Original Research Paper

Volume - 10 | Issue - 6 | June - 2020 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Pharma

EVALUATE ANALGESIC AND ANTI-INFLAMMATORY EFFECT OF ETHANOLIC LEAVES EXTRACT OF SOLANUM VIRGINIANUM (L)

Geeta Devi Sahu*	Department of Pharmacology, School of Pharmacy, LNCT University, Bhopal, Madhya Pradesh, India-462026. *Corresponding Author
Vishal Shrivarstava	Department of Pharmacology, School of Pharmacy, LNCT University, Bhopal, Madhya Pradesh, India-462026.
Parul Senger	Department of Pharmacology, School of Pharmacy, LNCT University, Bhopal, Madhya Pradesh, India-462026.
Jay Prakash Rai	Department of Pharmacology, School of Pharmacy, LNCT University, Bhopal, Madhya Pradesh, India-462026

ABSTRACT Present study was evaluated the Analgesic and Anti-inflammatory properties of ethanolic leaves extracts of Solanum virginianum (L). (ELSvE). In this study, (ELSvE) in doses of 200 and 400 mg/kg was used. The phytochemical analysis, analgesic activity and anti-inflammatory activity was evaluated using hot plate method, tail immersion test, acetic acid induced writhing response in mice and carrageenan-induced paw edema in rats, cotton pellet induced granuloma method in mice. Intensive investigation on phytochemical constituents It was found that various phytochemical were present Proteins & Amino acids, Saponins and high amount of flavonoids.

It was found that the all (ELSvE) extracts showed significant ($p<0.05$ and $p< 0.01$) analgesic activity but among the two doses, 400 mg/kg showed highest analgesic activity at reaction time 120 min. There was a significant reduction of pain full sensation due to tail immersion in warm water. The maximum inhibitory effect of (ELSvE) Showed significant ($p< 0.01$) at 90 min post dose in 400 mg/kg and also showed a dose dependent analgesic activity. Injection of acetic acid into control mice produced 52.4=2±0.5 writhes. Pretreatment with (ELSvE) at doses of 200 and 400 mg/kg reduced the number of writhes 38.2±1.5 (25.30 % protection) and 32.2±2.5 (38.18 % protection) respectively. Among the two doses 200, 400 mg/kg showed the slightly lower analgesic activity than standard drug Diclofenac Sodium 28.8±1.2 (54.25 % protection). It was observed that the onset of writhing was delayed and duration of writhing was shortened. In Carrageenan-Inuced Paw Edema in Rats, the dose of 400 mg/kg exhibited a significant inhibition of 48 % after 3 h, the effect increased after 3h (52%). In Anti-inflammatory activity the extracts showed significant and similar to that of indomethacine (10 mg/kg). Cotton Pellet-Induced Granuloma Method in Rats Among the two dose 400 mg/kg showed the slightly lower reduced weight of granumola than standard drug dexamethazone 28.92±0.04 (29.8% inhibition). ELSvE possesses several important pharmaceutical and pharmacological properties. The current study describes that (ELSvE) has significant analgesic anti-inflammatory properties. Conclusion of the study is that this herbal medicine can be used as an alternative therapy for the treatment of minor to moderate types of as a painkiller and inflammation.

KEYWORDS : Solanum Virginianum; Acetic Acid Induced Writhing; Analgesic; Anti-inflammatory.

INTRODUCTION

Plants have been used as a potential source of medicine, due to an enormous diversity of bioactive compounds[1]. Many of the plants used in the traditional medicine to alleviate the common ailments and to promote a healthy life[2]. World Health Organization mentioned that 80% of world populations are dependent on the traditional medicine (Sen and Chakraborty, 2016). India possesses well-versed knowledge of the traditional medicine and its practice since from the ancient past[3]. The continuity of the traditional medicinal practice still today, owing to its cure and effective restoration potential. Bioactive compounds from the plant sources have always been of great significance to develop novel therapeutic drugs. In recent years, increased attention toward the use of herbal drugs has been observed throughout the world[4]. The resurgence in usage of herbal medicine accelerates the research on pharmacological activities of plants used in the traditional medicine. *Solanum virginianum* L (Syn.:- *Solanum xanthocarpum* Schrad. & H. Wendl.) belongs to the family *Solanaceae*, commonly known as wild eggplant or nightshade plant, with medicinal properties as per folk medicine[5]. *Solanum virginianum* is used for treating in cough and fever in India, especially Manipur. The objective of the present study was to scientifically evaluate typhoid potential of *Solanum virginianum*. Phytochemicals present in leaves, stem, roots and fruit of *Solanum virginianum* was studied in the current study by biochemical tests[6]. It was found that various phytochemical were present in high proportion alkaloids, terpenoids, glycosides, flavonoids, saponins, coumarins, tannin, proteins and amino acids[7].

MATERIALS AND METHODS

Plant Collection And Authentication Of Plant:

Plant of *Solanum virginianum* leaves was collect from the side road of Hoshangabad forest area, locality of Bhopal Madhya Pradesh, India, in the month of Feburary 2020 in an amount enough for all the experiment in a lone lot and the plant material were authenticated. The *Solanum virginianum* leaves was wash underneath running tap water cut into minute piece of 2-3cm and shade dried up (300c, 50 ± 5% Relative humidity) for 15days. The shade dried up plant material was pulverized with a dry Grinder to get the coarse powder [9-11]. The powder was stored in air tight Container for further use.

Drying And Pulverization Of The Plant Material

After collection and authentication the leaves were washed to remove the dust Particles and allowed to air dry in a shade for complete drying. Then the dried leaves without moisture were powdered in a mixer grinder[12].

Preparation Of The Plant Extract

The coarse powder was packed tightly in the soxhlet apparatus and extracted with ethanol for 72 hours with occasional shacking maintained at 60ºC throughout the extraction process[13]. The extract was concentrated to of its original volume by evaporation. The resulting ethanolic extract of the *Solanum virginianum* leaves was subjected to phytochemical study.

Phytochemical Analysis

The ethanolic extract of *Solanum virginianum* leaves were subjected to qualitative phytochemical tests for different constituents such as alkaloids, carbohydrates, glycosides, flavonoids, phenolic compounds, proteins, and free amino acids and triterpenoids[15].

Test For Carbohydrate

Small quantity of extract was dissolved in 5ml of water and filtered.

Molisch Test

The filtrate was treated with a few drops of α- napthol (20% in ethyl alcohol). Then 1 ml of concentrated H_2SO_4 was added along the

sides of inclined test tube and observed for formation of violet coloured ring at the interface.[16]

Test for glycosides and anthroquinones Borntrager's test
A small amount of ethanolic extract was hydrolysed with hydrochloric acid for few hours on water bath and the hydrosylate was extracted with benzene[17]. The benzene layer was treated with dilute ammonia solution and observed for the formation of reddish pink colour.

Legal Test
The extract was dissolved in pyridine and made alkaline with few drops of 10% NaOH and freshly prepared sodium nitroprusside was added and observed for formation of blue colour.

Test for flavonoids Ammonia test
Filter paper strips were dipped in the dilute solution of the extract, ammoniated and observed for colour change from white to yellow[18].

Test for Tannins and Phenolic compounds
The extract was dissolved in distilled water and dissolved into three portions. Sodium chloride (10%) was added to one portion, 1% gelatine to second portion and gelatine salt reagent to third portion. Precipitation with later or both gelatin salt reagents was indicative of the presence of tannins. Precipitation with salt solution indicates a false positive test. Positive tests were further confirmed by the addition of a few drops of dilute ferric chloride (1%$FeCl_3$) to the test extract which gave blue or green black coloration[19].

Test for Proteins and Amino acids
Small amount of extract was dissolved in distilled water and filtered.

Biuret's test
To the ammoniated alkaline filtrate add 2-3 drops of 0.002% copper sulphate and observed for appearance of red or violet colour.

Millon's test
To 2 ml of filtrate 5-6 drops of millons reagent (1 g of mercury + 9 ml of fuming nitric acid solution) was added and observed for red precipitates.

Ninhydrin test
To the filtrate lead acetate solution was added to precipitate tannins and filtered. The filtrate was spotted on paper chromatogram and sprayed with ninhydrin reagent and heated at 110ºC for five minutes and observed for red or violet colour.

Xanthoprotein test
To the filtrate a few drops concentrated nitric acid was added by the side of test tube and observed for appearance of yellow colour.

Test for sterols and triterpenes
The extract was refluxed with alcoholic potassium hydroxide until the completion of saponification. Then the mixture was diluted with distilled water and extracted with diethyl ether. The ethereal extract was evaporated and the unsaponifiable matter was subjected to the following tests.

Libermann- Buchard's test
The ether soluble residue was dissolved in chloroform and a few drops of acetic anhydride was added followed by a few drops concentrated sulphuric acid form sides of the test tube and observed for the formation of blue to blue- red colour[20].

Salkowski's reaction
To the ether soluble residue 2 ml of concentrated sulphuric acid was added and observed for the formation of yellow ring at the junction which turns red after one minute.

Animal approval
The study was conducted after obtaining from committee for the purpose of control and supervision on animals (CPCSEA) and institutional animal ethics committee (IAEC), proposal number (1587/PO/Re/S/11/CPCSEA).

Animals
Albino mice weighing 20-25 gm and wistar rats weighing 150- 200 gm were used for this study. The animals were obtained from animal house, College of Pharmacy, SSSUTMS, Sehore M.P., India. On arrival, the animals were placed randomly and allocated to treatment groups in polypropylene cages with paddy husk as bedding[21]. Animals were housed at a temperature of 24±2ºc and relative humidity of 30-70%. A12: 12 light: day cycle was followed. All animals were allowed to free access to water and bed with standard commercial pelleted chow[22]. All the experimental procedures are protocols used in this study were reviewed by Institutional Animal Ethics Committee 1587/PO/Re/S/11/CPCSEA) of and were accordance with the guidelines of the IACE.

Acute Toxicity Studies
The acute toxicity was performed according to OECD guidelines 423. The selected Albino rats were used for toxicity studies. The animals were divided into five groups of three in each. The animals were fasted overnight prior to the acute experimental procedure. Extract was given orally to rats at the graded doses like 5, 50, 100, 1000 & 2000 mg/ kg body weight. Immediately, after dosing, the animals were observed continuously for first four hours for behavioural changes were closely observed for hyperactivity, ataxia, convulsion, salivation, tremors, diarrhoea, lethargy, sleep. They were then kept under observation up to 14 days after drug administration to determine the mortality, if any. One-tenth and one-fifth of the maximum tolerated dose (200 and 400 mg/ kg, body weight) of ethanol leaf extract of *Solanum virginianum.* selected to evaluate anti-inflammatory and analgesic activity studies in rats [23-25]

PHARMACOLOGICAL STUDIES
ANALGESIC ACTIVITY

Hot plate method in mice
The hot plate assay method was employed for the purpose of preferential assessment of possible centrally medicated analgesic effects of ethanolic extract of *Solanum virginianum* leaf. The central analgesic drug pentazocine was used for positive control group. In this experiment, four groups (n=6) of Swiss albino mice (20-25 g) were placed on a hot plate maintained at room temperature for 15 min. Food was withdrawn on the preceding night of the experiment[26]. Group I- Normal Control received CMC (0.5%), and Group II- standard treated with pentazocine (3 mg/kg i.p), whereas group III and IV- animals were treated orally with ethanolic extract leaf of *Solanum virginianum* (200 and 400 mg/kg respectively). Each animal was then individually placed gently on Eddy's hot plate at 55ºC. Latency to exhibit nociceptive responses such as licking paws or jumping off the hot plate were determined at 30, 60, 90 and 120 min after administration of the drugs or vehicle[27].

Tail immersion test
This method assessment was used to evaluate the centrally medicated analgesic effects of ethanolic leaf extract of *Solanum virginianum*. The wistar rats were divided into four groups each consists of six animals. They were placed into individual restraining cages leaving the tail hanging out freely. The lower 5cm portion of the tail is marked and this part of the tail was immersed in a water bath containing water at a temperature of 55± 0.5 ºC. Withdrawing the tail from the hot water showed the analgesic effect. The reaction time was noted on a stop-watch. Each animal served as control[28]. The average of the two values was the initial reaction time. Group –II served as standard and received pentazocine (3 mg/kg, i.p) The Group III and IV were treated orally with ethanolic leaf extract of *Solanum virginianum* 200 mg/kg and 400mg/kg) respectively. The reaction time of the groups was taken at 0, 30, 60, 90 and 120min. The cut off time of the immersion was 15seconds. The reaction time was measured.

Acetic acid induced writhing response in mice
This method was used to preferentially evaluate possible peripheral analgesic effects of ethanolic extract of *Solanum virginianum.* Four groups of Swiss albino male mice (n=6) were fasted overnight prior to start the experiment with free access to water. The peripheral analgesic drug Diclofenac sodium (10 mg/kg) was used as a positive control. Group-I Normal Control received CMC (0.5%) Group-II was treated with Diclofenac Sodium (10mg/kg), whereas Group III and IV were treated orally with the ethanolic extract of *Solanum virginianum* at a dose of 200 mg/kg and 400mg/kg respectively.

After 30 min of treatment, the mice were injected intra peritoneally with 0.1 ml of 1% acetic acid solution to induce the characteristic writhings. The mice were then placed in an observation box and the numbers of writhing were counted in a 5min period[29,30]. The response of the extract and Diclofenac sodium treated groups was compared with those of animals in the control group [44].

ANTI-INFLAMMATORY ACTIVITY

Carrageenan-induced paw edema in rats

For this experiment, the rats (120-150g) were divided into four groups (n=6). The group I received 0.5% CMC (10ml/kg), while the Group II received Indomethacin (10mg/kg). The Group III and IV were treated orally with the ethanolic extract of *Solanum virginianum* at a dose of 200 mg/kg and 400 mg/kg orally. Acute inflammation was produced by injecting 0.1 ml of 1% (w/v) carrageenan suspension into the sub planter region of the right hind paw of the rats[31]. The animals were pretreated with the drug 1hour before the administration of carrageenan .The paw thickness was measured at 1, 2, 3 and 4 h after carrageenan injection by using digital vernier callipers.

Cotton pellet induced granuloma method in rats

Cotton pellets, weighing 5mg each were sterilized. Under ether anaesthesia, the pellets were introduced subcutaneously through a skin incision on the back of the animals. Starting from 30 min after the implantation of cotton pellet for all the rats, Group-I normal control received CMC (0.5%) orally[32]. Group-II was treated with Dexamethasone (1 mg/kg), whereas Groups III and IV were treated orally with 200 mg/kg and 400 mg/kg of ethanol extract of leaf *Solanum virginianum.* The test drugs were administered daily for 7days. On the 8th day, the animals were sacrificed with diethyl ether. The granulomas were removed and the weighed.

RESULT AND DISCUSSION

Pharmacological Studies

From the qualitative phytochemical analysis of ethanolic extract of *Solanum virginianum*. It content Flavonoids, Proteins & Amino acids, Saponins and high amount of flavonoids.

Table 1: Phytochemical Analysis Of Solanum Virginianum Leaf Extract.

S.No.	Parameter	Value
1	Alkaloid	-
2	Carbohydrates	-
3	Glycosides	-
4	Flavonoids	++
5	Tannins & Phenolic compounds	-
6	Proteins & Amino acids	+
7	Saponins	+
8	Sterols or Triterpenes	-

++: high content, +: moderate, - : Negative,

ANALGESIC ACTIVITY

The analgesic activity of ethanolic leaves extract of Solanum virginianum was assessed using hot plate method in Swiss albino mice. The ethanolic leaves extract *Solanum virginianum* showed significant analgesic activity at 200 and 400 mg/kg. Analgesic activity was comparable with standard drug pentazocine. Among the two doses, 400 mg/kg showed maximum analgesic activity at reaction time 120 min (7.4±0.24) is slightly lower than the standard drug pentazocine (9.8±0.15) in this analgesic testing model[33], pentazocine significantly prolonged the reaction time of animals with relatively extended duration of stimulation, confirming centrally active drugs. In the present study, all extracts showed significant ($p<0.05$ and $p< 0.01$) analgesic activity but among the two doses, 400 mg/kg showed highest analgesic activity at reaction time120 min.

Table 2: Analgesic effect of ethanolic extract of Solanum virginianum on hot plate test in Swiss albino mice

GROUP	Paw licking or jumping in seconds			
	30min	60min	90min	120min
Group-I Control	2.3±0.20	2.7±0.15	2.8±0.10	2.9±0.10
Group-II Pentazocine (3mg/kg)	2.7±0.16	6.8±0.15**	9.7±0.64**	9.8±0.15**
Group-III (200mg/kg)	2.7±0.15	3.7±0.05*	4.7±0.05**	4.2±0.15**
Group-IV (400mg/kg)	2.8±0.05	5.8±0.05**	7.3±0.05**	7.4±0.24**

Values were mean ± SEM, (n=6), *P<0.05 **P<0.01 Vs control. Data were analyzed by using One-way ANOVA followed by Dunnett's test.

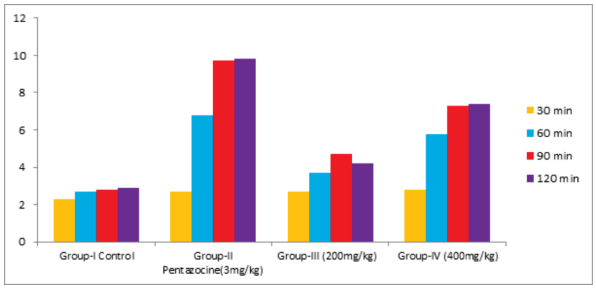

Figure 1: Analgesic effect of ethanolic leaves extract of *Solanum virginianum* on hot plate method in mice.

Tail Immersion Method

There was a significant reduction of pain full sensation due to tail immersion in warm water. The maximum inhibitory effect of *Solanum virginianum*. Showed significant ($p< 0.01$) at 90 min post dose in 400 mg/kg. The maximum anti-nociceptive properties of the plant extract (3.4±0.02) were not as effective as that of pentazocine, 3 mg/kg (5.3±0.02)[34].

Table3: Analgesic effect of ethanolic leaves extract of Solanum virginianum on tail immersion method in rats

Group	Mean latency to tail immersion in seconds				
	0 min	30 min	60 min	90 min	120 min
Group-I Control	1.5±0.05	1.3±0.05	1.5±0.01	1.2±0.04	1.8±0.02
Group II Pentazocine (3mg/kg)	1.6±0.05	2.5±0.02**	4.5±0.02**	5.7±0.05**	5.3±0.02**
Group III (200mg/kg)	1.4±0.04	1.8±0.05*	2.2±0.04*	2.5±0.04	2.7±0.05*
Group IV (400mg/kg)	1.3±0.05	2.2±0.05*	2.5±0.01**	3.6±0.02**	3.4±0.02**

Values were mean ± SEM (n=6), *P<0.05 **P<0.01 Vs control. Data were analyzed by using One-way ANOVA followed by Dunnett's test.

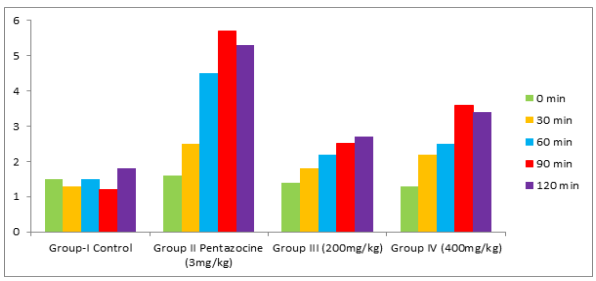

Figure2: Analgesic Effect of Ethanolic Leaves Extract of *Solanum virginianum* on Tail Immersion Method in Rats.

Acetic Acid- Induced Writhing Response in Mice

The oral administration of ethanolic leaves extract *of* of *Solanum virginianum.* Showed a dose dependent analgesic activity. Injection of acetic acid into control mice produced 52.2±0.5 writhes. Pretreatment with Ethanolic extract of of *Solanum virginianum* at doses of 200 and 400 mg/kg reduced the number of writhes 38.2±1.5 (25.30 % protection) and 32.2±2.5 (38.18 % protection) respectively. Among the two doses 200, 400 mg/kg showed the slightly lower analgesic activity than standard drug Diclofenac Sodium 28.8±1.2 (54.25 % protection) it was observed that the onset of writhing was delayed and duration of writhing was shortened.

Table 4: Analgesic effects of ethanolic leaves extract of Solanum virginianum on acetic acid writhing test in Swiss albino mice

Group	Number of writhes	% Inhibition
Group-I Control	52.2±0.5	____
Group-II Diclofenac Sodium (10mg/kg)	25.8±1.2**	54.25
Group-III (200mg/kg)	38.2±1.5**	25.30
Group-IV (400mg/kg)	32.2±2.5**	38.18

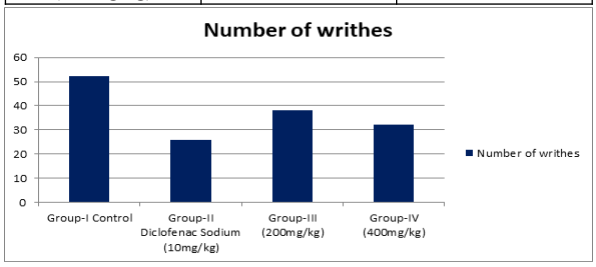

Figure 3: Analgesic effect of ethanolic leaves extract of *Solanum virginianum* , on acetic acid induced writhing response in mice.

Anti-Inflammatory Activity

Carrageenan-Inuced Paw Edema in Rats

The anti-inflammatory effect of the ethanolic leaves extract of *Solanum virginianum* on carrageenan – induced hind paw edema as shown in Table 4. The ethanolic leaves extract of *Solanum virginianum* at doses 200 and 400 mg/kg produced a significant effect against carrageenan induced inflammatory effect[35]. The dose of 400 mg/kg exhibited a significant inhibition of 47 % after 3 h, the effect increased after 3h (53%). Anti-inflammatory activity of ethanolic extract of *Solanum virginianum*. showed significant and similar to that of indomethacine (10 mg/kg).

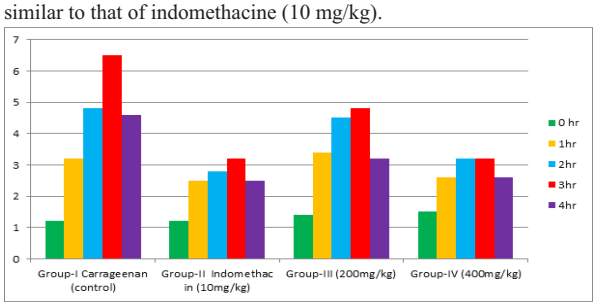

Figure 4: Anti-inflammatory activity of ethanolic leaves extract of Solanum virginianum (L), on carrageenan induced paw edema method in Wistar rats.

Table 5: Anti-inflammatory Activity Of Ethanolic Leaves Extract Of Solanum Virginianum, On Carrageenan Induced Paw Edema Method In Wistar Rats.

GROUP	Paw thickness in mm					%Inhibition at 3hr
	0 hr	1hr	2hr	3hr	4hr	
Group-I Carrageenan (control)	1.2±0.04	3.2±0.05	4.8±0.064	6.5±0.05	4.6±0.04	------
Group-II Indomethac in (10mg/kg)	1.2±0.02	2.5±0.05**	2.8±0.0**	3.21±0.05**	2.5±0.05**	52
Group-III (200mg/kg)	1.4±0.05	3.4±0.05	4.5±0.02	4.8±0.02*	3.2±0.05**	27
Group-IV(400mg/kg)	1.5±0.04	2.6±0.02**	3.2±0.02*	3.2±0.05**	2.6±0.02**	48

Values were mean ± SEM, (n=6), *P<0.05, **P<0.01 vs control. Data were analyzed by using One-way ANOVA followed by Dunnett's test

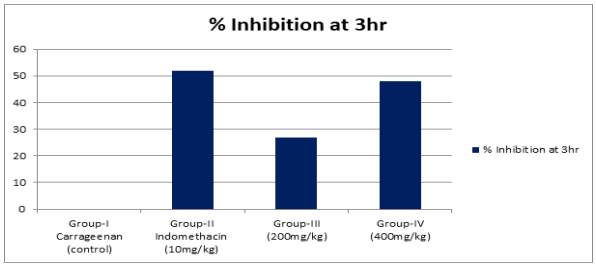

Figure 5: Anti-inflammatory activity of ethanolic leaves extract of Luffa acutangula (L), on carrageenan induced paw edema method in Wistar rats. Results are expressed as a percentage inhibition.

Cotton Pellet-Induced Granuloma Method in Rats

The anti-inflammatory effect of the ethanolic leaves extract *o*f *Solanum virginianum* assessed by using cotton pellet induced granuloma method in Wistar rats. The ethanolic leaves extract of *Solanum virginianum* Showed significant anti-inflammatory activity at 200 and 400 mg/kg dose. After 7 days, the mean weight of granulomatous tissue surrounding the threads was significantly lower for the group treated with *Solanum virginianum* extract as compared to the control group. Among the two doses 400 mg/kg showed maximum decreased formation of granuloma tissue. The results indicate that *Solanum virginianum* at dose level of 200mg/kg and 400 mg/kg produced a significant decrease in the weight of granuloma 38.25±0.05 (7.4% inhibition) and 34.42±0.05 (16.2% inhibition) respectively[36]. Among the two dose 400 mg/kg showed the slightly lower reduced weight of granumola than standard drug dexamethazone 28.92±0.04 (29.6% inhibition)

Table 6: Anti-inflammatory activity of ethanolic leaves extract of Solanum virginianum, on cotton pellet-induced granuloma in rats.

GROUP	Granuloma weight (mg)	% Inhibition
Group-I Control	42.14±0.05	-
Group-II Dexamethazone (1mg/kg)	28.92±0.04**	29.6
Group-III 200mg/kg	38.25±0.05**	7.4
Group-IV 400mg/kg	34.42±0.05**	16.2

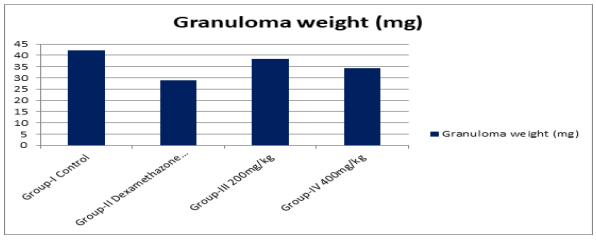

Figure 6: Anti-inflammatory Activity Of Ethanolic Leaves Extract Of Solanum Virginianum, On Cotton Pellet-induced Granuloma In Rats.

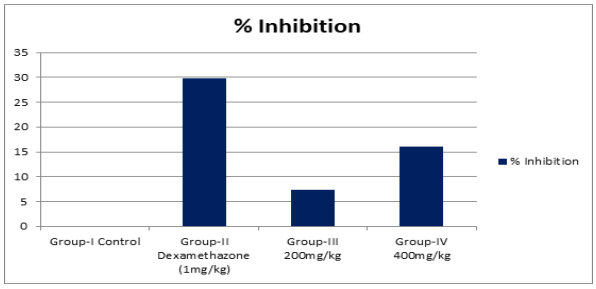

Figure7: Anti-inflammatory activity of ethanolic leaves extract of Solanum virginianum, on cotton pellet-induced granuloma in rats. Results are expressed as a percentage of inhibition.

DISCUSSION

The inflammation is complex process, which is frequently associated with pain and involves several events, such as the increase of muscular permeability, increase of granulocytes and mono nuclear cell migration, as well as the granulomatous tissue proliferation. Pain is subjective experience, which is difficult to define exactly even though we all experience it. Pain distinguished as two types, peripheral or neurogenic pain may involve the following pathological states: peripheral nociceptive afferent neurons which are activated by noxious stimuli and central mechanism which is activated by different inputs pain sensation.

The hot plate model was selected to investigate central antinociceptive activity because it has several advantages particularly the sensitivity to strong antinociceptive and limited tissue damage. Prostaglandins and bradykinins were suggested to play an important role in pain. Phenolic compounds are reported to inhibit prostaglandin synthesis. A number of phenolic compounds have been reported to produce analgesic activity. Other studies have demonstrated that various flavonoids such as rutin, quercetin, luteolin, biflavonoids and triterpenoids produced significant antinociceptive effect [37]. As phytochemical test showed presence of flavonoids and tannins in ethanolic extract of *Solanum virginianum*, they might suppress the formation of prostaglandin and bradykinins.

Acetic acid is known to trigger the production of noxious substances within the peritoneum, which induces the writhing response. The effect of the extract against the noxious stimulus may be an indication that it depressed the production of irritants and thereby reduction in number of writhes in the animals. The writhing induced by chemical substances is due to sensitization of nociceptors by prostaglandins. The abdominal constriction response induced by acetic acid is a sensitive procedure to establish peripherally acting antinociceptives. This response is thought to involve local peritoneal receptors[38]. This result indicates that the analgesic effect of Ethanolic extract of *Solanum virginianum*, might be mediated by inhibiting the synthesis or action of prostaglandins.

The centrally acting analgesic activity of the extract was also corroborated in our study by tail immersion test results. The fact that in thermal stimuli (hot plate & Tail immersion tests), the anti-nociceptive effect should be shown by acting centrally on opioid receptors. Since the drugs had shown the analgesic activity in tail immersion test, it seems that the ethanolic extract can act centrally. Taking this in to consideration the ethanolic extract of *Solanum virginianum*, possess peripheral and central analgesic properties. Moreover, Grumbach et al has shown that the effectiveness of analgesic agents in the tail flick pain model is highly correlated with human pain relief.

The ethanolic extract of *Solanum virginianum* showed anti-inflammatory activity on an acute inflammatory process like in carrageenan induced paw edema in rats paw. It is well known that leukocytes migration to the injured tissues in an important aspect of the inflammatory process. Histamine and serotonin are responsible for the immediate inflammatory response, whereas kinins and prostaglandins mediate prolonged response. Anti-inflammatory activity of many plants has been attributed to their high sterol/triterpene or flavonoids content. The anti-inflammatory effect of ethanolic extract of *Solanum virginianum* in rats with carrageenan-induced paw was significant.

It is known that the inflammatory granuloma is a typical response of a chronic inflammatory process and it has been established that the weight of the pellets is well correlated with the granulomatous tissue. The chronic inflammation occurs by means of the development of prolifereative cells. These cells can be either spread or in granuloma form. The *Solanum virginianum* extract showed significant anti-inflammatory activity in cotton pellet induced granuloma and thus found to be effective in chronic inflammatory conditions. It reflected its efficacy ininhibiting the increase in the number of fibroblasts and synthesis of collagen and mucopolysaccharide during granuloma tissue formation.

Brewer's yeast was used to induce fever in albino rats. Fever was recorded 18 hrs after yeast injection since yeast takes a total of about 18hrs to cause the elevation of body temperature. Subcutaneous injection of Brewer's yeast induces pyrexia by increasing the synthesis of prostaglandin. It is considered as a useful test for the screening of plants materials as well as synthetic drugs for their antipyretic effect. Yeast induced pyrexia is called pathogenic fever and its etiology could be the production of prostaglandins. The inhibition of prostaglandin synthesis could be the possible mechanism of antipyretic action as that of paracetamol and the inhibition of prostaglandin can be achieved by blocking the cyclo-oxygenase enzyme activity. There are several mediators for pyrexia and the inhibitions of these mediators are responsible for the antipyretic effect.

The oral administration of *Solanum virginianum* significantly attenuated rectal temperature of yeast induced albino rats. Thus it can be postulated that *Solanum virginianum*, contained pharmacologically active principles that interfere with the release of prostaglandins. After three hours of the test period, the ethanolic leaves extract of *Solanum virginianum* produced appreciable antipyretic activity against brewer's yeast induced pyrexia in albino rat. It was revealed that the extract showed dose dependent antipyretic activity.

CONCLUSION

The present thesis entitled “Evaluate analgesic and anti-inflammatory effect of ethanolic extract of *Solanum virginianum* (L)” deals with the exploration of pharmacological and phytochemical screening of the selected Indian medicinal plant *Solanum virginianum* (L) belonging to the family *Solanaceae* . It content Flavonoids, Proteins & Amino acids, Saponins and high amount of flavonoids. It was reported that the flavonoids frequently found in plants possess analgesic and anti-inflammatory activity. ELSvE possesses several important pharmaceutical and pharmacological properties. Conclusion of the study is that this herbal medicine can be used as an alternative therapy for the treatment of minor to moderate types of as a painkiller and inflammation. Further detailed study on Solanum virginianum (L) plant using different phlogistic agents in this area will enable us to understand the mechanism of action underline the above mention activity.

ACKNOWLEDGMENTS

Authors are thankful for the help of technicians and attenders of Pharmacology Department and Statistician of school of Pharmacy, LNCT University, Bhopal.

REFERENCES

1. Patel J.K. and Patel P.Y., Botanical therapeutics: discovery, development and manufacture-prospects and constraints. Journal of Natural Remedies. 2007: 7(1): 19-30.
2. Yadav M.O. and Parle M.I., A simple laboratory model for inducing and measuring pain in small experimental animals. International Journal of Pharmacy and Pharmaceutical Sciences; 2016 8(7): 156-162.
3. Gupta SK. ”Drug Screening Methods", 2nd edition, Jaypee Brothers Medical Publishers, New delhi. 2009: 480-498.
4. Kumar S, Vandana UK, Agrwal D and Hansa J. Analgesic, anti- inflammatory and anti-pyretic effects of Azadirachta indica (Neem) leaf extract in albino rats. International Journal and Science Research. 2015: 4:713-21.
5. Sumanta M, Dash G.K. Suman A. Analgesic, anti-inflammatory and antipyretic studies of Neolamarckia cadamba barks. Journal of Pharmacy Research. 2009: 2(6):1133-1136.
6. Al-khazraji SM. Studying the Analgesic, Anti-inflammatory and Antipyretic Properties of The Aqueous Extract of Petroselinum crispum in Experimental Animal Models. *IOSR Journal of Pharmacy* 2015: 9: 17-22.
7. Safari V.Z., Ngugi M.P., Orinda G, Njagi E.M. Anti-pyretic, anti- inflammatory and analgesic activities of aqueous leaf extract of Urtica dioica L. in albino mice. Medicinal and Aromatic Plants. 2016:5(2):1-7.
8. Saini NK and Singha M. Anti–inflammatory, analgesic and antipyretic activity of methanolic Tecomaria capensis leaves extract. Asian Pacific journal of tropical biomedicine. 2012: 2(11):870-4.
9. Ali K, Ashraf A, Biswas N.N,. Analgesic, anti-inflammatory and anti-diarrheal activities of ethanolic leaf extract of Typhonium trilobatum L. Schott. Asian Pacific journal of tropical biomedicine. 2012: 2(9):722- 6.
10. Rane M, Sahu N, et al., A Holistic Approach Review of Solanum virginianum L. Research and Reviews: Journal of Pharmacy and Pharmaceutical Sciences. 2014): 3 (3), 1-4.
11. Reddy N. M. and Rajasekhar Reddy N. Solanum xanthocarpum Chemical Constituents and Medicinal Properties: A Review: Scholars. Academic Journal of Pharmacy. 2014, 3 (2), 146-149.
12. K.Vijay , D. Rashmi, Banerjee M., Callus Induction and Plant Regeneration in Solanum tuberosum L. cultivars (Kufri Chipsona 3 and MP-97/644) via Leaf Explants. International Research Journal of Biological Sciences.2014:3 (6), 66-72.
13. Yemitan O.K. and Adeyemi O.O., Mechanistic assessment of the analgesic, anti-inflammatory and antipyretic actions of Dalbergia saxatilis in animal models. Pharmaceutical biology. 2017: 55(1):898-905.
14. Traditional Medicine. Report by the Secretariat. WHO; 2003. Available from: http://www.apps.who.int/gb/archive/pdf_files/WHA56/ea5618. pdf. [Last cited on 2017 Jul 17]
15. Mondal S, Ghosh D, Ganapaty S, Manna O, Reddy MV and Revanth V. Evaluation of Analgesic, Antipyretic and Anti-Inflammatory Effects of Ethanol Extract from a Fern Species Macrothelypteris Torresiana (Gaudich) Aerial Parts. Pharmacognosy Communications. 2016: 6(2):57.
16. Shah S.K. Jhade D.N., Evaluation of antifertility potential of Piper betle (Petiole) on female wistar rats “rising approaches of herbal contraception" Biochemistry and Biophysics Reports Volume 15, September 2018, Pages 97-102
17. Safari V.Z, Kamau J.K, Nthiga PM, Ngugi MP and Orinda G. Antipyretic, Anti-inflammatory and Antinociceptive Activities ofAqueous Bark Extract of Acacia Nilotica (L.) Delile in Albino Mice. Pain Manage Med. 2016: 2(113):2.
18. Mondal S, Ghosh D, Ganapaty S, Manna O, Reddy M.V. and Revanth V. Evaluation of Analgesic, Antipyretic and Anti-Inflammatory Effects of Ethanol Extract from a Fern Species Macrothelypteris Torresiana (Gaudich) Aerial Parts. Pharmacognosy Communications. 2016: 6(2):57.
19. Yemitan O.K., Adeyemi OO. Mechanistic assessment of the analgesic, anti-inflammatory and antipyretic actions of Dalbergia saxatilis in animal models. Pharmaceutical biology. 2017: 55(1):898-905.
20. Akuodor G.C, Essien A.,D, Akpan JL, Chilaka KC, Uwaezuoke NJ, Nwadike KI,

Nwobodo NN and Ezeokpo BC. Analgesic, antiinlfammatory and antipyretic activities of methanolic leaf extract of Maerua crassifolia. Journal of Coastal Life Medicine. 2016: 4(3): 225-230.
21. Kokate C.K, Puruhhit and S.B. Gohale. Textbook of Pharmacognosy 2009: 7: 533-537.
22. Vogel H.G. Vogel WH. Drug Discovery and Evaluation: Pharmacological Assays. Berlin, Germany: Springer; 2007.
23. Zanini A, Cherubino F, Zampogna E, Croce S, Pignatti P, Spanevello A. Bronchial hyperresponsiveness, airway inflammation, and reversibility in patients with chronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis, 2015; 10:1155–61.
24. Sahle T, Okbatinsae G. Phytochemical investigation and antimicrobial activity of the fruit extract of Solanum incanum grown in Eritrea. Ornamental Med Plants, 2017; 1(1):15–25
25. Parmar K.M, Itankar P.R, Joshi A, Prasad SK. Anti-psoriatic potential of Solanum xanthocarpum stem in imiquimod-induced psoriatic mice model. J Ethnopharmacol, 2017; 198:158–66.
26. Evaluation of comparative immunomodulatory potential of Solanum xanthocarpum root and fruits on experimental animal. Indian J Pharm Educ Res, 2018, 52(4 Suppl 2):s237–45.
27. Hicks R. The evaluation of inflammation induced by material implanted subcutaneously in the rat. J Pharm Pharmacol 1969;21:581-88
28. Nithya M, Ragavendran C, Natarajan D. Antibacterial and free radical scavenging activity of a medicinal plant Solanum xanthocarpum. Int J Food Prop, 2018; 21(1):328–42.
29. Huque A, Biswas S, Abdullah-Al-Mamun Md, Bhuiyan JR, Md. Harun ur Rashid Md, Jahan A. Analgesic, anti-inflammatory and anxiolytic activity evaluation of methanolic extract of Solanum xanthocarpum Leaf in swiss albino mice model. IJPCR, 2015; 7(1):68–76.
30. Barik CS, Parida N, Sahu D, Sahoo AR. Solanum surattense: evaluation of anthelmintic activity. J Pharm Adv Res, 2018; 1(5):240–6.
31. Burger T, Mokoka T, Fouché G, Steenkamp P, Steenkamp V, Cordier W. Solamargine, a bioactive steroidal alkaloid isolated from Solanum aculeastrum induces non-selective cytotoxicity and P-glycoprotein inhibition. BMC Complement Altern Med, 2018; 18(1):137.
32. M. Ren, Q. Tang, F. Chen, X. Xing, Y. Huang, and X. Tan, "Attenuates Th1 and Th2 responses in the treatment of ovalbumin-induced allergic inflammation in a rat model of allergic rhinitis," Journal of Immunology Research, 2017:1–12,.
33. O. Tahiri, D. Atmani-Kilani, S. Sanchez-Fidalgo et al., "The flavonol-enriched Cistus albidus chloroform extract possesses in vivo anti-inflammatory and anti-nociceptive activity," Journal of Ethnopharmacology, 2017: 209; 210–218,
34. D. L. Meng, L. Wang, J. N. Du et al., "The analgesic activities of Stauntonia brachyanthera and YM11 through regulating inflammatory mediators and directly controlling the sodium channel prompt," *Scientific Reports*, 2017: 7, 1.
35. T. Yu, X. Lao, and H. Zheng, "Influencing COX-2 activity by COX related pathways in inflammation and cancer," *Mini-Reviews in Medicinal Chemistry*, 2016: 16 (15);1230–1243,
36. Q. Xin, B. Bai, and W. Liu, "The analgesic effects of oxytocin in the peripheral and central nervous system," *Neurochemistry International*, 2017:103; 57–64,
37. B. R. Sharma, C. M. Park, J. W. Choi, and D. Y. Rhyu, "Anti-nociceptive and anti-inflammatory effects of the methanolic extract of Opuntia humifusa stem," *Avicenna Journal of Phytomedicine*, 2017,7;366–375,
38. D. P. Aragao, B. da Silva Souza, T. V. de Brito et al., "The anti-inflammatory and antinociceptive activity of albumins from Crotalaria retusa seeds," *Biomedicine & Pharmacotherapy*, 2017:93, 536–542.