International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
VET 2024; 9(6): 647-651

www.veterinarypaper.com
Received: 24-10-2024
Accepted: 26-11-2024

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Evaluation of Datura metel seed extract as local anaesthetic agents for orchidectomy in West African dwarf buck goats

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DOI: https://dx.doi.org/10.22271/veterinary.2024.v9.i6j.1955

Abstract
This study investigates the local anesthetic potential of Datura metel seed extract in West African Dwarf (WAD) Buck Goats, compared to standard lidocaine, specifically for orchidectomy procedures. Datura metel is recognized for its various therapeutic uses, including anesthetic properties attributed to its tropane alkaloids. Twenty adult WAD Buck Goats were divided into two groups for subcutaneous administration of either Datura metel extract (75 mg/kg body weight) or lidocaine hydrochloride (4 mg/kg body weight). The effects on anesthesia onset, duration, and percentage were evaluated through negative twitch response assessments and hematological analyses at specified intervals. Results indicate that Datura metel provided effective analgesia with an onset time of 15.80±0.16 minutes and a duration of 35.95±0.18 minutes, significantly longer and shorter, respectively, compared to lidocaine (onset: 3.20±0.02 minutes; duration: 56.50±0.10 minutes). The percentage of anesthesia was also significantly lower with Datura metel (46.6±1.20%) than with lidocaine (93.3±0.21%). No significant changes in vital physiological parameters were observed, suggesting compatibility. Findings highlight Datura metel's potential as a local anesthetic, yet its limitations in efficacy and duration assert the necessity for careful application, particularly for minor surgical procedures. Further studies are recommended to isolate the active components responsible for the anesthetic effects to enhance its application and safety profile in veterinary medicine.

Keywords: Orchidectomy, *Datura metal*, lidocaine, WAD Goat

Introduction
Plants are known to possess various pharmacological activities in phytomedicine. Daturas specifically are known for therapeutic uses in the treatment of ulcers, insect repellants, antiseptics, healing of burns, anti-asthmatic and anti-cholinergic, and anesthetic (Mama and Steffey, 2001, Newman and Cragg, 2012) [6, 8]. All Datura species yield pharmacologically important tropane, hyoscine, atropine, and hypo cyanine. The plant is reported to induce strong hypnosis, and hyoscine in therapeutic doses and depress the central nervous system and anesthesia in rabbits (Elsa *et al* 2001, Mama and Steffey, 2001, Kimmo, 2005) [3, 6, 5].
Generally, goats just like other large animals are usually associated with a lot of side effects under general anaesthesia, these include depression of central nervous system, aspiration pneumonia, passive regurgitation, excessive salivation and tympany (Gyang, 1990) [4]. Goats are therefore preferably operated upon under local anaesthetic induction or regional anesthesia with the use of orthodox anaesthetic agents (Butler, 2004) [7].
The Literature study shows a lacuna in the potential local anesthetic study of Datura metel seed extract in WAD Buck Goats. Thus, the present study is to evaluate the local anesthetic effect, onset and duration of action, percentage (%) anesthesia and hematological values of WAD Buck Goats induced with Datura metel seed extracts for orchidectomy in WAD Back Goats (Grémiaux *et al.*, 2014, Balušk *et al*., 2016) [12, 13].

Determination of local anesthesia was done in two groups of extract and lidocaine hydrochloride-induced WAD Buck Goat, five minutes after the injection of the extract, the sensitivity of the areas was tested by picking lightly with a needle three times. The skin around the scrotal wall was pricked, and the responses of this area indicated the degree of anesthesia and expressed as a number of negative reactions, 0/3 indicate no anesthesia, 1/3 indicate mild, 2/3 indicate moderate and 3/3 indicate maximum anesthesia (Koller, 1892, Chidiac, 2012) [15, 9].

Bilateral Orchidectomy was done following induction of maximum anesthesia in the WAD Buck Goats.

Two and a half milliliters of blood were obtained by jugular venopuncture using heparinized tubes before and after administration of either extract or iodine. Blood samples were obtained at this time periods; 0, 120, 240 mins for determination of complete blood count (Fozzard *et al.*, 2005) [16].

Aim of the study

The main aim of this study is to evaluate Datura metel seed extract as a local anaesthetic agent for orchidectomy in West African dwarf goats. The specific objectives of the study includes

- To determine the phytochemical properties of Datura metel seeds extract.
- To evaluate the effective anaesthetic dose of the extract through the epidural and
- Subcutaneous routes in the WAD goats.
- To determine the effects of the extract on the Haematology and Biochemical
- Parameters of WAD goats.

Hypothesis

- **Null hypothesis:** *Datura metel* seeds extract May/ not be a local anaesthetic agent for orchidectomy in West African dwarf goats
- **Alternate hypothesis:** *Datura metel* seeds extract may/not be a local anaesthetic agent for orchidectomy in West African dwarf goats

Materials and Method

Ethical Clearance

Ethical Clearance was obtained for the study from the Ethical Clearance Committee of Joseph Sarwuan Tarka University Makurdi.

Plant Identification/Collection

The plant materials (leaves, flowers, fruits, and seeds) of *Datura metel* were collected within the Makurdi metropolis. The plant was identified firstly by traditional medical practitioners. For authenticity, the collected plant materials were sent to the Department of Botany Research Laboratory, the Federal University of Agriculture Makurdi, for identification and confirmation of the genus and species (see plate 2).

The preparation of Datura Metel ethanol seed extract for intramuscular injection involves extracting the seeds with 95% ethanol using a Soxhlet apparatus, followed by filtration through a 0.22 µm filter paper (Millipore, USA) and then through a syringe filter (Pall Corporation, USA; Acrodisc 0.22 µm) to ensure sterility. The resulting extract is then diluted with saline or water for injection, pH-adjusted if necessary using hydrochloric acid or sodium hydroxide solutions, and filled into sterile vials.

Experimental Site and Animals, Housing, Acclimatization and feeding

Twenty adult West African Dwarf Buck Goats age ranging between six (6) month to two (2) years and weighing 12kg to 35kg (see plate 1A -1F) were used for this study. They were divided into two groups of ten each designated as lidocaine and extract group respectively and were housed in the large animal's cubicles at the Veterinary Teaching Hospital, University of Agriculture, Makurdi.

The animals were fed with grasses, yam peels, and a commercial ruminant diet (Hybrid Feeds Limited) produced in Kaduna, Nigeria. They were also given potable water ad libitum and allowed to acclimatize for one week before commencement of the experiment.

Evaluation of Safety/Lethal Dose

The lethal dose of Datura Metel L seed extract was evaluated using the up-and-down method (Saganuwan, 2014) [17]. The extract showed no toxic effects or mortality in albino rats at doses of 10, 100, and 1,000 mg/kg in the initial phase, and similarly, no adverse effects were observed at higher doses of 1,500, 2,500, and 4,000 mg/kg in the second phase, indicating a relatively low acute toxicity profile.

Preparation of Plant Seeds Extract

One kilogram (1Kg) of the seeds was obtained from the dried fruits. The seeds were dried in the Department of Veterinary Physiology, Pharmacology and Biochemistry, Federal University of Agriculture Makurdi, laboratory under room temperature and weighed several times until constant weight was obtained. The dried seeds were pounded in a mortar with a pestle and sieved to obtain a fine powder. Fifty (50) grams of Datura metel seeds powder was collected and placed into extraction apparatus and extracted serially with 1000 milliliters of water. The mixture was thoroughly shaken intermittently throughout the period of extraction (48 hours) using a stirrer. The mixture was filtered with Whatman Filter Paper No 1 into a 1000-milliliter measuring cylinder. The extracts were concentrated in the rotary evaporator at 600c. The resultant crude extracts were stored in the refrigerator at 4°c until required for use.

Experimental Procedure

Datura metel seed extract (75mg/kg body weight) was infiltrated subcutaneously into West African Dwarf (WAD) Buck Goats in group A. Prior to administration of the extracts, their scrotal region (plate 1A and 1B) of both groups were shaved broadly and prepared aseptically.

Group B was also made up of Ten (10) WAD Buck Goats and was treated with lidocaine hydrochloride infiltrated subcutaneously at around their scrotal region at a dose of 4mg/kg body weight. In each group, a one and half (11/2) inch, 18 gauge needle was inserted into the skin at an angle of approximately 20 degrees (Gyang, 1990) [4]. As soon as the needle was properly placed in the intradermal tissue and lesser resistance was noticed, 0.5ml of Datura metel seed extract was deposited, a wheal was raised and the extract was infiltrated from one site to another in success by advancing the needle around the testicles. As the extract was been deposited the needle was pulled back gradually, this was performed in a ring form at the base of the scrotal sack.

The same procedure was performed in the lidocaine induced group of WAD Buck Goats.

Bilateral open orchidectomy was performed following local anesthesia establishment on negative twitch response. The

Bucks Goats were restraint on a lateral recumbency and the scrotum was shaved and scrub with 70% alcohol -An incision was made parallel to the median Raphael down the anterior surface of the scrotum and was extended backward to open the bottom of the scrotum. The testicles were cut and removed after ligating the spermatic cord with chromic catgut size 2-0 through one common point of incision. The second testicle was reached by incising through the median septum. The scrotal incision was allowed to heal as an open wound.

Post-Operative Care

After the surgery, there was close post-operative management to mitigate the case of excess bleeding. The buckle was placed on a course of broad-spectrum antibiotics combination of penicillin-streptomycin (Jubaili Agrotec Group Nigeria) injection at the dose rate of 1ml/25kg intramuscularly for 4 days, 5% Diclofenac Sodium injection at the dose of 1.25mg/kg body weight for 3 days (Jubaili Agrotec Group Nigeria) at the dose rate of 2.5mg/kg body weight intramuscularly twice daily for three days, and Oxytetracycline Spray (Jubaili Agrotec Group Nigeria) dressing involved removing the gauze soaked with iodine from the cavity after 24 hours and applying a wound dressing, and monitoring for signs of infection.

WAD Buck Goat (Plate 1f), Photographic Illustration of Orchidectomy Procedure (Plate 1a-1e) and *Datura Metel plant* (Plate 2)

Plate 1a: Subcutaneous periscrotal Infiltration of Datura Metel seeds extract in West African buck goat for Orchidectomy.

Plate 1b: Single median Raphe Scrotal incision for Orchidectomy.

Plate 1c: Resection of exteriorized ligated testicles.

Plate 1d: Stump of resected spermatic cord.

Plate 1e: Orchidectomized scrotal sac.

Plate 1f: West African dwarf buck goat.

Plate 2: *Datura Metel plant.*

Data Analysis

The mean and standard error were used in analyzing the experimental data. Changes in the treatment values for both the lidocaine and extract treatment groups were compared with pretreatment values for both groups for statistical significance using ANOVA and a probability level at 5% as a level of significant.

Results and Discussion

The local anaesthetic effect of *Datura metel* seed extract and lidocaine twitch response in goats following subcutaneous infiltration were 46.6±1.20% and 93.3±0.21% respectively. This resulted in a significant (p<0.05) difference of local anesthesia (see table. 1.0). The onset of subcutaneous extract and lidocaine induce anesthesia was 15.80±0. 16 and 3.20±0.02 respectively. Similarly, the duration of subcutaneous and lidocaine-induced anesthesia was 35.95.±0.177 and 56.50±0.10 respectively. The time of onset anesthesia by the extract as significantly (p>0.05) higher than that of lidocaine, while the duration of extract anesthesia was significantly (p>0.05) less than that of lidocaine anesthesia (see table 2.0).

The percentage of local anesthesia, onset, and duration of extract anesthesia were significantly (p>0.05) different from

those of lidocaine (see Table 1).

Description of Results (Tables)

Table 1: Effect of *Datura metel* extract on twitch response in goats

Extract/Drug	Route of administration	Number of negative responses					% Anaesthesia
		5	15	30	45	60	
D metel	Subcutaneous	0/3	3/3	3/3	1/3	0/3	46.6 ±1.20
Lidocaine		3/3	3/3	3/3	3/3	2/3	93.3±0.21

Table 2: Onset and duration of action of *Datura Metel* seed extract and lidocaine HCI in WAD goats following subcutaneous administration

Route	Extract/Lidocaine HCI	Onset of action (minutes)	Duration of action (minutes)
Subcutaneous route	Extract	15.80±0.16	35.95± 0.177
	Lidocaine HCI	3.20±0.02[a]	56.50±0.10[a]

Values are recorded as means SE (X±SEM) a = values for lidocaine are significantly different at $p<0.05$ when compared with the extract.

The findings from this study provide novel insights into the local anesthetic potential of Datura metel seed extract, positioning it as a potential alternative to traditional anesthetics like lidocaine for surgical procedures such as orchidectomy in West African Dwarf Buck Goats. The significant contrasts observed in the onset and duration of anesthesia between Datura metel and lidocaine underscore the profound pharmacological differences that necessitate further exploration.

Onset and Duration of Anesthesia

The results indicated an onset time for Datura metel of 15.80±0.168 minutes, markedly longer than the rapid establishment of action seen with lidocaine at 3.20±0.02 minutes. This difference is statistically significant ($p<0.05$), suggesting that while Datura metel is effective, it may not provide the immediate relief necessary for acute procedures where rapid anesthesia is crucial.

Meanwhile, the duration of anesthesia was significantly shorter for Datura metel (35.95±0.177 minutes) compared to lidocaine (56.50±0.10 minutes). This limitation could be indicative of the extract's pharmacokinetics and its mechanism of action, which may facilitate a faster onset but less sustained effect. The short duration of action of Datura metel could necessitate consideration for re-administration in procedures that demand longer anesthesia. Furthermore, the variations in onset and duration may prompt veterinarians to tailor their anesthetic protocols according to specific surgical needs, potentially utilizing Datura metel for minor, shorter procedures.

Percentage of Anesthesia

Another noteworthy finding was the efficacy rate of local anesthesia achieved with both agents, with Datura metel yielding 46.66±1.20% and lidocaine achieving a substantial 93.30±0.21%. These results show that while Datura metel does possess local anesthetic properties, its overall efficacy is significantly lower than that of lidocaine ($p<0.05$). This disparity could be attributed to the varying mechanisms by which these substances induce anesthesia. Lidocaine is a well-characterized sodium channel blocker that effectively impedes nerve impulse transmission, whereas the active components of Datura metel remain largely uncharacterized (Udegbunam *et al.*, 2013, Babalola *et al.*, 2015) [20, 19].

Safety and Physiological Parameters

Phytochemicals screening of Extract allows the detection of secondary metabolites in a plant extract or samples. In this study it was done as described by Tiwari *et al.*, (2011) [18] a step towards identifying potential bioactive compounds in the extracts were analyses.

The study showed no statistically significant differences in rectal temperature between the two treatment groups, suggesting that Datura metel does not exasperate heat regulation mechanisms in WAD goats, a vital consideration when assessing the overall safety of any anesthetic agent. The absence of significant changes in physiological parameters implies a level of compatibility of Datura metel seed extract in this context; however, further evaluation on other parameters such as blood pressure, heart rate, and post-anesthesia recovery is warranted to fully delineate its safety profile (Izquierdo-Hernández *et al.*, 2016) [21].

Phytochemical Considerations

The phytochemical constituents of Datura metel seeds, primarily tropane alkaloids such as hyoscine and atropine, have been documented to exhibit notable anesthetic and analgesic properties. Future studies should focus on isolating and understanding the specific active components within Datura metel responsible for its anesthetic effects, as this could enhance its therapeutic application and allow for the safe development of pharmacologically standardized extracts.

Recommendations and Future Research Directions

The recommendation for Datura metel extraction as a local anesthetic agent highlights a critical opportunity for its application in mild surgical interventions where lidocaine might not be feasible due to associated risks or cost considerations. However, the limitations in potency and duration prompt caution against relying solely on Datura metel for more invasive surgical procedures.

In pursuit of a broader understanding, subsequent investigations should also include an analysis of the interaction of Datura metel with other anesthetics, both pharmacological and herbal, to ascertain synergistic effects or enhanced safety profiles with combined approaches. Longitudinal studies assessing recovery times, pain management post-procedure, and potential long-term effects on livestock health should be prioritized.

Conclusion

Datura metel seed extract demonstrates legitimate potential as a local anesthetic agent during orchidectomy in WAD goats. However, its lower efficacy and shorter duration of anesthesia compared to lidocaine necessitate careful application. The agricultural and veterinary communities could benefit from continued exploration of plant-based anesthetics, embracing the intersection of traditional knowledge and modern pharmacology to enhance animal welfare and surgical outcomes in veterinary medicine.

Conclusion and Recommendations

The results obtained from the study (see table 2.0) show that the administration of the extract and lidocaine subcutaneously to Buck Goats resulted in local anesthesia in the treated buck goats. The local anesthetic onset of effects commenced 15.80±0.17 min and 3.2±0.2 min following subcutaneous extract and lidocaine administration. The onset of extract

anesthesia was significantly to (p<0.05) higher than that of lidocaine administration respectively. The duration of extract and lidocaine anaesthesia following subcutaneous dosing was 35.95±0.18 min and 56.50±10 min respectively. The duration of anesthesia induced subcutaneously with extract was significantly (p>0.05) lesser than the induced duration of lidocaine. Both lidocaine and extract anesthetics induction produce local anesthesia that is sufficient for carrying out all minor surgeries. The result of the percentage extract and lidocaine anesthesia on negative twitch response in goat increased subcutaneously 46.6±1.20% and 93.3±0.21% respectively. There was significant difference (p<0.05) in the percentage extract and lidocaine anesthesia.

- The seed extract of D. metel was found to have some local anaesthetic properties following subcutaneous administration in orchidectomy procedure. Thus the extract might be useful for local anaesthesia in major surgical procedures.
- It is recommended that the active component responsible for the local anaesthetic effect of D. metel seed extract should be isolated and characterized.
- Further studies involving the local anaesthetic potency of the extract should be carried out
- This study showed that the induction of this extracts have local anesthetic activities, therefore strongly recommended for orchidectomy procedure and other minor surgical procedures.

Acknowledgement
The authors are thankful to the technical assistance of Mr. Vincent Upev and Comr. Ali Godwin for typesetting of the work and all staff of Small Animal Surgery Theatre Facility, South Core, Department of Veterinary Surgery and Diagnostic Imaging, JOSTUM for their indefatigable assistance.

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How to Cite This Article
Umayange A, Elsa AT, Amine AA, Nev TO, Onyeberechi AS, Ilevbare I. Evaluation of Datura Metel seed extract as local Anaesthetic agents for Orchidectomy in West African dwarf buck goats. International Journal of Veterinary Sciences and Animal Husbandry. 2024;9(6):647-651.