%)						
Beginning	1.00	0.67	0.67	0.67	0.00	0.163
End	1.00^{ab}	1.33^{a}	0.67^{ab}	0.33^{b}	1.00^{ab}	0.133
Difference	0.00	0.66	0.00	(0.34)	1.00	0.163
Monocytes(%)						
Beginning	5.00^{ab}	4.33^{b}	5.00^{ab}	4.67^{ab}	6.00^{a}	0.218
End	4.33	5.00	5.00	5.67	5.33	0.206
Difference	$(0.67)^{ab}$	0.67^{ab}	0.00^{b}	1.00^{a}	$(0.67)^{ab}$	0.206

Key: ^{ab} Means on the same row with different superscripts are significantly ($P < 0.05$) different, Pack Cell Volume (PCV), Red Blood Cell (RBC), White Blood Cell Count (WBC), Haemoglobin Concentration (Hb), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC)

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Table 4: Serum Biochemical Indices of Red Sokoto Bucks Fed Graded Levels of Ensiled Urea Treated Groundnut Shell Meal

Parameters	T1	T2	T3	T4	T5	SEM
AST(u/l)						
Beginning	195.08^{d}	195.08^{b}	216.62^{bc}	146.87^{a}	198.56^{c}	4.081
End	200.46	238.15	215.33	231.23	218.52	9.890
Difference	5.38^{ab}	43.07^{a}	(1.29)^{ab}	84.36^{ab}	19.96^{b}	9.545
ALP(u/l)						
Beginning	110.40	110.40	121.60	85.33	112.20	4.626
End	57.87	53.20	61.07	52.40	54.60	12.410
Difference	(52.53)	(57.20)	(60.53)	(32.93)	(57.60)	4.550
ALT(u/l)						
Beginning	61.06	60.42	61.62	55.67	60.39	0.825
End	50.36^{d}	60.22^{c}	63.46^{bc}	69.66^{ab}	66.18^{a}	2.235
Difference	(10.7)^{ab}	(0.20)^{c}	1.84^{c}	13.99^{a}	5.79^{bc}	1.590
Cholesterol(mol/l)						
Beginning	140.35	136.84	124.21	150.88	130.53	4.234
End	176.25^{a}	136.31^{b}	139.27^{b}	138.82^{b}	139.73^{b}	13.014
Difference	35.90^{a}	(0.53)^{c}	15.06^{abc}	(12.06)^{ab}	9.20^{bc}	4.128
TP(g/dl)						
Beginning	4.61	5.10	4.63	5.45	5.44	0.168
End	6.73^{b}	6.42^{b}	5.77^{c}	6.63^{b}	7.20^{a}	0.509
Difference	2.12	1.32	1.14	1.18	2.24	0.202
AB(g/dl)						
Beginning	3.69	3.87	4.00	4.21	3.12	0.159
End	3.50^{b}	3.34^{b}	3.00^{c}	3.44^{b}	3.79^{a}	0.468
Difference	(0.19)	(0.53)	(1.00)	0.77	0.67	0.142

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Glucose(mg/dl)						
Beginning	32.05	31.25	28.37	34.45	29.81	0.967
End	56.73	56.25	58.17	60.58	56.97	2.973
Difference	24.68	25.00	29.80	26.13	27.16	0.816
Creatinine (mg/dl)						
Beginning	0.60	0.62	0.71	0.67	0.68	0.034
End	0.57^{c}	0.49^{c}	0.45^{d}	0.60^{ab}	0.70^{a}	0.121
Difference	(0.03)	(0.13)	(0.26)	(0.07)	0.02	0.034
Urea(mmol/l)						
Beginning	35.86	36.26	36.31	36.26	35.56	0.134
End	29.92^{b}	27.02^{b}	19.80^{c}	28.43^{b}	36.85^{a}	0.407
Difference	$(5.94)^{b}$	$(9.24)^{b}$	$(16.51)^{a}$	$(7.83)^{b}$	1.29^{b}	1.545

Key: ^{abc} Means on the same row with different superscripts are significantly (P < 0.05) different, Aspartate Aminotransferase (AST), Alanine Transaminase (ALT), Alkaline Phosphatase (ALP), Total Protein (TP) and Albumin (AB).

DISCUSSION

The crude protein content of all the diets was higher than the acceptable 7% CP for ruminant maintenance, as advised by ARC (1980), and 8% for ruminal function, as proposed by Norton (1994). The excess CP in the treatment diets could help to balance out the amino acid imbalances that may have occurred during protein degradation. The crude fiber content of the diets were more than the minimum (12 %) requirement for goats. The high fiber content is essential for stimulating saliva and maintaining the correct pH for rumen microorganisms, which are crucial for digesting roughages.

The packed cell volume values range of 23.00 to 25.33% recorded in the beginning and at the end of the study were within the range of 22–38 %, as reported by Aksoy et al. (2021), for Red Sokoto bucks. The higher PCV values recorded at the end of the study in most of the treatments indicate either an increase in RBC or reduction in circulating plasma volume (Kopp and Hetesa, 2000). PVC levels can be influenced by factors such as age, sex and altitude (Vettorazzi et al., 2017). The biologically active compounds in the treatment diets may have improved nutrition utilization or oxygen-carrying capacity of the blood, resulting in improved PCV at the end of the trial (Ahamefule et al., 2005). RBC values obtained at the beginning and at the end of this study were within the normal range (8 to 18 x 10^12/L) (Aksoy et al., 2021), which indicated that the goats remained evidently in sound health throughout the investigation, regardless of nutritional supplementation. Erythrocytes are

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necessary for gaseous exchange and buffering of hydrogen ions (Kell et al., 2018). The white blood cells (WBC) values recorded at the beginning and at the end of the experiment were within the normal reference range 5.56–13.25; 5.88–13.77 and 4–12 x 109/L reported by Yusuf et al. (2024), Odeyinka et al. (2020) and Aksoy et al. (2021) respectively. White blood cells play a crucial role in immune response and defense against infections (Kell et al., 2018). Because the WBC counts were within the normal physiological range for clinically healthy goats, the likelihood of leukocytosis was ruled out. The normal WBC counts at the end of this study could be attributable in part to enhanced nutrition utilization in all groups. This indicated active immunity, implying that the goats were in good health condition.

Ahamefule et al. (2005) linked high WBC counts to recent parasitism or the presence of foreign body or antigen in the circulating medium. Addass et al. (2010) reported that the higher leucocyte count (WBC) is an indicator of immune response to infections or toxic substances in the organism and a low count is an indication of pathogenic infection or presence of antigens in the organism (Bradbury et al., 1999). The increase in WBC observed at the end of this study could be attributed to the ability of the body to fight infections and defend the body by phagocytosis against invasion by foreign substances (Olatunde et al., 2021). Hb values (7.68–8.44 g/dl) obtained at the beginning of this study were within reference range 6.7–8.6 g/dL, as reported by Millam et al. (2021), while the values (7.66–10.50 g/dl) obtained at the end of this study fall within the normal range (8.0–12.0g/dL), as reported by Millam et al. (2020) for Red Sokoto bucks.

According to Raza et al. (2019), lower haemoglobin levels are associated with an increased risk of cardiovascular disease, suggesting that haemoglobin can serve as a potential biomarker for accessing cardiovascular health. In general, an increase in Hb concentration is associated with greater ability to resist disease infection, and a low level is an indication of disease infection and poor nutrition (Njidda et al. 2013). All of the diets except T5 appeared to be capable of supporting high oxygen carrying capacity blood among the goats, owing to the relatively higher Hb concentration obtained at the end of this study. Furthermore, the Hb concentration of Red Sokoto bucks on the diets could indicate that the dietary proteins were of good quality. The MCH and MCV values recorded at the beginning of this study were not significantly different. However, MCH values, which were above the normal reference range, decreased substantially and significantly ($P < 0.05$) among the dietary treatments and were within the normal reference range, which could be attributed to the adequacy of diets to furnish the required nutrients to sustain health of the animals. MCHC values at the beginning and at the end of the study were within the normal values (30.00–36.00 g/dl), as reported by Aksoy et al. (2021), and similar to the values reported by Ntagbu et al. (2025) for Red Sokoto goats. Lymphocytes values at the beginning (63.69–66.67 %) and at the end of the study (64–67 %) were higher than 45.55–51.05 %, as reported by Kolo (2021) for Red Sokoto kids. The values for eosinophils (3–4%) recorded in this study were within the normal range of 1–8%, as reported by Kolo (2021) for Red Sokoto goats. The use of graded levels of Ensiled Urea Treated Groundnut Shell meal supplements did not negatively affect blood parameters in this study, indicating the adequacy of this diet for small ruminant nutrition.

ALT values (50.36–69.66 U/L) obtained at the end of this study were higher than the range of 11.52–46.26 U/L reported by Ewuola et al. (2017). Alanine Aminotransferase (ALT) is an enzyme primarily found in the liver of sheep. It is a specific marker for liver health and increased ALT levels may suggest liver disease or damage. The total protein values recorded in this study were within the normal range (4.65–10.19 g/dL) reported by Ewuola et al.

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(2017) in WAD goats, and higher than the mean value (4.4 g/Dl) reported by Ikhimioya and Imasuen (2007) in Red Sokoto goats. Abdel Hameed (2013) opined that serum protein concentration at any given time is a function of hormonal balance, nutritional status, water balance and other factors affecting health. Serum protein concentration indicates the balance between anabolism and catabolism of protein in the body. Total protein is a measure of all proteins in the blood, including albumin and globulins. This suggests that the experimental diets contain sufficient proteins for growth and health of the animals. There was an improvement in the levels of total protein in the blood as a result of the inclusion of EAGNSM in the diets. Changes in total protein levels could suggest various health conditions, such as dehydration, malnutrition, or disease (Lumeij, 1997). High protein values are indicative of efficient protein synthesis (Bello & Tsado, 2013). Albumin is a specific protein produced primarily by the liver. Decreased albumin levels can be indicative of liver disease, malnutrition, or kidney dysfunction (Thrall et al., 2012). The Albumin values (3.0–3.79 g/dL) fall within the normal range of 1.89–3.71 g/dL (Ewuola et al., 2017) but for animals on T5 which had higher value. Albumin is a specific protein produced primarily by the liver. Decreased albumin levels can be indicative of liver disease, malnutrition, or kidney dysfunction (Thrall et al., 2012). This implies that the animals were well nourished and healthy across the treatments.

Creatinine is a waste product produced by the muscles. The values (0.45–0.7 mg/dL) obtained at the end of this study were lower than the normal range (0.64–2.52 mg/Dl) reported by Ewuola et al. (2017) for goats except T5. Creatinine is a waste product of muscle metabolism, so its concentration can vary depending on several factors such as diet and breed among others. Urea is a waste product produced by the liver. The values (19.8–36.85 mmol/dL) obtained from this study were within the normal range published for WAD goats, 19.18–56.23 mg/dL (Ewuola et al., 2017). The range is wide because of normal variations due to protein intake, endogenous protein catabolism, state of hydration, hepatic urea synthesis, and renal urea excretion. This could be the reason for the variations in values recorded in this study. A positive correlation exists between level of protein (N) intake and blood urea concentration (Karnezos et al., 1994). In ruminants, blood urea can be influenced by dietary N-toenergy ratio, level of forage intake, and protein degradability in the rumen (Turnera et al., 2005).

CONCLUSION

This study shows that the inclusion of EAGNSM in the diet of Red Sokoto Bucks had no deleterious effect on the haematological and serum biochemistry parameters evaluated and could be included in their diets up to 20%.

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