Journal of Sustainable Veterinary & Allied Sciences
P-ISSN-2695-2661 e-ISSN: 2811-1346
JoSVAS 2026 September Vol. 8 Issue 3: 288-293

Original Research Article

SHORT-TERM HAEMATOBIOCHEMICAL RESPONSE TO DICLOFENAC ADMINISTRATION FOLLOWING DEHORNING IN WEST AFRICAN DWARF GOATS

***[a]ABDULKADIR, S. Z., [b]ABBAS, H. A., [c]ALIYU, A., [d]ADEDIRAN, S. O., [e]LAWAL, F. M., [f]AMBALI, R. T., [g]POPOOLA, K. O., [h]OGUNGBADE, H. O. & [i]HANAFI, Q. O.**

[1]Department of Veterinary Surgery and Radiology, University of Ilorin, Nigeria
ORCID: [a]0000-0003-3692-7273; [b]0009-0008-7116-237X; [c]0000-0002-9687-7928; [d]0000-0002-0165-8176; [e]0000-0001-5702-6971; [f]0009-0007-2172-1754; [g]0009-0000-0511-8575; [h]0009-0008-3044-0089; [i]0009-0006-0802-6258

**Correspondence:* abdulkadir.sz@unilorin.edu.ng; +2348067602494

ABSTRACT

Dehorning is a routine but painful management practice in goat husbandry, often necessitating effective analgesia to minimize stress and improve animal welfare. Five healthy WAD goats were selected and subjected to dehorning following pre-emptive analgesia using diclofenac 3 mg/kg IM administered at 0 (baseline), and 24, 72, and 120 hours post-dehorning. Blood samples were collected at these intervals for analysis of red and white blood cell counts, hemoglobin, packed cell volume, and stress biomarkers such as cortisol, lactate, and reactive oxygen species (ROS). The results showed non-significant reductions in red blood cell parameters, indicating mild anaemia likely due to surgical trauma. Conversely, white blood cell counts increased post-operatively, reflecting an inflammatory response. Serum cortisol and lactate levels showed statistically significant increases at 72 hours post-dehorning ($p < 0.05$), suggesting acute physiological stress, while ROS levels significantly decreased, and indicating diclofenac's transient antioxidant effect. By 120 hours, cortisol and ROS levels declined, suggesting recovery and effective pain modulation. The study concludes that diclofenac administration effectively minimized physiological stress in West African Dwarf goats when administered before and after dehorning. Pre-emptive and continued dosing blunted peak cortisol responses, supported metabolic recovery, and reduced oxidative stress, highlighting its role in improving surgical stress and welfare in small ruminants.

Keywords: Analgesia, pain, ruminants, stress, surgery

INTRODUCTION

Dehorning is a customary husbandry procedure in animal production industries so as to lower the risk of animal injury, reduce handler injury, and prevent damage to farm property (Adam *et al*., 2021). Pain in ruminant species elicits measurable physiological responses, including alterations in haematology and biochemical parameters (Buhari *et al*., 2020). These changes such as shifts in packed cell volume, serum enzymes, and stress-related biomarkers serve as vital indicators of health status and animal welfare (Onasanya *et al*., 2015). Studies have shown that factors like stress, management systems, and environmental conditions significantly influence these parameters, making them useful tools for assessing well-being in livestock animals (Radkowska & Herbut, 2014; Onasanya *et al*., 2015).

Non-steroidal anti-inflammatory drugs (NSAIDs) are widely used in veterinary medicine for their analgesic, anti-inflammatory, and antipyretic properties. In small ruminants, NSAIDs such as flunixin meglumine, meloxicam, and diclofenac have been shown to reduce post-operative pain, modulate stress biomarkers, and improve recovery following

http://doi.org/10.54328/covm.josvas.2026.357

surgical procedures such as dehorning, castration, and laparotomy (Coetzee *et al*., 2012; Stock *et al*., 2013; Buhari *et al*., 2020).

Diclofenac, a phenylacetic acid derivative and non-selective cyclooxygenase inhibitor, has demonstrated sustained analgesic effects, reduced inflammatory cell infiltration, and potential modulation of oxidative stress in livestock (Gomaa, 2017; Kolndadacha *et al*., 2023).

Most existing literatures on pain mitigation following dehorning in ruminants are focused on exotic breeds, with limited studies on Nigerian indigenous goats such as the West African Dwarf (WAD) goat, despite its economic importance for meat and milk production in low-resource farming system. Study on NSAID use in WAD goats is particularly scarce, and to the best of our knowledge no study has reported effected of diclofenac on stress hormones, metabolic indicators, and oxidative stress markers during surgical dehorning of WAD goats.

Given the paucity of data on dehorning WAD goats following administration of pre-emptive analgesia, this study aims to evaluate haematological and serum biochemical responses; cortisol, lactate, and reactive oxygen species to diclofenac administration prior and post-dehorning of WAD goat. We hypothesized that pre-emptive analgesia with diclofenac at 3 mg/Kg prior to dehorning would produce minimal stress compared to immediate and subsequent post-dehorning administrations at intervals could maintain pain-free recovery period in apparently healthy WAD goats.

The findings will contribute to evidence-based pain management strategies and promote humane livestock practices in tropical developing regions.

MATERIALS AND METHOD

An ethical approval for the study was sought from the Ethical Review Committee (UERC) University of Ilorin, and was granted, and assigned an approval number: UERC/FVM/2025/10 before commencement of this study. All procedures were conducted in compliance with institutional and international guidelines for animal welfare. The study was conducted at the large animal surgery unit of the Department of Veterinary Surgery and Radiology, faculty of Veterinary medicine, University of Ilorin, Kwara state, Nigeria. Five clinically healthy male West African Dwarf (WAD) goats used for this study have age range of 10±2 months, weight of 13.5±1.5 Kg and vital parameters within physiological limits; rectal temperature, pulse rate and respiratory rate were 38.1±1°C, 79±2 beats per minute, and 27±2 breaths per minute respectively. They were housed in small ruminant pens of the Veterinary Teaching Hospital (VTH) of the faculty and acclimatized for two weeks, within which they undergo clinical examination, haematological and parasitological screening prior to enrolment to confirm their health status. Prophylactic treatment with albendazole (Albenor®, Jubailiagrotec, Nigeria) at 7.5 mg/Kg PO (stat) and amoxicillin 15 mg/Kg (AmoxiCare®, Advacare pharmaceutical Limited, Shanghai, China) intramuscularly for 5 days was given. They were tethered for grazing during the day and housed indoors at night with *ad libitum* access to water and supplementary feeding with cassava peels and bean husks. Feed and water were withdrawn from the experimental animals for 12 and 6h, respectively, prior to surgery to decrease rumen volume which may exert pressure on the diaphragm.

A single-group design was used; the group serves as its own control via baseline measurements prior to surgery. Pre-emptive analgesia with 3% diclofenac (ShinePharm International, UK.) at 3 mg/Kg IM was administered 30 minutes before dehorning to mitigate acute pain and stress responses. The same dose was repeated at hours of 24, 72 and 120 (that is days 1, 3 and 5 respectively) post-dehorning.

PATIENT PREPARATION, ANAESTHESIA PROTOCOL AND DEHORNING PROCEDURE:

The goats were properly restrained, and the hair around the horn base was clipped, the area was disinfected with 0.3% chlorhexidinegluconate (Purit®, SaroLifecare Limited, Ibadan, Nigeria), 70% methyl-alcohol (Quick Aid®, Mecad Pharmaceutical Limited, Lagos, Nigeria) and then povidone-iodine (Wosan®, Jawa International Limited, Lagos, Nigeria).

Anaesthesia was induced using 2% xylazine hydrochloride (Bioveta, Czech Republic) as sedative at 0.05 mg/Kg IM and 5% ketamine hydrochloride (DutchFarm, Netherlands) as anaesthetic at 5 mg/kg IM following a cornual nerve block with 1% lidocaine (Malven®, Pharmax India PVT. Ltd, Mumbai, India) 1.5 mL/site to desensitize the branches of lacrimal and infra trochlear nerves before dehorning was performed meticulously as described by Hendrickson & Biard (2013) and Reddy *et al*. (2017). All procedures were carried out by a licensed Veterinary surgeon. Briefly, patient was draped, the skin-horn base was incised round with a scalpel (Scalpel blade®, New Delhi, India) and a Gigli wire (Surtex®, Surrey, England) was placed in the caudomedial aspect of the incision, the horn was removed by steady minimal force directing the Gigli wire held by both hands back and forth and with the assistant surgeon supporting the goat head. Bleeding was controlled by applying gauze pressure, the skin at the incision edges was adequately undermined to facilitate primary closure with simple interrupted suture pattern using Nylon suture size 0 (Lifecare®, AnhuKangning Industrial Group, Co. Ltd., Anhui, China). Post-operatively, wounds were treated with oxytetracycline spray (oxyspray®, Gujarat, India), amoxicillin 15 mg/Kg (AmoxiCare®, Advacare pharmaceutical Limited, Shanghai, China) intramuscularly

for 5 days. The wound was dressed daily for a week which healed by primary intention, the sutures were removed 12 days post-surgery and there were no complications and all the goats survived beyond experimental period.

DATA COLLECTION

About 5 mL of blood sample was collected via jugular venipuncture using needle and syringe pre-surgery (prior to first diclofenac administration as baseline data, 0- hour), and at 24-, 72-, and 120-hours post-dehorning (just before the post-surgical diclofenac administrations). For haematology, 3 mL was transferred into EDTA tubes and analyzed within 2 hours using an automated haematology analyzer (Mindray BC-2800Vet, China). For serum biochemistry, 2 mL was placed in plain tubes then centrifuged at 3,000 rpm for 10 minutes. Serum was aliquoted into cryovials and stored at –20°C until analysis to preserve biochemical stability.

BIOCHEMICAL ASSAYS

Cortisol: Measured using a commercially available ELISA kit (Monobind Inc., USA; sensitivity: 0.5 ng/mL; intra-assay CV: 5.6%; inter-assay CV: 7.4%). Lactate: Quantified enzymatically using a colorimetric lactate assay kit (Sigma-Aldrich, USA; sensitivity: 0.2 mmol/L; validated for caprine serum). Reactive Oxygen Species (ROS): Determined using a fluorometric assay kit (Cell Biolabs, Inc., USA; detection limit: 0.02 nmol/mL H_2O_2 equivalents).

All assays were performed in duplicate according to manufacturers' instructions.

DATA ANALYSIS

All data collected were expressed in mean ± standard error (SEM) of mean and subjected to Extended Paired t-test using commercially available InVivo Stat statistical software, version 4.1.2. A value of $p < 0.05$ was considered significant throughout this study.

RESULTS

SERUM BIOCHEMISTRY

Cortisol: Mean serum cortisol at baseline (0 hour) was 9.9 ± 2.3 ng/mL, increasing sharply to 25.8 ± 15.7 ng/mL at 72 hour ($p = 0.0090$). This marked rise was followed by a significant decline to 8.9 ± 2.8 ng/mL at 120 hour ($p = 0.0084$).

Lactate: Baseline lactate was 2.7 ± 1.1 mmol/L, rising significantly to 5.9 ± 0.9 mmol/L at 24 hour $p = 0.0001$) and remaining elevated at 72 hour 5.1 ± 0.2 mmol/L ($p = 0.0005$). Interestingly lactate level decreased at 120 hours 5.31 ± 0.87 mmol/L ($p= 0.0003$) though not close to the baseline mean value.

Reactive Oxygen Species (ROS): ROS levels decreased significantly from 1.5 ± 0.7 at baseline to 0.8 ± 0.4 at 24 hour ($p = 0.0204$), and remained lower throughout the study at 120 hour 0.9 ± 0.4 ($p = 0.0366$).

HEMATOLOGICAL PARAMETERS

Although, the RBC, PCV and Hb parameters showed no statistical significance downward the trends from the baseline through to 120 hours, however, WBC showed mild decreased 13.1 ± 4.1 x 10^3/µL at 24 hours but increased

TABLE II: CHANGES IN PVC, HB, RBC AND WBC OF WAD GOAT (MEAN ± SE)

Parameter (mmol/L)/Hour	0	24	72	120
Cortisol (ng/mL)	9.9 ± 2.3^{a}	17.3 ± 8.9	$25.8 \pm 15.7^{a,b}$	8.9 ± 2.8^{b}
Lactate(mmol/L)	$2.7 \pm 1.1^{a,b,c}$	5.9 ± 0.9^{b}	5.1 ± 0.2^{c}	5.3 ± 0.9^{a}
ROS	$1.5 \pm 0.7^{a,b}$	0.8 ± 0.4^{b}	1.2 ± 0.2	0.9 ± 0.4^{a}

Key: PCV: Packed cell volume, Hb: Hemoglobin, RBC: Red blood cell, WBC: White blood cell. There was no statistical significance at (P<0.05)

TABLE I: CHANGES IN SOME SERUM BIOCHEMICAL INDICES OF WAD GOAT (MEAN ± SE)

Parameter (mmol/L)/Hour	0	24	72	120
Cortisol (ng/mL)	9.9 ± 2.3^{a}	17.3 ± 8.9	$25.8 \pm 15.7^{a,b}$	8.9 ± 2.8^{b}
Lactate(mmol/L)	$2.7 \pm 1.1^{a,b,c}$	5.9 ± 0.9^{b}	5.1 ± 0.2^{c}	5.3 ± 0.9^{a}
ROS	$1.5 \pm 0.7^{a,b}$	0.8 ± 0.4^{b}	1.2 ± 0.2	0.9 ± 0.4^{a}

Means ± SE with the same superscript(s) across a row are statistically significant at P<0.05. Key: ROS, Reactive Oxygen Species

progressively, even though these changes were not statistically significant.

DISCUSSION

This study compared the pre-emptive analgesic effect of diclofenac administration pre-dehorning and post-dehorning repeated intramuscular diclofenac administration on hematological and biochemical stress markers in West African Dwarf (WAD) goats following surgical dehorning model. The results demonstrated significant temporal fluctuations in cortisol, lactate, and reactive oxygen species (ROS) levels, alongside non-significant but clinically notable changes in some erythrocytes indices and leucocyte count.

Cortisol Response: The significant rise in cortisol concentration at 72 hours post-dehorning suggests a pronounced activation of the hypothalamic–pituitary–adrenal (HPA) axis, followed by a resolution toward baseline thereafter, returning to baseline at 120 hours.

This aligns with the expected activation and subsequent resolution of hypothalamic–pituitary–adrenal (HPA) axis activity in response to nociceptive and inflammatory stimuli corroborating Kongara *et al.* (2023) who in another study also reported release of high concentrations of cortisol into circulation in response to pain.

Similar biphasic cortisol profiles have been documented in goats undergoing horn removal, with peak levels occurring within 24–72 hours depending on analgesic regimen (Adeyemi *et al.*, 2019). Diclofenac partial attenuation of cortisol rise in this study suggests effective reduction of peripheral prostaglandin-mediated pain as behavioural changes such as bleating, head shaking, and rubbing were not seen in the animals, although this is subjective as central pain pathways were not studied as evaluated in the study of Olatunji *et al.* (2020).

Lactate Trends: The sustained elevation of lactate from 24 to 72 hours post-procedure indicates persistent anaerobic metabolism, likely due to localized hypoperfusion at the surgical site and systemic metabolic demands of tissue repair as reported in another study by Hassan *et al.* (2022). Comparable findings in caprine surgical models suggest that prolonged lactatemia reflects both inflammatory hypermetabolism and possible vasoconstrictive effects of COX inhibition on microcirculatory flow (Garba & Musa, 2018). Notably lactate concentration showed slight reduction at 120 hours. This progressive decline suggests a partial relief of stress, potentially facilitated by the anti-inflammatory effects of diclofenac. Similar trends were observed in another study (Tekeli *et al.*, 2024), who documented decreased lactate levels in animals administered NSAIDs after surgery.

The significant reduction in ROS levels at 24 and 120 hours concur with the oxidative stress surges typically observed post-surgery in another study by Ibrahim *et al.* (2019). Diclofenac has been reported to exert secondary antioxidant effects by down regulating leucocyte activity and limiting lipid peroxidation, Chikezie *et al.* (2020). In the present study, this modulation may have contributed to a more favourable oxidative balance during the recovery phase, potentially supporting tissue healing.

Although changes in RBC, PCV, and Hb was not statistically significance, the values obtained fell below our referenced interval for caprine species 8–18 × 10^6/µL, 22–38% and 8-12 g/dL respectively (Fielder, 2022). This downward trend observed could be suggestive of a possible mild, subclinical anaemia in the control sample and a confounding factor attributable to the blood loss during repeated sample collection and surgical dehorning or physiological fluid shifts as corroborated in another study (Okafor *et al.*, 2021). WBC counts increased slightly, consistent with a moderate inflammatory response, but remained within the physiological range referenced, this is suggesting that diclofenac may have blunted more pronounced leukocytosis but did not suppress the immune function of these goats.

The haemato-biochemical parameters from this study confirm a typical acute stress profile following surgical dehorning of WAD goat, with cortisol and lactate elevations reflecting neuroendocrine and metabolic responses to nociceptive and inflammatory stimuli. The ROS reduction may indicate transient oxidative stress modulation during early recovery phase. Haematological shifts, while not statistically significant, could be clinically relevant in animals with pre-existing anaemia or in other surgical procedures with greater tendencies of blood loss or a study design requiring repeated blood collection.

These findings reinforce the value of pre-emptive NSAID administration in improving animal welfare during routine invasive husbandry practices. Diclofenac low cost, ease of administration, and extended dosing intervals make it a practical option for pain management in smallholder goat production systems. However, given its incomplete suppression of cortisol, combining diclofenac with other centrally acting analgesics such as Flunixin Meglumine, Tramadol etc. may further optimize welfare outcomes without compromising field feasibility (Bello *et al.*, 2023).

The results of this study underscore the critical role of pre-emptive analgesia in mitigating the physiological stress and inflammatory burden associated with surgical dehorning in WAD goats. This is further supported by the fact that the American Veterinary Medical Association (AVMA) also recommends pre-emptive analgesia and postoperative administration of pain relieve drugs for dehorning (Adam *et al.*, 2021). Diclofenac administered intramuscularly at 3 mg/kg prior to dehorning and repeated at 24, 72, and 120 hours, effectively modulated oxidative stress and reduced

inflammatory markers, even though cortisol suppression was incomplete.

CONCLUSIONS

The findings provide meaningful insights into the physiological changes that accompany surgical stress and the effectiveness of non-steroidal anti-inflammatory drugs (NSAIDs) in pain mitigation. The results showed that dehorning induces measurable stress responses, as evidenced by haematological changes in red blood cell (RBC) counts, haemoglobin levels, and packed cell volume (PCV), though not statistically significant but clinically vital.

The elevation of white blood cells (WBC) further confirmed an ongoing stress response, while alterations in cortisol, lactate and reactive oxygen species (ROS) levels observed indicate acute stress reflected by the goats during recovery state as observed that diclofenac attenuated some of these physiological stress indicators at the last hour of our study suggesting that the repeated diclofenac administration contributed to improved physiological recovery and reduced discomfort in the WAD goats despite diclofenac dosing interval in this study.

In conclusion, diclofenac demonstrated a beneficial role in managing pain and physiological stress with emphasis on the importance of pre-emptive analgesia in surgical procedures involving small ruminants. Based on these findings of this study, we recommend that pre-emptive analgesic administration be integrated as standard veterinary anaesthetic protocol in dehorning procedures to promote animal welfare and recovery in WAD goat post-surgery or management of intra-surgical stress through total intravenous anaesthesia (TIVA), with dosing intervals tailored to the drug's pharmacokinetics. This standardization has the potential to improve animal welfare, enhance recovery outcomes, and align husbandry practices with modern veterinary pain management principles.

LIMITATIONS AND FUTURE DIRECTIONS

The main limitation of this study is the small sample size (n = 5), which reduces statistical power and the generalizability of findings. Additionally, repeated handling for blood collection may have introduced a confounding stress component, potentially influencing cortisol measurements. Future research should incorporate larger cohorts, extended post-operative monitoring, evaluate WBC differentials and comparative trials of multimodal analgesic protocols to determine the optimal combination for stress and inflammation control in small ruminants.

ACKNOWLEDGMENTS

We acknowledge the support given by the Director of the Veterinary Teaching Hospital, University of Ilorin Prof. I. A. Adisa, for giving us access to small ruminant pens for our study. We also acknowledge the support given by the staff and clinical students of the Faculty of Veterinary Medicine during this work.

CONFLICTS OF INTEREST: The authors declare no conflict of interest.

FUNDING: This research received no external funding

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