



Evaluation of anti-inflammatory potential of *Nardostachys jatamansi* rhizome in experimental rodents

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PEER REVIEW

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Comments

This is a valuable research work in which authors have demonstrated the anti-inflammatory potential of *N. jatamansi* rhizome in experimental rodents. The activity was assessed based on inflammatory mediators which are the prime sign of inflammation. NJE was found to be a promising anti-inflammatory activity against acute, subacute and chronic model induced inflammation. Details on Page 42

ABSTRACT

Objective: To evaluate the anti-inflammatory effect of *Nardostachys jatamansi* (*N. jatamansi*) rhizome against acute, subacute and chronic models of inflammation in experimental animals.

Methods: *N. jatamansi* rhizome extract (150 and 300 mg/kg, *p.o.*) and the reference drugs phenylbutazone (100 mg/kg, *p.o.*) and acetylsalicylic acid (300 mg/kg, *p.o.*) were evaluated using models for inflammation (autocoids induced hind paw oedema, formaldehyde induced hind paw oedema, carrageenin-induced paw oedema, cotton pellet granuloma and subcutaneous air pouch model).

Results: In acute inflammation as produced by carrageenin 29.06% and 55.81%, by histamine 25.0% and 39.28%, by 5-hydroxytryptamine 21.37% and 36.95% and by prostaglandin E2-induced hind paw oedema 31.03% and 44.82% protection was observed. While in subacute anti-inflammatory models using formaldehyde-induced hind paw oedema (after 1.5 h) 13.88% and 33.33% and in chronic anti-inflammatory model using cotton pellet granuloma 7.4% and 17.58% protection from inflammation was observed. *N. jatamansi* rhizome extract also inhibited the inflammatory mediators (nitric oxide by 12.81% and 38.41%, by prostaglandin E2 12.58% and 47.82% while by TNF- α 13.51% and 41.89%) produced in the pouch.

Conclusions: The results of this study strongly indicate the protective effect of *N. jatamansi* rhizome extract against acute, subacute and chronic models of inflammation, which may be attributed to its anti-inflammatory potential.

KEYWORDS

Nardostachys jatamansi rhizome, Anti-inflammatory, Histamine, Carrageenin, Cotton pellet granuloma

1. Introduction

Pain is a common symptom of various inflammatory diseases and is the primary reason why patients pursue specialised treatment[1]. Thus, there is a great demand for more effective anti-inflammatory drugs[2]. Because currently available anti-inflammatory drugs have considerable side effects that inhibit their clinical use, many studies are currently underway to develop new treatments for

inflammatory diseases[3]. The search for alternatives to current treatments is necessary and will greatly benefit those afflicted with inflammatory diseases[4]. Natural products have been one of the most successful sources for the discovery of new therapeutic agents[5]. *Nardostachys jatamansi* (*N. jatamansi*, commonly named as jatamansi) belongs to family Valerianaceae.

N. jatamansi is perennial herb whose rhizome and roots are mainly used as drug. *N. jatamansi* is described in

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Indian traditional system of medicine (Ayurveda) for its use in mental disorders, insomnia, hyperlipidemia, hypertension and heart diseases and memory improvement^[6,7]. It has protective effect in Parkinsonism, epilepsy, cerebral ischemia and free radical scavenging activity^[8]. Jatamansi showed antifungal, antioestrogenic, and jatamansone has been reported to possess anti-arrhythmic, anti-asthmatic, nematocidal and anti-bacterial activity^[9]. Jatamansi is capable of lowering norepinephrine as well as serotonin in brain^[10]. To the best of our knowledge, there has been not any research reported on anti-inflammatory activity on *N. jatamansi*. Therefore, the present study was designed to demonstrate the anti-inflammatory effect of *N. jatamansi* extract (NJE) in experimental animals.

2. Materials and methods

2.1. Chemicals

Carrageenin, histamine, 5-hydroxytryptamine (5-HT), prostaglandin E2 (PGE2), bradykinin, acetylsalicylic acid (ASA) and phenylbutazone (PBZ) were purchased from Sigma Chemicals and formaldehyde from British Drug House, Mumbai, India. All the chemicals used were of analytical grade.

2.2. Animals

Wistar rats weighing 200–250 g of either sex were procured from Royal college of Pharmacy, Health and Sciences Berhampur, Orissa. They were kept in departmental animal house in well cross ventilated room at (22±2) °C with light and dark cycles of 12 h for 1 week before and during the experiments. All studies were performed in accordance with the guide for the care and use of laboratory animals, as adopted and promulgated by the Institutional Animal Care Committee, CPCSEA, India (Reg. No. 1018C/06/CPCSEA).

2.3. Preparation of plant extract

The plant material (dried rhizome) was procured from local market of Berhampur, Orissa, India in December 2010. The plant material was identified and the voucher specimen was deposited in the institutional herbarium. The rhizomes of plants of *N. jatamansi* were washed thoroughly in tap water, shade dried and powdered. Crushed material was subjected to extraction in a Soxhlet apparatus at 60–70 °C for 6 h continuously in 50% distilled ethanol. The extracted material was evaporated to dryness under reduced pressure (40–45 °C). The yield of the material was 14.65%. This crude extract was referred to as NJE. The extract obtained was further subjected to pharmacological investigation.

2.4. Anti-inflammatory activity

2.4.1. Study of NJE on acute inflammation

2.4.1.1. Carrageenin-induced hind paw oedema in rats

The acute hind paw oedema was produced by injecting

0.1 mL of carrageenin (prepared as 1% suspension in 1% carboxymethyl cellulose) locally into the plantar aponeurosis of the right hind paw of rats^[11]. NJE (150 and 300 mg/kg, *p.o.*) was administered to two different groups while the other two groups served as negative and positive controls and received vehicle (1 mL/kg, *p.o.*) and standard drug, acetylsalicylic acid (ASA, 300 mg/kg, *p.o.*), respectively. NJE and ASA were administered 1 h prior to the injection of carrageenin. The rat pedal volume up to the ankle joint was measured using plethysmometer (Ugo Basile, 7140 Comerio-varese, Italy) at 0 h (just before) and 3 h after the injection of carrageenin. Increase in the paw edema volume was considered as the difference between 0 and 3 h. Percent inhibition of oedema volume between treated and control groups was calculated as follows:

$$\text{Percent inhibition} = (1 - V_t/V_c) \times 100$$

Where V_c and V_t represent the mean increase in paw volume in control and treated groups, respectively.

2.4.1.2. Autacoids-induced hind paw oedema in rats

This experiment was conducted as per the methodology used by Singh and Pandey^[12]. The autacoids, *viz.*, histamine (1 mg/mL), 5-HT (1 mg/mL), PGE2 (1 µg/mL) and bradykinin (20 µg/mL) were employed as phlogistic agents. The effect of NJE (150 and 300 mg/kg, *p.o.*) was tested individually against each autacoid. Right hind paw oedema was induced by the sub-plantar injection of 0.1 mL of respective phlogistic agent. Test compounds were administered 1 h prior to the inflammatory insult. The pedal volume was measured just before (0 h) and 3 h after the phlogistic challenge. PBZ (100 mg/kg, *p.o.*) was employed as reference standard.

2.4.2. Study of NJE on subacute inflammation

2.4.2.1. Formaldehyde-induced hind paw volume

The test was performed according to the technique developed by Brownlee^[13]. Pedal inflammation was induced by injecting 0.1 mL of 4% formaldehyde solution below the plantar aponeurosis of the right hind paw of the rats. The paw volume was recorded immediately prior to compound administration (0 h) and then at 1.5, 24 and 48 h after formaldehyde injection. Vehicle (1 mL/kg, *p.o.*), NJE (150 and 300 mg/kg, *p.o.*) and standard drug, ASA (300 mg/kg, *p.o.*) were administered 1 h prior to formaldehyde injection.

2.4.3. Study of NJE on chronic inflammation

2.4.3.1. Cotton pellet granuloma in rats

The effect of NJE on chronic or proliferative phase of inflammation was assessed in cotton pellet granuloma rat model as described by Winter and Porter^[14]. Autoclaved cotton pellets weighing (35±1) mg each were implanted subcutaneously through small incision made along the axilla or flank region of the rats anesthetized with ether. The different groups of rats were administered the NJE (150 and 300 mg/kg, *p.o.*) and ASA (300 mg/kg, *p.o.*) once daily for 7 consecutive days from the day of cotton pellet insertion. The control group received vehicle (1 mL/kg, *p.o.*). On the eighth day, all the rats were sacrificed and the cotton pellets covered by the granulomatous tissue were excised and dried in hot air oven at 60 °C till a constant weight was achieved.

Granuloma weight was obtained by subtracting the weight of cotton pellet on 0 d (before start of experiment) from the weight of the cotton pellet on eighth day.

2.4.3.2. Subcutaneous air pouch (SAP)

The SAP protocol used was similar to that described by Raymundo *et al*^[15]. Briefly, air pouches were produced by subcutaneous injections of 10 mL of sterile air into the intrascapular region of the mice. After 3 d, another 10 mL of air was injected to maintain the pouches. Three days after this last injection, animals received an injection of 0.5 mL of sterile carrageenan suspension (1%). Mice were pre-treated with oral doses of vehicle, dexamethasone (0.5 mg/kg) and NJE 1 h before and 23 h after carrageenan injections in the SAP. Animals were sacrificed 24 h after the carrageenan injection, and the cavity was washed with 2 mL of sterile phosphate buffer. Exudates were collected. An aliquot of exudates was diluted 1:20 in Turk liquid (0.5% crystal violet dissolved in 30% acetic acid). The exudates were centrifuged at 4000 r/min for 10 min at 4 °C; the supernatants were collected and stored at -20 °C until further analysis.

2.4.3.2.1. TNF- α and PGE2 measurements

Supernatants from exudates collected in the SAP were used to measure, TNF- α , and PGE2. TNF- α were quantified by enzyme-linked immunosorbent assay, using the protocol supplied by the manufacturer (PeproTech). PGE2 was determined by using EIA kits (Cayman Chemical Co., MI, USA), according to the method of Pradelles *et al*^[16].

2.4.3.2.2. Nitrate measurement

To evaluate NO production, nitrate (the stable metabolite of NO) concentration in the supernatants was measured according to Xu *et al.*^[17] with several modifications^[15]. The absorbance was measured at 540 nm using microplate reader, and the nitrate concentration was calculated using a standard curve of sodium nitrate.

2.5. Statistical analysis

The values were represented as mean \pm SEM for six animals. Analysis of variance test was followed by individual comparison by Newman-Keuls test using Prism Pad software (Version 3.0) for the determination of level of significance. The value of $P < 0.05$ was considered statistically significant.

3. Results

Table 2

Effect of NJE on autacoids induced hind paw oedema in rats.

Drug	Dose (mg/kg)	Histamine		5-HT		PGE2		Bradykinin
		Increase in oedema volume (mL)	% Protection	Increase in oedema volume (mL)	% Protection	Increase in oedema volume (mL)	% Protection	
Control	–	0.28 \pm 0.02	–	0.46 \pm 0.02	–	0.29 \pm 0.04	–	0.28 \pm 0.04
PBZ	100	0.13 \pm 0.01 ^c	53.57	0.21 \pm 0.01 ^c	54.34	0.11 \pm 0.01 ^c	62.06	0.16 \pm 0.02 ^c
NJE	150	0.21 \pm 0.02 ^b	25.00	0.36 \pm 0.03 ^a	21.37	0.20 \pm 0.02 ^a	31.03	0.26 \pm 0.02
NJE	300	0.17 \pm 0.01 ^c	39.28	0.29 \pm 0.02 ^c	36.95	0.16 \pm 0.03 ^b	44.82	0.27 \pm 0.03

Values are mean \pm SEM of 6 rats in each group.

a: $P < 0.05$, b: $P < 0.01$, c: $P < 0.001$ compared with control group.

3.1. Effect of NJE on carrageenin-induced hind paw oedema

The mean increase in paw oedema volume was about (0.86 \pm 0.11) mL in the vehicle-treated control rats. NJE (150 and 300 mg/kg, *p.o.*) significantly reduced the mean paw oedema volume at 3 h after carrageenin injection. NJE (150 and 300 mg/kg, *p.o.*) exhibited anti-inflammatory activity in a dose-dependent manner with the percent inhibition of paw oedema of 29.06 and 55.81 respectively, as compared with the control group. However, the standard drug, ASA (300 mg/kg, *p.o.*) showed highly significant ($P < 0.001$) anti-inflammatory activity with the percent inhibition of 69.76 (Table 1).

Table 1

Effect of NJE on carrageenin induced hind paw oedema and cotton pellet granuloma in rats.

Drug	Dose (mg/kg)	Carrageenin-induced paw oedema volume (mL)	% Protection	Weight of cotton Pellet granuloma (mg)	% Protection
Control	–	0.86 \pm 0.11	–	106.15 \pm 2.50	–
ASA	300	0.26 \pm 0.03 ^c	69.76	67.28 \pm 1.85 ^c	36.61
NJE	150	0.61 \pm 0.08 ^a	29.06	98.21 \pm 2.10 ^a	7.40
NJE	300	0.38 \pm 0.05 ^b	55.81	87.48 \pm 2.00 ^c	17.58

Values are mean \pm SEM of 6 rats in each group.

a: $P < 0.05$, b: $P < 0.01$, c: $P < 0.001$ compared with control group.

3.2. Effect of NJE on cotton pellet granuloma

The study of NJE on proliferative phase of inflammation indicated that NJE (150 and 300 mg/kg, *p.o.*) significantly ($P < 0.05$; $P < 0.001$) reduced the granuloma formation with inhibition of 7.4% and 17.58% as compared with ASA (300 mg/kg, *p.o.*), which showed significant ($P < 0.001$) inhibition on granuloma formation with the percent inhibition of 36.61 (Table 1).

3.3. Effect of NJE on autacoids-induced hind paw oedema

The mean increase in paw oedema volume produced at 3 h after injection of different autacoids, *viz.*, histamine, 5-HT, PGE2 and bradykinin was (0.28 \pm 0.02), (0.46 \pm 0.04), (0.29 \pm 0.04) and (0.28 \pm 0.04) mL, respectively. NJE (150 and 300 mg/kg, *p.o.*) significantly inhibited hind paw oedema induced by histamine (25%, $P < 0.01$ and 39.28%, $P < 0.001$), 5-HT (21.37%, $P < 0.05$ and 36.95%, $P < 0.001$) and PGE2 (31.03%, $P < 0.05$ and 44.82%, $P < 0.001$) respectively, but not that of bradykinin. However, PBZ (100 mg/kg, *p.o.*) significantly ($P < 0.001$) inhibited all autacoids including bradykinin induced hind paw oedema with 53.57, 54.34, 62.06 and 42.85 percent inhibition (Table 2).

3.4. Effect of NJE on formaldehyde-induced hind paw oedema

NJE (150 mg/kg, *p.o.*) significantly diminished the mean paw oedema volume at 1.5 h (13.88%) ($P<0.05$) and 24 h (5.43%) (non significant). The maximum inhibition of oedema volume produced by NJE (300 mg/kg, *p.o.*) was almost comparable to that of ASA (300 mg/kg, *p.o.*) (51.38% versus 55.55% at 1.5 h). Interestingly, the effect of NJE persisted up to a period of 24 h in contrast to ASA, the effect of which was significant only at 1.5 h (Table 3).

Table 3

Effect of NJE on formaldehyde induced hind paw oedema in rats.

Drug	Dose (mg/kg)	Formaldehyde induced hind paw oedema volume (mL)					
		1.5 h	% Protection	24 h	% Protection	48 h	% Protection
Control	–	0.72±0.04	–	0.92±0.07	–	0.51±0.06	–
ASA	300	0.32±0.02 ^c	55.55	0.54±0.03 ^c	41.30	0.49±0.05	3.92
NJE	150	0.62±0.03 ^a	13.88	0.87±0.06	5.43	0.48±0.04	5.80
NJE	300	0.35±0.04 ^c	51.38	0.71±0.05 ^a	22.82	0.47±0.03	7.80

Values are mean±SEM of 6 rats in each group.

a: $P<0.05$, b: $P<0.01$, c: $P<0.001$ compared with control group.

3.5. Effect of NJE on TNF- α , nitric oxide and PGE2

This inflammatory response was also accompanied by an increase in the levels of TNF- α (496.11%), nitric oxide (312.33%), and PGE2 (132.46%) were observed in the vehicle-treated group when compared with PBS. Pre-treatment of mice with NJE significantly suppressed the carrageenan-induced NO, PGE2 and TNF- α level in the vehicle-treated group when compared with PBS. NJE (150 mg/kg, *p.o.*) exhibited anti-inflammatory response in a dose-dependent manner with the percent inhibition of the level of TNF- α , NO and PGE2 as 13.15, 12.81 and 12.58 respectively. While the inhibition of percentage produced by NJE (300 mg/kg, *p.o.*) in TNF- α , NO and PGE2 as 41.89, 38.41 and 47.82 respectively. However, ASA (300 mg/kg, *p.o.*) significantly ($P<0.001$) inhibited TNF- α (66.57%), nitric oxide (81.4%) and PGE2 (61.69%). That means the ASA showed the maximum percentage inhibition as compared to vehicle treated group (Table 4).

Table 4

Effect of NJE on NO ($\mu\text{mol/L}$), PGE2 (pg/mL) and TNF- α (ng/mL) production in the SAP model.

Drug	Dose	NO ($\mu\text{mol/L}$)	PGE2 (pg/mL)	TNF- α (ng/mL)
Vehicle	–	67.21±2.40	89.71±3.40	79.82±2.38
PBS	100	16.30±0.81 [†]	38.59±1.80 [†]	3.39±0.98 [†]
NJE	150	58.60±2.10 ^b	78.42±2.60 ^b	69.32±2.20 ^b
NJE	300	41.39±2.00 ^c	46.81±2.20 ^c	46.38±2.60 ^c
ASA	300	12.51±0.96 ^c	34.37±2.10 ^c	26.68±2.10 ^c

Values are mean±SEM of 6 rats in each group.

[†]: $P<0.001$ compared with vehicle-treated mice with the PBS-treated group; a: $P<0.05$, b: $P<0.01$, c: $P<0.001$ compared with Vehicle treated group.

4. Discussion

The present study demonstrates the potent anti-inflammatory activity of the ethanolic extract of *N. jatamansi* rhizome in different models of inflammation, *i.e.*, acute exudative (carrageenin-induced rat paw

oedema), subacute (formaldehyde) and chronic proliferative inflammation (cotton pellet granuloma), there by indicating the possibility of developing *N. jatamansi* rhizome as the cheaper, safer and potent anti-inflammatory therapeutic agent. Carrageenan is the phlogistic agent of choice for testing anti-inflammatory drugs as it is not known to be antigenic and is devoid of apparent systemic effects[18]. The carrageenin induced paw oedema model in rats is known to be sensitive to cyclooxygenase inhibitors and has been used to evaluate the effect of non-steroidal anti-inflammatory agents[19]. The oedema and inflammation induced by carrageenin is shown to be mediated by histamine and 5-HT during first 1 h. After which increased vascular permeability is maintained by the release of kinins up to 2.3 h and from 2.3 to 6.0 h, the mediators appear to be prostaglandins, the release of which is closely associated with migration of leucocytes into the inflamed site[20]. It is well known that carrageenan induced paw oedema is characterized by biphasic event with involvement of different inflammatory mediators. In the first phase (during the first 2 h after carrageenan injection), chemical mediators such as histamine and serotonin play role, while in second phase (3–4 h after carrageenan injection) kinins and prostaglandins are involved[21].

Our results revealed that administration of ethanolic extract of *N. jatamansi* inhibited the oedema starting from the first hour and during all phases of inflammation, which is probably inhibition of different aspects and chemical mediators of inflammation. In autacoids induced inflammations, *N. jatamansi* produced significant inhibitory activity against histamine, 5-HT and PGE2 induced hind paw oedema in rats but failed to exhibit activity against bradykinin induced hind paw oedema. Administration of *N. jatamansi* at different doses level (150 and 300 mg/kg) attenuated the increased pedal volume against the phlogistic challenge. *N. jatamansi* caused a subsequent recovery towards normalization comparable to the PBZ group animals. Inflammation induced by formaldehyde is biphasic, an early neurogenic component is mediated by substance P and bradykinin followed by a tissue mediated response where histamine, 5-HT and bradykinin are known to be involved[22]. In the formaldehyde-induced inflammation, the *N. jatamansi* demonstrated significant anti-inflammatory activity that lasted up to 24 h in contrast to ASA, which was effective only at 1.5 h, suggesting its long duration of action. The cotton-pellet granuloma is widely used to evaluate the transudative and proliferative components of the chronic inflammation[23]. In order to assess its efficacy against proliferative phase of inflammation in which tissue degeneration and fibrosis occur, the widely used cotton pellet granuloma test was employed. During the repair process of inflammation, there is proliferation of macrophages, neutrophils, fibroblasts and multiplication of small blood vessels, which are the basic sources of forming a highly vascularised reddish mass, termed granulation tissue[24,25]. Though *N. jatamansi* (150 and 300 mg/kg, *p.o.*) significantly reduced the granuloma formation, the effect was of less intensity, when compared with ASA (300 mg/kg, *p.o.*). Macrophages are the first line of defence against microbial invaders and malignancies by nature of their

phagocytic, cytotoxic and intracellular killing capacities^[26]. Macrophage activation by lipopolysaccharide results in the release of several inflammatory mediators such as NO and the proinflammatory cytokines, TNF- α ^[27]. NO is a highly reactive molecule produced from guanidine nitrogen of NO synthase.

However, overproduction of NO can be harmful and may result in septic shock, neurologic disorders, rheumatoid arthritis, and autoimmune diseases^[28]. Therefore, inhibition of NO production is an important therapeutic target in the development of anti-inflammatory agents. In this study, we demonstrated that the ethanolic extract of *N. jatamansi* suppressed NO production and TNF- α secretion at higher doses, both of which are crucial in the inflammatory and healing mechanism and naturally occurring flavonoids, such as rutin and quercetin, have been reported to scavenge NO^[29]. It is well known that PGE2 is factors involved in many inflammatory processes^[30] and in pain induction and perception^[31]. PGE2 increases in parallel with tissue oedema, a condition which can be suppressed by NSAIDs (inhibitors of cyclooxygenase)^[32].

The increase in TNF levels in the SAP were accompanied by a corresponding increase in interferon. Significant increase in the level of TNF, a cytokine that plays an important role in acute phase reactions and immune response^[33], was observed. NJE also inhibited PGE2 and TNF production. As seen in this experiment, the ability of this extract to suppress inflammation when it is applied after the onset of inflammation is likely to be due to the genuine anti-inflammatory activity.

Conflict of interest statement

We declare that we have no conflict of interest.

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Comments

Background

The research into plants with alleged folkloric use as anti-inflammatory agents should therefore be viewed as a fruitful and logical research strategy in the search for new anti-inflammatory drugs. The inflammatory response involves a complex array of enzyme activation, mediator release, fluid extravasations, cell migration, tissue breakdown and repair which are aimed at host defense and usually activated in most disease condition. Currently much interest have been paid in the searching of medicinal plants with anti-

inflammatory activity which may lead to the discovery of new therapeutic agent that is not only used to suppress the inflammation but also used in diverse disease conditions where the inflammation response in amplifying the disease process. There is a growing interest in herbal remedies because of their effectiveness, minimal side effects in clinical experience and relatively low cost. Therefore, present study was designed to demonstrate the evaluation of anti-inflammatory potential of *N. jatamansi* rhizome in experimental rodents.

Research frontiers

The inflammation is the common health problems in the recent therapeutic scenario. Mostly the drugs from natural origin are widely used as an anti-inflammatory agent, which is caused by biological and chemical agent. While screening of ethanolic extract of *N. jatamansi* rhizome showing significant anti-inflammatory activity against acute, subacute and chronic induced inflammation.

Related reports

The objective of this study, to assess the anti-inflammatory activity of *N. jatamansi* rhizome against acute, subacute and chronic induced inflammation. NJE (150 and 300 mg/kg, *p.o.*) and the reference drugs phenylbutazone (PBZ: 100 mg/kg, *p.o.*) and ASA (300 mg/kg, *p.o.*) were evaluated using different models for inflammation. In subacute anti-inflammatory models using formaldehyde-induced hind paw oedema, in chronic anti-inflammatory model using cotton pellet granuloma. The folklore medicine has evidence of effectiveness of herbs in treating various types of inflammation.

Innovations and breakthroughs

N. jatamansi (commonly known as jatamansi), is a medicinal plant used in various Ayurvedic formulations. In the present study, authors have demonstrated the anti-inflammatory activity of *N. jatamansi* rhizome in experimental animals. From the results, it is clear that the NJE has shown dose dependent activity among which at the dose level of 300 mg/kg, *p.o.* shows greater activity which is comparable with the control and standard groups.

Applications

The treatment with NJE significantly prevents the drug induced inflammation. As seen in this experiment, the ability of this extract to suppress inflammation when it is applied after the onset of inflammation is likely to be due to the genuine anti-inflammatory activity. From the literature survey, it has been found that *N. jatamansi* is safe to humans. Thus, NJE is use for the treatment of inflammation.

Peer review

This is a valuable research work in which authors have demonstrated the anti-inflammatory potential of *N. jatamansi* rhizome in experimental rodents. The activity was assessed based on inflammatory mediators which are the prime sign of inflammation. NJE was found to be a promising an anti-inflammatory activity against acute, subacute and chronic model induced inflammation.

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