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EFFECT OF INTERVAL OF FEEDING ROUGHAGE AND CONCENTRATE ON THE HAEMATOLOGICAL AND BIOCHEMICAL PARAMETERS OF SOKOTO RED BUCKLING

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ABSTRACT

Fifteen (15) Sokoto Red bucklings of similar weight (5-6 months old) were used in a Completely Randomized Design (CRD) to evaluate the effect of interval of feeding roughage and concentrate on the haematological parameters and biochemical characteristics of Sokoto Red buckling at the Prof. Lawal Abdul Saulawa Livestock Teaching and Research Farm, Federal University Dutsin-Ma, Katsina State. The experiment involved three treatments (Treatment 1: concentrate and roughage were offered at the same time; Treatment 2: roughage and concentrate fed at two hour intervals; Treatment 3: roughage and concentrate fed at three hour intervals). None of the hematological and biochemical parameters measured was significantly ($P>0.05$) affected. It is concluded that interval of feeding roughage and concentrate did not reveal any negative effect on the animals' health as regards the hematological and biochemical parameters studied.

Keywords: Interval, hematological, biochemical, roughage, concentrate, buckling

INTRODUCTION

Goat production continues to play a significant role in animal protein supply in Nigeria (Aruwayo, 2018) and that small ruminants possess excellent potentials at mitigating the shortage of human protein consumption in Nigeria (Aruwayo and Muhammad, 2018). Goats are small ruminants with excellent potentials at mitigating the shortage of human protein consumption in Nigeria (Aruwayo and Muhammad, 2018). They are sources of meat for human consumption with an advantage of short gestation interval. There is also the absence of religious bias against goat products and wide acceptability in various cultures and tribes. Goats are generally kept in small herds on mixed farms and provide their owners with a broad range of products and socioeconomic services such as cash income (meat), security, gifts and manure for the crops (Chiejina and Behnke, 2011). Goats possess the capacity to survive on low quality feeds and crop residues, possess short gestation period and known for multiple birth (Aruwayo and Muhammad, 2018) while Aruwayo *et al.* (2016) reported that ruminant animals especially goats possess the capacity to thrive on poor quality roughages and agro-by products that cannot sustain other groups of livestock and are excellent browsers, hardy and possess the capacity for high turnover. However, it can be said that small ruminants are performing below the expected productive capacity. Aruwayo and Garba (2015) reported a huge gap between supply and demand for ruminant products like meat, milk, hides, skin etc. This can be attributed to myriads of challenges among which is availability

of feed and the utilization. Shellepe and Daniel (2017) reported that the major problem of goat production in northern Nigeria is inadequate nutrition caused by scarcity of feed and prevalence of poor quality roughages especially during the dry season while Aruwayo and Maigandi (2013) reported that the most important factor responsible for the gap in the relationship between the demand and supply of ruminants in Nigeria is the supply of feed both in quantity and quality. The available feed need to be efficiently utilized for optimal performance. One of the ways of achieving this is feeding of concentrate supplements which has the capacity to aid feed utilization and improves productivity of the ruminants. However, the scarcity and high cost of the concentrates nearly keep them out of the reach of the farmers.

One of the challenges that has been of great concern for ruminant production is the strategic utilization of available feed resources for optimal productivity. Farmers and researchers have been attempting to develop feeding system that will improve the utilization of the available feeds and feeding stuff. Adeleke (2015) investigated the effect of sequence and interval of feeding concentrate and roughage on Yankasa ram, and reported that interval of feeding roughage and concentrate was significant at two hours. The author recommended further study to be carried out. Hence the current study aimed at evaluating the effect of interval of feeding roughage and concentrate

supplement on the haematological parameters and biochemical characteristics of Sokoto Red bucks.

MATERIALS AND METHODS

Location of the Study

The experiment was conducted at the Prof. Lawal Abdul Saulawa Livestock Teaching and Research Farm, Federal University Dutsin-Ma, Katsina State, which is located in the Sudan Savanna ecological zone that lies between Latitude 12°27'18"N and Longitude 7°29'29"E. It is located at an elevation of 542.08 meters (1778.48 feet) above sea level, Dutsin Ma has a Subtropical steppe climate (Classification: BSh). The district's yearly temperature is 33.2°C (91.76°F) and it is 3.74% higher than Nigeria's averages. Dutsin Ma typically receives about 55.47 millimeters (2.18 inches) of precipitation and has 58.72 rainy days (16.09% of the time) annually (Weather and Climate, 2020).

Experimental Animals and Experimental Design

Fifteen (15) Sokoto Red bucklings (5-6 months of age) were used in a Completely Randomized Design (CRD) to evaluate the interval of feeding roughage and concentrate on the haematological parameters and biochemical characteristics of Sokoto Red buck that involved three treatments. In treatment 1 which served as the control; concentrate and roughage were offered at the same time. In treatment 2, the roughage was offered first then followed by concentrate after two

hours while in treatment 3, concentrate was offered three hours after feeding of roughage. The roughage and concentrate were fed at 70: 30 respectively, at 4% of live body weights.

The experimental animals were sourced from Kagadama market, Kaita local government area of Katsina State. They were quarantined for two weeks during which they were fed with roughage and concentrate for adaptation and observation for diseases infection and parasites infestation. Deworming was also done with Albendazole and Levamisole to get rid of internal parasite. Ivermectine was administered to the animal subcutaneously against external parasite and also treated with oxytetracycline (a broad spectrum antibiotics) by injection. At the end of the quarantine period, the animals were tagged, weighed for the initial body weight, and then balanced for weight as they were randomly allotted to the treatments. The animals were housed in individual pens where they were offered the experimental diets in the morning at 4% of the live body weight throughout the eighty seven days period of the feeding trial before the collection of blood samples. The leftovers were weighed the next day in the morning before being served day's diet. Water was given *ad libitum*.

Experimental Diets

The experimental diets comprised concentrate and roughage. The roughage fed was groundnut haulms, while the concentrate was composed of cotton seed cake, maize, maize offal, bone meal, and common salt.

Table 1: Ingredient Composition of Concentrate and Roughages (%)

Concentrate	Percentage	Roughage	Percentage
Maize offal	67.85	Groundnut haulms	100
Cottonseed cake	30.15		
Bone meal	1.50		
Common salt	0.50		
Total	100.00		

Blood sample collection

Bleeding was done early in the morning and 10ml blood samples were collected through the jugular vein from three randomly selected experimental animals from each of the experimental groups before offering feed to them. The blood samples were divided into two parts consisting of about 3ml of the sample which were placed in EDTA (anti-coagulant) bottle for hematological parameter analysis and 7ml put in a universal bottle and allowed to stand for about 2 hours at room temperature, centrifuged at 700xg for 15 minutes. The centrifuged the serum was

separated, decanted and stored in a deep freezer for blood biochemical parameters test.

Haematological Characteristics Determination

Whole blood samples in EDTA bottles were analyzed for hemoglobin (Hb) content using cyanomethemoglobin method (Coles, 1986). Packed cell volume (PCV), erythrocyte and leucocytes count were determined according to the methods described by Coles (1986).

Biochemical Parameters Determination

The blood urea concentration was estimated by Nessler's reaction (Tannins and Maylor, 1968). Total proteins were estimated by the Biuret method as

described by Henry and Stobel (1957). Albumin was determined by Bromo Cresol Green Method (Grant, 1987), while globulin was determined by differences between total protein and albumin. The bilirubin was determined by Colometric method described by Jendrassik and Grof (1938). Creatinine was determined by Jaffe reaction (Sarre and Nierenkrankheiten, 1959) by the use of photometric test for endpoint measurement.

Statistical Analysis

Data collected were subjected to analysis of variance using the General Linear Model procedure of SAS (SAS 2001). The treatments means were separated using Duncan Multiple Range Test.

RESULTS AND DISCUSSION

The chemical composition of the experimental diets comprising of the concentrate and the roughages is shown in Table 2.

Table 2: Chemical Composition of the Experimental Diets (%)

PARAMETERS	CONCENTRATE	ROUGHAGE
Dry matter	87.18	87.81
Crude protein	16.94	9.5
Crude fiber	5.74	34.64
Ash	7.18	6.97
Nitrogen free extract	52.69	39.02
Ether extract	17.45	9.87
Neutral detergent fibre	14.28	37.47
Acid detergent fibre	11.21	26.07

The Haematological parameters of Sokoto Red bucks fed roughage and concentrate at different intervals were shown in Table 3 None of the parameters was significantly ($P>0.05$) different.

The PCV fell between 25.67% and 26.67%, and is comparable to the value 25.7±3.1 (%) obtained for Red Sokoto goats (Tambuwal *et al.*, 2002) but lower than the values of 27.81 to 35.64% reported by Aruwayo *et al.* (2016) when Sokoto red goat was fed untreated and urea treated rice milling waste. However, reports in Baladi goats (Azab and Abdel-Maksoud 1999) and Red Sokoto goats (Tambuwal *et al.*, 2002) showed PCV values of 27.25±0.59 and 25.7±3.1 respectively.

The Haemoglobin (Hb) values obtained in this study did not differ significantly ($P>0.05$) among the treatments, the values ranged from 8.50 g/dl to 8.87 g/dl, the value were comparable with 7 –15 g/dl reported by Daramola *et al.* (2005) but higher than the values of 5 – 6 g/dl obtained by Belewu and Ogunsola (2010) for goats fed fungi-treated *Jatropha curcas* kernel cake rations. The relatively higher Hb concentration obtained in this study implies that the different interval of feeding was able to sustain hemoglobin levels that generally seemed to be capable of supporting high oxygen carrying capacity of blood in the goats. The RBC counts reported in this study (2.83 to 3.10 g/l) were very low compared to the values of 9.2 – 13.5 g/l reported by Tambuwal *et al.*

(2002), 9.9 – 18.7 g/l by Taiwo and Ogunsanmi (2003) and Aruwayo *et al.* (2007). The reduced RBC counts recorded present a likely susceptibility to anaemia-related disease conditions by these goats.

The WBC counts which reduced across the dietary treatments was within the range of 6.8 – 20.1×10⁹/l reported by Daramola *et al.* (2005) and 14.88 to 19.07 × 10⁹/l stated by Aruwayo *et al.* (2016). This implies that the goats possess moderately potent defence mechanism against any infectious agents (Daramola *et al.*, 2005). The Lymphocytes values (79.33%-82.00%) and those of neutrophils (14.33% - 18.33%) obtained in this study fell within the broad range of 47–82% and 17–52% for Lymphocytes and neutrophils, respectively (Tambuwal *et al.*, 2002; Daramola *et al.*, 2005). These values suggest that the goats used in this study had well-developed immune system (Daramola *et al.*, 2005). The Monocytes values (0.33% - 4.00%) observed in this study were also within the normal range (0-10%) reported by Tambuwal *et al.* (2002). The presence of basophils in the blood has been reported (Jain, 1993) to be an indication of a disease condition, however, the level (0.67) observed was not harmful since it is within the range of 0-3% reported by Coles (1986) for healthy goats. The level of eosinophil obtained showed that there was no harm of parasitic infection since it was within the range of 1-8% (Coles, 1986).

TABLE 3: Haematological Parameters of Sokoto Red bucks Fed Roughage and Concentrate at Intervals.

Parameters	Treatments			SEM
	T1	T 2	T 3	
Packed cell volume (%)	26.00	26.67	25.67	0.87 ^{NS}
Haemoglobin (g/dl)	8.63	8.87	8.50	0.84 ^{NS}
TRBC ($\times 10^9/L$)	2.83	3.07	3.10	0.76 ^{NS}
TWBC ($\times 10^9/L$)	13.63	10.80	14.10	0.12 ^{NS}
Neutrophil (%)	16.33	18.33	14.33	0.71 ^{NS}
Lymphocyte (%)	82.00	79.33	81.67	0.87 ^{NS}
Monocyte (%)	1.00	0.33	4.00	0.25 ^{NS}
Eosinophil (%)	0.67	0.00	0.00	0.42 ^{NS}
Basophil (%)	0.67	0.00	0.00	0.42 ^{NS}
Band (%)	0.00	2.00	0.00	0.08 ^{NS}

TRBC= Red Blood Cell, TWBC= White Blood Cell, SEM= Standard Error of Mean; NS= not significant

The biochemical parameters of the experimental animals fed concentrates and roughages are shown in Table 4. The serum biochemical parameters obtained from the study were not significantly ($P > 0.05$) affected by the Interval of feeding roughage and concentrate. Serum biochemistry analysis is used to determine the level of heart attack, liver damage and to evaluate protein quality and amino acid requirements in animals as reported by Harper *et al.* (1979). The serum total protein content (43.33 - 45.33%) obtained is within the normal range of 30-65 % for healthy goats (RAR, 2009). This implied that the different interval of feeding did not negatively affect adequate supply of protein, because total serum protein is an indicator of protein quality of feed. Albumin helps to hasten blood clot during injury, thereby reducing loss of blood. The values obtained for albumin 19.00 – 21.67 g/l are slightly lower than the normal range of 24–44 g/l in a healthy goat as reported by (Tambuwal *et al.*, 2002).

The values of aspartate aminotransferase (AST) and alanine amino transferase (ALT) obtained in this study was within the normal ranges of 124.00–143.33 iu/l and 35.33–46.00 iu/l, respectively (Sirois 1995). The AST values were higher than the values (21.02–43.78 iu/l) reported by Oloche *et al.* (2019) for Kano brown goats fed *Gmelina arborea* leaves and supplemented with diets containing water soaked sweet orange (*Citrus sinensis*) peels, while the ALT values obtained in this study were also higher than the range of 10.10–12.98 iu/l also reported by Oloche *et al.* (2019). Increased ALT values are a sign of liver disease, because it's a liver-specific hepatocellular enzyme that is used to

assess liver damage (Mahgoub *et al.*, 2008). These results indicated that the test diets did not interfere with the levels of these enzymes to pre-dispose the animals to any form of liver dysfunction or damage. The ALP values (23.00 - 39.00) were higher than 7 - 30 iu/l (Sirois 1995; Daramola *et al.*, 2005).

The blood urea nitrogen (BUN) values (20.33 - 23.00 mg/dl) obtained were within the normal range of 25-60 mg/dl (goatlink.com). In general, lower concentration of BUN is an indication of low dietary protein level or hepatic chronic disease. On the other hand, the increase of BUN could be the result of renal failure and body dehydration (Mishra *et al.*, 2013).

In this study, the creatinine levels (0.63 - 1.07) observed were lower than those reported (Mohammed *et al.*, 2016) for Black Aardi, Damascus and Barbari goats which are within the normal range (1.2-1.9 mg/dl) for goats. Mohammed *et al.* (2016) opined that differences in energy and protein content of feeds could alter the level of creatinine in the blood serum. Water deprivation could also elevated the level of creatinine in the serum of goats (Abdelatif *et al.*, 2010). The cholesterol level (3.73 – 5.00 mmol/l) is comparable to 3.10±0.27 mmol/l reported by Njidda *et al.* (2013) for Sokoto red bucks. This implies that protein offered in the feed was adequate. Esonu *et al.* (2001) stated that the serum cholesterol levels depend on the amount and quality of protein offered in the feed (Esonu *et al.*, 2001). Cholesterol levels are used to detect bile obstruction i.e. mild and progressive damage to the liver (Silanikove and Tiomkin, 1992).

TABLE 4: Biochemical Parameters of Sokoto Red Goats Fed Roughage and Concentrate at Intervals.

Parameters	Treatments			SEM
	T1	T2	T3	
TP (g/dl)	43.33	44.33	45.33	0.91 ^{NS}
Albumin (g/l)	21.67	20.67	19.00	0.91 ^{NS}
Cholesterol (mmol/l)	3.73	4.83	5.00	0.56 ^{NS}
AST (iu/l)	127.33	143.33	124.00	0.84 ^{NS}
ALT (iu/l)	35.33	46.00	43.33	0.73 ^{NS}
ALP(iu/l)	39.00	32.33	23.00	0.05 ^{NS}
Creatinine (mg/dl)	1.07	1.00	0.633	0.61 ^{NS}
BUN (g/dl)	20.33	23.00	21.00	0.88 ^{NS}

TP= Total protein; AST= Aspartate aminotransferase; ALT= Alanine aminotransferase, ALP= Alkaline phosphatase; BUN= blood urea nitrogen; SEM= Standard Error Mean; NS= not significant

CONCLUSION

It can be concluded that interval of feeding roughage and concentrate did not reveal any negative effect on the animals' health as regards the hematological and biochemical parameters studied. Therefore, concentrates and roughages can be fed together or at different intervals.

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REFERENCES

- Abaje I. B. (2007). Introduction to soils and vegetation. Kafanchan: Personal Touch Productions.
- Abbey T. K., Alhassan A., Ameyibor K., Essiah J.W., Fometu E. and Wiredu M. B. (2001). Cattle, sheep and goat production. In: Intergrated Science for Senior Secondary Schools. Unimax Macmillan Ltd., 42 Ring Road South, Industrial Area, Accra North, Ghana. pp. 356-308
- Abdelatif A. M., Elsayed S. A. and Hassan Y. M. (2010). Effect of state of hydration on body weight, blood constituents and urine excretion in Nubian goats (*Capra hircus*). *World J. Agric. Sci.* 6(2):178-188.
- Abdelatif A. M., Ibrahim M. Y. and Hassan Y. Y. (2009). Seasonal variation in erythrocytic and leukocytic indices and serum proteins of female Nubian goats. *Middle East J. Sci. Res.* 4(3):168-174.
- Adeleke R.A. (2015) Effect of Sequence and Interval of Feeding Concentrate Supplement and Roughage on Performance of Yankasa Weaner Rams. A Thesis submitted to the
- Postgraduate School, Ahmadu Bello University, Zaria, Nigeria, in partial fulfilment of the Requirements for the award of the degree of Master of Science in Animal Science.
- Adeloye A. (1998). The Nigerian Small Ruminants Species, Corporate Office, Max Press First Edition.
- Ademosun A. A., Bosman H. G. and Jansen, H. J. (1988). Nutritive studies with West African Dwarf goats in the humid tropics. In: B. Smith and H.G. Bosman (eds.) Goat production in the humid tropics. Pudoc wageningen Pp 51-61.
- Adu I. F. and Ngere L. O. (1979). The Indigenous Sheep of Nigeria. *World Review of Animal Production* 15:51-61.
- Adugna T., Roger, C. M., Arthur L. G., Tilahun, S. and Tegene, N. (2000). Nutritional constraints and future prospects for goat production in East Africa. In: The opportunities and challenges of enhancing goat production in East Africa.
- AOAC (2000). Official methods of analysis of the Association of official analytical chemist, 17th edition. Association of official analytical chemist, Arlington, Virginia, U.S.A.
- Aruwayo A (2018) Use of Urea Treated Crop Residue in Ruminant Feed, *International*

- Journal of Advances in Scientific Research and Engineering (IJASRE)*, 4(7): 54-66.
- Aruwayo A. and Maigandi S. A. (2013). Neem (*Azadirachta indica*) Seed Cake/Kernel as Protein Source in Ruminants Feed. *American Journal of Experimental Agriculture* 3(3): 482-494
- Aruwayo A., Yahaya M. A. and Garuba M. A. (2016) Biochemical and Hematological Characteristics of Growing Sokoto Red Kids fed Untreated and Urea Treated Rice Milling Waste in Katsina State. *Int'l Journal of Advances in Agricultural & Environmental Engg. (IJAAEE)* 3(2):350-352.
- Aruwayo A. and Garba M. G. (2015). Use of non-conventional feed resources in ruminants feed in Nigeria: a review. *FUDMA J. Agric & Agric.*, 1(1): 80-89.
- Aruwayo A. and Muhammad N. (2018). Nutrients digestibility, nitrogen retention and economics of Sokoto red goat (kid) fed untreated and urea treated rice milling waste. *FUDMA Journal of Sciences (FJS)*, 2(2):133-138.
- Aruwayo A., Maigandi S. A., Malami B. S. and Daneji A. I. (2007). Performance of lambs fed fore-stomach digesta and poultry litter waste. *Nig. J. Basic Appl. Sci.* 15(1&2):86-93.
- Azab M. E. and Abdel-Maksoud H. A. (1999). Changes in some haematological and biochemical parameters during pre-partum and post-partum periods in female Balami goats. *Small Ruminant Research*, 34(77-85).
- Babale D. M., Yahaya M. S., Nyako H. D. and Mbahi T. F. (2018). Nutrients Utilization and Hematological Indices of Sokoto Red Goats Fed Maize Cob Replacing Maize Bran with Cowpea Husk Basal Diet. *J. Adv. Plant Sci.*, 1: 103.
- Babatunde G. M., Fajimi, A.O. and Oyejide, A.O. (1992). Rubber seed oil versus palm oil in broiler chicken diets. Effects on performance, nutrient digestibility, haematology and carcass characteristics. *Animal Feed Science and Technology*, 35: 133-146.
- Balikci E., Yildiz A. and Gurdogan F., (2007). Blood metabolite concentrations during pregnancy and post-partum in Akkaraman ewes. *Small Ruminant Research*, 67 :(247-251).
- Banerjee G. C. (2007). A text Book of Animal Husbandry. 8th edn. Published by Raju primlani for Oxford and IBH publishing Co. Pvt. Ltd. New Delhi. Pp 1079
- Belewu, M. A., Ogunsola, F. O. (2010). Haematological and serum indices of goat fed fungi treated *Jatropha curcas* kernel cake in a mixed ration. *Journal of Agricultural Biotechnology and Sustainable Development*, 2(3): 035-038.
- Benjamin M. M. (1978). Outline of veterinary clinical pathology. 2nd edition, Iowa state University Press, Iowa, U.S.A., pp. 35-105.
- Benjamin M. M. (1989). Outline of Veterinary Clinical Pathology. 3rd edition. USA: Iowa State University Press, pp. 55-75.
- Bianca W. (1955). The effect of repeated short exposures to heat on the volume and hydration of the blood of the calf. *British Veterinary Journal*. 113:227-241.
- Campbell-Platt G. (1980). African locust bean and its West African fermented products. *Dadawa. Eco. Food Nutr.* 9:123-132.
- Carters J. O. (1994). Acacia nolotica: A tree legume out of control. In: Gutteridge, R.C, Shelton, H.M (Eds), forage tree legumes in tropical Agriculture. Pp. 338-535. CAB International, Walling Food.
- Castro A., Dhinsa D. S., Hoversland A. S., Malkus H., Rosenthal C. and Metcalf J. (1977). Serum biochemistry values in normal Pygmy goats. *Am. J. Vet. Res.* 38(12):2085-2087.
- Chiejina S. N. and Behnke J.M. (2011). The unique resistance and resilience of the Nigerian West African Dwarf goat to gastrointestinal nematode infections. *Parasites Vectors*, Vol. 4. 10.1186/1756-3305-4-12
- Cobley S. L. (1976). An Introduction to Botany of Tropical Crops. Longman group limited England. Pp 171
- Coles E. H. (1986). Veterinary clinical pathology 4th edition NB Sanders company. Harcourt Brace Jovanarich Inc.

- Daramola J. O., Adeloye A. A., Fatoba T. A., Soladoye A. O. (2003). Haematological and biochemical parameters of West African Dwarf goats. *Livestock Research for Rural Development*, 17(8).
- Deangelino J. L., Ishizuka M. M., Ribeiro L., Tucci T. V., Birgel E. H. (1990). Standard serum biochemical values of healthy goats reared in Saopaulo state. *Braz. J. Vet. Res. Anim. Sci.* 27(1)91-97.
- Dequ A., Melatu S. and Berhane G. (2009). Supplementation of iso-nitrogenous oil seed cakes in cactus (*Opuntia ficus-indica*) tef straw (*Eragrostis tef*) based feeding of Tigray Highland sheep. *Animal Feed Science and Technology*, 148(2): 214-226.
- Esonu B. O., Enenalom O. O., Udedibie A. B. I., Herbert U., Ekpore C. F., Okoli I. C. and Ihuekwumere, F. C. (2001). Performance and blood chemistry of weaner pigs fed raw mucuna (Velvet bean) meal. *Trop. Anim. Prod. Invest.* 4:49-55.
- Ewuola E. O., Falayan O. A. Cibore, F. A., Adebunmi, A. I Akinji R. A., Ogunlade J. T. and Adeneye J. A (2004). Physiological response of growing West African Dwarf goats fed groundnut shell-based diets as concentrate supplements. *BOWEN J. Agric.* 1 (1): 61-69
- Grant G. H. (1987). Etal Amino acids and protein. In: *Fundamentals of Chemical Chemistry*. Tietz N.W. (Editor), third edition, W.B Saunders Company, Philadelphia, USA, 328-329.
- Gupta A. R., Putra R. C., Saini M., Swarup D. (2007). Haematology and serum biochemistry of Chital (*Axis axis*) and barking deer (*Muntiacus muntjak*) reared in semi captivity. *Veterinary Research Comm.* 31, 801-808
- Henry R. J. and Stobel C. (1957). Determination of serum proteins by the burette reaction. *Analytical Chem.*, 92:1491.
- Hopkins B. (1983). The taxonomy, reproductive biology and economic potentials of parkia in Africa and Madagascar. *Bot. J. Linnean Press*, New York. USA pp. 25-34.310
- Jain M. C. (1993). Physiology of blood with some comments on response to disease. *Int. J. Anim. Sci.* 8:195-231.
- Jansen C. and Van Den Burg K. (2004). Goat keeping in the Tropics. In: Robert, C. (Eds.). *Digigrafi*, Wageningen Publishing, The Netherlands. Pp. 1- 96.
- Jauhari O. S. (1960). "Some observation on vegetation propagation of ziziphus muuritaria (ber) from gootees and cutting with the aid of growth regulation", *Current Science*, 29: 30-31.
- Jendrassik L. and Grof. P. (1938). Bilrubin Dertermination by Colometric Method. *Biochem.*, 2. 297:81.
- Kallah M. S., Bale, J. O, Abdullahi U.S., Muhammad I. R. and Lawal, R. (2000). Nutrient composition of Native forbs Semi-arid and Dry sub-humid savanna of Nigeria. *Animal Feed Science and Technology*. 84: 137-145.310.
- Lakpini C. A. M. (2002). Feed and feeding strategies for small Ruminant in various physiological states. In: Lakpini, C. A. M., Adamu, A.M., Ehoche, O. W. and Gefu, J. O. (Eds.). *Manual for small Ruminants production in Nigeria*. Workshop at National Animal production Research Institute.
- Lakpini C. A. M., Adamu, A. M., Ehoche, O. W. and Gefu, J. O. (2002). *Manual for small ruminant production*. National animal production research institute. vi-ix. Ahmadu Bello University, Shika, Nigeria 13th-18th January, Pp 40-48.
- Mahgoub O., Kadim L. T., Tageldin M. H., Al-Marzooqi W. S., Khalaf Q. and AmbuAli A (2008). Clinical profile of sheep fed non-conventional feeds containing phenols and condensed tannins. *Small Ruminant Research*, 78(1-3):115-122.
- Makun H. J., Daudu O. M., Otaru S. M., Barje P. P. and Ode Bile O. E. (2016). Effect of supplementation with different protein sources on the feed intake and growth in Red Sokoto and Sahelian goats. *J. Anim. Prod. Res.*, 28(1):263-274

- McDonald P., Edward R. A., Greenhalgh J. F. D. and Morgan C. A. (2002). *Animal Nutrition* (6th Edn) Prentice Hall, United Kingdom. 235-40.
- Mellado M., Olivares I., Rodriguez A. and Mellado J. (2006). Relation among blood profiles and goat diets on rangeland. *J. Appl. Anim. Res.* 30:93-98.
- Mishra A, Chatterjee U. S. and Mandal, T. K. (2013). Induction of Chronic Renal Failure in Goats Using Cisplatin: A New Animal Model. *Toxicol. Int.* 20(1):56-60.
- Njidda A. A., Hassan I. T., and Olatunji E. A. (2013). Haematological and biochemical parameters of goats of semi-arid environment fed on natural grazing rangeland of Northern Nigeria. *Journal of Agriculture and Veterinary Science.* 3(2):01-08.
- Obiozoba I. C. (1998). Fermentation of African locust bean. Text on Nutri. Quality of plant fruit. (Edn) Osagie, Eka (2000). Post-Harvest Research Unit. Dept. Biochem. Uniben. Nigeria. Pp 160-198.
- Oduye O. O. and Adadevoh B. K. (1976). Biochemical values of apparently normal Nigerian sheep. *Nigerian Veterinary Journal.* 5(1):43-50.
- Olabanji R.O., Ojebiyi, O.O., Tona, G.O. and Ologun, O. (2009). Haematological and serum biochemical response of growing rabbits fed diets containing processed mango (*Mangifera indica*). in: J.A.Akinlade., T.B.Olayeni., T.A Rafiu., A.O Akinwunmi., O.A Aderinola., O.O Ojebiyi and Odunsi, A.A (eds.) Global Economic Recession and the Challenges to Livestock Production in Nigeria. Proceedings of the 14th annual conference of Animal Science Association of Nigeria held at Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria: 170 – 173311.
- Oloche J., Atooshi M. Z. and Tyokase M. U. (2019). Growth performance and blood profile of West African Dwarf (WAD) goats fed varying levels of treated sweet orange peels. *Trop Anim Health Prod* **51**, 131–136.
- Olusanya S. K., Edewor E. E., and Health E. (1976). Studies on the blood chemistry and other haematology parameters in buffaloes in a ranch in Nigeria. *Nigerian Veterinary Journal,* 5(1):27-31.
- Opara M. N., Udevi N., and Okoli I. C., 2010. Haematological Parameter and Blood Chemistry of Apparently Healthy West African Dwarf (WAD) goats in Owerri, South Eastern Nigeria. *New York Science Journal,* 3 (8), 68–72.311
- Research Animal Resource [RAR] (2009). Reference values for laboratory animals: Normal haematological values. RAR Websites, RAR, University of Minnesota. Retrieved from <http://www.ahc.umn.edu/rar/refvalues.html>
- Sakha M., Shamesdini M. and Mohamad-zadeh F. (2009). Serum biochemistry values in Raini goat of Iran. *Internet J. Vet. Med.* 6:1-6.
- Sandabe U. K., and Chaudhary S. U. R. (2000). Effect of environmental temperature on some biochemical values in female Sahel goats. *Pak. Vet. J.,* 20(1):10-12.
- Sarre H. and Nierenkrankheifen, T. (1959). Jaffe reactions: Photometric colometric test for end point measurement. *Biochem Zeitschr.* 291:354.
- Sellepe, E. C. and Nyako H. D. (2017). Performance of Red Sokoto Goat Kids Fed Different Protein Supplements Under Semi Intensive System. *Journal of Animal and Veterinary Sciences.* 4(4): 25-29.
- Silanikove N. and Tiomkin D. (2010). Toxicity induced by poultry litter consumption: effect on measurements reflecting liver function in beef cows. *Animal Science* 54(02):203 – 209.
- Sirois M. (1995) *Veterinary clinical laboratory procedure.* Mosby Year Book Inc., St Louis, MO, p 160
- Solaiman S. G., Gurung N. K., McCrary Q., Goyal H. and McElhenney W. H. (2009). Feeding performance and blood parameters of male goat kids fed Easiflo cottonseed. *Small Rumin. Res.* 81(2-3):137-145.
- Statistical Analysis System, (2001). *Statistical Users Guide.* SAS Institute Inc. Cary, North Carolina, U.S.A.

- Taiwo V. O. and Ogunsanmi A. O. (2003). Haematology, plasma, whole blood and erythrocyte biochemical values of clinically healthy captive reared grey duiker (*Sylvicapra grimmia*) and West African dwarf sheep and goats in Ibadan, Nigeria. *Israel J Vet Med*, 5:43-47
- Tambuwal F.M., Agale B.M. and Bangana A. (2002). Haematological and Biochemical values of apparently healthy Red Sokoto goats. Proceeding of 27th Annual Conference Nigeria Society of Animal Production (NSAP), March, FUTA, Akure, Nigeria. Pp. 50 - 53.
- 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.
- Tannis R. J. and Maylor A. W. (1968). Physical and Chemical studies of low molecular weight form of cheese. *Biochem. J.*, 108:771.
- Thiang C. M., Sanh M. V. and Wiktorsson H. (2008). Effect of supplementation of mixed cassava and legume fodder on rumen degradability and performance of growing cattle. *Asian-Australian Journal of Animal Science*, 5 (4): 216-226.
- Tukur R., Adamu G. K., Abdulrahid I. and Rabi'u M. (2013). Indigenous trees inventory and their multipurpose uses in Dutsin-Ma area, Katsina State. *European Scientific Journal*, 9(11), 288-300.
- Turner K. E., Wildeus S. and Collins J. R. (2005). Intake, performance and blood parameters in young goats offered high forage diets of lespedeza or alfalfa hay. *Small Rumin. Res.* 59:15-23.
- Weather and Climate (2020). Dutsin-Ma Climate Summary. Dutsin Ma, Katsina, NG Climate Zone, Monthly Averages, Historical Weather Data (tckctck.org).
- Yahaya Y., Muhammad I.R. and Garba Y. (2009). Survey of Plants used as Milk Enhancers in Birnin Gwari Local Government Area, Kaduna State, in Olojede, A.O, Okoye, B.C, Ekwe, K.C, Nwachukwu, I.N and Alawode, O. (eds). Global Food Crisis and Nigerian Agriculture. Proceedings of the 43rd annual conference of Agricultural Society of Nigeria held at National Universities Commission and Raw materials Research and Development Council, Abuja, Nigeria: 1018 – 1021.
- Zemmenlink G. (1999). Utilization of poor quality roughages in Northern Guinea savanna Zone. A paper presented at the proceeding of the International symposium on Animal production in the topics held at University of Ibadan 26th -29th March 1973. Edited by J.K. Loosli, V.A. Oyenuga and G.M. Babatunde (1999), Printed by Heinaman Educational Book Nigeria PLc. Ibadan Nigeria.