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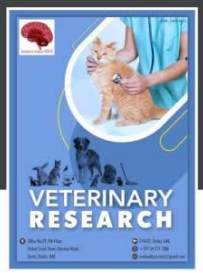


# Electrocardiological, Hemato-Biochemical and Clinical Evaluation of Parentral Anaesthesia in Goats

[1]Mrigakshi Yadav, [1]S.K. Rastogi, [2]Satish Kumar and [1]Malini Pant
*[1]Department of Veterinary Physiology and Biochemistry, College of Veterinary and Animal Sciences, [2]Teaching Veterinary Clinical Complex, College of Veterinary and Animal Sciences, G.B. Pant University of Agriculture and Technology, 263145 Pantnagar, Uttarakhand, India*

**Key words:** Anaesthesia, goat, electrocardiography, hematology, blood glucose

**Corresponding Author:**
Mrigakshi Yadav
*Department of Veterinary Physiology and Biochemistry, College of Veterinary and Animal Sciences, G.B. Pant University of Agriculture and Technology, 263145 Pantnagar , Uttarakhand, India*

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**Abstract:** Monitoring anaesthetic depth allows recognizing the extent of physiological stress. Heart is the core organ directly influenced by stress while hematological and biochemical analysis allow quick and accurate diagnosis. This study aimed to evaluate stress on goats subjected to propofol and xylazine-ketamine anaesthesia electrocardiographically, hematologicaly, biochemicaly and by clinical parameters thereby suggesting a suitable anaesthetic for short term surgical interventions. Twelve healthy adult female crossbred goats, aged 2-4 years were randomly allocated to two groups according to the anaesthetics. Electrocardiography (ECG), Oxyhemoglobin ($HbO_2$) saturation, Hematological (Hb concentration, PCV, TEC, TLC, DLC, MCV, MCH and MCHC), blood glucose and clinical parameters (rectal temperature, pulse and respiratory rates) were assessed. The results indicated that after propofol and xylazine-ketamine administration $HbO_2$ decreased (within normal physiological limits after xylazine-ketamine administration), all ECG parameters increased except QRS interval (no change). During propofol anaesthesia rectal temperature, respiratory rate and hematological parameters (except lymphocyte count) decreased while blood glucose concentration and pulse rate increased. During xylazine-ketamine anaesthesia, similar observations were recorded except that pulse rate decreased and MCHC non-significantly increased. Propofol produced favorable effects on cardiovascular system, rectal temperature and pulse rate whereas, xylazine-ketamine exerted more effective anaesthetic effects on respiratory system, blood glucose concentration and hematology suggesting it to be a safer and better choice over propofol for short period anaesthetic requirements in goats. Therefore, it could be suggested for further investigations in clinical conditions.

## INTRODUCTION

Anaesthetics anaesthetize animals by minimizing anxiety and eliminating pain. The primary anaesthetic Propofol (2, 6-diisopropylphenol) is a short-acting, intravenously administered hypnotic agent with smooth, rapid induction and recovery is associated with less frequent side effects in goats (Prassinos *et al*., 2005) causing minimal residual effects (Stoelting and Miller, 2000) producing a safe and effective anaesthesia. Xylazine (2-(2, 6-xylidino)-5, 6-dihydro-4H-1, 3-thiazine hydrochloride) is a $\alpha_2$ adrenergic agonist inducing deep sedation, muscle relaxation and analgesia; commonly used for sedation in ruminants (Malik and Sing, 2007), minimally affecting cardiovascular and respiratory system (Hall *et al*., 2001). Ketamine ((RS)-2-(2-Chlorophenyl)-2-(methylamino) cyclohexanone) having shorter duration of action and lesser psychomimetic profile makes it favorable as a "dissociative" anaesthetic. Ketamine is frequently described as "unique drug" because of its hypnotic, analgesic and amnesic effects. The xylazine-ketamine is considered to be a very reliable anaesthetic combination where xylazine is used as premedication and ketamine for the induction and maintenance of general anaesthesia.

Monitoring anaesthetic depth during general anaesthesia allows to recognize the extent of compromise to the body system and to make adjustments in the anaesthetic protocol to prevent untoward short and long-term effects on the animal (Fish *et al*., 2008). Anaesthesia can have unpredictable effects on the patient's normal homeostasis which may persist even after recovery from anesthesia. These effects can be easily determined by hematology (Jacobsen *et al*., 2004) and biochemical analysis, fastest and best diagnostic tools. Compton metabolic profile test reflects the nutritional status of animals with or without the presence of clinical abnormalities. Among all biochemical compounds glucose is a principal energy source for most body cells. Heart is a chief body organ directly influenced by stress and is a sensitive indicator of various body functions. ECG determines cardiac functions and electrical dysfunctions in response to any damage or effects of drugs. The portable pulse oximeter measures the oxygen saturation of animal's hemoglobin along with pulse rate and pulse character by non-invasive method. The probe consists of a pair of small Light-Emitting Diodes (LEDs) facing a photodiode through the animal's body. One LED is red (660 nm wavelength) and the other is infrared (905, 910 or 940 nm wavelength). Absorption at these wavelengths differs significantly between oxyhemoglobin and deoxygenated blood forms due to the pulsating arterial blood alone; therefore, the oxy/deoxyhemoglobin ratio is calculated from the ratio of absorption of the red and infrared light. Its simplicity of use and the ability to provide continuous and immediate oxygen saturation values makes it useful for patients with respiratory, cardiac problems or for apnea and hypopnea diagnosis. The present study was aimed to study suitability of propofol and xylazine-ketamine anaesthesia as intravenous general anaesthetic by studying and quantifying electrocardiological, hematological, blood glucose and clinical parameters under short term anaesthetic regimen in goats.

## MATERIALS AND METHODS

**Goats:** This study was performed at College of Veterinary and Animal Sciences (C.V.A.Sc.), G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India (78.06°E; 30.33°N). All procedures including animals used were reviewed and approved by Institutional Animal Ethics Committee, C.V.A.Sc.

Twelve apparently healthy (Local X Barbari) female goats weighing 23.66±2.22 kg, aged 2-4 years were maintained in the experimental facilities on morning and evening grazing on local pasture and mixture of concentrate (flour, wheat bran, crude sugar fortified with mineral mixture, vitamins and salt) fed at the dose rate of 250 g/goat/day and had free access to fresh tap water.

Prior to the experiment, tail area over the 3rd-4th coccygeal vertebrae (pulse oximeter's probe's placement) and elbow, stifle regions (ECG probes placement) were shaved aseptically. The animals were acclimatized to the placement of recording electrodes, room environment and handling personnel daily for at least one week till the uniform ECG and respiratory parameters could be obtained. The recording was done in ventilated, sound attenuated, electrically and wind shielded room. Food was withheld for 12-18 h and water for 6-8 h from all the goats before anaesthesia.

**Anaesthetic protocol:** The animals were allocated by simple randomization into 2 groups (P and XK) comprising of 6 animals in each group. In Group P, each goat was premedicated with glycopyrrolate (0.02 mg $kg^{-1}$; Pyrolate, 0.2 mg $mL^{-1}$, Neon Laboratories Ltd.), Intramuscularly (IM) and followed in 5 min by propofol (4 mg $kg^{-1}$; Profol, 10 mg $mL^{-1}$, Claris Life Sciences Ltd., Ahmedabad, India) intravenously (IV).

In Group XK, each goat was premedicated with glycopyrrolate (0.02 mg $kg^{-1}$, IM) followed by anaesthesia induction with xylazine (0.05 mg $kg^{-1}$; xylazin, 10 mL, Indian Immunologicals Ltd.), IV and followed in 5 min by ketamine (4 mg $kg^{-1}$; Aneket 500 mg 10 $mL^{-1}$, Neon Laboratories Ltd.), IV.

**Electrocardiographic recordings:** ECG was recorded, in right lateral recumbency (Fig. 1) in standard limb lead II

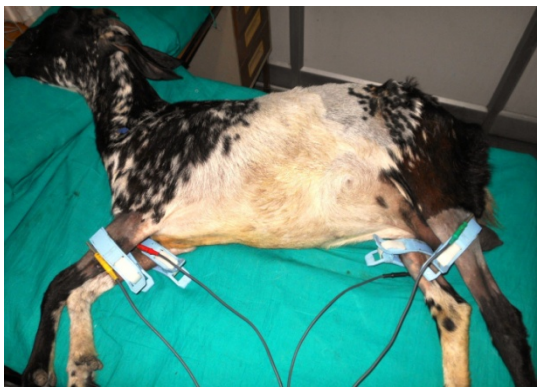

Fig. 1: Site for electrode placement and recording of ECG

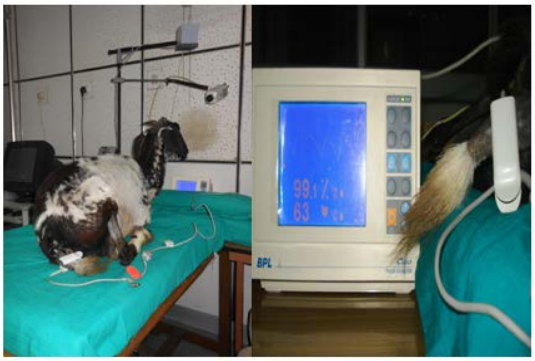

Fig. 2: Site for placement of probe of pulse oximeter

on a portable ECG machine (Cardiart-108T/MK-VII, BPL Limited, India), calibrated at 10 mm $mV^{-1}$ and paper speed of 25 mm $sec^{-1}$. The bipolar electrodes were applied on the anterolateral aspect of all four limbs, just proximal to the elbow/stifle joint. Recordings were recorded pre-experimentally (control), 10 min, one hr and two hr after the induction of propofol and ketamine.

**Pulse oximeter recordings:** The probe of pulse oximeter (Cleo, BPL Limited, Kerela, India) was placed over coccygeal artery at the level of 3rd-4th coccygeal vertebrae (Fig. 2). Recordings were recorded pre-experimentally (control), 10 min, one hr and two hr after the induction of propofol and ketamine.

**Clinical parameters recording:** Clinical parameters included time of induction, duration of anaesthesia and recovery time, status of induction, pedal and palpebral reflexes, respiratory rate, rectal temperature and pulse rate. These were recorded pre-experimentally (control), 10 min, one hr and two hr after the induction of propofol and ketamine.

**Blood sampling and laboratory analysis:** Periodical blood samples were drawn aseptically from jugular vein for hematology and serum biochemical estimations. Approximately 2 mL venous blood was collected in a vial having disodium EDTA (100 g, Thomas Baker Chemicals Ltd., Mumbai, India), 2 mg $mL^{-1}$ blood as an anticoagulant and these samples were immediately subjected to hematological analysis as per standard method.

About 1 mL of venous blood was collected in centrifuge tube and plasma harvested was stored at -20°C until analyzed for the biochemical parameter (blood glucose).

Blood samples were withdrawn pre-experimentally (control), 1 h and 3 h after the induction of propofol and ketamine.

**Hematological recordings:** It included Hemoglobin (Hb), Packed Cell Volume (PCV), Total Erythrocyte Count (TEC), Total Leucocyte Count (TLC), Differential Leucocyte Count (DLC), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Volume (MCV) and Mean Corpuscular Hemoglobin Concentration (MCHC).

Hemoglobin concentration (Hb; g%) was estimated by optical density of cyanmet-hemoglobin (Drabkin's) method described by Drabkin and Austin (1932). Packed Cell Volume (PCV; %) was estimated by microhaematocrit method of Dacie and Lewis (1975). Total Erythrocyte Count (TEC; million $cmm^{-1}$) and Total Leukocyte Count (TLC; thousand $cmm^{-1}$) was counted up by haemocytometer method (Schalm *et al*., 1975). Differential leucocyte count (DLC, %) was counted up as per the method described by Schalm *et al*. (1975).

**Biochemical parameter:** Quantitative measurement of blood glucose was accomplished using Glucose Test Kit (Span Diagnostic Ltd., Sachin, India). Principle of determination is that Glucose Oxidase (GOD) oxidizes glucose to gluconic acid and hydrogen peroxide. In the presence of enzyme peroxidase, released hydrogen peroxide is coupled with phenol and 4-aminoantipyrine (4-AAP) to form colored quinoneimine dye. Absorbance of colored dye is measured at 505 nm and is directly proportional to glucose concentration in the sample. Standard glucose solution of 100 mg $dL^{-1}$ was also processed same way as sample and its absorbance was recorded:

$$\text{Plasma glucose (mg dL}^{-1}) = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}}$$

**Statistical analysis:** Data obtained for each parameter from both groups of female goats was analyzed by two way ANOVA, carried out with the help of STPR 3 and STPR 43 (Standard programme 3 and 43). The data is presented as mean, standard error of mean difference and statistical significance was fixed at $p<0.05$.

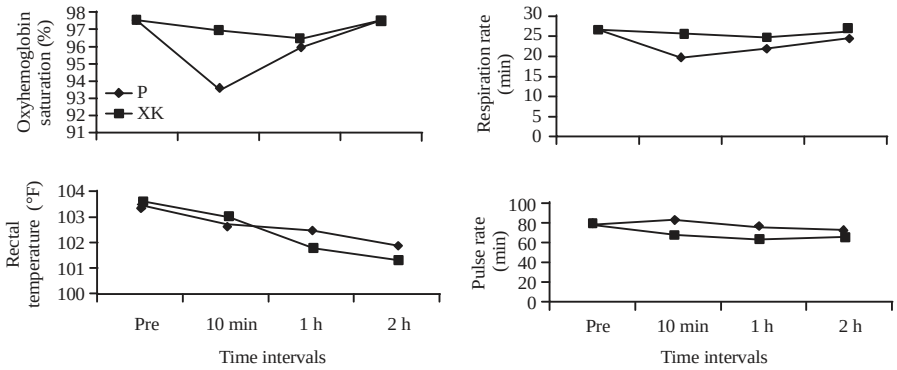


Fig. 3: Line diagrams depicting clinical parameters under different anaesthetic conditions in goats

## RESULTS AND DISCUSSION

**Clinical parameters:** The results of the groups (P, XK) are summarized in Table 1 and Fig. 3. Onset of anaesthesia as assumed by seeing the pedal and palpebral reflexes was quicker in group P whereas the anaesthesia duration was longer in XK group. The high lipid solubility of propofol is suggested to be responsible for its rapid onset (Guyton *et al*., 2002). Smooth, rapid and uneventful induction and recovery were observed with propofol but not xylazine-ketamine. Cravin and Alkhafaji (2006) observed agitation in the patients after recovery from xylazine-ketamine anaesthesia due to the frequent occurrence of hallucinations after ketamine anaesthesia.

A marked significant decrease was observed in $HbO_2$ and respiratory rate in group P. In group XK, similar pattern was recorded except that magnitude of decline was much lower and respiratory rate remained within the normal range suggesting that xylazine-ketamine is better tolerated anaesthetic compared to propofol.

Madan *et al*. (2010) reported propofol to have respiratory depressant activity. This might be due to the effect on control of ventilation and central chemoreceptor sensitivity, reducing the ventilatory response to hypercapnia and the ventilatory adaptation to hypoxia. Propofol potentiates hypoxic pulmonary vasoconstriction. Ismail *et al*. (2010) observed hypoxemia in goats after xylazine-ketamine administration.

Both groups recorded a non-significantly decreased rectal temperature compared to xylazine-ketamine. The data suggests propofol to have more effective anaesthetic effects on rectal temperature.

Ismail *et al*. (2010) reported significant decrease in rectal temperature after xylazine-ketamine administration in goats. Rana *et al*. (2013) reported significant decrease in rectal temperature after propofol administration in pigs. Decreased rectal temperature after propofol administration might be due to lowered sympathetic nerve activity by propofol (Ebert and Michael, 1994). Ketamine causes sympathomimetic actions but the sympatholytic activity of xylazine is more effective than the effects of ketamine (Afshar *et al*., 2005).

Table 1: Mean±SE of Onset, duration and recovery from anaesthesia in goats (n = 6)

| Parameter | Propofol | Xylazine-ketamine |
|---|---|---|
| Onset of anaesthesia (min) | 0.33±0.03 | 5.83±0.60 |
| **Duration of anaesthesia:** | | |
| Regained pedal reflex (min) | 9.50±0.43 | 9.50±0.43 |
| Regained palpebral reflex (min) | 12.67±0.88 | 17.50±0.76 |
| **Recovery from anaesthesia:** | | |
| Sternal recumbency (min) | 12.30±0.88 | 40.83±0.70 |
| Regained righting reflex (min) | 17.00±0.77 | 49.83±0.70 |

Pulse rate in Group P significantly increased and later decreased and vice-versa in group XK. Propofol was observed to have significantly higher pulse rate as compared to xylazine-ketamine suggesting it to have more effective anaesthetic effects on pulse rate. The sympatholytic activity of xylazine declined pulse rate after xylazine-ketamine induction (Afshar *et al*., 2005).

**ECG findings:** The results of ECG tracings of the groups (P, XK) are summarized in Fig. 4. P wave amplitude in both groups significantly increased with the adequacy of anaesthesia. Group P revealed significantly lower value compared to XK group suggesting propofol being better anaesthetic. R and T wave amplitudes and heart rate in group P, significantly increased with anaesthetic adequacy while in group XK, it significantly (R wave) and non-significantly (T wave, heart rate) decreased. Propofol produced more significant enhancement in R and T wave amplitudes than xylazine-ketamine, suggesting xylazine-ketamine as an effective anaesthetic (Fig. 5).

PR and QT intervals in group P significantly decreased and then increased while in group XK, a significant increase was observed. Propofol was suggested as better anaesthetic as xylazine-ketamine was observed to exert more significant effect on intervals. In both the groups no changes were observed in QRS interval at different time intervals.

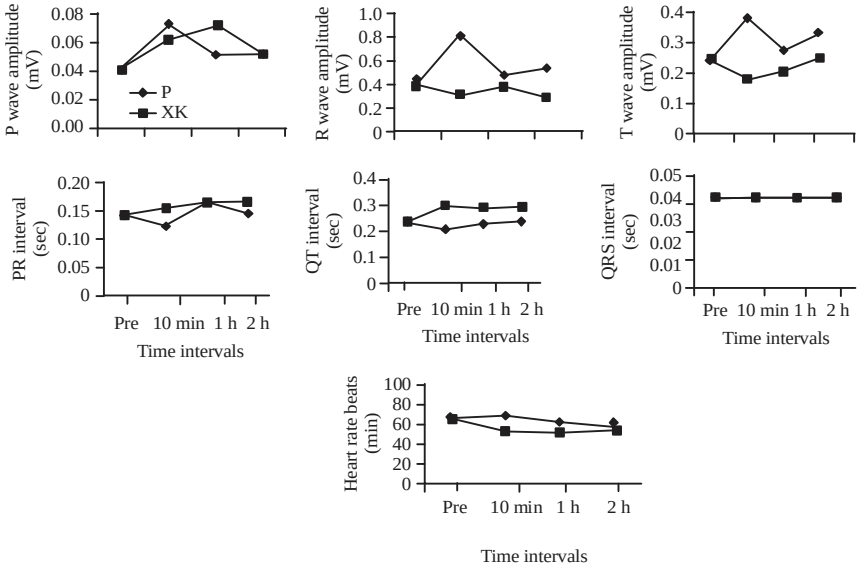


Fig. 4: Line diagrams depicting ECG parameters under different anaesthetic conditions in goats

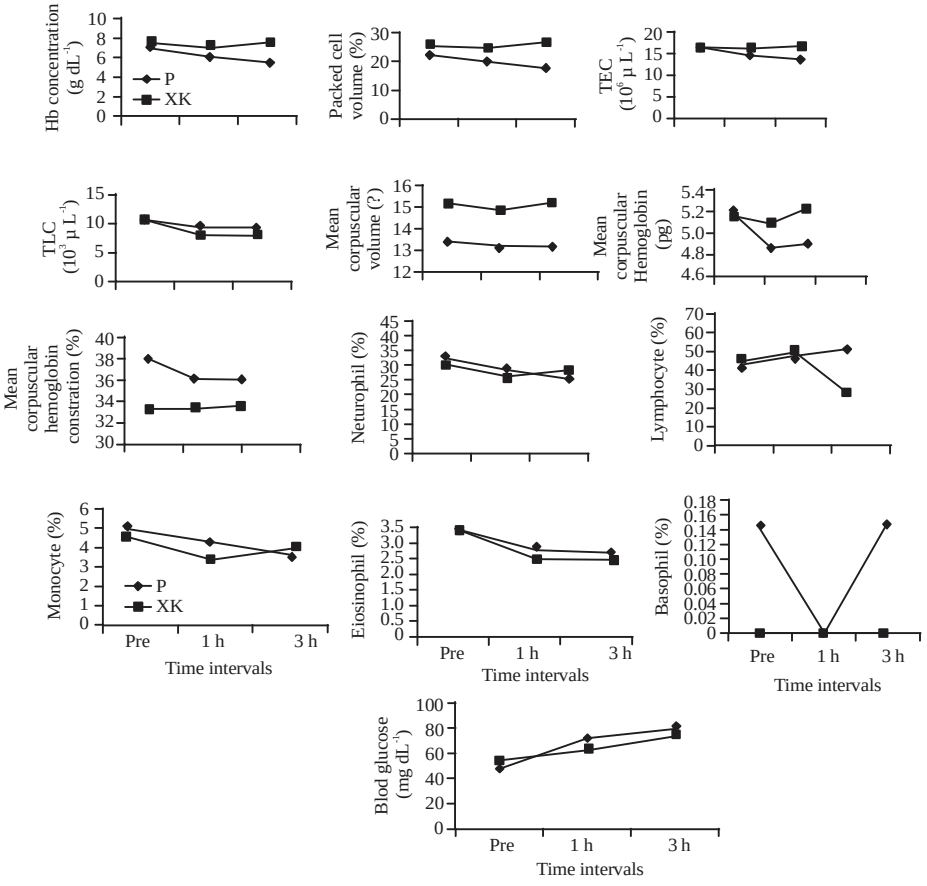


Fig. 5: Line diagrams depicting hematological and biochemical parameters under different anaesthetic conditions in goats

Increased amplitudes, intervals and heart rate might be due to simultaneous increase in sensitivity of the myofilaments to $Ca^{+2}$ and $Na^{+}$ by propofol (Kanaya *et al*., 2003; Guyton, 2006; Madan *et al*., 2010). Xylazine being

α2 agonist decreases sympathetic outflow to heart. The positive inotropic effects of ketamine may be responsible for increasing the amplitude after xylazine-ketamine anaesthesia (Rowland, 2005). Aroni *et al*. (2009) and Morgan *et al*. (2002) reported that ketamine blocks voltage-sensitive calcium channels and depresses sodium channels. Xylazine overrides the sympathetic effects of ketamine by excitatory carotid baroreceptor reflex induced by hypotension and decreased sympathetic and increased vagal activity (Afshar, 2005).

**Hematological and biochemical parameters:** The results of the groups (P, XK) are summarized in Fig. 5. Hb, TEC and PCV significantly decreased in both the groups while non-significant changes were observed in TLC, MCV and MCHC. Very little changes were observed after xylazine-ketamine administration the hematological parameters remained within normal range. The present findings are in agreement with the observations of Chandrashekarappa *et al*. (2009) and Malik and Singh (2007). Ismail *et al*. (2010) reported that hemoglobin concentration was within normal limits after xylazine-ketamine anaesthesia. This decrease might be due to the spleenic pooling of erythrocytes (Riebold, 1996) or relative hemodilution as suggested by Muir (1990) and Wagner *et al*. (1991).

In both the groups DLC significantly decreased except lymphocyte count which increased and eosinophil, basophil count which exhibited non-significant changes. After xylazine-ketamine administration DLC remained within normal range. The reduced neutrophil count was in accordance with the results of Casas-Diaz *et al*. (2011).

In both the groups, blood glucose significantly increased. Xylazine-ketamine had significantly lower blood glucose in comparison to propofol, suggesting xylazine-ketamine to have more effective anaesthetic effects on blood glucose.

Chandrashekarappa *et al*. (2009) and Camkerten *et al*. (2013) reported significant hyperglycemia after propofol induction and xylazine-ketamine administration.

This rise of glucose during anaesthesia might be attributed as a result of decreased membrane transport of glucose utilization, impaired insulin activity and increased blood concentration of adrenocortical hormones as suggested by Bayan *et al*. (2002).

## CONCLUSION

After propofol and xylazine-ketamine administration clinical and haematological parameters decreased during anaesthesia except Lymphocyte count and blood glucose concentration. Respiratory, hematological and blood glucose concentration remained within normal physiological limits during xylazine-ketamine anaesthesia. ECG, hematobiochemical and clinical parameters could be effectively utilized to evaluate efficacy of parentral anaesthesia Propofol produced favorable effects on cardiovascular system, rectal temperature and pulse rate whereas xylazine-ketamine exerted more effective anaesthetic effects on respiratory system and hematobiochemical parameters. Xylazine-ketamine would be a better choice for short period anaesthetic requirements in goats.

## ACKNOWLEDGEMENTS

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