JOURNAL OF VETERINARY AND APPLIED SCIENCES
VOLUME 14, ISSUE 1: 634 – 643 (2024)
Published by: Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria
ISSN: 2315-6856; e-ISSN: 2636-5553; Website: www.jvasonline.com

Serum biochemistry profile of West African Dwarf goats given normal saline or 5% dextrose saline infusions peri-operatively during rumenotomy

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Abstract

Rumenotomy is usually indicated in ruminants to relieve rumen impaction and other obstructive disorders of the rumen or fore-stomach. The effects of peri-operatively administered normal saline or 5% dextrose saline infusions on the serum biochemistry profile of goats was investigated in this study. Fifteen West African Dwarf (WAD) goats, randomly assigned to three groups (n = 5), were used for the study. Groups 1 and 2 received a total of 300 ml of Normal saline and 5% Dextrose saline, respectively across three days peri-operatively, while Group 3 served as the Control that was not given any infusion. Rumenotomy was done on all the goats. Pre- and post-rumenotomy blood glucose and serum levels of total protein, urea, chloride, sodium, potassium, calcium and bicarbonate were assayed following standard procedures. Results showed that blood glucose levels of the Groups 1 and 2 goats were significantly ($p < 0.05$) lower than that of Group 3 post-rumenotomy, and serum levels of chloride and sodium were significantly ($p < 0.05$) higher in the Group 1 and 2 goats when compared to Group 3 goats post-rumenotomy. Parameters such as the serum total protein, urea and potassium significantly varied among the groups at specific times post-rumenotomy, in favour of the dextrose saline infused group (Group 2) with regards to amelioration of post-surgical stress. It was concluded that infusion of dextrose saline mainly and to a lesser extent normal saline ameliorated post-rumenotomy stress in the WAD goats. The use of peri-operatively administered dextrose saline infusion was recommended during rumenotomy.

Keywords: Goats; Rumenotomy; Post-surgery stress; Normal Saline infusion; 5% Dextrose saline infusion; Serum biochemistry.

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Article History: Initial manuscript submission received – July 20, 2023; Final revised form received – May 03, 2024; Accepted for publication – May 09, 2024; Published – May 31, 2024.

Introduction

West African Dwarf (WAD) goats are found in the region south of Latitude 14° North across West Africa (Adeloye, 1985; 1998), and are commonly reared traditionally at subsistence level. Goats are selective feeders but under harsh conditions are likely to ingest foreign bodies (Otesile *et al*., 1982; 1983). This mode of feeding predisposes them to ruminal impaction due to ingestion of indigestible materials such as polyethene, fibres, metals and glass (Sanni *et al*., 1998).

Rumenotomy is a surgical procedure performed to relieve some disease conditions of the rumen or fore-stomach (Remi-Adewunmi *et al*., 2006, Saidu *et al*., 2016). The most common indication for this procedure in small ruminants is in the relief of rumen impaction. Other indications include surgical treatment of toxic indigestion of rumen origin, relief of obstruction of the rumino-reticular or reticulo-omasal orifices, a prelude to the treatment of omasal and abomasal impaction and removal of neoplasms such as papillomas at the cardia of the rumen (Gyang, 1992). Another very important area where rumenotomy is indicated is in *in-vivo* nutritional studies which usually accompany implantation of rumen fistula alone or together with intestinal (duodenal) cannula (Aka *et al*., 2009).

Severe trauma as occurs in major surgery brings about metabolic changes in body water and electrolyte physiology (Lobo *et al*., 2013). In such conditions, there is retention of salt and water as the body's way of preserving the extracellular fluid (ECF) and circulating blood volume (Desborough, 2000). Furthermore, in response to surgery, there is decrease in serum colloid osmotic pressure (Brockner *et al*., 1969; Shippy and Shoemaker 1983), due to increased capillary permeability and fluid shifts from the vascular bed to the interstitial fluid compartment (Kongstad*et al*., 1999; Shippy and Shoemaker 1983).

During surgery, appropriate fluid therapy is essential to protect organ function in the peri-operative period (Rassam and Counsell, 2005), and administration of crystalloids in correct volume and concentration prevents overload with extensive salt and water. Patients' assessments determine patient fluid content needs. It is acceptable and often desirable to initiate fluid therapy with an isotonic balanced crystalloid solution while awaiting test reports on the electrolyte status of the patient (Harold *et al*., 2013).

Normal saline is 0.9% saline solution in water. This means that there is 0.9 g of salt (NaCl) per `100 ml of sterile water or 9 g per litre. This solution has 154 mEq of sodium per litre. Dextrose saline infusion contains 5% dextrose and 0.45% sodium chloride in water for injection. Electrolytes per 100 ml of dextrose saline are: sodium - 77 mEq, chloride – 77 mEq. The osmolarity of dextrose saline is 406 mOsmol/L (which is hypertonic), while the caloric value of is 170 kcal/L. Normal saline infusions are clinically indicated as sources of hydration and electrolytes replacement while intravenous injections of dextrose saline are clinically indicated for parenteral replenishment of fluid, minimal carbohydrate calories and sodium chloride as required by the clinical condition of the patient.

The physiological principles of fluid therapy and electrolyte management had earlier been reported, but a gap exists between knowledge and clinical practice (Rassam and Counsell, 2005). Therefore, this study evaluated the serum biochemical profile of West African Dwarf (WAD) goats given normal saline or 5% dextrose peri-operatively during rumenotomy.

Materials and Methods

Animals and Grouping: Fifteen adult male goats (aged 6 - 7 months) were acquired and allowed to acclimatize for 14 days prior to the experiment. During this period, they received

Peste des petit ruminants (PPR) vaccination. They were housed in standard goat pens with access to grasses and drinking water. Subsequently, they were randomly assigned to one of three groups (n = 5). Goats in Groups 1 were given Normal saline (Biomedical®, Nigeria) peri-operatively during the rumenotomy, while those in Group 2 were given 5% dextrose saline (Biomedical®, Nigeria) peri-operatively during the rumenotomy. The Group 3 goats served as Control that was not given any crystalloid during the rumenotomy. All the fifteen goats underwent rumenotomy.

Determination of Baseline Parameters: Prior to the surgery, vital parameters (heart and respiratory rates, rectal temperature), and blood glucose and body weight of goats were measured and recorded. Three millilitres of blood was collected from each goat's jugular vein and processed for the assay of the serum biochemistry profile.

Preparation of the Animals for Surgery: The goats were starved of grasses for 12 hours prior to anesthesia. However, clean water was provided up to the time of pre-medication. The left flank of each goat was shaved and prepared aseptically using 0.5% chlorhexidine gluconate solution. This was followed by draping the site for surgery.

Induction of Anaesthesia: The goats were premedicated with 2% xylazine hydrochloride (Indian Immunologicals Ltd, India) at 0.05 mg/kg, intramuscularly. Flank analgesia was induced by performing an inverted "L" block anaesthesia using lignocaine hydrochloride (Hans-E-Lembeke, Germany) administered at the dose of 10 mg/kg.

Intravenous fluid administration: The external jugular vein of the goats in Groups 1 and 2 was prepared aseptically using 0.5% chlorhexidine gluconate for venipuncture. Using a 21G sterile needle and infusion set, intravenous (IV) fluid administration was instituted just before the commencement of skin incision, and continued intra-operatively and post-operatively. Each goat in groups 1 and 2 received a total of 300 mls of their designated fluids.

Surgery: The rumenotomy was performed by a single trained veterinary surgeon using 7cm long vertical skin incision as described by Mulat *et al*. (2014). Closure was also done as described by Mulat *et al*. (2014).

Post-operative Care and Data Collection: The goats were allowed to recover in a well-ventilated recovery pen. All the goats received 20% oxytetracycline at 10 mg/kg on days 0, 3 and 6, while goats in Groups 1 and 2 additionally received 100ml of their designated fluids on days 1, 2 and 3 post-rumenotomy, that made up the total of 300 ml given.

Blood was obtained from each of the goats for the determination of the under listed parameters on days 1, 3 and 7 post-rumenotomy. Blood glucose was determined using AccuCheck glucometer and kit (Roche Diabetes Care, Inc., Switzerland), while other serum biochemical parameters were assayed following standard methods as described by Tietz (1995) for total protein, Fawcett and Scott (1960) for urea, Skeggs and Hochstrasser (1964) for chloride, Maruna (1957) for sodium, Henry (1974) for potassium, Barnett *et al*. (1973) for calcium and Natelson (1951) for bicarbonate. Body weights were also measured using a weighing scale on post rumenotomy days 0, 1, 4, 7, 10 and 14.

Statistical Analysis: Data collected were subjected to one way analysis of variance (ANOVA) using SPSS version 15. The least significant difference was used to separate variant means at post hoc. Probability values of less than 0.05 were considered significant.

Results

The blood glucose levels of the goat groups did not significantly ($p > 0.05$) vary on day 0, but from day 1 post rumenotomy (PR), the

blood glucose levels of the Group 1 and 2 goats were significantly ($p < 0.05$) lower than that of the Untreated Control Group 3 (Figure 1). There were no significant variations among the groups in their levels of serum total protein except on day 7, when the mean serum total protein levels of Group 2 goats was significantly ($p < 0.05$) lower than that of Group 3 Control goats (Figure 2). The mean serum urea of Group 1 goats was significantly higher ($p < 0.05$) than that of Group 3 on day 0, but on day 1 that of Group 2 was significantly lower than those of Groups 1 and 3 (Figure 3). On day 3, however, the mean serum urea level of the Group 1 goats was significantly ($p < 0.05$) higher than those of the Groups 2 and 3, while on day 7, the serum urea levels of goats in Groups 1 and 3 were significantly ($p < 0.05$) higher than that of Group 2 (Figure 3).

There were no significant differences ($p > 0.05$) in their mean levels of serum chloride on days 0 and 1, but on days 3 and 7, the serum chloride levels of goats in Groups 1 and 2 were significantly ($p < 0.05$) higher than that of the Group 3 (Figure 4). The mean serum levels of sodium did not significantly ($p > 0.05$) vary among the groups on Day 0, but on Day 1, the serum sodium levels of the Groups 1 and 2 were significantly ($p <0.05$) higher than that of the Group 3 (Figure 5). On Day 3 however, the mean serum sodium levels of Groups 1 and 3 were significantly ($p < 0.05$) lower than that of Group 2, while on Day 7 the mean serum sodium levels of both Groups 1 and 2 were significantly ($p < 0.05$) higher than that of the Group 3 controls (Figure 5).There were no significant differences ($p > 0.05$) between the groups in their mean serum potassium levels on days 0, 1 and 3, but on day 7, the serum potassium levels of the Group 1 goats was significantly ($p < 0.05$) higher than those of the Groups 2 and 3 (Figure 6). The serum calcium levels did not significantly ($p > 0.05$) vary among the groups on days 0 and 3, but on day 1 the serum calcium levels of the Group 2 goats was significantly ($p < 0.05$) lower than those of the Group 1 and 3, while on day 7, that of Group 2 became significantly ($p < 0.05$) higher than those of the Groups 1 and 3 (Figure 7). There were no significant variations ($p > 0.05$) among the groups in their serum bicarbonate levels all through the study (Figure 8). The mean body weights of the Groups 1 and 3 goats were significantly higher than those of the Group 3 goats all through the study (Figure 9).

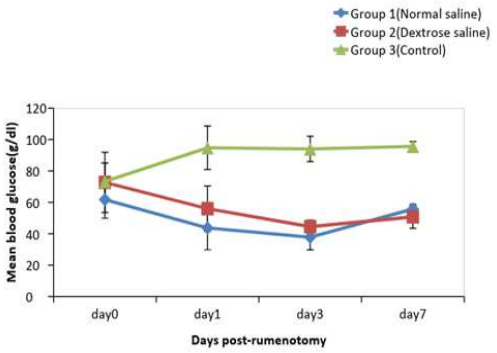

Figure 1. Blood glucose levels of West African goats given Normal saline or 5% Dextrose saline peri-operatively during rumenotomy, compared to a Control group not given fluid therapy.

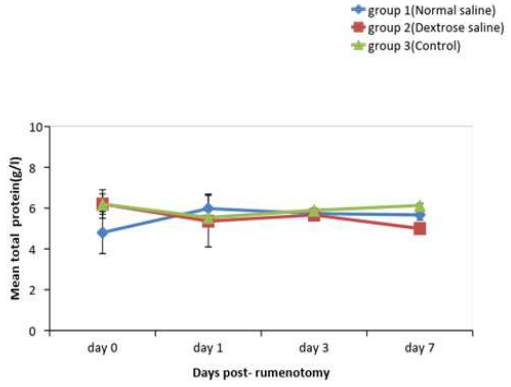

Figure 2. Mean serum total protein levels of West African goats given Normal saline or 5% Dextrose saline peri-operatively during rumenotomy , compared to a Control group not given fluid therapy.

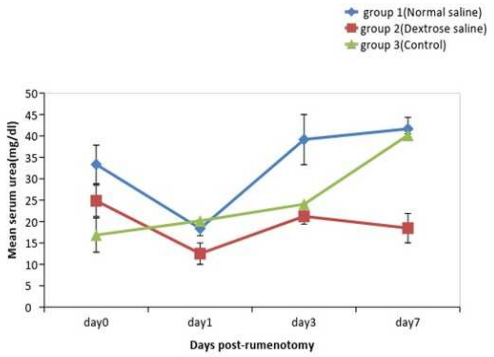

Figure 3. Mean serum urea levels of West African goats given Normal saline or 5% Dextrose saline peri-operatively during rumenotomy , compared to a Control group not given fluid therapy.

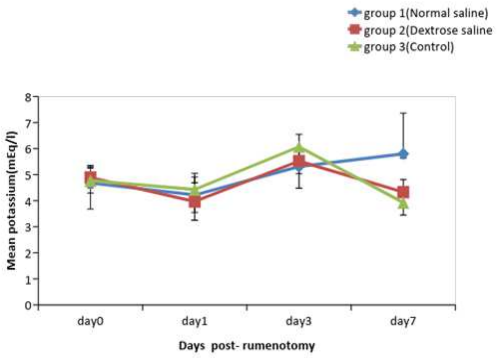

Figure 6. Mean serum potassium levels of West African goats given Normal saline or 5% Dextrose saline peri-operatively during rumenotomy , compared to a Control group not given fluid therapy.

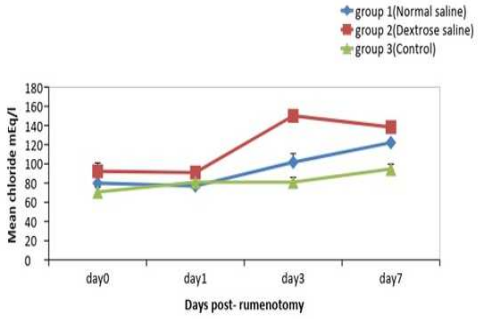

Figure 4. Mean serum chloride levels of West African goats given Normal saline or 5% Dextrose saline peri-operatively during rumenotomy , compared to a Control group not given fluid therapy.

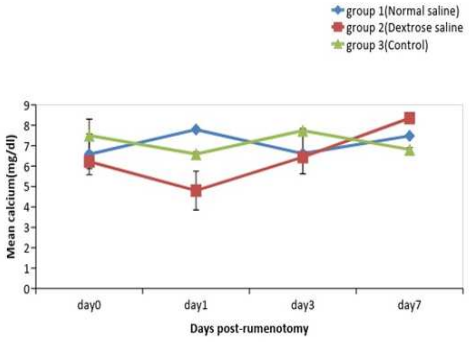

Figure 7. Mean serum calcium levels of West African goats given Normal saline or 5% Dextrose saline peri-operatively during rumenotomy , compared to a Control group not given fluid therapy.

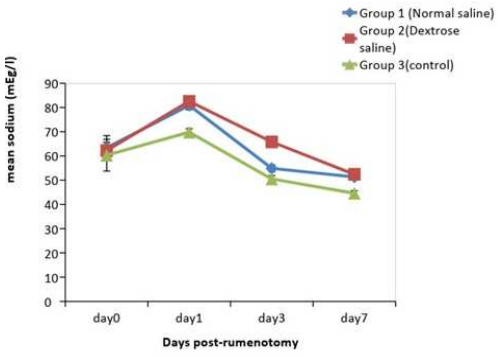

Figure 5. Mean serum sodium levels of West African goats given Normal saline or 5% Dextrose saline peri-operatively during rumenotomy , compared to a Control group not given fluid therapy.

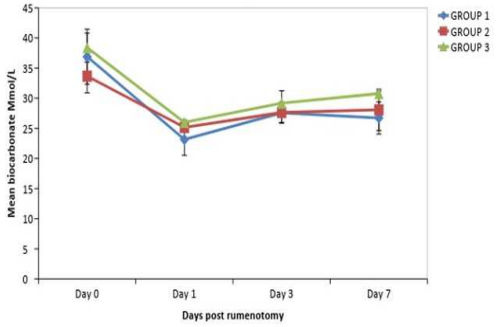

Figure 8. Mean serum bicarbonate levels of West African goats given Normal saline or 5% Dextrose saline peri-operatively during rumenotomy , compared to a Control group not given fluid therapy [Group 1 – Normal saline; Group 2 – Dextrose saline; Group 3 – Control].

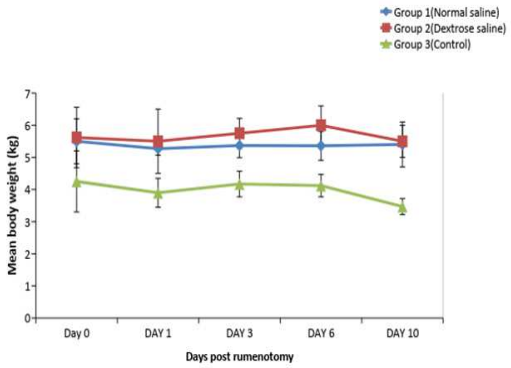

Figure 9. Mean body weights of West African goats given Normal saline or 5% Dextrose saline peri-operatively during rumenotomy , compared to a Control group not given fluid therapy.

Discussion

The significantly higher blood glucose level recorded in the Control group post-rumenotomy may be attributed to higher level of post-surgical stress relative to Groups 1 and 3 goats which were given normal saline and 5% dextrose saline infusions, respectively. Blood glucose concentration has been earlier reported to increase after surgery (Desborough, 2000; Ugwu *et al*., 2020). This has been attributed to cortisol and catecholamine release, post-surgery, in response to stress and pain, which facilitate glucose production as a result of increased hepatic glycogenolysis and gluconeogenesis (Bondy, 1980; Brook and Marshal, 2001; Rassam and Counsell, 2005). Additionally, it has been suggested that increase in blood glucose concentration is related to the intensity of the surgical injury (Rassam and Counsell, 2005). Therefore, the high blood glucose value obtained in the Control group (Group 3) implies that goats in this group experienced more surgical stress; thus it may be speculated that the administration of fluids normal saline and 5% dextrose saline to goats in Groups 1 and 2 reduced their surgical stress level.

There were so significant differences in serum total protein levels between the groups except on Day 7 when the serum total protein of Group 2 goats was significantly lower than that of Group 3 (Control). In earlier reports, Oyeyemi *et al*. (2000) recorded a significant drop in the level of total plasma protein (TPP) in West African Dwarf bucks after bilateral orchidectomy. Equally, Olaifa and Opara (2011) reported a significant decrease in TPP in West Africa Dwarf bucks at the first week following castration using a burdizzo. It has been posited that protein catabolism post-surgery is stimulated by increased cortisol concentration. Predominantly, skeletal muscle is broken down but some visceral muscle proteins are also catabolized to release the constituent amino acids (Desborough, 2000). Furthermore, Desborough (2000), reported that the amino acid may be further catabolized for energy or are used in the liver to form new proteins, particularly acute phase proteins. In addition, physiological response with increased mobilization of fluid and albumin into the intestine and interstitial space result in decrease in TPP post trauma/surgery (Petroianu and Alberti, 2011; Alberti *et al*., 2003; Lobo *et al*. 2013). It is thought that the decrease in serum total protein in Group 2 goats on Day 7 post-rumenotomy may have resulted from increased extracellular fluid volume which relatively lowered the serum total protein concentration.

It is noteworthy that the serum urea level in the Group 2 goats was significantly lower than those of other groups on Day 1, 3 and 7. It is thought that the administration of dextrose saline may have improved the glomerular filtration rate of the Group 2 goats relative to the others, as earlier studies have shown that blood loss and decreased glomerular filtration rate (GFR) occurs in the immediate post-operative period and can lead to higher serum urea levels (Mohammed *et al*., 2008; Olaifa and Opara, 2011; Lobo *et al*., 2013).

The serum electrolyte assay results showed that the serum chloride and sodium levels of

the Groups 1 and 2 given normal saline and dextrose saline infusions respectively were significantly higher than that of the control group post-rumenotomy. It has been reported that the most important neuroendocrine response in the peri-operative period is sodium and water conservation with excretion of potassium (Rassam and Counsell, 2005; Holte *et al*., 2002; Singh, 2003). The principal mediators of this response are anti-diuretic hormone (ADH), aldosterone and rennin-angiotensin II systems (Desbrough, 2000; Zaloga *et al*., 1990). Also the response to injury and stress is an increase in the size of the pores in the capillary membrane and the transcapillary escape rate of albumin increases (Lobo *et al*., 2013). As albumin leaks out of the intravascular compartment into the interstitial space, water and sodium are also drawn into the interstitial space (Lobo *et al*., 2013). Therefore, the relatively lower serum sodium and chloride levels obtained in Group 3 (Control group) goats which were not given intravenous fluids suggests that movement of plasma sodium into the interstitial space occurred in response to surgical stress. On the contrary, higher sodium and chloride levels obtained in Groups 1 and 2 which were given normal saline and dextrose saline, respectively suggests that the sodium and chloride contained in this fluids replaced the sodium and chloride loss from the intravascular space. However, it is important to note that sick patients can easily be overloaded with excessive salt and water during the flow period since salt is retained in the immediate period post-injury (Lobo *et al*., 2013). Therefore, normal saline and dextrose saline should be administered in the correct volume in the immediate period post-rumenotomy period, to avoid salt overload.

Potassium is the major intracellular cation while in the extracellular fluid, sodium (Na^+) is the principal cation (Schall, 1982; Pettifer, 2002). The high extracellular Na^+ concentration and low K^+ concentration are maintained by the active Na^+-K^+ pump of the cell membrane (Pettifer, 2002). On post rumenotomy day 1 while serum sodium concentration of goats in all the groups increased, the potassium concentration of the three groups decreased. These results suggest that in response to the increase in concentration of sodium in the extracellular fluid (serum) a compensatory decrease in potassium ion occurred. Also as recorded in the results of this study, on post-rumenotomy days 1 and 3, the groups with relatively lower serum potassium levels and higher sodium chloride levels were the Groups 1 and 2 goats (normal saline and dextrose saline treated groups). This suggests that infusion of both solutions containing sodium and chloride lead to compensatory excretion of potassium from the extracellular fluid compartment to maintain serum ionic balance.

The present study also showed that serum bicarbonate levels of Group 3 (Control) goats was relatively higher than that of Groups 1 and 2 post-rumenotomy, though this was not statistically significant. Natasha *et al*. (2023) had earlier reported a decrease in bicarbonate level after normal saline infusion in cat. Chloride is the primary extracellular anion, which plays an important role in acid-base regulation (Pettifer, 2002; Rassam and Counsell, 2005). This role is linked to its reciprocal relationship with bicarbonate (Pettifer, 2002). Therefore the lower bicarbonate levels of Groups 1 and 2 goats and their higher chloride levels relative to the Group 3 goats suggests that more bicarbonate was excreted in both groups probably in an attempt to maintain the acid-base status of the goats.

Painful procedures may decrease the post-operative performance of animals and thus their body weight gain (Fitzpatrick *et al*., 2006; Luna, 2008). Lower body weight post-surgery as seen in Group 3 often occurs due to decreased food consumption as well as post-operative protein catabolism (Fitzpatrick *et*

al., 2006) Also, the liver converts amino acids into other substrates notably glucose, fatty acids and ketone bodies. This results in marked weight loss and muscle wasting in patients after major surgical or traumatic injury (Desborough, 2000). This was noted in this study in the Group 3 goats that had a lower body weight. In this study while decrease in body weight was noted post rumenotomy on days 1, 3, 6 and 10 in Group 3; Groups 1 and 2 which were given fluid had higher body weight

Conclusion and Recommendation: Based on the results of the study, it was concluded that infusion of both normal saline and dextrose saline ameliorated the stress response to rumenotomy. It is specifically recommended that dextrose saline should be routinely infused in goats in the peri-rumenotomy period since goats given dextrose saline had a better response to post-rumenotomy stress based on the parameters evaluated in this study.

Conflict of interest

The authors declare no conflict of interest.

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