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SHORT CUMMUNICATION
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Evaluation of Physiological and Hemato-Biochemical Parameters of Red Sokoto Goats Undergoing Rumenotomy

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ABSTRACT

This study evaluated the physiological, hematological, and biochemical changes in Red Sokoto goats undergoing rumenotomy. Five healthy (N=5) Red Sokoto bucks, aged 6 months to 1 year and weighing 10–15kg, were utilized for the study. The goats underwent rumenotomy after being prepared and anaesthetized, and their normal physiological clinical parameters including rectal temperature, pulse and respiratory rates were evaluated. Other physiologic indices evaluated were; packed cell volume, hemoglobin, red and white blood cells count, differential neutrophils, lymphocytes, and serum biochemical markers which includes; ALT, AST, ALP, BUN, creatinine, and glucose. These parameters were evaluated at baseline (pre-surgery) and immediately post-surgery, then subsequently at days 2, 7, and 14. The physiological parameters fluctuated within the normal range. There was no significant difference between baseline and postoperative values ($P>0.05$). There was a decreasing trend in the mean PCV, Hb, and RBC before and after the rumenotomy but it was not significant. The total WBC and differential leukocyte counts pre and postoperative have no significant changes ($P>0.05$), and the mean values were within normal physiologic reference limit. There were no remarkable changes ($P<0.05$) observed in all the selected serum biochemical indices evaluated, except for BUN between days 0 and 7, and the mean values were within the normal range. This study demonstrates that rumenotomy in Red Sokoto goats did not elicit significant systemic physiological, hematological and biochemical alterations. These findings underscore the importance of meticulous perioperative management in minimizing surgical stress and associated complications. This finding provides valuable insights into the goats physiological, hematological and biochemical responses to rumenotomy, thereby contributing to advancements in veterinary surgical techniques and enhancing animal welfare.

Keywords: Rumenotomy, Red Sokoto Goats, Physiological, Hematological, Biochemical.

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INTRODUCTION

Goat production constitutes a cornerstone of livelihood for many rural communities, and significantly enhances household nutrition and health. Goat rearing is a crucial component of food security and provides a vital source of income for rural households and subsistence farmers (Ahamefule et al., 2012). Rumen impaction is a pathological condition characterized by the accumulation of non-biodegradable substances within the major compartment of the ruminants' stomach. This leads to impaction of the rumen, causing tympany of the rumen, and other gastrointestinal abnormalities as reported by Priyanka and Dey (2018); Ahmad et al. (2023); Nev et al. (2024). In Nigeria, ruminants that are managed extensively within the urban and sub-urban settlements are mostly susceptible to ingestion of foreign materials (pica) (Remi-Adewunmi et al., 2004; Martin et al., 2021). It is hypothesized that the ingestion of foreign materials by ruminants may result from inadequate dietary provisions by their owners, potentially

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prompting them to consume non-nutritive substances to meet their nutritional needs (Martin et al., 2021; Ahmad et al., 2023). Rumenotomy, defined as incision into the rumen, is currently the only effective method of treatment for rumen impaction following plastic foreign bodies accumulation in the rumen (Boodur et al., 2010). Blood serves as a critical indicator of an animal's physiological status, reflecting exposure to toxicants and other adverse conditions (Togun et al., 2007). Hematological analyses are essential for diagnosing diverse diseases and assessing the degree of damage caused by blood disorders to bodily systems (Olaifa and Opara, 2011). Furthermore, serum chemistry provides valuable insights into animal health by evaluating metabolites and other body fluid components that are significantly influenced by pathological, dietary, biological, and environmental stressors (Afolabi et al., 2010; Opara et al., 2010). Beyond disease diagnosis, the examination of blood constituents offers crucial information for disease prognosis. This is because physiological alterations invariably lead to corresponding changes in blood components (Elsa and Onyeyili, 2002; Togun et al., 2007; Akinrinmade and Akinrinde, 2021). Whilst studies have examined hematological profiles in clinically healthy Red Sokoto goats and those with rumen impaction (Elsa and Onyeyili, 2002), comprehensive research on the physiological, hematological, and biochemical effects of rumenotomy, particularly in the absence of foreign body impactions, remains limited despite its clinical significance, especially in Red Sokoto goats. This study sets out to investigate and characterize the physiological, hematological, and biochemical profiles of Red Sokoto goats following rumenotomy performed in an experimentally healthy subject without rumen impaction. The findings of this investigation are expected to provide valuable baseline data, facilitating the identification of potential complications and the development of appropriate therapeutic interventions.

MATERIALS & METHODS

Experimental Animals

A total of five apparently healthy Red Sokoto goats (bucks) aged 6 months to 1 year, weighing between 10-15kg, were used. The goats were acquired from the University farm and Transported to the experimental facility where the research was conducted. The goats were conditioned for period of 14 days prior to the commencement of the experimental procedures. The bucks were fed on bean husk and wheat bran, and clean drinking water was provided *ad libitum*. Pre-Surgical evaluation was performed by determination of vital parameters (temperature, pulse rate, respiratory rate) and blood samples were taken and recorded before the procedure which served as baseline data. Feed and water were withdrawn from the experimental animals for 12 and 6h, respectively, prior to surgery to decrease the chances of regurgitation as described by Abubakar et al. (2014); Abubakar et al (2025). The goats were properly restrained, and the left para lumbar region was shaved and cleaned to disinfect the area with 0.3% chlorhexidine gluconate (purit(R), Saro Lifecare Limited, Ibadan, Nigeria) and surgical spirit (Quick Aid(R), Mecad Pharmaceutical Limited, 5, Alhaji Sheikh Street, Owode, Lagos state, Nigeria) and covered with povidone-iodine (Wosan®, Jawa International Limited, Lagos, Nigeria). The goats were sedated with xylazine hydrochloride at 0.05mg/kg through intramuscular route. While regional analgesia of the flank was performed using an inverted "L" block technique with 2% lidocaine HCl (Malven®, Pharmax India PVT. Limited, Mumbai, India) at dose rates of 2mg/kg in order to achieve the desensitization of the flank according standard procedure described by Abubakar et al. (2025).

Surgical Procedure (Rumenotomy)

The laparotomy incision was made directly on the skin of the aseptically prepared left flank, followed by dissection through the subcutaneous and abdominal musculature to expose the peritoneum according to standard procedure described by Baird (2013), Dharmaceelan et al. (2017) and Frattina et al. (2024). Once the peritoneum was opened, the rumen was exteriorized, and the less vascularized area was identified. The rumen was secured prior to the incision (Niehaus, 2008; Maroney, 2023). Fixation was achieved using four holding sutures to affix the rumen to the skin at the dorsal, ventral, cranial, and caudal aspects of the incision, followed by the removal of ruminal contents. The rumen was sutured using Lambert pattern over sawn with simple continues pattern, using chromic catgut size 2.0 (Lifecare(R) Anhu Kangning Industrial Group, Co. Ltd., Tianchang City, Anhui, China), the abdominal muscles and subcutaneous layer were sutured using a simple continuous suture pattern with chromic catgut size 1.0 (Lifecare(R) Anhu Kangning Industrial Group, Co. Ltd., Tianchang City, Anhui, China). Finally, the skin was sutured using a Ford-interlocking suture pattern with size 2.0 nylon (Lifecare(R) Anhu Kangning Industrial Group, Co. Postoperative antibiotics (amoxicillin 15mg/kg), a multivitamin 1mL/10kg, and diclofenac sodium 2.5mg/kg were administered intramuscularly for 5 days post-surgery, and the wound was dressed daily for 1 week post-surgery. The wound healed by primary intention, and the sutures were removed two weeks after the surgery. There were no complications observed, and all the goats survived both the postsurgical period and beyond.

Data Collections

The physiologic parameters (temperature, pulse, and respiratory rates) were recorded on day 0 and postoperative days 2, 7, and 14. Five (5 mL) of blood was collected from the experimental animals through jugular venipuncture using a syringe and needle at baseline (pre-operative), and at days 2, 7, and 14 postoperatively as described by Ahmad et al. (2025). The collected blood was then transferred to an EDTA bottle (3mL) for complete blood count analysis and to a plain bottle (2mL) for serum biochemistry analysis. Hematological indices evaluated were packed cell volume, hemoglobin, red and white blood cells, neutrophils, and lymphocytes using an automatic hematology analyzer (Model: HB7021, Voltage: 220V, Power 200VA, Fuse: F2AL250V, PEC MEDICAL, Date: 21-05-21). The blood samples were transferred to plain bottles and allowed to

clot for two hours at room temperature and centrifuged at 1000×g for 20min using a Laboratory Centrifuge (Model: 800, Voltage: 220V, Cycles50C/S, Current 0.5AMP, Ex-Factory 90.12, made in the People Republic of China) to harvest the serum. Some biochemical markers (ALT, AST, ALP, BUN, Creatinine and Glucose) were assessed at baseline (day 0) and post-surgery (days 2, 7, and 14). Day 0 denotes the time directly preceding the operation.

Data Analysis

Data derived from temperature, pulse rate, respiratory rate, PCV, hemoglobin, RBC, WBC, neutrophils, lymphocytes, monocytes, eosinophils, basophils, ALT, AST, ALP, creatinine, BUN, and glucose at days 0, 2, 7, and 14 were expressed as mean ± standard error of mean and subjected to one-way ANOVA. The analysis was conducted using Invivostat version 4.10.

RESULTS

The mean±SEM of rectal temperature, pulse, and respiratory rates are presented in Table 1. Both pre and post-rumenotomy mean values were within the normal range and were not significant (P>0.05), for rectal temperature, pulse, and respiratory rates. Table 2 details the mean ± SEM of the hematological parameters: packed cell volume (PCV), hemoglobin (Hb), total erythrocyte count (TEC), total leukocyte count (TLC), and neutrophil, lymphocyte, monocyte, and eosinophil counts. A decrease in the mean values of PCV, Hb, and TEC was noted post-rumenotomy in comparison to the pre-rumenotomy values. However, none of the values were statistically significant and remained within the normal range. There was no significant difference (P<0.05) in the total and differential leukocyte counts at different pre and postoperative periods, and all the mean values remained within the normal reference range. The mean ± SEM of selected biochemical parameters, including ALT, AST, ALP, creatinine, BUN and glucose, are presented in Table 3. There were no significant differences (P<0.05) observed in any of the parameter except, BUN between days 0 and 7, and the mean values were within the normal range.

DISCUSSION

Changes in physiological parameters, hematological indices and serum biochemical profiles after surgical procedures involving omentum and rumen have been documented in both large and small ruminants as reported by Dehghani et al. (2000), Elsa and Onyeyeli (2002), AL-Zghoul et al. (2008), and Saidu et al. (2022).

The absence of significant variations in the mean values of rectal temperature, pulse rate and respiratory rates across the different pre and post-rumenotomy, suggesting that, the procedure could not have any impact on the vital signs as they remained within the normal physiological range. These findings align with those of Saidu et al. (2022), who reported no significant changes in the mean values of rectal temperature, respiratory rate, and heart rate in Kano Brown goats that underwent rumenotomy using different stress-inducing restraints, namely standing and lateral recumbency.

A non-significant decrease in the levels of PCV, Hb, and RBCs was observed across the various post-rumenotomy periods. Elsa and Onyeyeli (2002) reported a significant decrease in haematocrit, hemoglobin, and red blood cell counts in Red Sokoto goats with rumen impaction. Similarly, Akinrinmade and Akinrinde (2012) documented decreases in PCV, Hb, and RBC values in West African Dwarf goats

Table 1: The mean physiological parameters (Temperature, Pulse and Respiratory rates) of goats undergoing rumenotomy

Parameters	Days			
	Control	2	7	14
Temperature (°c)	39.20±0.28	39.60±0.30	37.88±0.52	38.36±0.63
Pulse Rate(beat/min)	79.20±2.06	71.60±4.58	76.00±4.73	84.00±6.81
Respiratory Rate(cir/min)	28.40±1.75	27.40±0.87	24.40±4.58	22.40±1.60

All the values within the rows are not significant (P>0.05).

Table 2: The mean hematological parameters of goats undergoing rumenotomy

Parameters	Days			
	Control	2	7	14
Packed Cell Volume (%)	25.00±0.84	23.40±0.40	23.20±2.71	22.8±2.62
Hemoglobin(g/dl)	8.26±0.45	8.04±0.89	7.70±0.83	7.26±0.82
Red Blood Cells (×10^6/mm^3)	10.50±0.72	10.11±0.42	10.16±1.74	8.85±0.90
White Blood Cells (×10^6/L)	15.42±1.43	13.04±0.84	14.65±1.83	11.83±0.72
Neutrophils(×10^9/L)	5.23±0.74	3.79±0.51	4.53±0.94	4.414±1.18
Lymphocyte (×10^9/L)	9.36±0.88	8.35±1.00	9.24±1.15	6.76±1.03
Monocyte (×10^9/L)	0.35±0.11	0.27±0.04	0.51±0.10	0.19±0.07
Eosinophils (×10^9/L)	0.46±0.08	0.64±0.15	0.38±0.10	0.44±0.03

All the values within the rows are not significant (P>0.05).

Table 3: The mean biochemical parameters of goats undergoing rumenotomy

Parameters	Days after surgery			
	Control	2	7	14
Alanine Amino Transferase (u/L)	51.70±11.72	39.98±8.12	58.75±9.84	79.52±19.97
Aspartate Transaminase (u/L)	114.76±6.17	125.28±20.91	272.62±90.96	142.58±35.33
Alkaline Phosphatase (u/L)	55.20±3.80	61.72±3.92	74.52±11.51	80.59±12.17
Creatinine (µmol/L)	160.65±33.62	146.50±26.72	210.45±31.10	115.53±10.89
Blood Urea Nitrogen (mmol/L)	10.70±0.60[a]	10.77±0.62	17.58±1.95[b]	16.06±2.89
Glucose (mmol/L)	3.21±0.13	3.06±0.14	7.53±2.49	7.51±2.59

All the values within the rows are not significant (P>0.05), except BUN.

suffering from impacted non-biodegradable materials in their rumen. In contrast, Akinrinmade and Akinrinde (2012) also noted significantly higher ($P<0.05$) mean values of PCV, RBC, Hb, mean corpuscular volume (MCV), and mean corpuscular hemoglobin concentration (MCHC) in goats without impacted foreign bodies (WFBR) compared to goats with foreign body rumen impaction (FBR). The lower values of PCV, Hb, and RBC observed in goats without foreign body impaction in this study could be attributed to blood loss during the surgical procedure (Salisu et al., 2024).

In this study, no significant changes were observed in the total and differential leukocyte counts, indicating a lack of meaningful variations in these parameters at different time points before and after the rumenotomy procedure in goats. Importantly, all measured leukocyte counts remained within the established normal reference range for goats throughout the study, suggesting that rumenotomy does not elicit significant systemic inflammatory or immune responses. Elsa and Onyeyeli (2002) reported no significant difference in the total and differential leukocyte counts in healthy red Sokoto goats without impactions. Similarly, these findings are consistent with those reported by previous researchers who studied West African Dwarf (WAD) goats (Daramola et al., 2005; Opara et al., 2010; Akinrinmade and Akinrinde, 2012; Alimi et al., 2020). Additionally, most of the differential leukocytes were composed of lymphocytes and neutrophils, aligning with the typical leukocyte profile of goats (Salisu et al., 2024).

There were no significant differences in serum ALT, AST, ALP, creatinine and glucose concentrations before and after rumenotomy in goats. However, a significant variation ($P<0.05$) was observed in the mean values of serum BUN.

In agreement with our findings, Dehghani et al. (2000) reported a significant increase ($P<0.05$) in blood urea nitrogen levels following exploratory laparotomy in goats, which may be attributed to the catabolic breakdown of tissues resulting from trauma, indicative of pre-renal azotaemia.

Similarly, Onah et al. (2014) also reported a significant ($P<0.05$) increase in the mean BUN values, creatinine concentrations, and serum AST activities following both peritoneum-sutured and non-sutured laparotomy techniques in omentopexed WAD goats, indicating catabolic breakdown of tissues and muscle degeneration post-surgery. Furthermore, AL-Zghoul et al. (2008) observed elevated mean BUN, creatinine and serum AST activities following elective castration in sheep.

Serum glucose levels showed a notable increase on days 7 and 14 following rumenotomy compared to pre-rumenotomy values. Previous studies have similarly reported elevated blood glucose levels after surgery (Udegbunam et al., 2012; Omeh et al., 2021). This increase is attributed to the release of cortisol and catecholamines in response to surgical stress and pain, which stimulate glucose production through hepatic glycogenolysis and gluconeogenesis (Sahir & David, 2005). Furthermore, the magnitude of the glucose rise appears to correlate with the severity of surgical injury and the degree of stress experienced by the animals (Omeh et al., 2021).

Conclusion

This study demonstrates that rumenotomy in Red Sokoto goats did not elicit significant systemic physiological, hematological and biochemical alterations. These findings underscore the importance of meticulous perioperative management in minimizing surgical stress and associated complications. The investigation provides valuable insights into the goat's physiological, hematological and biochemical responses to rumenotomy, thereby contributing to advancements in veterinary surgical techniques and enhancing animal welfare. Despite the limitations inherent in a small sample size and the absence of statistically significant differences for most parameters, further research is imperative to corroborate these preliminary findings. Future investigations should incorporate larger sample sizes, encompass a wider array of biomarkers, and encompass a broader range of goat breeds to refine and optimize surgical protocols for rumenotomy in both clinically healthy animals and those experiencing foreign body rumen impactions.

DECLARATIONS

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Conflict of Interest: The authors declare no conflicts of interest.

Data Availability: The data presented in this research are available from the corresponding author upon reasonable request, provided it will be appropriately utilized.

Ethics Statement: Approval for the use of goats was obtained from the Faculty Research Ethics Committee (FAREC), reference: no. UDUS/FAREC/2023/AUP-R0-10. The experimental manipulations were performed in accordance with international standards, as outlined in the ARRIVE guidelines.

Author's Contribution: USA and YHD conceived and designed the experiment. USA, YHD, HAB, NA, and ZS performed the study, and conducted lab analyses. AAA and USA supervised and coordinated the experiments and provided clinical data. USA and AAA performed statistical analyses of experimental data. AAA and USA prepared the draft of the manuscript. All authors critically revised the manuscript and approved the final version.

Generative AI Statement: The authors declare that no Gen AI/DeepSeek was used in the writing/creation of this manuscript.

REFERENCES

Abubakar, A.A., Andeshi, R.A., Yakubu, A.S., Lawal, F.M., and Adamu, U. (2014). Comparative evaluation of midventral and flank laparotomy approaches in goat. *Journal of Veterinary Medicine,* 2014, 920191. https://doi.org/10.1155/2014/920191

Abubakar, N., Yakubu, A.S., Buhari, S., Abubakar, A.A., Ismaila, M.S., Bodinga, H.A., Nawawi, H.Y., Dahiru, A., Zaid, S., Ahmad, U.S., Uwais, U.A., and Zaki, K. (2025). Comparative loco-regional analgesia using lidocaine alone and lidocaine-tramadol mixture on some physiological parameters in goats undergoing rumenotomy. *Journal of Animal Health and Production,* 13(1), 113-117. https://dx.doi.org/10.17582/journal.jahp/2025/13.1.113.117

Afolabi, K.D., Akinsoyinu, A.O., Olajide, R., and Akinleye, S.B. (2010). Hematological parameters of the Nigerian local grower chickens fed varying dietary levels of palm kernel cake. *Proceedings of 35th Annual Conference of Nigerian Society for Animal Production*: 247.

Ahmad, U.S., Abubakar, A.A., Bodinga, H.A., Abubakar, N., Oviawe, E.I., Shehu, Z., and Mayaki, A.M. (2023). Rare cases of rumen impaction in two Sokoto Gudali calves. *Advances in Animal and Veterinary Sciences*, 11(11), 1854-1858. https://dx.doi.org/10.17582/journal.aavs/2023/11.11.1854.1858

Ahmad, U.S., Hassan, A.Z., Emmanuel, E.G., Sani, M.A., Anafi, F.O., and Abubakar, A.A. (2025). Haematological and histological evaluation of camel bone as a potential orthopaedic biomaterial. *Journal of Animal Health and Production,* 13(1), 129-136. https://dx.doi.org/10.17582/journal.jahp/2025/13.1.129.136

Ahamefule, F.O., Odilinye, O., and Nwachukwu, E.N. (2012). Milk yield and composition of Red Sokoto and West African Dwarf does raised intensively in a hot humid environment. *Iranian Journal of Applied Animal Science,* 2(2), 143-149.

Akinrinmade, J.F., and Akinrinde, A.S. (2012). Hematological and serum biochemical indices of West African Dwarf goats with foreign body rumen impaction. *Nigerian Journal of Physiological Sciences,* 27, 83–87.

Akinrinmade, J.F., and Akinrinde, S.A. (2021). Prevalence of rumen impaction with non-biodegradable materials in cattle in Ibadan, Nigeria. *Nigerian Journal of Animal Production*, 39(1), 211–217. https://doi.org/10.51791/njap.v39i1.2278

Alimi, O.A., Abdulwahab, W.F., Amid, S.A., Abdulkadir, S.Z., Lawal, F.M., Aliyu, A., Adediran, S.O., Ajadi, A.A., Bolaji, B., Uthman, H.O., and Adeyanju, J. B. (2020). Hematological prediction study of peritonitis following laparotomy in goats. *Journal of Veterinary Medical Sciences,* 82(5), 531–535. https://doi.org/10.1292/jvms.19-0552

Al-zghoul, M.B.F., Al-rukibat, R.K., Talafha, A.Q., Ababneh, O., and Bani Ismail, Z.A. (2008). Cellular and some biochemical changes in blood and peritoneal fluid constituents in Awassi lambs following elective castration. *American Journal of Animal and Veterinary Sciences,* 3(1), 23-27. https://doi.org/10.3844/ajavsp.2008.23.27

Baird, A.N. (2013). Bovine gastrointestinal surgery. In D. A. Hendrickson & A. N. Baird (Eds.) Turner and McIlwraith's techniques in large animal surgery (4th ed., pp. 212–219). Wiley Blackwell.

Boodur, P., Sivaprakash, B.V., Kasaralivar, V.R., & Dilip, D. (2010). Methylene blue reduction test in cattle affected with rumen impaction due to plastics. *Journal of India Poly Vet,* 11(2), 184–188.

Daramola, J.O., Adeloye A.A., Fatoba, T.A., and Soladoye A.O. (2005). Hematological and biochemical parameters of West African Dwarf goats: *Livestock Research for Rural Development*. 17(8) 21-27.

Dehghani, S., Nazifi, S., and Barzegar, M.R. (2000). Evaluation of cellular and biochemical parameters of blood and peritoneal fluid following exploratory laparotomy in the goat. *Journal of Veterinary Medicine Series A: Physiology, Pathology, Clinical Medicine, 47*, 143–148. https://doi.org/10.1046/j.1439-0442.2000.00269.x

Dharmaceelan, S., Kumaresan, A., & Devi, K. (2017). Surgical management of Ruminal Impaction in a goat. *Intas Polivet*, *18*(2), 329-330.

Elsa, A.T., and Onyevili, P.A. (2002). Haematology of the Red Sokoto goats with rumen impaction. *Online Journal of Biological Sciences, 2*(8), 522–523. https://doi.org/10.3923/jbs.2002.522.523

Frattina, L., Carbonari, A., Burgio, M., Giannini, F., Locantore, F., Rizzo, A., and Cicirelli, V. (2024). Ovariectomy in mouflons under field conditions: a comparative assessment of midventral and flank laparotomy approaches. *Frontiers in Veterinary Science*, *11*, 1405847. https://doi.org/10.3389/fvets.2024.1405847

Martin, S., López, A.M., Morales, M., Morales, I., Tejedor-Junco, M.T., and Corbera, J.A. (2021). Rumenotomy in small ruminants–a review. *Journal of Applied Animal Research*, 49(1), 104-108. https://doi.org/10.1080/09712119.2021.1894156

Maroney, M. (2023). Rumenotomy: Approaches and practical aspects. In *American Association of Bovine Practitioners Conference Proceedings* (pp. 59-62). https://doi.org/10.21423/aabppro20238744

Nev, T.O., Orakpoghenor, O., Aondowase, U., and Terfa, A.J. (2024). Comparative Hematological Responses in Rumenotomy: Impact of Diazepam and Xylazine Pre-medication in West African Dwarf Goats Undergoing Propofol Anaesthesia. *Journal of Research in Veterinary Sciences*, 2(4), 152-152. https://doi.org/10.5455/JRVS.20240329022137

Niehaus, A.J. (2008). Rumenotomy. *The Veterinary Clinics of North America: Food Animal Practice*, 24(2): 341-347.

Olaifa, A.K. and Opara, N.M. (2011). Haematological and Biochemical parameters of West African Dwarf bucks castrated by burdizzo method. *Veterinarski Archive,* 81, 743– 750.

Omeh, C. N., Udegbunam, I. R., Eze, C. A and Okereke, N. H. (2021). Effects of rumenotomy plus infusion of two saline crystalloid solutions on serum biochemical parameters and erythrocyte osmotic fragility of West African dwarf goats. *East African Medical Journal,* 98(1), 3348- 3364.

Onah, J. A., Eze, C A., Aba, P. E., Ukwueze, C. O. and Odo, R. I. (2014). Blood and serum biochemistry of omentopexed West African dwarf (WAD) goats following peritoneum sutured and not sutured Slaparotomy. *Animal Research International*, 11(1): 1881-1888.

Opara, M.N., Udevi, N. and Okoli, I.C. (2010): Hematological parameters and blood chemistry of apparently healthy WAD goats in Owerri, South eastern Nigeria. *New York Science Journal,* 3 (8), 68- 72.

Priyanka, M., and Dey, S. (2018). Ruminal impaction due to plastic materials-An increasing thread to ruminant and its impact on human health in developing countries. *Veterinary World*, 11(9), `1307-1315. https://doi.org/10.14202/vetworld.2018.1307-1315

Remi-Adewunmi, B.D., Gyang, E.O., and Osinowo, A.O. (2004). Abattoir survey of foreign body rumen impaction in small ruminants. *Nigeria Veterinary Journal*, 25, 32-38. https://doi.org/10.4314/nvj.v25i2.3472

Sahir, S., and David, J. (2005). Perioperative electrolyte and fluid balance. *Continuing Education in Anaesthesia, Critical Care and Pain, 5*(5), 159–163. https://doi.org/10.1093/bjaceaccp/mki042

Salisu, A.U., Abdul, A.A., Salisu, B., Salisu, A.M., Sadiq, Y.A., and Charles, M.P. (2024). Haemato-biochemical response to Kirschner pin and improvised chrome vanadium long screw used for the stabilization of femoral fracture in goats. *Journal of Applied Veterinary Sciences, 9*(2), 79-86. https://dx.doi.org/10.21608/javs.2024.262263.1307

Saidu, A.M., Fadason, S.T., Ochube, G.E., and Adamu, S. (2022). Rumenotomy-induced stress of standing and lateral recumbency restraints based on physiologic parameters and interleukin-6 expressions in Kano-Brown goats. *Journal of Veterinary and Biomedical Sciences, 4*(2), 10–24. https://doi.org/10.36108/jvbs/2202.40.0220

Togun, V. A., Oseni, B. S. A., Ogundipe, J. A., Arewa, T. R., Hammed, A. A., Ajonijebu, D. C., Mustapha, F. (2007). Effects of chronic lead administration on the haematological parameters of rabbits – a preliminary study. In: *Proceedings of the 41st Conferences of the Agricultural Society of Nigeria,* pp: 341.

Udegbunam, R.I., Agu, N.N., and Udegbunam, S.O. (2012). Efficacy of piroxicam on acute pain induced by full thickness excision wounds in rats. *African Journal of Pharmacy and Pharmacology, 6*(22), 1668–1674. https://doi.org/10.5897/AJPP12.113