

PHYTOCHEMICAL INVESTIGATION AND ANALGESIC ACTIVITY OF STEM BARK EXTRACT OF *SAPINDUS TRIFOLIATUS* LINN

ABSTRACT

Aims: The study is designed to isolate the phytoconstituents and screen for the analgesic activity of stem bark extracts of *Sapindus trifoliatus* Linn.

Methodology: The cleaned, dried and powdered stem barks of *Sapindus trifoliatus* were subjected to extraction. The extracts were then packed into column chromatography for the isolation of phytoconstituents and they were characterized by IR, ¹HNMR, ¹³CNMR and mass spectroscopy. In vivo analgesic activity was performed by tail flick and acetic acid induced writhing methods.

Results: Preliminary phytochemical studies showed the presence of steroids, terpenoids, flavonoids, saponins, carbohydrates. Isolation of extracts led to give compounds like saponin glycoside, a steroid and triterpenoid. The extract was found to be safe up to 2000 mg/kg body weight. Analgesic activity was found significant at level P=05 when compared with control by tail flick and acetic acid induced writhing models in experimental animals.

Conclusion: From ethanolic extract isolated a saponin glycoside, from petroleum ether stigmaterol and triterpenoid ursolic acid. The presence of saponin glycoside, triterpenoids, steroids might be responsible for the analgesic activity of the stem bark extract of *Sapindus trifoliatus* Linn.

Keywords: *Sapindus trifoliatus*, Sapindaceae, Stigmaterol, ursolic acid, tail flick method, acetic acid writhing model, analgesic.

1. INTRODUCTION

Pain is an unpleasant physical sensation linked with damages in the tissue/s [1]. Pain is normally originated by noxious stimuli and spread over neural networks to the CNS where, it is interpreted as such. It acts as a method to shield the body from likely damage [2]. To different noxious stimuli like injury to the tissue or any infections, inflammation is a protective response which is a result of both innate and adaptive immune systems [3,4].

Inflammation and pain still remain as one of the most challenging health issues affecting around 80% of the world's adult population even though there is access to adequate medications [5]. In majority of communities across the world it is considered as a major clinical and socio-economical problem [6]. Untreated and chronic pain is a widespread condition which results in both psychological and physical damage [7]. Non-specific inflammation results in major inflammatory ailments which include pelvic inflammatory disease, hypersensitivities, hay fever, inflammatory bowel diseases, asthma, reperfusion injury, rheumatoid arthritis, glomerulonephritis, autoimmune diseases and it might also lead to deprivation from social activities. If these conditions are not properly addressed they may lead to major complications that might result in death [8].

Presently used drugs against inflammation and pain act as a centerpiece for treating these problems. But, even these are accompanied by various adverse effects and toxicities like ulceration, GIT irritation, variations in kidney function, changes in B.P, liver damage and inhibition of platelets resulting in bleeding. Use of NSAIDs especially COX 2 inhibitors result in elevated risk

of CVS abnormalities [8,9]. Even, opioid related analgesics are also accompanied with large number of adverse effects and toxicities which includes constipation, hearing loss, pruritus, nausea and vomiting, drowsiness, disturbance in hormonal homeostasis, addiction and respiratory problems. In the light of this, there is a requirement to boost medicinal plant research because they are claimed to be potent anti-inflammatory agents to manage pain [10].

Sapindus trifoliatus (*Sapindaceae*) generally called as Indian filbert or soap nut tree. Various parts of this tree are used for their therapeutic potential. Reports suggest that fruits have expectorant, abortifacient, emetic and alexipharmic effects and it is also employed in case of chlorosis, excessive salivation and epilepsy [11]. Current study was performed for phytochemical investigation and to examine the analgesic activity of *Sapindus trifoliatus* stem bark extract

2. MATERIAL AND METHODS

2.1. Preparation of ethanolic extract: The stem bark of *Sapindus trifoliatus* were obtained from Mangaluru, Karnataka. The *Sapindus trifoliatus* plant was authenticated by botanist Dr. Neoline J. Pinto, head of botany Department, St. Agnes College, Mangaluru. The stem barks were washed, dried and subjected for size reduction into a coarse powder using mechanical grinder. Obtained powder was then passed through sieve no. 40 and extracted using ethanol by process of maceration. Resulting extract was dried using flash evaporator under controlled temperature and reduced pressure.

2.2. Preliminary Phytochemical Screening

To know the existence of secondary metabolites related to analgesic activity of *Sapindus trifoliatus* linn standard phytochemical examination was performed [12,13,].

2.3. Isolation of compounds from Ethanolic extract

The powdered stem bark (500 g) of *Sapindus trifoliatus* were subjected to continuous soxhlet extraction and maceration process by using ethanol. Resulting extract was concentrated on water bath to obtain sticky reddish brown residue (yield 35g). The ethanolic residue (30 g) was suspended in water (5 ml). This was then loaded onto a silica gel column (150 g) prepared in water. The column was eluted with 10 %, 50 %, 75 % aqueous methanol and 100 % methanol. These eluates were combined and concentrated to yield a light brown coloured semi solid mass (15 g). This residue (15g) again suspended in 5 ml of methanol, subjected to repeated column chromatography using silica gel (150 g). It was eluted with increasing polarity of solvents. Every time 10 ml of eluates were collected and continuously monitored by TLC (visualization; vanillin : H₂SO₄ reagent). The eluates of ethyl acetate: Ethanol: water (25:5:2) showed single spot on TLC and then chloroform: methanol: water (40:10:1) showed a single spot in TLC. They separately concentrated and recrystallised from methanol and named it as Compound I (45 mg). Light brown colored resinous matter was obtained from all other fractions and were not further processed. Compound I gave pink colour for Libermann Burchard and responded for Molisch's tests indicating the presence of glycoses and test for saponins.

2.3.1. Hydrolysis of Compound I:

Add 5ml of 2 N HCl to solution of compound (5 mg) in MeOH (5 ml). Reflux the resultant mixture for 2h at 100 °C and under reduced pressure evaporate it to dryness. 5ml of distilled water is added and was extracted using ether. Extract was washed with water and solvent was evaporated. After addition of distilled water (5 ml) it was extracted with ether. The ether extract was washed with water and solvent was evaporated. Then it was dried over an. sodium sulfate to get powder of light yellow color.

2.3.2. Identification of the sugars:

Rotary evaporator was used to evaporate aqueous hydrolysate which was left after extraction using ether and resulting residue was dissolved using 2 drops of pyridine. It was co-chromatographed with standards like xylose, fucose, rhamnose, fructose, glucose, galactose and arabinose. Spots developed by sugars were visualized using spray reagent aniline hydrogen phthalate and heating at 105 °C. n-butanol: EtOH:H₂O (4:2:1) was used as developing solvent. Arabinose, glucose and xylose were identified.

2.4. Isolation of compounds from Petroleum ether extract

The pet. ether extract (20 g) was dissolved in CHCl₃ (20 ml) and adsorbed onto silica gel (20 g). Solvent was evaporated, after evaporation it was loaded onto silica gel column (70-300 mesh, 150 g) prepared in petroleum ether (60–80°C). Pet ether 100% was eluted first followed by graded mixture of petroleum ether : CHCl₃ (95:5, 90:10, 80:20, 70: 30), CHCl₃ 100%, graded mixture of CHCl₃: MeOH (95:5, 90:10, 80:20) and finally with methanol. TLC was used to monitor the elution (Silica gel G; visualized using spray reagent aniline hydrogen phthalate and heating at 105°C). Every time 10 ml were collected in a test tube and same volume of eluates (TLC monitored) were combined and was concentrated to 5 ml and placed in a desiccator.

Elution which was carried out using pet. ether (60-80 °C): CHCl₃ graded mixture (95:05) gave single spot on TLC (petroleum ether: CHCl₃; 95:05) and was named as compound II (50 mg). Elution carried out using pet. ether: CHCl₃ graded mixture (80:20) gave single spot on TLC (petroleum ether: CHCl₃; 80:20) and was named as compound III (55 mg).

2.4.1. Acetylation of Compound II

Compound II (5 mg) was taken up in dry pyridine (0.2 ml) and freshly distilled AC₂O (1 ml) was added to it. The mixture was kept at room temperature overnight, then added to the crushed ice, stirred and kept for 2 h, filtered and dried. The solid obtained was crystallized from C₆H₆ as fine needles; m.p. 144 °C.

2.5. Acute toxicity studies

Female adult albino rats were used to study acute toxicity in accordance with “Up and Down” [14] method and OECD guidelines 425 [15]. Guidelines of IAEC of KSHEMA, Deralakatte, Mangaluru (KSHEMA/AEC/28/2010) was followed during experimentation.

2.6. Screening of Analgesic activity

2.6.1. Tail flick method [16]:

Study was performed using albino rats whose average body weight was 200 gm. Rats were separated into 5 groups of 6 animals. All the rats were individually numbered and weighed. First group was taken as control. Rats in second group were treated with std. pentazocine. Ethanolic extract of *Sapindus trifoliatus* stem bark (suspended in 0.5% Na CMC) was given to third, fourth and fifth group 100 mg/kg, 200mg/kg and 400mg/kg body weight (p.o.). Every rat was kept in restrainer, prior to treatment basal reaction time was measured by keeping distal one-third portion of tail. Tail was kept on wire of nichrome without touching it. After this step extracts were administered orally, reaction time was measured for every 30 min. intervals for 2h after administering the drug. To prevent tissue damage 10 seconds of cut off time was employed. After every 30 min reaction time was recorded for 120 min and after each time interval average values of reaction time are calculated and was compared with pretest value by analysis of significance.

2.6.2. Writhing by acetic acid [16]:

Study was performed using albino mice with body weights between 20-25 gm. Mice were separated into 5 groups of 6 animals. All the mice were individually numbered and weighed. 0.1ml acetic acid 0.6% v/v i.p was given to all animals. First group was taken as control. Std aspirin was given to animals in second group. 30 min prior to administration of acetic acid ethanolic extract of *Sapindus trifoliatus* stem bark (suspended in 0.5% Na CMC) was given to third, fourth and fifth group 100 mg/kg, 200mg/kg and 400mg/kg body weight (p.o.). By injecting acetic acid into peritoneal cavity of mice pain is produced. Stretching of abdomen with simultaneous stretching of

at least one hind limb indicated writhing effect. This was observed for 30 min and change in number of writhings in test group compared with standard treated and control treated groups. The percentage inhibition was calculated by using the formula.

Percentage inhibition = $[1 - \frac{R_t}{R_c}] \times 100$

R_t = Mean number of writhings in treated group; R_c = Mean number of writhings in control group

2.7. Statistical Analysis:

The results were expressed as mean \pm SEM. The total variation present in the data was analysed by one way analysis of variance (ANOVA) followed by Post hoc test (Dunnett's test).

3. RESULTS AND DISCUSSION

3.1. Analysis of Compound I

Physical state : Yellow coloured crystals

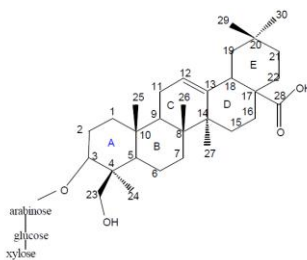
R_f Value : 0.72 (Solvent system; CHCl₃: MeOH, 80:20)

Melting Point : 274-276 °C

3.1.1. Spectral Characteristics of Compound I:

IR (KBr cm⁻¹): 3428.81 (OH) 2931.27 (C-H stretch in CH₂ of alkane), 1737.55 (C=O) 1645.95 (C=C stretch C 12 (13) double bond), 1464.67 (C-H deformation of methyl and methylene (CH₃/CH₂), 1372.1 gemdimethyl grouping 1350- 1264.11 (C-O stretch of primary alcohol), 1043.30 (C-O stretch). **¹H NMR (DMSO-d₆):** δ 12.05 (CO-OH protons), δ 5.15 (CH=C (C₁₂ vinyl group), δ 0.5-2 aliphatic protons (CH₃, CH₂ protons), δ 3.6 (O-CH₂ protons of primary alcoholic group), δ 3.1 broad (OH protons), δ 3.38 (OH protons of the sugar). **¹³C NMR (DMSO-d₆):** Chemical shifts of the aglycone moieties δ 38.2 (C-1), 31.9 (C-2), 76.3 (C-3), 39.9 (C-4), 45.47 (C-5), 29.0 (C-6), 32.8 (C-7), 33.3 (C-8), 47.13 (C-9), 35.9 (C-10), 25.5 (C-11), 121.58 (C-12), 143.84 (C-13), 45.7 (C-14), 30.37 (C-15), 29.2 (C-16), 45.4 (C-17), 46.2 (C-18), 41.4 (C-19), 29.0 (C-20), 32.1 (C-21), 31.9 (C-22), 62.4 (C-23), 27.2 (C-24), 25.5 (C-25), 29 (C-26), 27.2 (C-27), 178.54 (C-28), 32.8 (C-29), 24.1 (C-30), δ 99.6 (C-1'), 76.3 (C-2'), 72.9 (C-3'), 69.9 (C-4'), 68.2 (C-5'), 103.1 (C-1''), 79.4 (C-2''), 73.4 (C-3''), 70.9 (C-4''), 68.4 (C-5''), 63.1 (C-6''), 105.8 (C-1'''), 81.2 (C-2'''), 73.8 (C-3'''), 72.4 (C-4'''), 69.4 (C-5'''), 64.9 (C-6''').

The ¹H NMR spectrum of compound I showed six methyl groups. The ¹³C spectral data exhibited the presence of 30 carbon signals, consisting of six methyl carbon at δ 25.5 (C-24), 25.3 (C-25), 29 (C-26), 27.9 (C-27), 24.2 (C-30), 32.1 (C-29) and presence of an acid signal at δ 178.54 (C-28). Inspection of ¹³C NMR spectral data of compound I showed that the presence of three sugar moieties (anomeric carbons at δ 99.6, 103.1, 105.08) along with 30 carbon signals for an aglycone. The chemical shift of C-3 (δ 76.3) suggested that in compound I the sugar moieties were linked at C-3. From the above IR, ¹H NMR, ¹³C NMR data the proposed structure of compound I as given below.



3.2. Analysis of Compound II

Physical state : Pearl white crystals

R_f value : 0.8 (solvent system-Pet ether: CHCl₃:95:05)

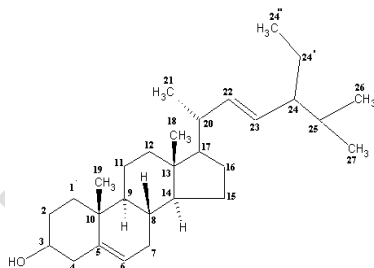
Melting point : 168° C

It gave a red colour in Salkowski's test and a green colour in Libermann-Burchard's test.

3.2.1. Spectral characteristics of Compound II

IR (KBr cm^{-1}): 3429.0 cm^{-1} (br, OH str), 2919.0 cm^{-1} (C-H str. in CH_3), 2850.0 cm^{-1} (C-H str. in CH_2), 1656.0 cm^{-1} (C=C str.), 1108.0 cm^{-1} (C-H deformation in gem dimethyl), 1006.0 cm^{-1} (C-O str. Of secondary alcohol), 615 cm^{-1} (rocking vibration of CH_2). **$^1\text{H NMR}$ (CDCl_3):** δ 0.76 (s, 3H, H-19), δ 0.79 (s, 3H, H-18), δ 0.94 (s, 3H, H-21), δ 0.83 (t, 3H, H-24''), δ 0.87 (d, 3H, H-26) δ 1.07 (d, 3H, H-27), δ 2.17 (d, 1H, OH), δ 4.69 (m, 1H, H-3), δ 5.35 (s, 1H, vinylic proton), δ 5.15 (d, 2H, allylic proton), δ 1.13 to δ 1.25 (m, 16H, 8 x CH_2), δ 1.38 to δ 1.68 (m, 9H, methine protons). **Mass Spectra (GC-MS):** Molecular formula: $\text{C}_{29}\text{H}_{48}\text{O}$, Molecular weight: 412 GC-MS (m/z), 412 (M^+ , $\text{C}_{29}\text{H}_{48}\text{O}$), the other peaks appeared at 394, 351, 300, 271, 255, 213, 159, 145, 133, 105, 83, 55(100%).

Isolated compound II gave a characteristic colour reaction of Sterols. It gave red colour in Salkowski's test and a green colour in Libermann-Burchard's test. It formed an acetate m.p. 143-145 $^\circ\text{C}$. The peak at 1656.0 cm^{-1} in IR spectra indicated C=C stretching while peaks at 1108.0 cm^{-1} , 1006.0 cm^{-1} and 615 cm^{-1} indicated the C-H deformation in gem dimethyl, C-O stretching of secondary alcohol and rocking vibration of CH_2 respectively. Peak at 3429.0 cm^{-1} indicated the presence of OH group while the $^1\text{H NMR}$ signal at δ 2.17 indicated OH at C-3 position. The $^1\text{H NMR}$ signal at δ 5.35 gave singlet which indicated one vinylic proton at C-6 position while the $^1\text{H NMR}$ signal at δ 5.15 gave doublet indicated two allylic protons at C-7 position. The GC-MS spectra showed the molecular ion peak m/z 412. The Mass fragmentation was typical to that of Stigmasterol. Comparison of spectral data with the known compound (Steroids) supported its characterization as Stigmasterol[17]



3.3. Analysis of Compound III

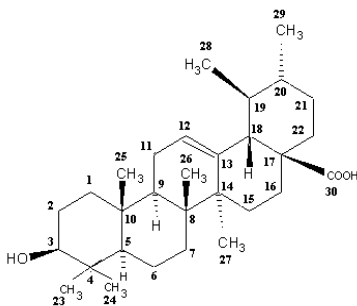
Physical state: Pale yellow powder, R_f value: 0.38 (solvent system- Pet ether: CHCl_3 ; 80:20), Melting point 272 $^\circ\text{C}$, It gave a green colour in Libermann-Burchard's test.

3.1.1. Spectral characteristics of Compound III

IR (KBr cm^{-1}): 3375.32 cm^{-1} (br, OH str), 2939.24 cm^{-1} (C-H str. in CH_3), 2372.90 cm^{-1} (C-H str. in CH_2), 1644.70 cm^{-1} (C=C str.), 1457.25 cm^{-1} (C-H deformation in CH_3), 1378.20 cm^{-1} (C-H deformation in gem dimethyl), 1035.43 cm^{-1} (C-O str. Of secondary alcohol), 650.18 cm^{-1} (Rocking vibration of CH_2). **$^1\text{H NMR}$ (CDCl_3):** δ 1.03 (s, 3H, H-23), δ 0.91 (s, 3H, H-24), δ 0.76 (d, 3H, H-25), δ 0.94 (s, 3H, H-26), δ 0.97 (s, 3H, H-27), δ 0.87 (s, 3H, H-29), δ 0.83 (s, 3H, H-28), δ 2.39 (d, 1H, H-18), δ 1.07 to δ 1.78 (m, 16H, 8x CH_2), δ 1.89 to δ 2.17 (m, 4H, 4xCH), δ 4.69 (d, 2H, allylic protons), δ 2.37 (m, 1H, OH), δ 3.21 (m, 1H, H-3), δ 5.13 (s, 1H, vinylic proton), 271, 259, 231, 205, 177, 137 and 95. **Mass spectra (LC-MS):** Molecular formula: $\text{C}_{30}\text{H}_{48}\text{O}_3$, Molecular weight: 456 LC-MS (m/z): 456 (M^+ , $\text{C}_{30}\text{H}_{48}\text{O}_3$), the other peaks appeared at 440, 425, 409(100%), 391, 353, 325, 313.

Compound III gave characteristic colour reaction for Triterpenoids. It gave a green colour in Libermann-Burchard's test. The peak at 1644.70 cm^{-1} , 1378.20 cm^{-1} and 1035.43 cm^{-1} in IR spectra

indicated C=C stretching, C-H deformation in gem dimethyl and C-O stretching of secondary alcohol respectively. Peak at 650.18 cm^{-1} in IR spectra indicated rocking vibration of CH₂ while peak at 3375.32 cm^{-1} indicated the presence of OH group. The ¹H NMR signal at δ 2.37 indicated OH at C-3 position. The ¹H NMR signal at δ 5.13 gave singlet which indicated one vinylic proton at C-12 position while the ¹H NMR signal at δ 4.69 gave a doublet which indicated two allylic protons at C-11 position. The LC-MS spectra showed the molecular ion peak at m/z 456. The Mass fragmentation was typical to that of Ursolic acid. Comparison of spectral data with the known compound (Triterpenoids) supported its characterization as Ursolic acid[18].



3.4. Acute toxicity studies

The ethanolic extract was found to be safe upto 2000mg/kg body weight

3.5. Analgesic activity

TABLE 1: Effect of ethanolic stem bark extract of *Sapindus trifoliatus* on Tail Flick Method

Treatment	Dose (mg/kg)	Reaction Time in minutes				
		0	30	60	90	120
Control	5ml/kg	2.3±0.1	2.3±0.038	2.42±0.109	2.28±0.19	2.19±0.23
Pentazocine	10	2.57±0.02	4.56±0.62	7.3±0.27	8.24±0.27	7.07±0.10
	100	2.51±0.02**	3.39±0.33**	4.46±0.05**	4.84±0.14**	4.07±0.02**
EEST	200	2.40±0.01**	3.29±0.01**	4.10±0.01**	4.95±0.005**	4.71±0.016**
	400	2.53±0.01**	4.71±0.01**	5.24±0.05**	5.97±0.01**	4.95±0.01**

EEST= Ethanolic extract of *Sapindus trifoliatus*,** The mean difference is significant at the 0.05 level, when compared to the control group.

Table 1 shows the effect of drug and the extracts treatment on Tail flick method. Reaction time of 400mg/kg dose of ethanolic extract of *Sapindus trifoliatus* stem bark which is equivalent to that of 10 mg/kg body weight of Pentazocine. On comparison with control in all dose levels reaction time was found to be significant (P=0.05). Sensitivity to strong analgesics and limited tissue damage were reasons behind selecting this model to evaluate extracts central analgesic potential. Significant elevation in pain threshold (P= 0.05) was observed in all the extract test doses (100 mg/kg, 200 mg/kg and 400 mg/kg) by increasing the reaction time starting from 30 min of observation onwards as compared to the control group. At 120 min maximum analgesic effect was observed for extracts with their values being 4.07, 4.71, 4.95 respectively as compared with std pentazocine (10 mg/kg), it had analgesic value of 7.07 at 120 min. Analgesic activities was shown by extract doses during all the times of observation in dose dependent manner. To attain maximal effect extract doses took longer time for all doses it was found to be 120 min. It may be because of probable time lag for the drug to enter in to the central compartment and distribute into the target site or formation of active metabolites that are endowed with analgesic activity with better half-life. High concentration of active metabolites might be the reason for relatively better action of 400 mg/kg at all observation time. Activating the periaqueductal gray matter (PAG) to release endogenous peptides (i.e., endorphin or enkephalin) may be the possible mechanism of extracts

central analgesic effects. These peptides descend the spinal cord and work as pain impulse transmission inhibitors at synapse on dorsal horn or through peripheral mechanisms involved in the inhibition of PG, leukotriene, and other endogenous substances that are important in central pain transmission [19].

TABLE 2: Effect of ethanolic stem bark extract of *Sapindus trifoliatus* on writhing by acetic acid model.

Treatment	Dose (mg/kg)	Writhing	% inhibition
Control	0.5% CMC	46.00±1.78	-
Standard Aspirin	30	14.00±0.89*	70%
EEST	100	37.67±2.25**	19%
	200	32.00±0.89**	31%
	400	21.33±1.36**	54%

EEST= Ethanolic extract of *Sapindustrifoliatus*;** The mean difference is significant at the 0.05 level, when compared to the control group.

Table 2 shows the effect of drug treatment on acetic acid writhing method. The ethanolic stem bark extract of *Sapindus trifoliatus* at dose (100, 200 and 400 mg/kg) inhibited the writhings and also showed significant dose proportionate inhibited writhings. The inhibitory effect of the 400 mg/kg body weight of ethanolic extract was found to be equivalent to that of 30 mg/kg of Aspirin. Significant (P=0.05) peripheral analgesic activities was seen in all the doses of stem extract (100, 200 and 400 mg/kg) by decreasing writhing numbers with the values of 19%, 31%, 54% as compared to control. These results proved that there was dose dependent increase from lower dose (100 mg/kg) to the higher dose (400 mg/kg) in peripheral analgesic activity of extract. Dose dependent increase in analgesic activity might be due to higher concentration of active constituents with maximum dose. The possible mechanism by which the extract produced peripheral analgesia in this model might be associated with inhibiting the synthesis and release of various endogenous inflammatory mediators and suppression of sensitivity of peripheral nociceptors in the peritoneal free nerve endings for chemical-induced pain. These proposed mechanisms are in line with the principles that stated, any agent that decreases the number of writhing will demonstrate analgesia by inhibiting the synthesis and release of PGs, and by inhibiting the peripheral pain transmission [20].

4. CONCLUSION

The preliminary phytochemical analysis of the ethanolic extract of the stem bark showed the presence of flavonoids, triterpenoids, steroids, resins, tannins and reducing sugars. Further, thorough analysis of the stem bark extract by the separation of the chemical constituents and characterization by various methods like IR, ¹H NMR, ¹³CNMR and mass spectroscopy revealed the presence of a saponin glycoside (compound I), a sterol stigmasterol (compound II) and a triterpenoid ursolic acid (compound III). Further the analgesic activity was analyzed using in vivo methods like tail flick method and acetic acid induced writhing method in experimental animals. So, it can be said that the analgesic effects exhibited by the extract may be because of the presence of these above mentioned and currently identified phytoconstituents, this suggestion is in line with the reports that stated, phytoconstituents such as alkaloids, flavonoids, steroids, and tannin isolated from plants have been reported to have a potent analgesic activity.

ETHICAL APPROVAL

"All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee" (KSHEMA/AEC/28/2010)

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