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Review Article

Physiological Response of Yankasa Rams to Graded Levels of Ensiled Ammoniated Groundnut Shell Meal

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Abstract

The study assessed the physiological parameters of yankasa rams as affected by diets containing graded levels of ensiled ammoniated groundnut shell meal (EAGNSM). Twenty (20) Yankasa rams used for the study were divided into five groups of four animals each; with an average weight of 11.50 ± 2.06kg. 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: 500g of Gamba grass (Andropogan gayanus) every morning (9.00am); followed by the experimental diets based on 4% body weight of the animals in the afternoon (12pm). Drinking water was provided ad libitum. Blood samples were collected from the jugular vein of the rams at the beginning and 90th day of the feeding trial for determination of haematological and serum indices. The results reveal that, packed cell volume (PCV), haemoglobin (Hb) and the red blood cells (RBC) at the end of study significantly ($P < 0.05$) improved significantly over the initial values except for T1 and T5. The AST decreased, while Alanine pro increased significantly across the treatments at the end of the experiment. The difference between the initial and final values of High density lipoprotein (HDL) and Globulin were not significant ($P > 0.05$) across the treatments. Urea values were significantly ($P < 0.05$) different. However, the values (2.2 - 5.9 mmol/L) obtained were within the normal reference range. Total Protein values also falls within the normal range of 5.4-7.5g/dL. It could be concluded that inclusion of EAGNSM in the diet of Yankasa rams had no deleterious effect on the haematological and serum biochemistry parameters evaluated and could be included in their diets for sheep up to 20%.

Keywords: Ensiled; Ammoniated; Groundnut Shell; Heamatological Indices

Introduction

The Yankasa ram is a popular breed of sheep in Nigeria, known for its ability to adapt to various feeding conditions [22]. 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 [19]. [21] reported that ammoniation of fibrous feed sources can improve the performance of sheep. In a similar vein, urea and subsequent ensiling has been adopted as processing strategy for crop residues such as soybean haulms that are hitherto nutritionally poor and fibrous for feeding sheep [2,11]. 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.

According to [12], blood parameters are thought to be important indicators of a farm animal's physiological stage, demonstrating the link between diet and health. [6] 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 [24]. 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 [1].

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.

The objective of this study is to evaluate the effects of graded levels of ensiled ammoniated groundnut shell meal on the hematological and biochemical indices of Yankasa rams.

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 7°44N and Longitude 8° 22°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 508 to 1016mm with a minimum temperature range of 24,20 ± 1-4°C and maximum temperature between 39.50 ± 2.20% and 64.00 ± 4.80% [30].

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 2.5cm screen. The GNS was ammoniated by dissolving 5kg of urea grains in 95 liters of water and allowed to stand for 24 hours before use as described by [23]. The GNS meal (100 kg) was soaked in the 5 % urea solution for 7 days and thereafter, decanted. The filtrates were ensiled for 21 days, dried and incorporated in five treatment diets as follow: 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), 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).

Experimental animals and management

A total of twenty (20) growing Yankasa rams aged between 7-8 months with an average body weight of 11.50 ± 2.06 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 5ml/20kg orally, injected with Oxytetracycine L.A 1ml/10kg (im), Ivomectine 0.3ml/25kg (sc) and Multivat 1ml/10kg body weight. The rams were housed in demarcated individual pens with concrete floors.

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

Table 1: Percentage composition of Experimental Diet.

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.

The basal diet: 500g of Gamba grass (Andropogan gayanus) was offered to the animals every morning (9.00am) followed by the experimental diets offered at 4% body weight. Drinking water was also provided ad libitum. The basal diet was fed for the period of 60 days; while the experimental diets were fed throughout the 90 days duration of the study.

Data collection

Homogenous samples of test diets were analyzed for proximate compositions as outlined by [4]. Gross energy (GE MJ/kg) was calculated using the equation recommended by [17] as shown below: GE (MJ/kg) = 0.0226CP + 0.0407EE + 0.0192CF + 0.0177NFEBlood samples were collected from all the experimental animals at the beginning and on the last day of the study.

About 5ml of blood was collected at each of the sampling stages from each of the rams via 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 [7] using 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 determination of the various serum indices. Serum aspartate aminotransferase, serum alanine transferase and alkaline phosphatase were analysed spectrophotometric linked reaction method [9]. The blood urea nitrogen was assessed by the method of [31], Creatinine was determined according to the method described by [14].

Statistical analysis

Data on haematological and serum indices was analyzed through one-way analysis of variance (ANOVA) using SPSS (version 24) [28]. 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 tool.

Result and Discussion

Proximate composition of experimental diets

The results for proximate composition of experimental diets are presented in Table 1. Dry matter (DM) ranged from 91.61 – 94.29 %, crude protein ranged from 13.33 -13.61 %, crude fiber ranged from 13.19 - 25.51 %, ash ranged from 4.80 - 18.52 % while ether extract and nitrogen free extract ranged from 3.93 - 5.43% and 32.47 - 54.94 %, respectively. The crude protein content of all the diets was higher than the acceptable 7% CP for ruminant maintenance as advised by [5] and 8% for ruminal function as proposed by [18]. The excess CP in the treatment diets could help to balance out the amino acid imbalances that may have occurred during protein degradation.

Haematological indices of Yankasa rams in response to diets containing graded levels of ensiled ammoniated groundnut shell meal

The results of the haematological parameters of Yankasa rams as influenced by feeding graded levels of ensiled ammoniated groundnut shell meal is presented in table 2. It was observed that all the initial haematological parameters measured except MCH and MCV were significantly ($P < 0.05$) different across the treatments. PVC values were 25, 25, 24, 20 and 25 % for T1, T2, T3, T4 and T5 respectfully. WBC values were 6.4, 6.8, 8.3, 3.4 and 5.4 ($\times 10^9$/L) for T1, T2, T3, T4 and T5 respectfully. RBC values were 4.4, 4.2, 4.0, 3.2 and 4.1 ($\times 10^{12}$/L) for T1, T2, T3, T4 and T5 respectfully.

	Experimental Diets					
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**GG**
DM	91.07	94.29	94.01	93.99	93.84	91.05
CP	13.61	13.56	13.33	13.37	13.41	9.48
CF	13.19	16.24	19.36	22.43	25.51	47.80
EE	5.43	4.50	5.09	4.52	3.93	0.71
Ash	4.08	8.43	11.66	15.05	18.62	16.91
NFE	63.69	57.27	50.09	44.63	38.53	25.10
GE MJ/Kg.	1.909	1.814	1.775	1.707	1.635	

Table 2: Proximate Composition of experimental diets.

DM: Dry Matter; CP: Crude Protein; CF: Crude Fibre; EE: Ether Extract and NFE: Nitrogen Free Extract; GG: Gamba Grass

The PVC, Hb, RBC, MCHC and PLT values recorded at the end of the experiment were significantly ($P < 0.05$) different across the treatments. The PVC (%) values were; 31, 27, 29, 28 and 32; and Hb (g/L) values were; 11.3, 9.0, 9.6, 9.3 and 11.0. for T1, T2, T3, T4 and T5 respectfully. The PVC (%) values were not significantly different; both at the initial and the end of the experiment between the animals on control diet (T1) and T5 in which the test ingredient completely replaced the maize offal in the diet. Similarly, Hb and RBC values were also not significantly different at the beginning and the end of the study among the two treatments (T1 and T5). The difference between the initial and end PVC, Hb, WBC, RBC and platelets values were statistically similar for animals on T1 and T5.

Mean PCV values recorded at the beginning and the end of the experiment were within the normal reference range (23.0 – 55.0%) reported by [25] except for animals on T4 which recorded a value of 20%. PVC levels can be influenced by factors such as age, sex and altitude [33]. 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 [3].

RBC values: 3.2-4.4 x 10^{12}/L and 4.5-5.3 x 10^{12}/L obtained at the beginning and the end of this study were below the normal range (8 to 16 x 10^{12}/L) [25]. This could be as a result of poor nutrition of the animals before the commencement of the experiment which was however, improved with the feeding of the experimental diets. According to [29] nutritional status of animals can affect the RBC counts.

Hb values (6.4-8.7g/dl) and (9.0-11.3g/dl) obtained at the beginning and end of this study respectively; were similar to the values reported by [20] and falls within the normal range (5.5 to 16.5 g/dl) [25]. All of the diets appeared to be capable of supporting high oxygen carrying capacity of blood among the sheep, owing to the relatively higher Hb concentration obtained at the end of this study. Furthermore, the Hb concentration of Yankasa rams on the diets with ammoniated groundnut shells, which was within normal range could indicate that the dietary proteins were of good quality.

WBC values obtained at the beginning of this study except for animals on T4 (3.9×10^9/L) falls within the normal range (5 to 15 x 10^9/L) [25]. WBC values (5-7 × 10^9/L) recorded at the end of the feeding trial were also within the normal reference range. White blood cells play a crucial role in immune response and defense against infections [13]. Because the WBC counts were within the normal physiological range for clinically healthy sheep, the likelihood of leukocytosis was ruled out. The normal WBC counts at the end of this study is indicative of active immunity, implying that the sheep were in good health condition even after feeding on ammoniated groundnut shell meal.. The difference between the initial and end PVC, Hb, WBC, RBC and platelets values were positive except for WBC where the animals on T2 and T3 recorded negative difference. This result implies that the diets largely had positive influence on the haematological indices of Yankasa Rams. According to [29], nutritional status of animals can affect the RBC count.

The non-significant effects observed in this study for MCV and MCH implies that the nutritional quality of the diets was not impaired. MCV values (60 µ3) obtained from this study across the treatments were higher than the normal range (30 - 50 µ3) reported by [25]; while MCH values (20 pg) obtained across the treatments from this study were within the normal range (10 to 20 pg) reported by [25].

Serum Biochemical indices of Yankasa ram in response to diets containing graded levels of ensiled ammoniated groundnut shell meal

Serum biochemistry parameters of Yankasa ram as influenced by feeding graded levels of ensiled groundnut shell meal is presented in table 3,4. It was observed that all the initial parameters measured except Globulin were significantly ($P < 0.05$) different across the treatments. The initial Total Protein (g/Dl) values were 5.5, 7.4, 7.5, 5.1 and 6.3 for T1, T2, T3, T4 and T5 respectfully. Albumin (g/Dl) were: 5.6, 2.9, 2.7, 3.1 and 3.0; Creatinine (mg/Dl) were: 0.9, 0.91, 0.76, 0.61and 0.98; while Urea (mmol/L): 2.4, 6.2, 8.4, 9.7 and 1.5, for T1, T2, T3, T4 and T5 respectfully. Similarly, all biochemical indices measured at the end of the study differ significantly ($0 < 0.5$) across the treatments. Total Protein (g/Dl) values were: 6.2, 6.2, 6.9, 5.1 and 7.1; Creatinine (mg/Dl) were: 0.8, 0.8, 0.9, 1.3 and 1.0; while Urea (mmol/L) were: 3.0, 5.9, 5.8, 2.2 and 4.7; for T1, contain T2, T3, T4 and T5 respectfully. Total Protein level was significantly ($P < 0.05$) higher in T5 compared to T1 (control diet) for both initial and final blood samples. Creatinine levels in T1 and T5 which were significantly different initially, but were not significantly ($P > 0.05$) different at the end of the study. The urea level which was significantly higher initially in T1 compared to T5, was significantly lower at the end of the study.

Parameters	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)	SEM
PVC (%)						
Beginning	25^{a}	25^{a}	24^{a}	20^{b}	25^{a}	0.628
End	31^{ab}	27^{c}	29^{abc}	28^{c}	32^{a}	0.638
Difference	6^{b}	2^{c}	5^{b}	8^{a}	7^{ab}	0.688
Hb (g/L)						
Beginning	8.7^{a}	8.3^{ab}	8.0^{b}	6.4^{c}	8.2a^{b}	0.221
End	11.3^{a}	9.0c	9.6^{b}	9.3^{bc}	11.0^{a}	0.257
Difference	2.6^{a}	0.7^{b}	1.6^{b}	2.9^{a}	2.8^{a}	0.252
WBC (10^9/L)						
Beginning	6.4^{b}	6.8^{b}	8.3^{a}	3.4^{d}	5.4^{c}	0.397
End	7.0	5.0	7.0	5.0	7.0	0.372
Difference	0.6^{c}	$(1.8)^{a}$	$(1.3)^{b}$	1.6^{b}	1.6^{b}	0.171
RBC (10^{12}/L)						
Beginning	4.4^{a}	4.2^{a}	4.0^{a}	3.2^{b}	4.1^{a}	0.124
End	5.1^{ab}	4.5^{c}	4.8^{bc}	4.7^{bc}	5.3^{a}	0.094
Difference	0.7^{bc}	0.3^{c}	0.8^{bc}	1.5^{a}	1.2^{ab}	0.128
MCHC (g/c)						
Beginning	333	332	333	334	334	0.182
End	333^{ab}	334^{a}	332^{b}	333^{ab}	333^{ab}	0.248
Difference	0.0	2.0	(1)	(1)	(1)	0.181

MCH (pg)						
Beginning	20	19	20	20	20	0.091
End	20	20	20	20	20	0.00
Difference	0	1	0	0	0	0.091
MCV (ft)						
Beginning	60	59	60	60	60	0.091
End	60	60	60	60	60	0.00
Difference	0	1	0	0	0	0.091
PLT ($\times 10^3$ /L)						
Beginning	217^{a}	208^{ab}	200^{b}	108^{c}	204^{b}	10.705
End	254^{b}	225^{d}	221^{d}	233^{c}	263^{a}	4.483
Difference	37^{c}	17^{d}	21^{d}	125^{a}	59^{b}	10.619

Table 3: Haematological indices of Yankasa Rams.

Key: a, b, c = Means on the same row with different superscripts are significantly (P < 0.05), Pack cell volume (PCV), Red blood cell (RBC) White blood cell count (WBC), Hemoglobin concentration (Hb), Mean corpuscular volume (MCV), Mean corpuscular hemoglobin (MCH) and Mean corpuscular hemoglobin concentration (MCHC).

Parameters	T1	T2	T3	T4	T5	SEM
AST(u/l)						
Beginning	56^{d}	99^{b}	93^{bc}	106^{a}	92^{c}	4.807
End	45^{c}	58^{b}	58^{b}	66^{a}	54^{b}	1.890
Difference	$(11)^{c}$	$(41)^{a}$	$(35)^{b}$	$(40)^{a}$	$(38)^{ab}$	3.116
ALP(u/l)						
Beginning	4^{b}	3^{b}	6a	4^{b}	6^{a}	0.401
End	9.0^{a}	4.5^{b}	9.0^{a}	4.0^{b}	8.0^{a}	0.637
Difference	5^{a}	1.5^{b}	3^{b}	0^{c}	2^{b}	0.458
ALT(u/l)						
Beginning	52^{d}	106^{a}	89^{b}	106^{a}	67^{c}	5.808
End	50^{e}	93^{a}	58^{d}	73^{b}	68^{c}	3.951
Difference	$(2)^{c}$	$(13)^{b}$	$(31)^{a}$	$(33)^{a}$	1^{c}	3.642
LDL(mol/l)						
Beginning	80^{c}	83^{bc}	91^{a}	88^{ab}	86^{ab}	1.230
End	$87b^{c}$	85^{c}	91^{ab}	87^{bc}	93^{a}	0.945
Difference	7^{a}	2^{b}	0^{b}	$(1)^{b}$	7^{a}	0.852
HDL(mg/dl)						
Beginning	54^{b}	50^{bc}	45^{c}	60^{a}	52^{b}	1.471
End	58^{a}	52^{ab}	48	56^{a}	53^{ab}	1.141
Difference	4	2	3	(4)	1	0.478
TP(g/dl)						
Beginning	5.5^{c}	7.4^{a}	7.5^{a}	5.1^{c}	6.3^{b}	0.266
End	6.2^{b}	6.2^{b}	6.9^{b}	5.1^{c}	7.1^{a}	0.192
Difference	0.7^{ab}	$(1.2)^{a}$	$(0.6)^{b}$	0^{c}	0.8^{ab}	0.119

AB(g/dl)						
Beginning	5.6[a]	2.9[b]	2.7[b]	3.1[b]	3.[0b]	0.293
End	4.7[a]	3.5[b]	4.7[a]	3.9[b]	3.9[b]	0.142
Difference	(0.9)[b]	0.6[b]	2[a]	0.8[b]	0.9[b]	0.159
Globulin(mg/dl)						
Beginning	0.3	0.3	0.4	0.4	0.4	0.024
End	0.5[a]	0.2[b]	0.3[b]	0.3[b]	0.2[b]	0.035
Difference	0.2	(0.1)	(0.1)	(0.1)	(0.2)	0.020
Creatinine (mg/dl)						
Beginning	0.9[b]	0.91[b]	0.76[c]	0.61[d]	0.98[a]	0.036
End	0.8[b]	0.8[b]	0.9[b]	1.3[a]	1.0[b]	0.059
Difference	(0.1)[b]	(0.11)[b]	0.14[b]	0.69[a]	0.02[b]	0.066
Urea(mmol/l)						
Beginning	2.4[d]	6.2[c]	8.4[b]	9.7[a]	1.5[e]	0.866
End	3.0[c]	5.9[a]	5.8[a]	2.2[d]	4.7[b]	0.406
Difference	0.6[c]	(0.3)[c]	(2.6)[b]	(7.5)[a]	3.2[b]	0.695

Table 4: Serum Biochemical Indices of Yankasa rams fed graded levels of ensiled urea treated Groundnut shell meal.

Key: a, b, c = Means on the same row with different superscripts are significantly ($P < 0.05$), Aspartate Aminotransferase (AST), Alanine transaminase (ALT), Alkaline phosphatase (ALP), Low density lipoprotein (LDL), High density lipoprotein (HDL), Total protein (TP) and Albumin (AB).

Total protein is a measure of all proteins in the blood, including albumin and globulins. Total Protein values in the animals fell within the normal range of 5.4-7.5g/dL [25]. There was an improvement in the levels of total protein in the blood as the result of inclusion of EAGNSM in the diets, suggesting sufficient protein for growth and health. Higher protein values are indicative of efficient protein synthesis [8]. The Albumin values (3.5 - 4.7 g/dL) falls within the normal range of 2.6-4.2g/dL [25]; but for animals on T1 and T3 which were a little bit higher. Albumin is a specific protein produced primarily by the liver. Decreased albumin levels can be indicative of liver disease, malnutrition, or kidney dysfunction [32]. This implies that the animals were well nourished and healthy across the treatments.

Urea is a waste product produced by the liver. The values (2.2 - 5.9 mmol/L) obtained from this study were higher than the normal range 0.56 - 1.67mmol/L (10-30mg/dL) published for sheep, [25]. The higher values obtained in this study could be as a result of increase dietary protein which resulted in increased urea production. If sufficiently marked, this increased urea production can cause plasma/serum urea to rise. However, the values (2.2 - 5.9 mmol/L) were within the normal range of urea nitrogen in blood or serum: 1.8 to 7.1 mmol/L (5 to 20 mg/dl,) published by [10]. 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.

Alanine Aminotransferase (ALT) is another 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. ALT values (50 - 93 u/L) in this study were higher than the normal range of 10-40 u/L [25]. Creatinine is a waste product produced by the muscles. The normal reference range for creatinine in sheep is 0.6-1.5 mg/dL [16]. The values (0.8 - 1.3 mg/dL) obtained from this study were within the normal range for sheep.

High-Density Lipoprotein (HDL) is often referred to as "good cholesterol" and plays a crucial role in lipid transport. The values (48 - 58 mg/dL) recorded in this study falls within the normal reference range of 20-60 mg/dL [16].

The results obtained in this study are in agreement with [1] who reported that incorporating graded levels of ammoniated groundnut shell meal in the diet of Yankasa rams had significant positive effects on their hematological and biochemical indices. The researchers observed improvements in the hematological parameters such as RBC count, hemoglobin concentration and PCV with increasing levels of ammoniated groundnut shell meal in the diet. A similar trend was observed in this study. This was evident in animals on T4 which had the lowest PCV, Hb, RBC and WBC values at the beginning of the experiment; recovering substantially at the end of the study. The platelet count were within the normal reference range (170-400 $\times 10^3$/L). [27] noted that platelet count tend to increase with incidence of toxin and pathogens; which implies

that there was no incidence of toxin as a result of the inclusion of EAGNSM in the diets.

Conclusion

- From this study it could be concluded that feeding graded levels of ensiled ammoniated groundnut shell meal in the diet of Yankasa Rams have no detrimental effect on the health status of the animals.
- The inclusion of ensiled ammoniated groundnut shell meal in the diet of Yankasa rams had significant positive effects on their hematological and biochemical indices the animals.

Recommendation

From this study it is therefore recommended that, graded levels of ensiled ammoniated groundnut shell meal be added to the diet of sheep up to 20%, to improve their health status and performance.

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