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Research Article

Phytopharmacological Assessment from Two Medicinal Plants Used for Analgesic and Anti-inflammatory Purposes in Burkina Faso

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Abstract: The purpose of this investigation was to elucidate the anti-nociceptive and anti-inflammatory properties of aqueous acetone extracts from *Cienfuegosia digitata* Cav; and *Sida Alba* L. in Swiss mice, with an aim to provide a scientific basis for the traditional use of these plants in the treatment of inflammation disorders. In anti-inflammatory activity, the carrageenan-induced paw edema and oil croton-induced ear edema in Swiss mice. As for analgesic effects, acetic acid writhing and formalin test methods were used in mice. About anti-inflammatory potential, the extracts at doses of 100; 200 and 400 mg/kg body weight produced significant comparatively to the control groups ($p<0.05$; $p<0.01$ and $p<0.001$) and we noticed a dose-dependent anti-inflammatory activity. The dose-dependent inhibition of edema was observed at 1; 2 and 3 h. However, extracts showed dose-dependent inhibition of croton oil induced ear oedema, at doses of 200; 300 and 500 µg/ear. As for analgesic activity, extracts produced significant analgesic effects in acetic acid writhing and formalin test method ($p<0.05$; $p<0.01$ and $p<0.001$) compared to the control groups and a dose-dependent inhibition was observed. The present study concludes that *Cienfuegosia digitata* Cav. and *Sida Alba* L. have anti-inflammatory and analgesic properties.

Keywords: Analgesic, *Cienfuegosia digitata* cav., inflammation, mice, *Sida Alba* L

INTRODUCTION

World over, at least 35.000 plant species are used for medicinal purposes (Kong *et al*., 2003). The most important industrial medicines nowadays are based on about 90 species of herbs and in developing countries (Ikpme *et al*., 2007). Focus on plant research has increased worldwide in recent time and a large body of evidence has been collected to show the immense capacities of medicinal plants used in various traditional systems. Many data on the phytopharmacology have showed medicinal plants capacities in certain area of pharmacology (Osadalor *et al*., 2011) and researchers are also beginning to appreciate the role of medicinal plants in health care delivery (Kolwole *et al*., 2011). Medicinal plants and herbs have been used for many centuries for the treatment or prevention of diseases and for the promotion of good health. Certainly, herbal medicine as old as the human species itself and before the availability of synthetic drugs, man was completely dependent on natural medicinal plants for curing diseases as inflammatory diseases (Soods *et al*., 2009).

In African traditional medicine, ethno medicines prepared from plants materials are used to treat a wide range of disease conditions including pain and inflammation. These ethno medicines are relied on by local West African dwellers for their primary health care since the plant materials used in their preparation are cheap and readily available (Jodi *et al*., 2008).

Ethnobotanical investigations in the central region of Burkina Faso have shown that some herbaceous such as *Cienfue gosia digitata Cav.* and *Sida alba* L. (Malvaceae) are frequently used in traditional medicine to treat various kinds of diseases such as malaria, fever, pain, variola, as well as having antibacterial, anti-inflammatory, anti-viral activities and hepatoprotective properties (Nacoulma, 1996). Phytochemical analysis of these Malvaceae species under study has mainly demonstrated the presence of saponosides, coumarins, polyphenols compounds, terpenoid/steroid and alkaloids compounds (Nacoulma, 1996).

In the previous study, the extracts and fractions from *Cienfuegosia digitata* Cav. and *Sida alba* L. were evaluated for their in vitro antioxidant and anti-

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inflammatory activities (Konaté *et al*., 2010a, b). Most of the synthetic drugs used at present for analgesic and anti-inflammatory effects that cause many side and toxic effects. Plants still represent a large untapped source of structurally novel compounds that might serve as lead for the development of novel drugs. Medicinal plants are in use since a long time for analgesic and anti-inflammatory activities because of the reason that they are devoid of side effects (Ahmad *et al*., 1992). According to WHO there is about 82% population that depends upon herbal drugs and these are gaining popularity because of less side effects and low-priced (Kumara, 2001).

There is yet no scientific report validating the ethnomedicinal uses of those Malvaceae in the treatment of inflammation pain. This led us to investigate the anti-inflammatory and analgesic potential of *Cienfuegosia digitata* cav. and *Sida Alba* L. in experimental animal models.

MATERIAL AND METHODS

Plants material: Cienfuegosia digitata Cav. And *Sida Alba* L. were collected in August 2008 in Gampela, 25 Km east of Ouagadougou, capital of Burkina Faso. The plants were identified in the Laboratory of plants Biology and Ecology, University of Ouagadougou, where a voucher specimen was deposited.

Preparation of extracts: Fifty grams (50 g) of powdered plant material was extracted with 80% aqueous acetone (500 mL) in 1/10 ratio (w/v) for 24 h under mechanic agitation (SM 25 shaker, Edmund BÜHLER, Germany) at room temperature. After filtration, acetone was removed under reduced pressure in a rotary evaporator (BÜCHI, Rotavopor R-200, Switzeland) at approximately 40°C and freeze-dried by a being Telstar Cryodos 50 freeze-dryer. The extract residues were weighed before packed in waterproof plastic flasks and stored at 4°C until use.

Animals handling: Swiss NMRI mice (25-30 g) of both sexes were used for this study. All animals were housed in cages under controlled conditions of 12-h light/and 12 h without light and 25°C. They received pellets of food enriched with 20% protein and water ad libitum. They were deprived of food for 15 h (but with access to drinking water) and weighed before the experiments. Experiments on the animals were performed according to the protocols already approved by the Institute of Health Sciences Research/University of Ouagadougou (Burkina Faso) and met the international standards for animal study.

Anti-inflammatory property:

Carrageen-induced paw edema test: The anti-inflammatory activity was evaluated according to Ninghan *et al*. (1994). The acute inflammation was induced by injection of 50 µL of 1% w/v carrageenan in normal saline into the subplantar region of right hind paw Swiss mice were divided into five groups, each containing six mice. Extracts (100; 200 and 400 mg/kg body weight), phenylbutazon and distilled water were orally administered 1 h prior to injection of carrageenan injection using plethysmometer (Ugo Basile, No 7141, Italy). The average volumes of the right hind paw of each mouse was calculated from three readings. The inhibitory activity was calculated according to following formula:

$$\% \text{ Inhibition} = (A\text{-}B) \text{ control} - (A\text{-}B) \text{ treated} / (A\text{-}B) \text{ control} \times 100$$

A is the paw eircumference at time t, B is the paw circumference before carrageen injection, A-B is edema, (A-B) control is edema or paw size after carrageenan injection to control mice at time.

Ear edema induces by croton oil: Topical inflammation was carried out according to Miller and Tainter (1994). Swiss mice were divided into four groups, each containing six mice. Animals were anaesthetized with 100 mg/kg ketamine hydrochloride; inflammation was induced in the morning between 10.00 a.m. and 12.00 noons to avoid inflammatory response variation due to circadian fluctuation of endogenous corticosteroids.

Cutaneous inflammation was induced by applying 5 µL of solution of croton oil dissolved in 42% alkaloid extracts and the samples (hydrocortisone) on the inner surface of the right ear. Control mice received only the irritant solution. Six hours later, the mice were sacrificed and the plug (diameter = 7 mm) was removed from both the treated (right) and the untreated (left) ears. Edematous response was measured as the weight difference between the two plugs. The anti-inflammatory activity was expressed as percentage reduction of edema in treated mice compared with the control mice.

Analgesic capacity:

Acetic acid-induced writhing test: The analgesic activity of the samples was studied using acetic acid-induced writhing model in mice model (Winter *et al*., 1962). Nociception was induced by an intraperitoneal injection of 0.6% acetic acid solution in a value of 10 ml/kg body weight. The animals were divided into five groups with six mice in each group. Group I, animals

Table 1: Effect of oral administration of Aqueous Acetone Extract (AAE) from *Cienfuegosia digitata* Cav; on carrageenin-induced hind paw edema

		Increase in paw volume (ΔV mL)			Edema inhibition (%)		
Samples	Doses (mg/kg bw)	1 h	3 h	5 h	1 h	3 h	5 h
Control	---	0.22±0.02	0.37±0.01	0.40±0.02	---	---	---
AAE $_{Cien}$	100	0.13±0.00*	0.21±0.02*	0.17±0.01***	40.90	43.24	57.5
AAE $_{Cien}$	200	0.10±0.01**	0.17±0.01*	0.14±0.007***	54.54	54.05	65.00
AAE $_{Cien}$	400	0.07±0.01***	0.14±0.01*	0.12±0.01***	68.18	62.16	67.00
Phenyl butazone	10	0.12±0.01*	0.21±0.01*	0.18±0.01***	45.45	43.24	55.00

Values are Mean±SEM (n = 6) one-way ANOVA followed by Dunnett's t-test: compare all vs, control group (reference drug): p>0.05; *p<0.05; **p<0.01; ***p<0.001 compared with control

received vehicle (10% DMSO in water, 10 ml/kg body weight), animals of group II received paracetamol 100 mg/kg body weight while animals of group III; group IV and group V were treated with 100; 200 and 400 mg/kg body weight of extracts dissolved in 10% DMSO 1h orally before acetic acid injection. The number of writhes occurring between 5 and 20 min after acetic acid injection was recorded. The analgesic effect was expressed as the percentage reduction of writes in treated mice compared to those in the control group. The percentage inhibition was calculated using the following Eq. (1):

(%) inhibition = (A-B/A) ×100, where A is mean for the control group and B is mean for the treated group.

Formalin-induced nociception: The analgesic effect of *Cienfugosia digitata* Cav. and *Sida Alba* L. was also evaluated using formalin-induced paw licking according (Sawadogo *et al*., 2006). The animals were divided into five groups with six mice in each group. Group I, animals received vehicle (10% DMSO in water, 10ml/kg body weight), animals of group II received paracetamol 100 mg/kg body weight while animals of group III; group IV and group V were treated with 100; 200 and 400 mg/kg body weight of extracts dissolved in 10% DMSO were orally administered. One hour after drug administration, 20 µL of formalin (2.5% in normal saline) was injected into the plantar surface of the left hind paw of mice. The time spent in licking the injected paw was recorded and expressed as the total licking time in early phase (0 to 5 min) and late phase (15 to 30 min) after formalin injection. The percentage inhibition was calculated following Eq. (1).

Statistical analysis: The data were expressed as Mean±Standard Deviation (SD) of six determinations (n = 6). Results were analyzed by one-way ANOVA followed by Dunnett's *t*-test using Prism 4 software. The level of significance was accepted at $p \leq 0.05$.

RESULTS

Anti-inflammatory property:

Carrageenan induced paw edema test: Carrageenan-induced paw edema was markedly inhibited by intraperitoneal treatment with the extracts or phenyl butazone (10 mg/kg bw). The extracts at doses of 100; 200 and 400 mg/kg body weight produced significant compared to the control groups ($p<0.05$; $p<0.01$ and $p<0.001$) and a dose-dependent anti-inflammatory activity. The dose-dependent inhibition of edema was observed at 1; 2 and 3 h. The results were shown in the Table 1 and 3.

Ear edema induced by oil croton: Results obtained from extracts and hydrocortisone significantly reduced the ear edema comparatively to the control groups ($p<0.05$; $p<0.01$ and $p<0.001$). In addition, extracts showed dose-dependent inhibition of croton oil induced ear edema, at doses of 100; 200 and 400 mg/kg bw. Results are summary in the Table 2 and 4.

Antinociceptive capacity

Acetic acid-induce writhing test: As for acetic acid-induced writhing test, the extracts effectively reduced the number of abdominal muscle contractions induced by 0.6% acetic acid solution. The extracts have a dose

Table 2: Effect of topical administration of Aqueous Acetone Extract (AAE) from *Cienfuegosia digitata* Cav; on croton-induced ear edema

Samples	Doses (µg/mL)	Volume of edema (mg)	Inhibition (%)
Control	---	6.66±0.13	---
AAE $_{Cien}$	100	5.75±0.10*	13.66
AAE $_{Cien}$	200	4.21±0.10**	36.78
AAE $_{Cien}$	400	2.47±0.10***	62.91
Hydrocortisone	100	3.13±0.10***	53.00

Values are Mean ± SEM (n = 6) one-way ANOVA followed by Dunnett's t-test; compare all vs; control group (reference drug): p 0.05; *: p<0.05; **: p<0.01; ***: p<0.001 compared with control

Table 3: Effect of oral administration of Aqueous Acetone Extract (AAE) from *Sida Alba* L. on carrageenin-induced hind paws edema

		Increase in paw volume (ΔV mL)			Edema inhibition (%)		
Samples	Doses (mg/kg)	1 h	3 h	5 h	1 h	3 h	5 h
Control	---	0.23±0.01	0.36±0.01	0.42±0.01	---	---	---
AAE $_{Cien}$	100	0.14±0.01*	0.22±0.00*	0.18±0.01***	39.13	38.89	57.14
AAE $_{Cien}$	200	0.12±0.01**	0.18±0.01**	0.17±0.00***	47.83	50.00	59.52
AAE $_{Cien}$	400	0.08±0.00***	0.16±0.01**	0.14±0.00***	65.22	55.56	66.67
Phenyl Butazon	10	0.13±0.00*	0.20±0.01**	0.18±0.00***	43.47	44.44	57.14

Values are Mean ± SEM (n = 6) one-way ANOVA followed by Dunnett's t-test; compare all vs; control group (reference drug): p>0.05; *: p<0.05; **: p<0.01; ***: p<0.001 compared with control

Table 4: Effect of topical administration of Aqueous Acetone Extract (AAE) from *Sida Alba* L. on croton-induced ear edema

Samples	Doses (µg/ear)	Volume of edema (mg)	Inhibition (%)
Control	---	6.87±0.06	---
AAE $_{Cien}$	100	5.99±0.04*	12.80
AAE $_{Cien}$	200	4.30±0.02**	37.41
AAE $_{Cien}$	400	2.68±0.07***	60.99
Hydrocortisone	100	3.15±0.00***	54.15

Values are Mean±SEM (n = 6) one-way ANOVA followed by Dunnett's t-test; compare all vs; control group (reference drug): p 0.05; *p<0.05; **p<0.01; ***p<0.001 compared with control

Table 5: Effect of Aqueous Acetone Extract (AAE) from *Cienfuegosia digitata* Cav. on writhing-induced by acetic acid

Compounds	Doses (mg/kg b.w.)	Number of writhing	Inhibitions (%)
Control	---	59.20±1.30	---
Paracetamol	100	28.60±1.52**	51.69
AAE $_{Cien}$	100	23.40±1.14**	60.47
AAE $_{Cien}$	200	15.20±1.10***	74.32
AAE $_{Cien}$	400	10.00±1.87***	83.10

Values are Mean±SEM (n = 6) one-way ANOVA followed by Dunnett's t-test; compare all vs; control group (reference drug): p>0.05; *p<0.05; **p<0.01; ***p<0.001 compared with control

Table 6: Effect of Aqueous Acetone Extract (AAE) from *Sida Alba* L. on writhing-induced by acetic acid

Compounds	Doses (mg/kg b.w.)	Number of writhing	Inhibitions (%)
Control	---	60.20±1.30	---
Paracetamol	100	29.4±1.14**	51.16
AAE $_{Sida\ alba}$	100	24.00±0.71**	60.13
AAE $_{Sida\ alba}$	200	17.20±1.10***	71.42
AAE $_{Sida\ alba}$	400	12.00±0.71***	80.07

Values are Mean±SEM (n = 6) one-way ANOVA followed by Dunnett's t-test; compare all vs; control group (reference drug): p 0.05; *p<0.05; **p<0.01; ***p<0.001 compared with control

dependent protection. Results are presented in the Table 5 and 6. However, one noticed that Cienfuegosia digitata Cav. produced higher inhibition comparatively to Sida Alba. The extracts at doses of 100; 200 and 400 mg/kg body weight produced significant compared to the control groups (p<0.05; p<0.01 and p<0.001) and a dose-dependent anti-nociceptive activity.

Formalin-induced nociception: Formalin-induced nociception, one also notes that the extracts inhibited inflammation induced by formalin significantly compared to the control (p<0.05; p<0.01 and p<0.001) and a dose-dependent anti-nociceptive activity. The inhibition was also a dose-dependent. The extract of *Cienfuegosia digitata* Cav. produced also higher inhibition than *Sida Alba* (Table 7 and 8).

DISCUSSION

In Burkina Faso system of medicine, certain herbs are claimed to provide relief of pain and inflammation. The claimed therapeutic reputation has to be verified in a scientific manner. In the present study one such drug extracts from *Cienfuegosia digitata* and *Sida Alba* were taken for the study to assess for its in vivo anti-inflammatory and analgesic activities in mice.

Preliminary phytochemical screening revealed the presence of polyphenols compounds, saponosides, coumarins, terpenoid and steroid compounds, and alkaloids in the extracts (Nacoulma, 1996; Konaté *et al*., 2010b). These constituents may be responsible for the anti-inflammatory and analgesic activities (Hanasaki *et al*., 1994). Flavonoids have been reported to possess potent inhibitory effect on enzymes involved in the production of the chemical mediators of inflammation and metabolism of arachidonic acid (Oweyele *et al*., 2005; Saleem *et al*., 2011). Many anti-inflammatory plants and agents modify inflammatory responses by accelerating the destruction or antagonizing the action of the mediators of inflammatory reaction. Foods and fruits rich in flavonoids and other phenolic compounds have been associated with decreased risk of developing inflammatory and other related diseases (Sies *et al*., 2005; Shrivastava and Patel, 2007), thus suggesting that the flavonoids in garden egg might be part of the active anti-inflammatory constituents in the plant. Flavonoids isolated from medicinal plants possess anti-inflammatory capacity (Musa *et al*., 2007). Certain hypothesis strongly supported that flavonoids and saponins are well known for their ability to inhibit pain perception as well anti-inflammatory properties (Hossain *et al*., 2011). According to Annegowda *et al*. (2010), bioactive compounds derived from plants have been utilised since from the earlier time for the various purposes including

Table 7: Effect of Aqueous Acetone Extract (AAE) from *Cienfuegosia digitata* Cav; on licking the hind paw-induced by formalin injection

Compounds	Doses (mg/kg b.w.)	First phase (0 to 5 min)	Inhibitions (%)	Second phase (15 to 30 min)	Inhibitions (%)
Control	---	86.60±1.34	---	127.00±2.24	---
AAE $_{Cien}$	100	69.20±5.17**	20.00	92.20±1.92***	27.40
AAE $_{Cien}$	200	72.00±1.58*	16.86	74.8±2.05***	41.10
AAE $_{Cien}$	400	63.00±1.41**	27.25	68.00±1.58***	46.46
Paracetamol	100	46.60±1.14***	46.19	55.60±1.82***	56.22

Values are Mean ± SEM (n = 6) one-way ANOVA followed by Dunnett's t-test: compare all vs; control group (reference drug): p>0.05; *p<0.05; **p<0.01; ***p<0.001 compared with control

Table 8: Effect of Aqueous Acetone Extract (AAE) from *Sida Alba* L. on licking the hind paw-induced by formalin injection

Compounds	Doses (mg/kg b.w.)	First phase (0 to 5 min)	Inhibitions (%)	Second phase (15 to 30 min)	Inhibitions (%)
Control	---	86.8±2.39	---	121.2±1.79	---
AAE $_{Sida\ alba}$	100	71.4±1.67*	17.74	95.40±2.70***	21.28
AAE $_{Sida\ alba}$	200	73.00±2.28*	15.89	75.00±1.58***	38.11
AAE $_{Sida\ alba}$	400	63.40±1.52**	26.95	66.40±2.07***	45.21
Paracetamol	100	47.40±1.14***	45.39	54.00±1.58***	55.45

Values are Mean±SEM (n = 6) one-way ANOVA Followed by Dunnett's t-test: Compare all vs; control group (reference drug): p>0.05; *: p<0.05; **p<0.01; ***p<0.001 compared with control

the treatment of pain. Terpenoid and steroid compounds are widely distributed in the plant and exhibit distinctive pharmacological properties. Naturally occurring terpenoids were known to possess anti-inflammatory and analgesic properties (Asmawi *et al*., 2011).

The antinociceptive effect was assessed by two different models: the formalin test and acetic acid-induced writhing test in mice, whereas the anti-inflammatory effects were examined with ear edema model. The formalin test is a valid and reliable model of nociception and is sensitive for various classes of analgesic drugs. Formalin is known to produce biphasic pain behaviours (Abbadie *et al*., 1997). The first transient phase is ascribed to the direct effect of formalin on sensory C fibers and the second prolonged phase is associated to the development of an inflammatory response and the release of analgesic mediators (Buritova *et al*., 2005). It was reported that substance P and bradykinin participate in the manifestation of the first phase responses and histamine, serotonin, prostaglandin and bradykinin are involved in the second phase response (Otuki *et al*., 2001; Choi *et al*., 2003).

In the present study, acetic acid injection was demonstrated to induce a characteristic writhing response in the mice. Acetic acid-induced writhing is a highly sensitive and useful test for analgesic drug development especially peripherally acting analgesics. Acetic acid induces pain by liberating endogenous substances (bradykinin, serotonin, histamine, sunstance P) (Lu *et al*., 2007). Antinociceptive activity of these Malvaceae was tested by acetic acid-induced writhing model causing pain sensation by triggering localized inflammatory response and formalin induced nociception. Acetic acid, which is used to induce writhing, causes analgesia by liberation of endogenous substances, which in turn excite the pain nerve endings (Taestikul *et al*., 2003). Increased levels of PGE_2 and $PGE_{2\alpha}$ in the peritoneal fluid have been reported to be responsible for pain production caused by intraperitoneal administration of acetic acid (Derardt *et al*., 1980). The result of the test showed that the extracts of these Malvaceae at dose 500 mg/kg bw exhibit significant writhing inhibition ($p<0.001$) as compared with the control. The compounds present in the plant extracts may be responsible for the obtained antinociceptive activity. According to the basis of these results it can be concluded that the extracts have an possesse antinociceptive activity.

The most widely used primary test for the screening of new anti-inflammatory agents is the carragenin-induced mice paw edema model (Sawadogo *et al*., 2006). The edema formation is a biphasic event. The initial phase, observed during the first hour, is attributed to the release of histamine and serotonin (Vinegar *et al*., 1969) and the delayed edema is due to the release of bradykinin and prostaglandins. It has been reported that the second phase of edema is sensitive to steroidal and non-steroidal anti-inflammatory agents (Di Rosa *et al*., 1971). The extracts reduced the paw volume significantly from 1 to 5h in which the highest effects were found at the third hour. These results tend to suggest the probable anti-inflammatory activity of the extracts.

The ear edema model permits the evaluation of anti-inflammatory steroids and is less sensitive to non-steroidal anti-inflammatory agents. In croton oil induced ear edema test, mediators of anti-inflammation are released following stimulation. The extracts have significant anti-inflammatory effects in this test, thus it may have a membrane stabilizing effect that reduces capillary permeability and/or has inhibitory effects on mediators. Intraperitoneal administration of the

extracts, 30 min before topic application of croton oil, dose dependently inhibited the development of ear edema (Vogel and Vogel, 1997).

CONCLUSION

This study on these Malvaceae confirms that *Cienfuegosia digitata* Cav. and *Sida Alba* L. are good candidates for anti-inflammatory and analgesic uses. Thus, which many explain the traditional basis of using these plants in the treatment of various ailments like fever, inflammatory and analgesic disorders in Burkina Faso? Further pharmacological investigations are required to identify the active constituents of the plant extracts responsible for the antinociceptive and anti-inflammatory and effects.

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REFERENCES

Abbadie, C., B.K. Taylor, M.A. Petason and A.I. Basbaum, 1997. Diffrential contribution of the two phases of the formalin test to the pattern of C-Fos expression in the rat spinal cord: Studies with remifentanil and lidocaine. Pain, 69: 101-110.

Ahmad, F., R.A. Khan and S. Rasheed, 1992. Study of analgesic and anti-inflammatory activity from plant extracts of *Lactuca scariola* and artemisia absinthium. J. Istam. Acad. Sci., 5: 111-114.

Annegowda, H.V., M.N. Mardi, S. Ramanthan and S.M. Mansor, 2010. Analgesic and antioxidant properties of ethanolic extract of *Terminalia catappa* L. leaves. Int. J. Pharma., 6(6): 910-915.

Asmawi, M.Z., O.M. Arafat, S. Armirin and I.M. Eldeen, 2011. In vivo anticiceptive activity of leaf extract of *Crinum asiaticum* and phytochemical analysis of the bioactive fractions. Int. J. Pharma., 7(1): 125-129.

Buritova, J., S. Lanue, M. Aliaga, J.M. Besson and F. Cdpaert, 2005. Effects of the high efficacy 5. HT1A receptor agonist, F 13640 in the formalin pain model: Ac-Fos study. Eur. J. Pharmacol., 514: 121-130.

Choi, S.S., K.J. Han, J.K. Lee, H.K. Lee and E.J. Han, 2003. Antinociceptive mechanisms of orally administered decursinol in the mouse. Life Sci., 73: 471-485.

Derardt, R., S. Jougney, F. Delevalcee and M. Falhout, 1980. Release of prostaglandins E and F in an algogenic reaction and its inhibition. Eur. J. Pharmacol., 61: 17-24.

Di Rosa, M., J.P. Giround and D.A. Willoughby, 1971. Studies of the acute inflammatory response induced in rats in different sites by carrageenan and turpentine. J. Pathol., 104: 15-29.

Hanasaki, Y., S. Ogawa and S. Fuki, 1994. The correlation between active oxygens scavenging and antioxidative effects of flavonoids. Free Radical Biol. Med., 16: 845-850.

Hossain, S.H., M.B. Alam, N.S. Chowdhury, M. Asadrjjaman, R. Zahan, M.M. Islam, M.E.H. Mazumder, M.E. Haque and A. Islam, 2011. Antioxidant, analgesic and anti-inflammatory activities of the herb *Eclipta prostrate*. J. Pharmacol. Toxic, 6(5): 468-480.

Ikpme, E.V., O. Udensi, U.B. Ekaluo, E.A. Uyoh, B.O. Asuquo and F.B. Udoh, 2007. Effect of crude extract of *Carica papaya* seeds on the reproductive efficiency of male albino rats. Global J. Pure Appl. Sci., 13: 365-368.

Jodi, S.M., T. Adamu, U. Abubakar, M.G. Abubakar, S. Adamu and V.E. Ukato, 2008. Pytochemical and acute toxicity studies on the ethanol extract of *Gardenia sokotensis*. Sokoto J. Vet. Sci., 7: 73-76.

Kolwole, S.O., O.T. Kolwole and M.A. Akanji, 2011. Effects of aqueous extract of *Khaya senegalensis* stem bark on biochemical and hematological parameters in rats. J. Pharmacol. Toxico, 6(6): 602-607.

Konaté, K. and A. Souza, 2010a. Polyphenol contents, antioxidant and anti-inflammatory activities of six malvaceae species traditionally used to treat hepatitis B in Burkina Faso. Eur. J. Sci. Res., 44(4): 570-580.

Konaté, K. and A. Souza, 2010b. In vitro antioxidant, lipoxygenase and xanthine oxidase inhibitory activities of fractions from *Cienfuegosia digitata* Cav., *Sida alba* L. and *Sida acuta* Burn f. (Malvaceae). Pak. J. Biol. Sci., 13(22): 1092-1098.

Kong, J.M., N.K. Goh, L.S. Chia and T.F. Chia, 2003. Recent advances in traditional plant drugs and orchids. Acta Pharmacol. Sin, 24: 7-21.

Kumara, N.K.V.M.R., 2001. Identification of strategies to improve research on medicinal plants used in Sri Lanka. WHO Symposium 2001. University of Ruhuna, Galle, Sri Lanka, pp: 2-14.

Lu, T.C., Y.Z. Ko, H.W. Huang, Y.C. Huang, Y.C. Lin and W.H. Peng, 2007. Analgesic and anti-inflammatory activities of aqueous extract from glycine tomentella root in mice. J. Ethnopharmacol., 113: 142-148.

Miller, L.C. and M.L. Tainter, 1994. Estimation of the ED50 and its error by means of logarithmic probit graph paper. Proceedings of the Society for Experimental Biology and Medicine, 57: 261-264.

Musa, Y.M., A.K. Haruna, A.H. Yaro, A.A. Ahmadu and H. Usman, 2007. Analgesic and anti-inflammatory effects of leaf extracts of *Pseudocedrella kotschyii* harms (Meliaceae). J. Pharmacol. Toxicol, 2: 542-550.

Nacoulma, O.G., 1996. Medicinal plants and their traditional uses in Burkina Faso. Ph.D. Thesis, University of Ouagadougou, pp: 328.

Ninghan, L., 1994. Chinese Medicinal Herbs of Hong Kong. Hong Kong Commercial Press, Hong Kong, Vol. 6.

Osadalor, H.B., I.I. Ariyo, M.A. Emokpae and K.C. Anukam, 2011. Hypoglycemic effects of unripe pawpaw on streptozotocin induced diabetic albino rats. J. Med. Plants Res., 5(1): 90-94.

Otuki, M.F., F.V. Lima, A. Malheiros, V. Cechinel-Filho, M.F. Delle, R.A. Yunes and J.B. Calixto, 2001. Evaluation of the antinociceptive action caused by ether fraction and a triterpene isolated from resin of protium kleinii. Life Sci., 69: 2225-2236.

Oweyele, V.B., Y.Y. Oloriegbe, E.A. Balaogun and A.O. Soladoye, 2005. Analgesis and anti-inflammatory properties of Nelsonia canescens leaf extract. J. Ethnopharmacol., 99: 153-156.

Saleem, T.K.M., A.K. Azeem, C. Dilip, C. Sankar, N.V. Prasanth and R. Duraisami, 2011. Anti-inflammatory activity of the leaf extacts of Gendarussa vulgaris Nees. Asian Pac. J. Trop. Biomed., 1(2): 147-149.

Sawadogo, W.R., R. Boly, M. Lompo, N. Somé, C.E. Lamien, I.P. Guissou and O.G. Nacoulmn, 2006. Anti-inflammatory, analgesic and antipyretic activities of *Dicliptera verticillata*. Int. J. Pharmacol., 2(4): 435-438.

Shrivastava, N. and T. Patel, 2007. Clerodendrum and healthcare: An overview. J. Med. Arom. Plant Sci. Biotech., 1: 142-150.

Sies, H., T. Schewe, C. Heiss and M. Kelm, 2005. Cocoa polyphenols and inflammatory mediators. Am. J. Clin. Nutr., 81(1): 304S-312S.

Soods, S., A. Bansal, N. Muthuraman, S. Gill and M. Bali, 2009. Therapeutic potential of *Citrus medica* L. peel extract in carrageenan induced inflammatory pain in rat. J. Med. Plants Res., 3(4): 123-133.

Taestikul, T., A. Panthong, D. Kanjanapothi, R. Verpoorte and J.J.C. Scheffer, 2003. Anti-inflammatory, antipyretic and antinociceptive activities of Tabernaemontana pandacaqui Poir. J. Ethnopharmacol., 84: 31-35.

Vinegar, R., W. Schreiber and R. Hugo, 1969. Biphase development of carrageenan oedema in rats. J. Pharmacol. Exp. Ther., 166: 96-103.

Vogel, H.G. and W.H. Vogel, 1997. Drug Discovery and Evaluation. Springer-Vealag, Berlin, Heidelberg, New York.

Winter, C.A., E.A. Risely and G.W. Nuss, 1962. Carrageenan-induced oedema in hind paw of the rats as an assay of anti-inflammatory drug. Proc. Soc. Exp. Biol. Med., 111: 544-547.