African Journal of Biotechnology Vol. 11(26), pp. 6878-6883, 29 March, 2012
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB10.684
ISSN 1684–5315 © 2012 Academic Journals

Full Length Research Paper

Anti-inflammatory and analgesic activities of the aqueous extract of *Leonotis leonurus* leaves in rats

V. Maphosa[1], A. A. Adedapo[2], B. Moyo[3] and P. J. Masika[1]*

[1]Agricultural and Rural Development Research Institute (ARDRI) University of Fort Hare, P/Bag X1314. Alice 5700. South Africa.
[2]Department of Pharmacognosy, University of Lagos, Nigeria.
[3]Department of Botany, University of Fort Hare, Alice 5700, South Africa.

Accepted 9 June, 2011

***Leonotis leonurus* (L.) R. BR. Lamiaceae is extensively for the treatment of various ailments and in the Eastern Cape province of South Africa, it is used for the treatment of effects of gastrointestinal parasites in animals. There is, however, scanty information on the pharmacological activities of this plant. The aqueous extract from the leaf of *L. leonurus* was investigated for its analgesic and anti-inflammatory properties. Carrageenan and histamine-induced rat paw oedema were conducted to evaluate anti-inflammatory activity, while acetic acid-induced writhing test was conducted to assess the analgesic activity of the plant. The extract was administered intraperitoneally (i.p) to rats at graded doses of 50, 100, 200 mg/kg body weight (BWt). Indomethacin (10 mg/kg BWt) was used as reference drug, whereas the vehicle (2 mg/kg BWt of 0.9% normal saline in Tween-80) was used as negative control. Acute toxicity was tested in rats at doses of 200, 400, 800 and 1600 mg/kg BWt. Compared with the control, the plant extract at 100 and 200 mg/kg BWt significantly ($P < 0.05$) reduced the formation of carrageenan - induced oedema, while with histamine-induced oedema the difference was insignificant ($P > 0.05$). In the acetic acid-induced writhing model, the plant extract produced a significant ($P < 0.05$) reduction in the number of writhes with all test doses and at 100 and 200 mg/kg BWt, the extract produced results that were similar to those of Indomethacin. This study revealed the potential of *L. leonurus* leaf aqueous extract in reducing pain and inflammation, suggesting that it has some anti-inflammatory and analgesic activities, hence, justifying its ethno-veterinary uses. The acute toxicity test showed that the plant is relatively safe to use.**

Key words: Analgesic, anti-inflammation, indomethacin, *Leonotis leonurus*, rats.

INTRODUCTION

Leonotis leonurus (L) R. BR. (Lamiaceae), lion's ear (English), umfincamfincane (Xhosa), has a wide distribution over large parts of South Africa (Hutchings et al., 1996; Van Wyk et al., 2000; Bienvenu et al., 2002). It is a shrub of about two to five meters in height with a thick woody base, pale brown branches and a strong smell in all parts (Van Wyk et al., 2000). The leaves are long, narrow rough above, velvety below with serrate edges, with characteristic bright orange flowers in compact clusters. Reports on phytochemical and HPLC analyses have shown the presence of alkaloids, saponins (of steroid and or triterpenoids groups) and tannins in the leaves of the plant (Bienvenu et al., 2002).

L. leonurus is used for treating various ailments both in humans and animals. In humans, leaves are used for colds, dysentery, coughs, amenorrhoea, influenza, bronchitis, high blood pressure and headache (McGaw and Eloff, 2008). Externally, decoctions have been applied to treat skin related diseases like boils, eczema, itching and muscular cramps (Hutchings et al., 1996; Van Wyk et al., 2000; Bienvenu et al., 2002). In livestock, an infusion and decoction of the leaf and stem are used for the treatment of internal parasites in animals (Scott, 2004). A survey conducted in the Eastern Cape revealed that *L. leonurus* leaves are being used by farmers to treat helminthosis in

*Corresponding author. E-mail: pmasika@ufh.ac.za. Fax: +27 40 6022583.

goat (Maphosa and Masika, 2010). The aqueous extracts of *Aloe ferox* and *Elephantorrhiza elephantina* have been reported to have analgesic and anti-inflammatory activities (Mwale and Masika, 2010; Maphosa et al., 2009).

Helminthosis, a disease caused by infestation of parasitic nematodes, is one of the most important animal diseases worldwide, causing heavy production losses in grazing animals Akhtar et al. (2000), especially in sheep and goats which have less ability to resist and tolerate helminthes. The helminthes manifest by damaging the mucosa of the gastro intestinal tract, resulting in inflammation and painful conditions. Inflammation, a response of living tissues to injury, involves a complex array of enzyme activation, mediator release and extravasation of fluid, cell migration, tissue breakdown and repair (Vane and Bolting, 1995; Perianayagam, 2006). These mediators include prostaglandins, especially the E series, histamine, bradykinins, leucotrienes and serotonin, all of which also cause pain and fever (Asongalem, 2004). Inhibitions of these mediators from reaching the injured site or from bringing out their pharmacological effects will normally ameliorate the inflammation and other symptoms. Inflammation has become the focus of global scientific research because of its implication in virtually all human and animal diseases.

The conventional drugs used to ameliorate this phenomenon are either too expensive, toxic or not commonly available to the rural people, who constitute the major populace of the world (Kumara, 2001; Dharmasiri et al., 2003). This then has led to people turning to use of the plants as an alternative in the treatment of ailments in their livestocks. This study was therefore, conducted to investigate the anti-inflammatory and analgesic properties of the aqueous leaf extract of *L. leonurus* in rats, as well as its safety, so as to scientifically appraise its ethnoveteriary use.

MATERIALS AND METHODS

Plant collection and extract preparation

The leaves of *L. leonurus* were collected in February 2007 in the Ntselamanzi area, Nkonkobe Municipality of the Eastern Cape Province of South Africa. The area falls within the latitudes 30°00´ to 34°15´S and longitudes 22°45´ to 30°15´E. It is bounded by the sea in the east and the drier Karroo (semi-arid vegetation) in the west (Masika and Afolayan, 2003). The area consists of many villages which are generally classified as rural and poor (Erasto et al., 2005). The plant was identified in its vernacular name by Mr S. Boltina and authenticated by Mrs E. Brink at Albany Museum Herbarium in Grahamstown, South Africa. A voucher specimen (No. VMAP08) was deposited in the Griffen Herbarium at the University of Fort Hare.

The leaves were air dried at room temperature to constant weight, comminuted into coarse powders and then used for the preparation of the extracts for this study. The powder, (300 g) was boiled in distilled water (3000 ml) at room temperature of 24°C. The extract was filtered using a Buckner funnel and Whatman no. 1 filter paper. The filtrate was later freeze-dried at -50°C under vacuum using a lyophiliser (Savant Refrigerated Vapor Trap, RVT 4104, USA) for 48 h, yielding 53 g of the extract, which translates to 17.7%.

Animals

Adult male Wistar rats, (280 to 300 g) were used for the analgesic and (320 to 370 g) anti-inflammatory study. They were maintained at the Experimental Animal House of the Agricultural and Rural Development Research Institute (ARDRI), University of Fort Hare, South Africa. They were kept in rat cages, fed on commercial pellets (EPOL Feeds, South Africa Ltd.) and allowed free access to clean water in bottles *ad libitum*. Ethical procedures for keeping rats were according to the University of Fort Hare ethic committee's and international standards.

Chemicals and drugs

The chemicals, carrageenan, histamine, acetic acid and Tween-80 and the drug, indomethacin, all of analytical grade were obtained from Sigma-Aldrich Chemie Gmbh, Steinheim, Denmark.

Acute toxicity test

The acute toxicity of aqueous extract of *L. leonurus* was determined in rats according to the method of Hilaly et al. (2004). The adult male rats were fasted for 16 h and later randomly divided into five groups of six rats. Graded doses of the plant extract (200, 400, 800, 1600 and 3200 mg/kg p.o.) were separately administered to the rats in each of the groups by means of a bulbed steel needle and later allowed free access to food and water. Observations were made over a period of 48 h for any behavioural and physiological changes. Deaths were also recorded over this period.

Anti-inflammatory activities

Carrageenan-induced rat paw oedema

Twenty (20) adult male rats grouped into five received different treatments. Plant extract was administered at three dose levels (50, 100, 200 mg/kg body weight) to groups 1 to 3. indomethacin (10 mg/kg body weight) (positive control) to group 4 and vehicle (0.9% normal saline in 3% Tween-80 [2 ml/kg]) (negative control) to group 5, intraperitoneally (i.p). The doses of the plant extracts were determined based on the toxicity levels results. Acute inflammation was produced by the sub-plantar administration of 0.1 ml of 1% w/v carrageenan in normal saline that contained Tween -80 in the right hind paw of the rats. The paw volume was measured at 0, 1, 2 and 3 h after the carrageenan injection using a micrometer screw gauge and the increase in the linear diameter of the right hind paws were taken as an indication of paw oedema. The percentage inhibition of the inflammation was calculated from the formula: % inhibition = $D0\text{-}Dt/D0$ x 100. Where, $D0$ is the average inflammation (hind paw oedema) of the control group of rats at a given time; Dt is the average inflammation of the drug treated (that is, extracts or reference indomethacin) rats. (Gupta et al., 2005; Sawadogo et al., 2006; Moody et al., 2006).

Histamine-induced rat paw oedema

Using the method of Perianayagam et al. (2006), the paw oedema was produced by sub-plantar administration of 0.1% w/v freshly prepared solution of histamine into the right hind paw of rats. The

Table 1. Anti-inflammatory activities of the aqueous extract of *L. leonurus* shoot and indomethacin on carrageenan-induced oedema in rats. Data expressed as mean ± SD. (n= 4).

Group	Dose (mg/kg)	Paw oedema volume (ml)		
		1 h	2 h	3 h
Control	-	1.65±0.47 [a]	0.98±0.28 [a]	0.66.±0.60 [a]
Indomethacin	10	0.44±0.15 [b] (73.3)	0.07±0.01 [b] (92.9)	0.02±0.01 [b] (97.0)
Extract	50	1.11± 0.56 [b] (32.7)	0.74±0.52 [b] (24.5)	0.40±0.19 [a] (39.4)
Extract	100	0.74.± 0.43 [b] (55.2)	0.52±0.07 [b] (47.0)	0.61±0.22 [a] (7.6)
Extract	200	0.61± 0.32 [b] (63.0)	0.87±0.18 [b] (11.2)	0.09±0.01 [b] (86.4)

Figures in brackets are inhibition (%); [B]significantly different from control ($P < 0.05$).

paw volume was recorded before the histamine injection (time 0) and 1, 2 and 3 h after the injection. Twenty (20) animals, which were divided into groups of four animals were pre-treated with either of the following treatments: extracts (50, 100, 200 mg/kg); 2 ml/kg of 0.9% normal saline in Tween 80 (vehicle control); 10 mg/kg indomethacin (standard drug). The drug and extracts were administered intra-peritoneally 1 h before inducing paw oedema. The percentage inhibition of the inflammation was calculated following the method described by Tsai and Lin (1999), Gupta et al. (2005), Sawadogo et al. (2006) and Moody et al. (2006).

Analgesic activity

Acetic acid-induced writhing response in rats

To evaluate the analgesic effects of the plant extract, the method described by Dharmasiri et al. (2003) was used. Five groups with four rats each, received the following intra-peritoneal treatment respectively: normal saline solution (2 ml/kg); indomethacin (10 mg/kg); plant extract (50, 100, 200 mg/kg). Thirty minutes later, 10 ml/kg of 0.7% acetic acid solution was administered intra-peritoneally to all animals in the different groups. The number of writhes occurring between five and twenty minutes after acetic acid injection was counted. A significant reduction of writhes in tested animals compared with those in the control group was considered as an antinociceptic response and was calculated using the formula: *C-D*/C x 100, where, C is the average number of writhings for the control group of rats and *D* is the average writhings of the drug/extract treated rats (Gupta et al., 2005; Sawadogo et al., 2006; Moody et al., 2006).

Statistical analysis

Data were expressed as means ± S.D for four animals per group. Differences between control and treatment groups were analyzed using one way ANOVA followed by the Turkey post hoc multiple comparisons tests using SPSS version 11.5 software. $P < 0.05$ was considered to be significant.

RESULTS

Acute toxicity test

Oral administration of graded doses (200, 400, 800, 1600 and 3200 mg/kg p.o.) of the aqueous extract of *L. leonurus* to rats did not ($P > 0.05$) affect behavioural nor physiological responses of the experimental rats during the 48 h period. The extract caused death of one rat out of four among the group receiving the highest dosage in the 3200 mg/kg dose about 10 min after the administration of extract.

Anti-inflammatory activity

Carrageenan-induced paw oedema

When compared with the control, treatment with the extract (100 and 200 mg/kg) and the reference drug significantly reduced ($P < 0.05$) the paw oedema at 1 h after carrageenan injection. The effect of the extract at 50 mg/kg dose was not significantly different ($P > 0.05$) from that of the control. The anti-inflammatory effect of the extract at 200 mg/kg (86.4%) was close to that of indomethacin (97.0%) at 3 h and it was at this time that both the effects of the extract and indomethacin were most pronounced (Table 1).

Histamine-induced paw oedema

The extract exhibited the most pronounced inhibitory effects (63.6, 43.4 and 52.5%) after 3 h of histamine injection at all dose rates (Table 2). Indomethacin produced its most inhibitory effects after 2 and 3 h (Table 2). The lower doses of the extract exhibited mild anti-histamine effect after 1 h of histamine injection.

Analgesic activity

Acetic acid-induced writhing in rats

All doses of *L. leonurus* (50, 100 and 200 mg/kg) and indomethacin (10 mg/kg) used in this experiment induced decreases in the number of writhes when compared with the control. The extract, at 50, 100, 200 mg/kg and indomethacin at 10 mg/kg exhibited a high inhibition of 96.2, 100, 100 and 100%, respectively (Table 3).

Table 2. Anti-inflammatory activities of aqueous extract of *L. leonurus* shoot and indomethacin on histamine-induced oedema in rats. Data expressed as mean ± SD. (n=4).

Group	Dose (mg/kg)	Paw volume oedema (ml)		
		1 h	2 h	3 h
Control	-	2.30±0.58 [a]	1.24±0.30 [a]	0.99±0.43 [a]
Indomethacin	10	1.02± 0.13 [b] (55.7)	0.13±0.07 [b] (89.5)	0.19±0.07 [b] (80.8)
Extract	50	2.11±1.07 [a] (8.3)	1.00±0.23 [a] (19.4)	0.36±0.18 [a] (63.6
Extract	100	1.71±1.16 [a] (25.7)	1.07±0.67 [a] (13.7)	0.56±0.28 [a] (43.4)
Extract	200	1.48±0.60 [a] (35.7)	0.92±0.61 [a] (25.8)	0.47±0.14 [a] (52.5)

Figures in brackets are inhibition (%); [b]significantly different from control ($P < 0.05$).

Table 3. Inhibition of rat writhing reflex by the aqueous extract of *L. leonurus* shoot and indomethacin on acetic acid induced writhing test. Data expressed as mean ± SD. (n= 4).

Group	Dose (mg/kg)	Number of writhing per 20 min	Inhibition (%)
Control	0	52.0 ± 1.2[a]	0
Indomethacin	10	0 ± 0 [b]	100
Extract	50	2.0 ± 0.8[b]	96.2
Extract	100	0 ± 0 [b]	100
Extract	200	0 ± 0 [b]	100

[b]Significantly different from control ($P < 0.05$).

DISCUSSION

Nematodes parasitize gastro-intestinal tract of animals, causing helminthosis, a condition resulting in inflammation and pain, hence, this study was carried out to investigate the use of the plant on symptomatic treatment. Acute inflammation such as carrageenan-induced oedema involves the synthesis or release of mediators at the injured site, their inhibition will normally ameliorate inflammation and other symptoms. This study showed that the aqueous extract from the leaves of *L. leonurus* possesses a significant anti-oedematogenic ($P < 0.05$) effect on paw oedema induced by carrageenan, which was dose-dependant and comparable to that of the reference drug. Reduction in inflammation is also enhanced through the stimulation of the immune system to release white blood cells (Steenkamp and Stewart, 2007). It therefore, could be that the immune cells were initiated already such that a sub-class of cytokines called *leukotrienes* (or *interleukins*) ensured that the immune response is checked before it destroys outlying healthy cells and tissue called off the inflammatory response.

Carrageenan-induced rat paw is a suitable experimental animal model for evaluating the antioedematous effect of natural products and is believed to be biphasic. The first phase (1 h) involves the release of serotonin and histamine and the second phase (over 1 h) is mediated by prostaglandins, the cyclooxygenase products and the continuity between the two phases is provided by kinins (Perianayagam et al., 2006). Development of oedema induced by carrageenan is commonly correlated with early exudative stages of inflammation (Adedapo et al., 2008). Bienvenu et al. (2002) reported that the leaves of *L. leonurus* contained tannins; these compounds are known to be potent cyclooxygenase -1 (COX-1) inhibitors, through their binding nature with proteins. Since the carrageenan-induced inflammation model is a significant predictive test for anti-inflammatory agents acting by the mediators of acute inflammation (Sawadogo et al., 2006), these results are an indication that *L. leonorus* can be effective in acute inflammatory disorders.

Reduction of oedema produced by histamine was rather minimal compared with carrageenan-induced oedema. Histamine is an important mediator of inflammation, a potent vasodilator, but also increases vascular permeability (Cuman et al., 2001; Linardi et al., 2002; Vasudevan et al., 2007). Although, the reduction was minimal, results showed that to some extent the extract suppressed the oedema produced by histamine. The extract may have exhibited its anti-inflammatory actions by means of either inhibiting the synthesis, release or action of inflammatory mediators such as histamine, serotonin and prostaglandins. Though the anti-histamine effect of the extract is generally poor, it nonetheless indicated that the extract exhibited anti-oedema as much as the reference drug.

With respect to the acetic acid-induced abdominal writhing, which is the visceral pain model (Sawadogo et al., 2006; Gupta et al., 2005) the result showed that all the doses produced significant ($P < 0.05$) analgesic effect. This analgesic effect of the extract could be attributed, at least part, to its anti-inflammatory effect as,

in the visceral pain model, the processor releases arachidonic acid via cyclooxygenase and prostaglandin biosynthesis which plays a role in the nociceptive mechanism (Sawadogo et al., 2006; Franzotti et al., 2002). Thus, the results obtained for the writhing test are similar to those obtained for the oedematogenic test using carrageenan. Therefore, the anti-inflammatory substances may also be involved in the peripheral analgesic activity because inhibition of the acute inflammation by this extract leads to their inhibitory effect on pain development. Findings of this study are in agreement with Ojewole (2005), who also reported anti-inflammatory and analgesic properties of *L. leonurus*.

Phytochemical and HPLC analyses showed the presence of alkaloids, saponins (of steroid and or triterpenoids groups) and tannins in the leaves of *L. leonurus* (Bienvenu et al., 2002). Non-steroidal anti-inflammatory drugs (NSAID) such as indomethacin act by the reduction of sensitization of pain receptors caused by prostaglandins at the inflammation site (Dhara et al., 2000). The different triterpenoids, polyphenolics and other chemical constituents of the plant may be involved in the observed antinociceptive and antiinflammatory effects of the plant's extract and may be having actions similar to NSAID. It should be noted that the anti-inflammatory activities of many plants have been attributed to their high sterol/triterpene (Pandurangan et al., 2008; Silva et al., 2005).

Conclusion

From this study, it can be concluded that the extract from the leaves of *L. leonurus* possess anti-inflammatory and analgesic activities, thus, giving pharmacological credence to the suggested ethno-veterinary use of the plant in the treatment of helminthosis in goats, which result in inflammation of the gastro-intestinal tract and pain.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support received from Govan Mbeki Research and Development Centre (GMRDC) at the University of Fort Hare and the National Research Foundation (NRF) South Africa. Appreciation is also indebted to Mrs Brink at Albany museum herbarium in Grahamstown for authenticating the plants.

REFERENCES

Adedapo AA, Sofidiya MO, Maphosa V, Moyo B, Masika P, Afolayan AJ (2008). Anti-inflammatory and analgesic activities of the aqueous extract of *Cussonia paniculata* stem Bark. ACG publications. Record Natural Products, 2: 46-53.

Akhtar MS, Iqbal Z, Khan MN, Lateef M (2000). Anthelmintic activity of medicinal plants with particular reference to their use in animals in the Indo-Pakistan subcontinent. Small Rumin. Res. 38: 99-107.

Asongalem EA, Foyet HS, Ekoo S, Dimo T, Kamtchouing P (2004). Anti- inflammatory, lack of central analgesia and antipyretic properties of *Acanthus montanus* (Ness) T. Anderson. J. Ethnopharmacol. 95: 63-68.

Bienvenu E, Amabeoku GJ, Eagles PK (2002). Anticonvulsant activity of aqueous extract of *Leonotis leonorus*. Phytomedicine, 9: 217-223.

Cuman RKN, Bersani-Amadio CA, Fortes ZB (2001). Influence of type 2 diabetes on the inflammatory response in rat. Inflam. Res. 50: 460-465.

Dhara AK, Suba V, Sen T, Pal S, Chaudhuri AKN (2000). Preliminary studies on the anti-inflammatory and analgesic activity of the methanol fraction of the root extract of *Tragia involucrata* Linn. J. Ethnopharmacol. 72: 265-268.

Dharmasiri JR, Jayakody AC, Galhena G, Liyanage SSP, Ratnasooriya WD (2003). Anti-inflammatory and analgesic activities of mature fresh leaves of *Vitex negundo*. J. Ethnopharmacol. 87: 199-206.

Erasto P, Adebola PO, Grierson DS, Afolayan AJ (2005). An Ethnobotanical study of plants used for the treatment of diabetes in the Eastern Cape Province, South Africa. Afr. J. Biotechnol. 4: 1458-1460.

Franzotti EM, Santos CVF, Rodriques HMSL, Mourao RHV, Andrade MR, Antoniolli AR (2002). Anti-inflammatory, analgesic, and acute toxicity study of *Sida cardiafolia*. J. Ethnopharmacol. 72: 273-278.

Gupta M, Mazunder UK, Sambath Kumbar R, Gomath PY, Rajeshwar B, Kakoti B, Tamil-Selven V (2005). Anti-inflammatory, analgesic and antipyretic effects of methanol extract from *Bauhina racemosa* stem bark in animal models. J. Ethnopharmacol. 98: 267-273.

Hutchings A, Scott AH, Lewis G (1996). Zulu medicinal plants: An inventory, Natal, South Africa: Univ. Natal Press, pp. 266-267.

Kumara NKVMR (2001). Identification of strategies to improve research on medicinal plants used in Sri Lanka. In: WHO Symposium. University of Ruhuna, Galle, Sri Lanka.

Linardi A, Costa SKP, DeSilva GR, Antunes E (2002). Involvement of kinins, mast cells, and sensory neurons in the plasma exudation and paw edema induced by staphylococcal entrotoxin B in the mouse. Eur. J. Pharmacol. 399: 235-242.

Maphosa V, Masika PJ, Moyo B (2010). Investigation of the anti-inflammatory and antinociceptive activities of *Elephantorrhiza elephantina* (Burch.) Skeels root extract in male rats. Afr. J. Biotechnol. 8(24): 7068-7072.

Maphosa V, Masika PJ (2010). Ethnoveterinary uses of medicinal plants: A Survey of plants used in the ethnoveterinary control of gastro-intestinal parasites of goats in the Eastern Cape Province, South Africa. Pharmaceut. Bio. 48(6): 697-702.

Masika PJ, Afolayan AJ (2003). An ethnobotanical study of plants used for the treatment of livestock diseases in the Eastern Cape Province, South Africa. Pharmaceut. Biol. 41: 16-21.

McGaw LJ, Eloff JN (2008). Ethnoveterinary use of southern African plants and scientific evaluation of their medicinal properties. J. Ethnopharmacol. 10: 1016.

Moody JO, Robert VA, Connolly JD, Houghton PJ (2006). Anti-inflammatory activities of the methanol extracts and an isolated furanoditerpene constituent of *Sphenocentrum jollyanum* Pierre (Menispermaceae). J. Ethnopharmacol. 104: 87-91.

Mwale M, Masika PJ (2010). Analgesic and anti-inflammatory activities of *Aloe feroxMill***.** aqueous extract. Afr. J. Pharmacy Pharmacol. 4(6): 291-297.

Ojewole JAO (2005). Antinoceptive, anti-inflammatory and antidiabetic effects of *Leonotis leonurus* (L.) R. Br. leaf aqueous extract in mice and rats. Methods Findings Exp. Clin. Pharmacolol. 27: 257-264.

Perianayagam JB, Sharma SK, Pillai KK (2006). Anti-inflammatory activity of *Trichodesma indicum* root extract in experimental animals. J. Ethnopharmacol. 104: 410-414.

Sawadogo WR, Boly R, Lompo M, Some N **(**2006). Anti-inflammatory, analgesic and antipyretic activities of *Dicliptera verticillata*. Internal J. Pharmacol. 2: 435-438.

Scott G, Springfield EP, Coldrey N (2004). A pharmacognostical Study of 26 South African Plant Species Used as Traditional Medicines. Pharmaceut. Biol. 42: 186-213.

Silva GN, Martins FR, Matheus ME (2005). Investigation of anti-

inflammatory and antinociceptive activities of *Lantana trifolia*. J. Ethnopharmacol. 100: 54-259.
Steenkamp V, Stewart MJ (2007). Medicinal Applications and Toxicological Activities of Aloe Products. Pharm. Biol. 45: 411-420.
Tsai CC, Lin CC (1999). Anti-inflammatory effects of Taiwan folk medicine 'Teng-khia-U' on carrageenan and adjuvant-induced paw oedema in rats. J. Ethnopharmacol. 64: 85-89.
Van Wyk B, Van Wyk P, Van Wyk BE (2000). Photographic guide to trees of Southern Africa. Briza Publications Pretoria, p. 123.
Vane JR, Bolting RM (1995). New insights into the mode of action of anti-inflammatory drugs. Inflam. Res. 44: 1-10.
Vasudevan M, Gunman KK, Parle M (2007). Antinociceptive and anti-inflammatory effects of *Thespesia populnea* bark extract. J. Ethnopharmacol. 109: 264-270.