CLINICAL RESEARCH

HEMATOLOGICAL AND CARDIOPULMONARY EFFECTS OF PROPOFOL ANESTHESIA IN RED SOKOTO GOAT OF NIGERIA

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ABSTRACT

Propofol is a unique non-barbiturate, non-steroid, short-acting general intravenous anaesthetic agent associated with rapid and smooth induction and rapid recovery. Earlier studies have indicated the adverse effect of propofol anesthesia on hematological parameters, contributing to immune suppression in dog. Propofol has also been reported to cause depression of respiratory function due to reduction of sensitivity of respiratory centre to carbon dioxide and tissue oxygen uptake in goat. The high cost of anesthetic agents, especially general or intravenous anesthetics, lack of technical know-how of endotracheal intubation and paucity of suitable anesthetic agents limits the ability of the surgeon to perform invasive surgery successfully in goats. This study was conducted to evaluate the effects of propofol anesthesia on the hematological and cardiopulmonary parameters in Red Sokoto goats of Nigeria for possible adoption in routine invasive surgical procedures in small ruminants due to non-availability of information on this aspect. Five apparently healthy female Red Sokoto goats weighing between 17-25 kg were used for the study. Propofol was used for induction of anesthesia with 4mg/kg body weight for 10 seconds and maintained at 0.4 $mgkg^{-1}min^{-1}$ by continuous infusion for 60 minutes. Hematological and cardiopulmonary parameters were recorded before anesthetization (T0) and subsequently at 5 (T5), 10 (T10), 15 (T15), 30 (T30), 45 (T45), and 60 (T60) minutes after anesthetization, and 1 hour post recovery (T120). The mean onset of propofol anaesthesia was found to be 20.6 ± 2.6 seconds. All the animals showed prolapsed third eyelid, whereas the tail, palpebral, deglutition and auricular reflexes were abolished. The goats showed no outward signs of excitement. Endotracheal intubation was difficult. Onset of action was rapid, so also the time of recovery. Hematological parameters in the study included Haematocrit (PCV%) value, Red Blood Cell (RBC) Count, Hemoglobin concentration (Hgb), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC),and White Blood Cell (WBC) Count. Cardiopulmonary parameters included rectal temperature, respiration rate, pulse rate, mean arterial blood pressure (MABP) and oxygen saturation level (SpO_2). The result of the present study did not reveal significant ($P>0.05$) alteration in hematological indices and cardiopulmonary parameters before anesthetization (T0), during anesthesia (T5-T60) and after recovery from anesthesia (T120). It is concluded that induction of propofol anesthesia at 4mg/kg body weight and maintenance at 0.4mg/kg/minute for surgical interventions in Red Sokoto goats triggered rapid onset and smooth perpetuation without detrimental hematological and cardiopulmonary consequences during anesthetization and post-recovery.

KEY WORDS

Cardiopulmonary, Hematology, Propofol, Red Sokoto Goat.

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INTRODUCTION

Drugs commonly used in anesthesia practice may significantly alter the oxidative state of blood cells, contributing to immune suppression that occurs transiently in the early post-operative period (Costa et al., 2013). The consequent oxidative stress gives rise to cellular damage, including accelerated apoptosis, which is a main contributing factor for post-operative lymphocytopenia and immunological insufficiency (Delogu et al., 2004).

Propofol is an alkyl phenol derivative (2, 6-di-isopropyl phenol), moderately soluble in water and commercially produced as an aqueous emulsion containing propofol (10 mg/ml), glycerol (100 mg/ml), soya bean oil (22.5 mg/ml), egg lecithin (12 mg/ml) and sodium hydroxide to adjust the required level of pH (Branson and Gross, 1994; Lin et al., 1997). Propofol is provided in sterile glass ampoule, but it does not contain preservatives. Therefore, the formulation is susceptible to microbial growth and endotoxin production (Arduino et al., 1991).

Propofol is a unique non-barbiturate, non-steroid, short-acting general intravenous anaesthetic agent (Hofmeister et al., 2008). It is associated with a rapid smooth induction and a rapid recovery compared to administration in the form of bolus or through infusion (Branson and Gross, 1994). It produces smooth induction and preservation by intermittent injection (Muir et al., 2007). Propofol effects are similar to sodium pentothal in terms of rapid onset of action. It does not provide analgesia; but, some studies have reported a less post-operative pain as compared to inhalation agents (Muir et al., 2007).

However, it is reported that prior to propofol administration, oxygen utilization ratio increased, whereas mean arterial pressure, mean pulmonary arterial pressure, central venous pressure, pulmonary capillary wedge pressure, cardiac index, oxygen delivery, mixed venous oxygen tension, and mixed venous oxygen content decreased from baseline in hypovolemic dogs (Ilkiw et al., 1992).

Propofol is extremely protein bound *in vivo* and is metabolized by conjugation in the liver. Its rate of clearance exceeds hepatic blood flow, suggesting an extra hepatic site of elimination and has several mechanisms of action (Vanlersberghe and Camu, 2008) both through potentiation of GABA, a receptor activity, thereby slowing the channel closing time (Krasowski et. al., 2002) and acting as sodium channel blocker as well (Haeseler and Leuwer, 2003; Fowler, 2004). Recent research has also suggested the endocannabinoid system which might contribute significantly to propofol's anesthetic action and to its unique properties (Fowler, 2004).

Earlier studies have indicated the adverse effect of propofol anesthesia on hematological parameters, such as red blood cells (RBC) count, hematocrit (PCV%), hemoblogin (Hgb) concentration and total leukocytes (WBC) count, 30-60 minutes after induction compared to the base values before induction, and should therefore be used with caution in immunossupressed patients.

The Bispectral index (BIS) has indicated that cardiovascular parameters, such as heart rate (HR) was not affected by propofol-anesthesia administered with or without tramadol before induction and 60 minutes after induction, while systolic arterial pressure (SAP), diastolic arterial pressure (DAP) and mean arterial pressure (MAP) were significantly ($P<0.05$) higher in 60 minutes after anesthetization compared to the base value in dogs (Costa et al., 2013).

Propofol has been reported to cause depression of respiratory function expressed by a decrease in tidal volume and respiratory rate in animals and humans. Incidence of apnea is common and is attributed to be dependent on the dose, speed of infection, concomitant premedication and the presence of hyper ventilation and hyperoxia (Langley and Heel, 1988; Smith et al., 1994). The decrease is attributed to reduction of sensitivity of respiratory centre to carbon dioxide and tissue oxygen uptake in goat (Lumb and Jones, 1997; Carroll et al., 1998). Myoclonus and apnea were associated with propofol administration at 5.1 mg/kg in goats (Pablo et al., 1997).

Goats are not commonly anesthetized with general anesthetic technique in most developing countries. This is why information on goat anesthetics is limited. In Nigeria, Intravenous anesthesia is not a common practice in small ruminant surgery, but mostly carried out in pet animals like dogs and cats. Local anesthesia with physical restraint is the common practice in both small and large animal surgeries. The high cost of these anesthetic agents, mostly general or intravenous anesthetics, lack of technical know-how of endotracheal intubation in goats and administration of suitable anesthetic agent to achieve anesthesia, limits the ability of the surgeon to perform invasive surgery successfully. This study aims to evaluate the effects of propofol anesthesia on the hematological and cardiopulmonary parameters in Red Sokoto goats for possible adoption in routine invasive surgical practice in small ruminants.

MATERIALS AND METHODS

A total of 5 apparently healthy adult Red Sokoto does were used for this study. They weighed between 17 to 27 kg, and were housed in the Usmanu Danfodiyo University Veterinary Teaching Hospital, Large Animal Pen. All the five goats were fed twice daily with commercial wheat bran and hay. Clean water was provided *ad libitum*. The goats were conditioned for one week before anaesthetization, after which they were examined and ascertained to be free from any clinical signs of illness, before trial.

Animal Preparation: The goats were fasted for 12 hours but water was provided until 2 hours before induction of anesthesia. The animals were weighed and vital parameters were recorded. Before induction of anesthesia, both the right and left jugular veins were catheterized using polyvinyl IV catheter (PRIMAFLON® , China) on disinfected clipped skin for the administration of drug and blood sample collection respectively and the base of the tail was clipped for the placement of pulse oximeter probe (PC-66® hand held oximeter, Singapore).

Induction and Maintenance of Anesthesia: Propofol (POFOL®, Dongkook Pharmaceuticals, Thailand) at 4mg/kg body weight was administered through the left jugular vein slowly over 10 seconds. Endotracheal intubation was attempted immediately once the goats became recumbent and showed absence of swallowing reflex.

The median effective dose (ED50) of propofol in goat has been calculated earlier (by use of probit analysis by taking into consideration induction time, frequency and duration of apnea, frequency of myoclonus, and other adverse effects (Reid et al., 1993). Induction of propofol anesthesia (4 mg/kg) has been proved to be rapid and smooth, providing satisfactory conditions for intubation in goats (Pablo et al., 1997). The anesthesia was maintained at 0.4 $mgkg^{-1}min^{-1}$ continuous infusion rate for 60 minutes (Kaiser-Klingler, 2012; Ferreira et al., 2016).

Blood Sampling for Hematogical Indices: Blood sample was collected from the preplaced catheter from one of the jugular veins before premedication and induction at 0 minute, followed by induction at 5 minutes interval for the next 15 minutes and at 15 minutes interval for the next 60 minutes, i.e., 0, 5, 10, 15, 30, 45, and 60 minutes between induction and continuous intermittent bolus injection time, and 1 hour after complete recovery.

The samples were stored in commercial EDTA sample bottles for complete blood count. The hematological parameters were determined according to the principles and methods discussed in the operational manual of fully automated Blood Cell Counter (Erma® PCE-210 Inc. Japan). The parameters measured were, Haematocrit (PCV%), White Blood Cell (WBC) Count, Red Blood Cell (RBC) Count, Hemoglobin concentration (Hgb), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin Concentration (MCHC), White Blood Cell (WBC) Count, Granulocytes, Percentage Monocytes (% Mon), Percentage Lymphocytes (% Lym.).

Cardiopulmonary Parameters: Following induction, the goats were positioned in right ventro-lateral recumbency. Heart and respiratory rates were monitored and recorded using a non-invasive technique (Haskins, 2007) using Veterinary patient monitor (Gladyvet 9200, China). Cardio-respiratory monitoring was performed using a non-invasive technique by the use of pulse oximeter with the probe wrapped around the clipped tail through the coccygeal artery. The arterial blood pressure was monitored and recorded indirectly using a non-invasive technique by the use of blood pressure cuff. Blood pressure meter was placed on cephalic artery with an appropriate size cuff (Wagner et al., 1991). Rectal temperature was monitored and recorded using digital thermometer (Famidoe Technology CO., Ltd. Guangdong, China).

RESULTS

Clinical symptoms: The mean onset of propofol anaesthesia was found to be 20.6 ± 2.6 seconds. All the animals showed prolapsed third eyelid, whereas the tail, palpebral, swallowing and auricular reflexes were abolished. The goats showed no outward signs of excitement. Endotracheal intubation was difficult and onset of action was rapid, so also the recovery time.

Hematological indices: There was no significant difference ($P>0.05$) in various hematological indices, viz., PCV (%), RBC ($x10^6/\mu l$), Hg b (g/dl), MCV (fl), MCH (pg/dl), MCHC (g/dl), WBC ($x10^3/\mu l$), Granulocyte ($x10^3/\mu l$)), Lymphocyte (%), and Monocyte (%) at different time intervals (5-120 min) from the base line information (T0) before induction highlighting the efficacy and safety of propofol anesthesia in Red Sokoto goats (Table-1).

Cardiopulmonary parameters: There was no significant difference ($P>0.05$) in various cardiopulmonary parameters, viz., rectal temperature (^0C), respiration rate (cycles/min), pulse rate (Beats/min), mean arterial blood pressure, and mean oxygen saturation at different time intervals (5-120 min) from the base line information (T0), with the unexplainable lone exception (chance error) with regard to recession of rectal temperature after recovery (T 120) of the anesthetized animals highlighting the efficacy and safety of propofol anesthesia in general with respect to the cardiopulmonary parameters in Red Sokoto goats (Table-2).

Table-1: Effects of Propofol anesthesia on hematological indices.

Parameter	0 Min	5 Min	10 Min	15 Min	30 Min	45 Min	60 Min	120 Min
PCV (%)	24.36 ± 0.7	21.90 ± 1.4	23.40 ± 0.9	22.74 ± 0.3	23.40 ± 0.5	21.66 ± 1.2	22.86 ± 1.2	23.94 ± 1.4
t	---	NS	NS	NS	NS	NS	NS	NS
RBC ($x10^6$/µl)	10.0 ± 1.1	9.5 ± 0.8	9.5 ± 1.5	9.2 ± 0.7	9.4 ± 0.9	13.5 ± 9.5	9.5 ± 0.9	9.8 ± 1.1
t	---	NS	NS	NS	NS	NS	NS	NS
Hg b (g/dl)	7.3 ± 0.7	6.2 ± 0.7	6.4 ± 1.2	6.1 ± 0.6	6.2 ± 0.7	6.2 ± 0.7	6.5 ± 0.6	6.5 ± 0.6
t	---	NS	NS	NS	NS	NS	NS	NS
MCV (f l)	18.1 ± 1.01	17.0 ± 1.8	16.9 ± 1.9	16.7 ± 1.8	16.8 ± 1.8	16.6 ± 1.8	16.8 ± 1.8	16.9 ± 1.7
t	---	NS	NS	NS	NS	NS	NS	NS
MCH (p g/dl)	7.3 ± 0.4	6.3 ± 0.8	6.7 ± 0.7	6.6 ± 0.5	6. 6 ± 0.6	6.6 ± 0.5	6.7 ± 0.5	6.6 ± 0.5
t	---	NS	NS	NS	NS	NS	NS	NS
MCHC (g/dl)	40.2 ± 1.3	39.0 ± 2.4	39.2 ± 1.9	39.8 ± 2.4	39.3 ± 1.6	39.9 ± 2.1	39.9 ± 1.9	39.5 ± 2.6
t	---	NS	NS	NS	NS	NS	NS	NS
WBC ($x10^3$/µl)	22.1 ± 6.8	14.6 ± 7.7	18.1 ± 6.5	16.6 ± 6.2	17.5 ± 4.5	18.3 ± 5.3	18.9 ± 5.5	17.0 ± 6.0
t	---	NS	NS	NS	NS	NS	NS	NS
Granulocyte ($x10^3$/µl)	12.2 ± 2.9	9.6 ± 4.4	8.7 ± 3.2	9.3 ± 2.7	8.6 ± 3.2	9.1 ± 3.3	10.7 ± 3.4	11.4 ± 4.1
t	---	NS	NS	NS	NS	NS	NS	NS
Lymphocyte (%)	22.1 ± 6.8	14.6 ± 7.7	18.1 ± 6.5	16.6 ± 6.2	17.5 ± 4.5	18.3 ± 5.3	18.9 ± 5.5	17.1 ± 6.0
t	---	NS	NS	NS	NS	NS	NS	NS
Monocyte (%)	4.0 ± 1.2	2.9 ± 1.0	2.9 ± 0.9	3.0 ± 1.9	3.4 ± 0.4	3.4 ± 0.7	3.3 ± 2.0	2.5 ± 1.0
t	---	NS	NS	NS	NS	NS	NS	NS

(1) The values in each cell represent Mean ± SEM, and each value (T1-T120) has been compared for statistical significance against the base value (T0) by t test at $P<0.05$.

(2) NS = Non-Significant.

Table-2: Effect of Propofol anesthesia on cardiopulmonary parameters.

Parameter	0 Min	5 Min	10 Min	15 Min	30 Min	45 Min	60 Min	120 Min
Rec. Temp (^{0}C)	39.24 ± 0.56	38.60 ± 0.61	38.40 ± 0.67	38.26 ± 0.6	38.26 ± 0.59	38.08 ± 0.58	37.96 ± 0.47	37.0 ± 0.66
t	---	NS	NS	NS	NS	NS	NS	SIG
RR cycles/min	25.20 ± 4.60	15.80 ± 2.49	20.40 ± 5.36	16.0 ± 3.74	19.60 ± 10.7	18.20 ± 6.87	17.2 ± 7.15	19.0 ± 3.31
t	---	NS	NS	NS	NS	NS	NS	NS
PR (Beats/min)	79.40 ± 5.55	75.60 ± 8.44	71.40 ± 8.14	70.80 ± 9.31	71.60 ± 12.30	71.80 ± 11.12	74.0 ± 12.02	69.8 ± 16.34
t	---	NS	NS	NS	NS	NS	NS	NS
MABP	72.40 ± 7.31	63.40 ± 8.20	62.20 ± 8.16	62.40 ± 6.54	61.0 ± 9.79	59.80 ± 11.62	64.20 ± 11.75	76.0 ± 11.76
t	---	NS	NS	NS	NS	NS	NS	NS
SpO_2	66.40 ±22.56	79.0 ±14.42	72.40 ±19.50	90.0 ± 5.78	83.40 ± 6.06	81.60 ± 10.43	92.80 ± 4.08	71.4 ±2 7.26
t	---	NS	NS	NS	NS	NS	NS	NS

(1) The values in each cell represent Mean ± SEM, and each value (T1-T120) has been compared for statistical significance against the base value (T0) by t test at P<0.05. (2) SIG = Significant, NS = Non-Significant.

DISCUSSION

The result of the present study showed that hematocrit (PCV%) decreased significantly (P<0.05) throughout the period of anaesthesia and 1 hour post recovery in all the goats. It concurs with the finding that a significant decrease was observed in PCV when acetylpromazine-propofol anaesthesia was administered in dogs (Gill et al., 1996).

Handel et al. (1991) have also reported a decrease in PCV during the first 10 minutes of induction of propofol in sheep (ewes). Wagner et al. (1990) and Wagner et al. (1991) attributed this to be due to inter-compartmental fluid shift in order to maintain normal cardiac output, and due to decrease in resting sympathetic tone and hemodilution that occur when drugs are been administered. In a different study conducted by Robertson et al. (1992) and Kwon et al. (1999) no significant change in haematocrit was observed in dogs. Brzeski et al. (1994) have reported that all hematological parameters when propofol was administered in sheep were found to be within the normal physiological range. PCV value was found to be within the physiological limit when xylazine was administered after induction with both high and low dose of propofol in horses (Mama et al., 1998).

There was no significant change (P>0.05) in RBC in this study which is contrary to the findings of Kilic (2008) where a decrease in Red Blood Cell count (RBC) at 60 minutes of anaesthesia was observed when propofol was administered in dogs and this was attributed to be due to pooling of circulating blood cells in the spleen or other reservoirs secondary to decrease sympathetic activity.

There was significant (P<0.05) decrease in Mean Corpuscular Volume (MCV) at 5, 10, 15, 30, 40 and 60 minutes. There was also significant (P<0.05) difference in the mean corpuscular hemoglobin concentration (MCHC) between the baseline value and at all other timing intervals post administration of the drug. However, there was no significant (P>0.05) decrease in MCHC throughout the anesthetic timing intervals. This is contrary to the findings of Kim and Jang (1999), where no significant changes in MCV and MCH were observed in propofol premedicated with xylazine in dogs.

Vishwakarma et al. (2013) have reported lymphocytes to be within the normal range when propofol was administered in sheep, however, in our own finding lymphocytes decreased significantly (P<0.05) at 5, 15, and 30 minutes within the period of anaesthesia and 1 hour after recovery. This might be due to the stress caused by pre-anaesthetic handling and restraint. There was no significant change (P>0.05) in total leucocytes count when propofol premedicated with xylazine was used by Kim and Jang (1999) in dogs, but in the present study, a significant (P<0.05) decrease in WBC was observed, however these changes could be attributed to the stress arising from manual handling and restraint and the cannulation of the jugular veins during premedication.

When propofol-triflupromazine was administered in buffalo calves, a non-significant decrease in hemoglobin concentration (Hgb) was observed (Singh et. al., 2014). Similarly, Ratnesh (2010) and Kumar et al. (2011) recorded a significant change in Hgb concentration when propofol anaesthesia was administered in buffalo calves, but Suresha et al. (2012) observed a significant decrease in Hgb when triflupromazine and propofol were administered in dogs. Decrease in hemoglobin has also been reported in dogs after the administration of dexmeditomidine (Gupta, 2010), in sheep after administration of butorphanol and in buffaloes after midazolam and butorphanol administration (Malik et al., 2011). A significant (P<0.05) change in Hgb concentration was recorded in this present study and this decrease may be as a result of splenic pooling of blood constituents (Hewson et al., 2006; Welberg et al., 2006).

The result of the present study showed a non-significant (P>0.05) fluctuation in respiratory rate following induction of anesthesia which persisted throughout the maintenance period and at 1 hour post recovery. This is in line with the work of Bayan et al. (2002) who reported an increase and then a subsequent decrease in respiratory rate after administration of propofol bolus in dogs.

Contrary to our findings, a decrease in respiratory rate were observed in goat by Carroll et al. (1998) when Detomidine-Butorphanol were used in dogs compared to propofol alone (Cullen and Reynoldson, 1997), and in horses when propofol in combination with detomidine was used (Mathews et al., 1999).

Propofol has been reported to cause depression of respiratory function expressed by a decrease in tidal volume and respiratory rate in animals and humans. Incidence of apnea is

common and is attributed to be dependent on the dose, speed of infection, concomitant premedication and the presence of hyper ventilation and hyperoxia (Langley and Heel, 1988; Smith et al., 1994). Lumb and Jones (1997) and Carroll et al. (1998) attributed the decrease to be due to reduction of sensitivity of respiratory centre to carbon dioxide and tissue oxygen uptake in goat.

A significance decrease in heart rate was observed in the present study following induction throughout the period of anesthesia and one hour post recovery; this is in line with the work of (Brussel et al., 1989) where a significant decrease in heart rate was observed in dogs after administration of propofol. However, our work goes contrary to the work of Kim and Jang (1999) when propofol alone was used in dogs or when tiletamin/zolazepam combination was used (Cullen and Reynoldson, 1997).

Higher heart rates were also observed by Lin et al. (1997) in xylazine-ketamine-halothane anesthesia in sheep as compared to medetomidine-propofol in dogs. In another finding, no statistically significant difference was observed in heart rate in dogs anesthetized with medetomidine/propofol combination (Thurmon et al., 1995). Intermittent increase and decrease were observed in propofol anesthetized dogs (Bayan et al., 2002). Boyle et al. (1989) attributed the decrease in heart rate to be due to negative ionotropic effect of propofol.

The result of the present study showed that there was a significant ($P<0.05$) decrease in rectal temperature throughout the period of anesthesia and 1 hour post recovery, as compared to the base line values. This is in line with the work of Carroll et al. (1998) who reported a decrease in rectal temperature of dog after propofol administration, also same result in sheep was reported by Zama et al. (2003). Kim and Jang (1999) reported significant decrease in body temperature and heart rate. Contrary to our findings Thurmon et al. (1995) reported that no significant difference in rectal temperature in dogs during medetomidine-propofol anesthesia was observed.

The result of the present study showed statistically insignificant ($P>0.05$) intermittent increase and decrease in systolic, diastolic and mean arterial blood pressure following induction of anesthesia and the same trend persist throughout the period of anesthesia and at 1 hour post recovery. This is in line with the work of Grimm et al. (1998) who reported a gradual decrease in systolic, diastolic and mean arterial blood pressure. Induction of anesthesia with propofol has been reported to reduce systolic and diastolic arterial blood pressure (Coates et al., 1987; McCollum and Dundee, 1986).

An intermittent increase and decrease in oxygen saturation level immediately following induction has been observed in the present study, same trend was observed and at 1 hour post recovery. Contrary to the present was the work, Ramin et al. (2012) have reported that oxygen saturation level significantly ($P<0.05$) decreased when compared with the baseline values in rabbit.

CONCLUSION

It can be concluded that induction and maintenance of propofol anaesthesia in goats at 4mg/kg and 0.4mg/kg/minute revealed rapid onset, smooth perpetuation with determinant hematological and cardiopulmonary consequence during anesthetization.

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UNDERTAKING

It is certified that the research review paper **"HEMATOLOGICAL AND CARDIOPULMONARY EFFECTS OF PROPOFOL ANESTHESIA IN RED SOKOTO GOAT OF NIGERIA"** is an original work carried out jointly by the authors in the Department of Veterinary Surgery and Radiology, Department of Theriogenology and Animal Production, Department of Veterinary Pharmacology and Toxicology, Usmanu Danfodiyo University Sokoto Nigeria and Department of Veterinary Surgery and Radiology, University of Agriculture Makurdi, Benue Nigeria. It has neither been published nor contemplated for publication elsewhere.

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