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NUTRITIONAL EVALUATION OF DIFFERENT NITROGEN SOURCES ON DIGESTIBLE NUTRIENT INTAKE AND HAEMATO-BIOCHEMICAL PARAMETERS IN GROWING YANKASA SHEEP

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ABSTRACT

Experiment was carried out to evaluate the response of growing Yankasa rams to complete stover based diets on digestible nutrient intake and haemato-biochemical parameters. Diets were formulated to contain 16% CP with urea at 0, 0.5, 1, 1.5 and 2% vis-à-vis cottonseed cake at 20, 15, 10, 5 and 0% and designated as diet 1, 2, 3, 4 and 5%, respectively. Twenty rams were used in the experiment and randomly allocated to five treatment groups of four animals each in completely randomized designed (CRD). Rams were fed experimental diets and water *ad libitum*. The result revealed significant ($P<0.05$) differences in the entire nutrient digestibility. Dry matter digestibility was higher (63.31, 65.93 and 64.07%) in animals fed diets 1, 2 and 3 while the least 48.04% in those fed diet 4. Crude protein digestibility was higher (79.65%) in animals fed diet 2 and the least (70.56%) for those fed diet 4. White blood cells were significantly ($P<0.05$) affected across the diets with rams fed diet 3, 4 and 5 having the higher values of 7.45, 7.00 and 7.00 $x10^9$/L, respectively, while those on diet 1 had the least 5.20 $x10^9$/L. There was significant ($P<0.05$) difference in blood urea 0 hours before feeding between the treatments with higher value 4.10 mmol/L for animals fed diet 4 and lower 3.15 mmol/L for animals on diet 1. Incorporation of urea at up to 2% had no detrimental effect on nutrient digestibility and blood parameters. Therefore, diet 3 is recommended for feeding growing Yankasa rams.

Keywords: Yankasa, urea, cottonseed cake, digestibility

INTRODUCTION

Sorghum stover is among the crop residues obtained on farm lands after harvest in most parts of North-eastern Nigeria. During dry season, ruminant animals feed on the leaves and leave the stalks as residue on the farm after harvest. Sorghum stover can be utilized effectively by ruminants if the particle size is reduced through mechanical means. Urea as a source of non-protein nitrogen is inexpensive and can be used in ruminant animals' feed in combination with other agro-industrial by-products. Kishore *et al.* (2017) reiterates that crop residues and agro-industrial by-products play an important role as a source of feed for ruminants, but the utilization of these feeds is limited because of poor nutrient content and digestibility. Sorghum stover can be used alongside other agro-industrial by-products and

in combination with urea to form complete diet. The determinants of the quality of diets fed to animals can only be assessed through their intake, digestibility to some extent and the effect of the diets on haemato-biochemical parameters. The present study was undertaken with an objective of assessing the effects of varied sources of nitrogen on nutrient digestibility and haemato-biochemical parameters in growing Yankasa sheep.

MATERIALS AND METHODS

Description of the Study Area

The research will be carried out at the Livestock Teaching and Research Farm, University of Maiduguri, Borno State. Maiduguri lies between Latitude $11^0 51'$ and 12^0N and longitude $13^0 05'$ and 14^0E. It falls within the Sahel savannah zone of West Africa which is characterized by 4-5 months of rainfall with an average of 500-600mm. The ambient temperature ranges from 27-45^0C while the relative humidity varies between 19 to 78% and remains at 45% during the wet season (Mayomi and Mohammed, 2014).

Collection and Preparation of Experimental Feed Materials

Sorghum stover was collected from harvested sorghum farms within Maiduguri and its environs after harvest and removal of the seeds. The stover was milled to about 3-5cm using stover milling machine which are then bagged and stored before usage.

Other feed ingredients such as urea graded fertilizer, cottonseed cake, wheat offal, sorghum panicle, molasses, bone meal and salt were purchased from Gamboru and Cattle market at Maiduguri.

Experimental Animals and their Management

Twenty (20) growing Yankasa rams were used in the experiment. The animals were purchased in Kasuwan Shanu (Cattle Market) at Maiduguri with an average weight of 18.23kg. The animals were quarantined for 14 days during which they were tagged, vaccinated against *pestes despetit ruminant*, dewormed with Albendazole at 12.5mmg/kg1 body weight for internal parasites and injected intramuscularly with antibiotic i.e Oxytettracycline L.A (Alfasan ®) 20%, at 1ml per 10kg body weight. During this period the animals were fed with groundnut haulms and maize offal for adaptation. The animals were divided randomly into five dietary groups of four animals each in a completely randomized design and allocated to their respective diets. All the animals were housed in well-ventilated pens (2 m × 2 m) pens disinfected using Dettol at the rate of 10mls/4litres of water as a fumigant. This was done prior to their introduction into the pens to maintain healthy surroundings and proper cleanliness during the experimental period.

Experimental Diets

Complete diets containing 16% crude protein (CP) were formulated for the experiment. Urea was incorporated into the diets at 0, 0.5, 1, 1.5 and 2% alongside with cottonseed cake at 20, 15, 10, 5 and 0% and designated as diet 1, 2, 3, 4 and 5%, respectively. Ingredients and compositions of the experimental diets were presented in Table 1.

Table 1: Ingredients and chemical composition (%) of experimental diets

Ingredients	**Diets**				
	1	**2**	**3**	**4**	**5**
Wheat offal	27.14	32.93	38.73	44.52	50.32
Sorghum panicle	27.36	26.07	24.77	23.48	22.18
Urea	0.00	0.50	1.00	1.50	2.00
Cotton seed cake	20.00	15.00	10.00	5.00	0.00
Milled sorghum stover	20.00	20.00	20.00	20.00	20.00
Molasses	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Parameters					
Dry matter	93.09	93.25	92.4	93.54	93.18
Organic matter	86.24	88.08	90.01	88.28	88.95
Crude protein	16.12	16.18	16.09	15.98	16.06
Ash	6.85	5.17	2.39	5.26	4.23
Neutral detergent fibre	36.83	35.46	36.61	38.32	35.48
Acid detergent fibre	28.51	25.47	22.23	25.42	21.64
Hemicellulose	8.32	9.99	14.38	12.9	13.84

Diet 1 = 0% urea with cottonseed cake (CSC) at 20%, Diet 2 = 0.5% Urea with CSC at 15%, Diet 3= 1.0% Urea with CSC at 10%, Diet 4 = 1.5% Urea with CSC at 5%, Diet 5 = 2.0% Urea with CSC at 0%

The respective diets were offered at 7.00 hr and 14.00 hr daily. During the feeding trial, animals were offered weighed quantities of respective complete diets *ad libitum*. Residues, if any, were weighed on the next day morning before offering of feed in order to calculate daily feed intake of animals. Fresh clean drinking water was provided to the animals and daily water intake is recorded. For growth performance, initial body weight, weekly weights and final body weights of the animals were measured in order to ascertain the growth performance. The experimental period lasted for 84 days (including 14 days adaptation period.

Digestibility Study

Three animals were randomly selected from each treatment and moved to metabolic cages after feeding trial. The animals were fed their respective diets and served fresh clean water daily. Faeces were collected and bulked for 7 days period and the amounts of feed offered and individual refusals, and faeces were weighed daily. After the 7 days faeces collection period a pooled representative sample was collected for laboratory analysis after thoroughly mixing the faeces from each animal.

Haematological and Biochemical Indices

Blood samples were collected via jugular veins of the experimental animals during the last week of all the experiments. Three animals were sampled

from each treatment for haematological and biochemical analyses. For haematological study, blood was collected in sample bottles with Ethylene Diamine tetra Acetic Acid (EDTA). Packed cell volume (PCV) was determined by the method described by Sirios (1995) while, Haemoglobin (Hb) concentrations, white blood cells (WBC) and red blood cells (RBC) by that of (Jelalu, 2014). Mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC), mean haemoglobin concentration (MHC) were calculated as described by (Jain, 1993).

Chemical Analysis

Feed samples were ground through a 1mm mesh sieve and analyzed for dry matter (DM) (55°C for 24h), Nitrogen (or CP) content was determined by the automated Kjeldahl method (AOAC, 1990), neutral detergent fiber (NDF) and acid detergent fiber (ADF) by procedure of Van Soest *et al*. (1991) without amylase, sodium sulfite or correction for residual ash. Rumen Ammonia N concentrations were determined by Kjeldahl distillation according to AOAC (1997).

Experimental Design

The experimental design was a completely randomized design (Steel and Torrie, 1980), with five treatments of four animals each.

Statistical Analysis

Data collected were subjected to Analysis of variance (ANOVA) as described by Steel and Torrie (1980) using MINITAB 16 (2014). Where significant differences existed between means, Duncan's new multiple range test (DMRT) was used to separate them.

RESULTS AND DISCUSSION

Nutrient Intake Digestibility of Growing Yankasa Rams Fed Diets Containing Different Nitrogen Sources

Table 2 shows the nutrient intake digestibility of growing Yankasa rams fed diets containing different nitrogen sources.

Table 2: **Nutrient intake digestibility of Yankasa rams fed diets containing different nitrogen sources**

parameters	Diets					SEM
	1	2	3	4	5	
DMI (g/day)	1042.31^{a}	1057.16^{a}	1055.29^{a}	829.05^{c}	949.51^{b}	30.92*
Average daily weight gain (g)	90.43^{b}	122.57^{b}	147.14^{a}	66.14^{c}	84.00^{c}	9.86*
DMD (%)	63.31^{a}	65.93^{a}	64.07^{a}	53.04^{c}	58.79^{b}	1.61*
OMD (%)	58.88^{b}	62.51^{a}	61.46^{a}	49.46^{d}	54.96^{c}	1.63*
CPD (%)	76.86^{b}	79.65^{a}	77.93^{b}	70.56^{c}	73.93^{b}	1.23*
NDFD(%)	63.55^{a}	64.48^{a}	63.91^{a}	52.88^{c}	58.22^{b}	1.69*
ADFD(%)	66.51^{a}	65.29^{a}	58.43^{b}	50.55^{c}	52.69^{c}	2.10*

$^{a, b,}$Means within each row with different superscripts are significantly different, *(P<0.05), Diet 1 = 0% urea with cottonseed cake (CSC) at 20%, Diet 2 = 0.5% Urea with CSC at 15%, Diet 3= 1.0% Urea with CSC at 10%, Diet 4 = 1.5% Urea with CSC at 5%, Diet 5 = 2.0% Urea with CSC at 0%, DMD=Dry Matter Digestibility, OMD=Organic Matter Digestibility, CPD=Crude Protein Digestibility, NDF= Neutral Detergent FibreDigestibility, ADF= Acid Detergent FibreDigestibility, SEM standard error mean, NS= Not significant

Significant (P<0.05) difference was observed in dry matter digestibility (DMD), organic matter digestibility OMD), crude protein digestibility (CPD), acid detergent fibre (ADFD) and neutral detergent digestibility (NDFD) across the dietary groups. The higher figures of DMD reported in this study range from 63.31 to 65.93 % was lower than 76.45 to 81.75% by Sani (2018). The low

digestibility in this study may be as a result of the difference in diet formulation. Jokthan *et al*. (2013) reported DMD of 51.33% which was lower than values recorded in this study. The result also disagreed with 68.02% reported by Elkholy *et al.* (2009) for sheep fed diet containing urea treated corn silage plus molasses. The DMD of 65.93% recorded in this study fell within the range of 60.49 to 79.68% documented by Abubakar *et al.* (2010) and below the range of 64.57 to 77.25% reported by Ngele *et al.* (2010) for growing Yankasa rams fed urea untreated and urea treated rice straw with supplements. Xu *et al*. (2019) reported DMD of 72.55% which was higher than the values recorded in this study. Adeola *et al*. (2021) and El-Nommeary *et al*. (2021) reported DMD of 75.64 and 70.58%, respectively, which disagreed with the values recorded in this study.

The OMD figure of 62.51 and 61.46% obtained in this study was higher than 50.87 to 53.10% reported by Abubakar *et al.* (2010). The OMD recorded in this study was lower than 70.89% reported by Sani (2018). In a trial carried out by Hirut *et al*. (2011), OMD of 64% higher than the present study was reported when fed basal diet of urea treated maize stover and supplemented with different levels of concentrate mix to Hararghe highland sheep. OMD of 77.75% reported by Xu *et al*. (2019) was higher than the values recorded in this study. Jokthan *et al*. (2013) reported OMD of 51.90% which was lower than values recorded in this study.

Crude protein digestibility of up to 79.65 % was recorded in this study which was higher than 71% reported by (Hirut *et al*., 2011) and 75.82% reported by Abubakar *et al.* (2010). It was also higher than the range of 64.89 to 77.97% reported by Sani (2018). Crude protein digestibility of 74.50 and 75.05% was documented by Khattab *et al*. (2013) and El-Nomeary *et al*. (2021) which were slightly lower than the reported values in this study. Xu *et al*. (2019) reported CPD of 78.99% which was closely related to the current study. Jokthan *et al*. (2013) reported CPD range of 56.32 to 63.51% which was lower than values recorded in this study. Similarly, range of 84.88 to 87.88% was reported by Adeola *et al*. (2021) was also not in lined with this study.

Higher figures of NDFD of 63.55, 64.48 and 63.91% recorded in this study are lower than 71% reported by Hirut *et al*. (2011), but higher than 58.26% reported by Sani (2018). Aimé *et al*. (1999) reported NDFD of 38.14% which is lower than the values in current study. Khattab *et al*. (2013) and Xu *et al*. (2019) reported NDFD of 52.00 and 54.31% which are slightly lower than the reported values in this study. Alabi *et al*. (2013) reported NDFD range of 59.46 to 65.86% which fell within the range of finding of the present study. The primary chemical components of feed that determines the rate of digestion are neutral detergent fiber (NDF) and acid detergent fiber (ADF) McDonald *et al*. (2002). The digestibility of a feed is influenced not only by its own composition but also by the composition of other feeds consumed. A positive relationship between the digestibility and intake of feed has been recognized in ruminants (McDonald *et al.* 2002). This is in lined with the present findings. However, the effect of increased digestibility on improving feed intake depends on the quality of roughage feed used. Concentrate added to roughage of low digestibility tends to be consumed in addition to the roughage (McDonald *et al.* 2002). Generally, when the herbage has less CP content, nitrogen supplementation increases both intake and digestibility, particularly when the CP content of the feed is less than 6% Lambourne *et al*. (1986). Digestibility is much reduced when a ration has too little CP in proportion to the amounts of soluble carbohydrates.

The ADFD of 66.51 % in this study is higher than 47.42% reported by Aimé *et al*. (1999) and range (46.95 to 52.89%) documented by (Sani, 2018). Higher ADFD value of 72.62% was reported by Hirut*et al*. (2011) and is higher compared to the range reported in this study. Alabi *et al*. (2013) reported ADFD range of 59.38 to 65.72% which fell within the range recorded in this study. Khattab *et al*. (2013) reported ADFD of 48.10

which is lower than the reported values in this study. Xu *et al*. (2019) reported ADFD of 88.44% which is higher than the reported values in this study.

Haematological and Biochemical Indices of Growing Yankasa Rams Fed Diets Containing Different Nitrogen Sources

Haematological and biochemical indices of Yankasa rams fed diets containing different nitrogen sources is shown in Table 3. Haemoglobin (Hb) and packed cell volume (PCV) were not significantly (P>0.05) affected by the dietary treatments. White blood cells (WBC) was significantly (P<0.05) affected across the diets. There was no significant (P>0.05) difference in red blood cell (RBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) of animals fed different experimental diets. No significant (P>0.05) difference recorded between experimental animals in total protein 0 hour (before feeding) and 5 hours (after feeding). Total glucose 0 hour and 5 hours are not significantly (P>0.05) different across the treatments. There are significant (P<0.05) difference in blood urea 0 hours before feeding between the treatments. No significant difference (P>0.05) in blood urea 4 hours after feeding.

The Haemoglobin (Hb) concentration estimate of growing Yankasa rams fed different experimental diets in this study range from 7.80 to 9.45 g/dl which fell within the range of 9.11 to 9.87 g/dl reported by Alabi and Ososanya (2017). The Hb range in this study fell within the range of 9.0 to 15.0 g/dl reported by (Kaneko, 1997; Patra *et al*., 2003). The range value of 8.25 to 11.30 g/dl reported by Sani (2018) is in conformity with the present study. The values obtained in this study are within the normal haemoglobin range of 9.00 to 15.00g/dl for sheep as reported by Merck (1998).

The Packed cell volume range from 24.00 to 28.50% reported in this study fell below the range of 29.20 to 30.02% reported in Alabi and Ososanya (2017). It is also below the range of 35.70 to 39.10% reported by Sani (2018) and fell within the range of 20.10 to 48.00% reported for Afee-Awassi sheep by Jawasreh *et al*. (2010). The results of this study are also in consonance with the range of 27.0 to 45.0% and 25 to 30% reported by Jain (1993) and Opara *et al*. (2010), respectively.

White blood cells (WBC) was significantly affected by diets across the treatments with higher values of 7.45, 7.00 and 7.00 $x10^9$/L slightly below the range of 7.80 to 8.70 $x10^9$/L documented by Sani (2018), but within the values of 3.2 to 15.80 $x10^9$/L reported Jawasreh *et al*. (2010) and Daramola *et al*. (2005). The WBC counts in this study are within the normal range of 5 to 11 g/dl reported by Scott *et al*. (2006) for sheep. The values obtained in this study indicate that the animals are healthy and devoid of parasite in the circulatory system.

The RBC counts recorded in this study range from 9.60 to 11.40 $x10^9$/L. The values were above the range of 8.33 to 9.36 $x10^9$/L found by Sani (2018). The values tally with the range of 9.2 to 13.5 $x10^9$/l reported by Tambuwal *et al*. (2002). Similarly, the RBC count in this result was not in conformity with 4.00 $x10^9$/L reported by Asaolu *et al.* (2012) when West African Dwarf goats were supplemented with *Moringa oleifera* multi-nutrient block. The RBC count values in this study fell within the range of 9.9-18.7 g/dl documented by Taiwo and Ogunsanmi (2003).

Table 3: **Haematological and biochemical indices of Yankasa rams fed diets containing different nitrogen sources**

parameters	Diets					SEM
	1	2	3	4	5	
Haematological						
Hemoglobin (g/dl)	7.80	7.95	9.10	8.40	9.45	0.30^{NS}
Packed cell volume (%)	24.00	24.00	27.50	25.50	28.50	0.86^{NS}
White blood cell ($x10^9$/L)	5.20^{c}	6.40^{b}	7.45^{a}	7.00^{a}	7.00^{a}	0.28^{*}
Red blood cell ($x10^9$/L)	9.60	10.00	11.4	10.50	9.30	0.32^{NS}
MCV (fl)	25.00	24.00	24.12	24.29	30.65	1.18^{NS}
MCH pg	8.13	7.95	7.98	8.00	10.16	0.40^{NS}
MCHC (g/L)	3.25	3.31	3.31	3.29	3.32	0.14^{NS}
Biochemical						
Total protein (g/L)						
0 hours (before feeding)	65.50	64.00	65.00	60.50	62.50	1.00^{NS}
5 hours (after feeding)	66.00	65.00	63.50	63.50	64.50	0.75^{NS}
Total glucose (mmol/L)						
0 hours (before feeding)	4.00	3.65	3.10	3.70	4.35	0.20^{NS}
5 hours (after feeding)	2.75	2.9.00	2.95	3.05	2.80	0.05^{NS}
Urea (mmol/L)						
0 hours (before feeding)	3.15^{c}	3.20^{b}	4.10^{a}	3.30^{b}	4.05^{a}	0.14*
5 hours (after feeding)	4.40	4.10	4.65	4.10	4.40	0.11^{NS}

[a, b,]Means within each row with different superscripts are significantly different, *(P<0.05), Diet 1 = 0% urea with cottonseed cake (CSC) at 20%, Diet 2 = 0.5% Urea with CSC at 15%, Diet 3= 1.0% Urea with CSC at 10%, Diet 4 = 1.5% Urea with CSC at 5%, Diet 5 = 2.0% Urea with CSC at 0%, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), SEM standard error mean, NS= Not significant

The MCV range from 24.00 to 30.65 fl in this study and the values are within the normal range of 23 to 48 fl reported by Vojta *et al*. (2011). The values recorded in this study are within the range of 28 to 40 fl observed by Banerjee (2007) for sheep. MCV value range of 29.8 to 33.9 fl reported by Bello and Tsado (2013) fell within the range reported in this study.

The MCH range of 7.95 to 10.16 pg recorded in this research are below the range of 35.70 to 39.85 pg obtained by Garba and Adeola (2020) for Yankasa sheep but, fell with the range of 9.3 to 17.7 pg documented by Bello and Tsado (2013). The MCHC range of 3.25 to 3.32 g/L in this study was within the range of 3.15 to 4.83 g/L that was reported by Bello and Tsado (2013). Njidda *et al.*

(2014) reported MVC, MCH and MCHC of 38.00 fl, 12.90 pg and 3.39 g/L w, respectively, contrary to the values reported in this study.

Total protein 0 hours before feeding ranged from 60.50 to 65.50 g/L and 5 hours after feeding from 63.50 to 66.00 g/L in this study. The figures were higher than the range of 5.40 to 8.30 g/dl and 6.00 to 7.65 g/dl documented by Sani (2018). However, these values were within the range of 6.3 to 8.5 and 5.0 to 12.3 g dL^{-1} reported for WAD goats and Afec-Awassi sheep by Daramola *et al*. (2005) and Jawasreh *et al*. (2010), respectively.

Total glucose recorded 0 hours before feeding and 5 hours after feeding in this study ranges from 3.10 to 4.35 g/dl and 2.75 to 3.05 g/dl are relatively comparable to the range of 2.70 to 3.70 g/dl and 2.85 to 3.75 g/dl reported by Sani (2018). It was also within the range of 2.50 to 3.90 g/dl reported by Davies *et al.* (2007).

The blood urea values recorded 0 hours before feeding and 5 hours after feeding in this study range from 3.15 to 4.10 mmol/L and 4.10 to 4.65 mmol/L which all fell below the range of 6.90 to 8.90 mmol/L and 8.55 to 9.40 mmol/L reported by Sani (2018). These values fell within the range of 0.8 to 9.2 mmol/l reported by Daramola *et al*. (2005) who fed West African Dwarf goats with supplements. Complete ration is the best feeding model as it reduces problems of nutrient deficiencies in livestock fed on poor quality feed resources with no adverse effects on animal health by allowing a synchronous and fractionated supply of all essential nutrients for attaining maximum production potential (Beigh *et al*., 2017).

CONCLUSION

From the result of this study, it is concluded that inclusion of urea at graded levels at up to 2% urea in a complete diet has no detrimental effect on nutrient digestibility and blood parameters. Crude protein digestibility was excellent with total protein in blood serum within the normal range of healthy animals. Diet 3 with urea at 1% with cotton seed cake at 10% is therefore recommended for growing Yankasa rams.

REFERENCES

Abubakar, M., Adegbola, T. A., Abubakar, M. M., Shehu, Y., Ngele M. B. and Kalla, D. J. U (2010). Nutritional Evaluation of Different Sources of Nitrogen on Digestible Nutrient Intake, Nitrogen Balance and Production of Rumen Metabolites in Growing Yankasa Sheep. *Emirate Journal of Food and Agriculture,* 224 (4):298 – 307.

Adeola, E. A., Garba, Y. and Baba, M. (2021). Growth performance and *in vivo* nutrients digestibility of growing Yankasa ram lambs fed diets containing graded levels of sesame residue. *Journal of Animal Health and Production,* 9(2): 107-111.

Aimé, J. N., Suchet L. L., Sandra, S., Charles L. O. and Arthur S. (1999). Effect of Urea Treatment on Digestibility and Utilization of Sorghum straw. *Biotechnology Agronomy Society and Environment*, 3(2):78–85

Alabi, B. O. and Ososanya, T. O. (2017). Haematology and serum analysis of West African dwarf (WAD) rams fed silage combinations of maize and *Macuna pruriens* L. Foliage. *Nigerian Journal of Animal Science*, 2:190-198.

AOAC. (1990). Association of Official Analytical Chemists. Official Methods of Analysis, DC.

AOAC. (1997). Association of Official Analytical Chemists, 16th edn. Official Methods of Analysis, Washington, DC.

Asaolu, V. O., Binuomote, R., Akinlade, J., Aderinola, O. and Oyelami, O. (2012). Intake and growth performance of West African Dwarf goats fed *Moringa oleifera*, *Gliricidia sepium* and *Leucaena leucocephala* dried leaves as supplements to cassava peels. *J. Biol.Agric. Health Care,* 2(10):76-88.

Banerjee, G. C. (2007). A Textbook of Animal Husbandry, 8th Edn. Oxford & IBH Publishing Co. Pvt. ISBN 10: 8120412605 / ISBN 13: 9788120412606.

Bello, A. A. and Tsado, D. N. (2013). Haematological and Biochemical Profile of Growing Yankasa Rams Fed Sorghum Stover Supplemented with Graded Levels of Dried Poultry Droppings Based Diet. *Pakistan Journal of Biological Sciences,* 16(24)1922 – 1928.

Daramola, J. O., Adeloye, A.A., Fatoba, T. A. and Joladoye, A. O. (2005). Haematological and Biochemical Parameters of West African Dwarf Goats. *Livestock Research for Rural Development.*17:7-8.

Davies, H. L., Robinson, T. F., Roeder, B. L., Sharp, M. E., Johnston, N. P., Christensen, A. C. and Schaalje, G. B. (2007). Digestibility, Nitrogen Balance, and Blood Metabolites in Lama (*Lama Glama*) and Alpaca (*Lama Pacos*) Fed Barley or Barley Alfalfa Diets. *Small Ruminant Research,*73: 1-7.

Elkholy, M. E. H. Hassanein, E. I. Soliman, M. H. Eleraky, W. Elgamel M. F. A. and Ibraheim, D. (2009). Efficacy of Feeding Ensiled Corn Crop Residues to Sheep.*Pakistan Journal of Nutrition,* 8 (12): 1858-1867

El-Nomeary, Y. A. A., Abd El-Rahman, H. H. H., Shoukry, M. M., Abedo, A. A., Salman, F. M. and Mohamed, M. I. (2021). Effect of different dietary protein sources on digestibility and growth performance parameters in lambs. *Bulletin of the National Research Centre,* 45(40): 1-11

Hirut Y., Solomon, M and Mengistu, U. (2011). Effect of concentrate supplementation on live weight change and carcass characteristics of Hararghe Highland sheep fed a basal diet of urea treated maize stover. *Livestock Research for Rural Development,* 23(12). www.lrrd.org/lrrd23/hiru23245.htm

Jain, N. C. (1993). *Schalm's veterinary haematology*. 4thedition. Lea and Febiger, Philadelphia

Jawasreh, K., Awawdeh, F. Ban Ismail, Z., Al-Rewashed, O. and Al-majali, A. 2010. Normal Haematology and Selected Serum Biochemical Values in Different Genetic Lines of Awassi Ewes in Jordan. *International journal of veterinary medicine.*7:64-73

Jelalu, K. (2014). *Laboratory Manual and Review on Clinical Pathology.* Published by OMICS Groups eBooks. 731. Gull Ave, Foster City CA 94404, USA.

Jokthan G. E., Muhammad, S. A. and Osuhur, C. U. (2013). Effect of cottonseed cake replacement with broiler litter on performance of Yankasa rams fed maize husk basal diets. *FUTA Journal of Research in Sciences*, (1): 147-155

Kaneko, J. J. (1997). Clinical Biochemistry of Domestic Animals, fifth ed. Academic Press, New York, USA, pp. 885–905.

Khattab I. M., Salem A. Z. M, Abdel-Wahed A. M., Kewan K. Z. 2013. Effects of urea supplementation on nutrient digestibility, nitrogen utilization and rumen fermentation in sheep fed diets containing dates. *Livestock Science*. 155: 223-229

Kishore, R. K, Srinivas, K. D and Raghava, R. E. 2(017). Prospects of Total Mixed Ration (TMR) Feeding in Livestock Production. *Bulletin of Environment, Pharmacology and Life Sciences*,6 (3) 2017: 90-95

Lambourne, L. J., Mosi, A. K. and Butterworth, M.H. (1986). Relationships between chemical composition and voluntary intake of feeds by sheep and cattle. pp. 162-178. N.D.Reidder,H.V. Keulen, N.G. Seligman and P.J.H. Neat (ed.). Modeling of extensive livestockProduction systems, Addis Ababa, Ethiopia. ILCA (International Livestock Center forAfrica).

Mayomi, I. and Mohamed, I. A. 2014. A decade of assessment of Maiduguri Urban expansion (2002-2012): Geospatial approach. *Global Journal Human Science*. B. 14 (2): version 1.0

McDonald P, Edwards R. A, Greenhalgh J. F. D., Morgan, C. A. (2002). Animal nutrition. 7th ed. London: Prentice Hall; (United States).

Merck, N. J.2006. *Merck Veterinary Manual*. Merck & Co., Inc. and Merial Ltd.

Ngele, M. B. 2008. Fermentation and metabolic trends in rams fed roughages with various supplements. PhD Thesis, Abubakar Tafawa Balewa University, Bauchi, Nigeria.

Ngele, M. B., Adegbola, T. A., Bogoro, S. E. F., Abubakar, M., and Kalla, D. J. U. (2010). Nutrient Intake, Digestibility and Growth Performance of Yankasa Sheep fed Urea Treated or Untreated Rice Straw with Supplements. *Nigerian Journal of Animal Production*, 37(1)61 – 70

Njidda, A. A., Shuaibu, A. A. and Isidahomen, C. E. (2014). Haematological and Serum Biochemical Indices of Sheep in Semiarid Environment of Northern Nigeria. *Global Journal of Science Frontier Research Agricultural and Veterinary*,14(2):49-56

Opara, M. N., Udevi, N. and Okoli, I. C. (2010). Haematological Parameters and Blood Chemistry of Apparently Healthy West African Dwarf (WAD) goats in Owerri, South Eastern Nigeria. New York Science Journal, 3(8):68–72

Patra, A. K., Sharma, K., Dutta, N. and Pattanaik, A. K. (2003). Response of gravid does to partial replacement of dietary protein by a leaf meal mixture of Leucaena leucocephala, Morus alba and Azadirachta indica. Anim. Feed Sci. Technol. 109:171–182.

Sani Y. M. (2018). Replacement Value of Urea for Cotton Seed Cake as a Source of Nitrogen in the Diets of Growing Yankasa Rams. MSc Thesis, Abubakar Tafawa Balewa University, Bauchi Nigeria

Scott, J. L., Ketheesan, N. and Summers, P. M. (2006). Leucocyte population changes in the reproductive tract of the ewe in response to insemination. *Reproduction, Fertility and Development*, 18: 627-634.

Sirios, M. (1995). Veterinary Clinical Laboratory Procedure. Mosby Year Book, Inc. St. Louis, Missouri, USA.

Steel, R. G. D. and Torrie, J. H. (1980). Principles and Procedures of Statistics 2nd edition: A biometrical approach. McGraw Hill Book Company, Inc. New York.

Taiwo, V. O. and Ogunsanmi, A. O. (2003). Haematology, plasma, whole blood and erythrocyte biochemical values of clinically healthy captive-reared grey duiker (Sylvicarpa grimmia) and West African dwarf sheep and goats in Ibadan, Nigeria. *Israel Journal of Veterinary Medicine*. 58:2–3

Tambuwal, F. M., Agale, B. M. and Bangana, A. (2002). Haematological and biochemical values of apparently healthy Red Sokoto goats. In: Proceedings of the 27th Annual conference of the Nigerian Society for Animal Production (NSAP), 17–21 March 2002, Federal University of Technology, Akure, Nigeria. 50– 53.

Van Soest, P. J. (1994). Nutritional Ecology of the Ruminant. Ithaca: Cornell University Press, 476 p.

Van Soest, P. J., Robertson, J. B. and Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*, 74: 3583-3597

Vojta, A., Shek-Vugrovečki, A., Radin, L., Efendić, M., Pejaković, J., Šimpraga, M. (2011). Hematological and biochemical reference intervals in Dalmatian pramenka sheep estimated from reduced sample size by bootstrap resampling. *Veterinary Archives*, 81:25–33

Xu, Y., Li, Z., Moraes, L. E., Shen, J., Yu, Z. and Zhu, W. (2019). Effects of Incremental Urea Supplementation on Rumen Fermentation, Nutrient Digestion, Plasma Metabolites, and Growth Performance in Fattening Lambs. *Animals* 9(9)1-12; doi:10.3390/ani9090652