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Review Article

Ayurveda Section

Ustrakantaka (*Echinops echinatus Roxburgh*) from Folklore Field Practice to Therapeutics: A Narrative Review

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ABSTRACT

"*Ustrakantaka*," the botanical source of which is *Echinops echinatus Roxb.,* is a wild branched xerophytic herb. It has a long history of use in traditional medicine, primarily valued for its stimulant properties in addressing sexual dysfunction and debility. The roots *(mula)*, leaves *(patra)*, flower *(pushpa)* and bark *(twak)* are frequently employed in folklore and Ayurveda. This plant exhibits multifaceted therapeutic potential, addressing urinary, liver and gynaecological disorders while also demonstrating antimicrobial, analgesic, antioxidant and anti-inflammatory properties. The plant's pharmacological activities are rooted in its diverse phytochemical profile, featuring the flavonoid apigenin and apigenin-7-O-glucoside, the phenolic compound Echinacin and the alkaloid Echinopsine. The present literature review provides an in-depth examination of *Echinops echinatus*, synthesising contemporary research on its historical context, ethnomedical application, pharmacognosy, phytoconstituents, pharmacological action and biological activity of the plant.

Keywords: Ethnomedicine, Flavonoids, Gynaecological disorders

INTRODUCTION

Since the dawn of human civilisation, diseases, disability and death have co-existed with life, as has the quest for positive health, happiness and longevity. With the gradual illumination of human intellect, materials that are safe and can be easily procured from natural surroundings have become a popular source of medicine for longstanding, emerging and reemerging infectious and non infectious diseases. Since then, *Audhbhidadravya* (drugs of vegetable origin) and their phytoconstituents have been the mainstay of the traditional systems of medicines [1]. According to data published recently in the World Health Organisation (WHO) health bulletin, traditional medicines are the mainstay of primary healthcare delivery and their demand is increasing throughout the world, especially in rural populations [2].

The global resurgence of interest in herbal products entails multidisciplinary scientific research activities not only on known but also on many lesser-known medicinal plants. One such obscure medicinal plant with multifaceted health benefits is *Ustrakantaka*, the botanical source of which is *Echinops echinatus Roxb*. Echinops originated from the Greek word "echinos," which signifies a hedgehog or sea urchin; both are spiny animals and the word "echinatus" means prickly. Thus, the name of the plant signifies its thorny appearance of the plant. It is an annual xerophytic herb [3]. It has been mentioned in Ayurvedic literature In *jwara chikitsa, ashmari chikitsa, masurika chikitsa*, etc. It has a bitter and pungent taste (*katu-tikta rasa*), a pungent post-digestion effect (*katuvipaka*), is hot in potency (*ushnavirya*) and alleviates deranged *vata-kaphadosha* [4].

Anti-inflammatory, antioxidant, reproductive health tonic, antidiabetic, hepatoprotective and analgesic are some of the pharmacological properties exhibited by the plant [5]. Echinacin, apigenin-7-O-glucoside, Echinaticin, Echinopsine, taraxasterol acetate and lupeol are the most important documented phytoconstituents present in it [6]. It is also a popular folklore dravya used by local *vaidyas*, *Siddha* practitioners, tribal people and traditional healers. In India, it is commonly used as a sexual stimulant, both orally and topically and is also practiced for impotence, hoarse cough, dyspepsia, hysteria, syphilis, scrofula, ophthalmia, chronic fever and inflamed and painful joints [7].

The age-old medicinal wealth and traditional knowledge are steadily depleting, so it's high time to explore lesser-known, easily available, cost-effective, potent ethnomedicinal plants with practical utility in place of rare, endangered and threatened drugs. The present review offers insight into the nomenclature, classical literature, botanical identity, distribution, ethnomedicinal significance, pharmacological activities and therapeutic uses of this plant.

DISCUSSION

Classical Ayurvedic literature, such as the *Charak Samhita*, *Sushrut Samhita*, *Nighantus*, *Ayurvedic* Pharmacopeia of India and The Reviews on Indian Medicinal Plants, as well as databases including Google Scholar, the National Action for Mechanised Sanitation Ecosystem (NAMASTE) portal, PubMed, Science Direct, Scopus, Web of Science, the AYUSHDHARA portal and the Cochrane Library, were searched for data collection. The keywords used for the database search include "*Echinops echinatus* or/and pharmacognosy," "*Echinops echinatus*," "echinops," "*Ustrakantaka*," "*Usnakantak*,""*Brahmadandi*,""*Utkanto*,""Folklore,""ethnomedicinal use," "phytochemical," and "globe thistle." A manual search of authentic databases was performed to broaden the search spectrum of the study.

1. **Vernacular names:** The plant is well known as Indian Globe Thistle or Camel's Thistle in English and as *Utakatira*, *Untakanta*, *Oontkatara* and *Brahmdandi* in Hindi. *Kadechubak*, *Batresh* and *Shuliyo* are its prevalent names in Maharashtra, Odisha and Gujarat [8].

a **Synonyms and nomenclature:** The word *Ustrakantaka* signifies that camels eat this spinous herb. In classical texts of Ayurveda, *Ustrakantaka* is referred to by many synonyms, such as *Uttakantak*, *Uttkanta* (herb with abundant thorns), *Rakta*, *Raktapushpi* and *Lohitpushpi* (plants bearing red-coloured flowers), *Varnapushpi* (plants having coloured flowers), *Kantakphal* (fruits bearing thorns), *Kantalu* (plants with many thorns/bristles), *Karmadan* (it pierces the hands when touched), *Tikshnagra* (the branches have sharp ends) and *Vrittaguccha* (signifies the discoid shape of clustered flowers) [9].

b **Geographical distribution:** *Echinops* is mainly available in Afghanistan, Africa, Southeast Asia and the Mediterranean region of the world. In India, it grows extensively in Maharashtra, Gujarat, Rajasthan, Odisha, Karnataka and other dry regions of Andhra Pradesh, up to an altitude of 5,000 feet [10].

c **Morphology:** It is a xerophytic branched herb reaching a height of 30-60 cm. The branches are covered with white cottony pubescence. Leaves are arranged alternately, non petiolate, oblong to lanceolate, extensively pinnatifid, 8-12 cm long, spinescent, pale above and pubescent beneath. The margin is sinuate, pointed and spinous, with spines about 2 cm long. Flowers are borne at the terminal ends of branches as solitary florets united together into compound globose heads. The heads are purplish-white, compact, with a diameter of 2-3 cm, attached to a stout peduncle, bracteate and spinescent. Involucres bear sharp spines, resemble yellow-coloured pappus hairs and form cylindrical brush-like structures over the achene. Outer involucre bracts are glabrous and oblanceolate, with intermediate bracts (1 or 2) turning into sharp spines of about 2.5 cm. The innermost bracts (5-8) are connate into a tube for more than half of their length. Free segments are acute–obtuse, ciliate, with a laciniate apex and have scarious margins. The anthers are tailed and fimbriated. Fruit cypselae have a short brush-like pappus over them. Achenes are about 4 mm long, densely villous and obconic. The roots are cylindrical, brown-coloured, tough, rough and tortuous [Table/Fig-1,2] [11].

[Table/Fig-1]: Green plant of *Ustrakantaka*.

[Table/Fig-2]: Plant and flower of *Ustrakantaka* in dried state.

2 **Review in ayurveda:** *Ustrakantaka* has been mentioned in the *Charak Samhita* as a component of *Chandanadi taila in Jwara chikitsa* [12]. In the *Sushrut Samhita*, it is prescribed for the treatment of *Ashmari* (calculus) [13]. The plant is well described in Ayurvedic lexicons, such as in the *Karviryadi varga* of *Raj Nighantu*, the *Lakshmanadi varga* of *Shodhal Nighantu* and the *Sahadevyadi varga* of *Nighantu Adarsha* [9,14,15]. *Chakradutta* advised using the plant for *Masurika* (pustular eruptions) and Lingsthamban (erectile dysfunction) [16].

a **Rasapanchaka (Ayurvedic pharmacodynamic principles):** *Ustrakantaka* has *Laghu-Ruksha guna*, *Tikta-Katu rasa*, *Ushna virya*, *Katu vipaka* and is predominantly *Kapha-Vata shamak*. The seeds possess *Guru* and *Sheet Guna*, *Madhur Rasa*, *Madhur vipaka* and *Sheet Virya* (cold potency).

b **Action and indications:** Classical lexicons, including *Rajnighantu*, *Shodhal Nighantu*, *Nighantu Ratnakar* and *Nighantu Adarsha*, have articulated the properties and uses of *Ustrakantaka* [13,14,16,17]. The plant is recommended to be prescribed for *Aruchi* (anorexia), *Hridyaroga* (heart ailments), *Prameha* (diabetes), *Mutrakricchta* (dysuria), *Trishna* (thirst), *Bandhyatva* (infertility), *Kasa* (cough), *Dourbalya* (generalised weakness), *Vishphotaka* (boils), *Prasav* (labour pain), *Mukhadantaroga* (oral cavity disorders), *Netraroga* (eye diseases) and *Yoshapasmar* (hysteria). It is *Deepana* (digestive), *Ruchya* (taste enhancer), *Mutral* (diuretic), *Poustika* (nutrient), *Vrishya* (aphrodisiac), *Ropana* (wound healer), *Shigraprasavkarak* (facilitates delivery), *Kasaghna* (antitussive), *Cakshushya* (improves vision), *Jantughna* (antihelmintic), *Raktashodhaka* (blood purifier) and *Hridyarogahara* (pacifies cardiac ailments) in karma.

3 **Ethnomedicinal and therapeutic relevance:** *Ustrakantaka* is widely practiced as a medicinal herb among ethnic groups, tribal communities, local vaidyas and traditional practitioners throughout India. Tribal communities use its leaves, root bark, flowers, seeds and aerial parts in the form of powder, juice, paste, ash, decoction and infusion for various systemic illnesses. The ethnomedicinal uses of *Ustrakantaka* are summarised in [Table/Fig-3] [18-36].

S. No.	Disease	Locality/System of medicine	Methodology of prescribed uses
1.	Sexual disability [18]	Traditional healers of Chhattisgarh	Local application of root bark paste prior to intercourse.
2.	Labour pain and to facilitate delivery [19,20]	Traditional healers of Chhattisgarh	Oral intake and application of root paste on lower abdomen
		Tribes residing in south Rajasthan	Root kept under scalp hairs of pregnant women
3.	Roundworms [21]	Tribal peoples of southern Rajasthan	Powdered leaf or root extract consumed with honey
4.	Leucorrhoea [22]	Tribes residing in south Rajasthan	Oral intake of whole plant ash with ghee.
5.	Diabetes [23,24]	Tribal peoples of Gujarat	Suspension of root bark is consumed with milk
		Tribes of Kerala	Decoction of entire plant or leaves.
6.	Skin disease [24,25]	Tribal peoples of satpura hill range	Local application of inflorescence spines with cow ghee in Eczema
		People of Kerala	Local application of leaves paste on skin papules.
7.	Febrifuge [26]	Gond tribe of Bhandara Maharashtra	Oral intake of whole plant decoction
8.	Respiratory problems [18,27]	Tribals of Chhattisgarh	Inhalation of leaves and roots fumes in Asthma
		Gond tribe of Bhandara Maharashtra	Oral intake of root extract in whooping cough
9.	Heatstroke [28]	Tribes residing in south Rajasthan	Whole plant paste applied on sole and palm
10.	Liver disease, renal colic [29,30]	Indigenous peoples of Cholistan desert and Gond tribe of Bhandara Maharashtra	Use root/whole plant decoction
11.	Scorpion sting [31]	People in Ahmednagar Maharashtra	Oral intake of raw roots
12.	Hair Lice [32]		Powdered root mixed with babul gum is applied on root hairs
13.	Gastrointestinal, circulatory, respiratory, nervous and cardiovascular disorders [33]	Indigenous Pashto tribe of Pakistan	Decoction of whole plant is consumed orally
12.	Polyurea [34]	People in Nara region of Pakistan	Root decoction for oral consumption
13.	Diarrhoea [35]	Tribal of Orissa	Whole plant
14.	Fever, joint pain haemorrhoids and worm infestation [36]	Ethiopian traditional medicine	Varied plant parts

[Table/Fig-3]: Popular ethnomedicinal uses of *Ustrakantaka* in traditional practice [18-36].

a **Chemical constituents:** Preliminary phytochemical studies conducted on the plant extracts revealed that flavonoids, alkaloids, glucosides, glycosides, phenolic compounds, saponins, triterpenoids and sterols are the major phytoconstituents present in the aerial parts, seeds, roots, flowers and whole plant of *Ustrakantaka*. The details have been collected from various databases such as PubChem, Indian Medicinal Plants, Phytochemistry And Therapeutics (IMPPAT) and research articles and are summarised in [Table/Fig-4] [37-43].

S. No.	Chemical compound	Class of compound	Plant part
1.	Echinopsine	Alkaloid	AP, seed, FL, WP
2.	Echinozolinone (3-(2-Hydroxyethyl)quinazolin-4-one)	Alkaloid	AP, WP
3.	7-hydroxyechinozolinone	Alkaloid	FL
4.	Echinopsidine	Alkaloid	AP, WP
5.	Taraxasterol acetate, Taraxasterol	Triterpenoid	AP, WP
6.	Apigenin	Flavonoid	AP , FL, St
7.	Apigenin 7-O-glucoside	Flavonoid glycoside	AP FL,
8.	Echinacin	Phenolic compound	WP, AP
9.	Echinatin (4,4'-dihydroxy-2'-methoxy-chalcone)	Flavanoid	WP
10.	α, β, δ-amyrin acetate	Triterpenoid	FL, St
11.	Quercetin, dihydroquercetin-4'-methyl ether	Flavanoid	FL, leaves
12.	Luteolin	Flavanoid	FL
13.	Luteolin-7-glucoside	Flavonoid glycosides	FL
14	Allophanic acid and Ω methyl allophanic acid	Aminoacid and peptide	Root
15.	Lupeol and lupeol acetate	Triterpenoid	FL, St,
16.	7-Hydroxyisoflavone	Isoflavone glycoside	WP
17.	Echinoside	Isoflavone glycoside	WP
18.	1-Hentriacontanol/hentriacontane	Fatty acid/fatty alcohol	FL, WP
19.	Palmitic acid (hexadecanoic acid)	Unsaturated fatty acid	FL, WP
20.	Ethyl palmitate (ethyl hexadecanoate)	Fatty acid ester	St
21.	Betulinic acid	Triterpenoid	FL, St, WP
22.	β-amyrin	Triterpenoid	FL
23.	β-sitosterol	Steroid	FL, St
24.	Daucosterol (β-sitosterol glucosides)	Steroid	WP
25.	β-sitosterol acetate	Stigmastane steroids	St, WP
26.	Echinaticinglucopyranoside	Flavonoid	WP, AP
27.	Kaempferol (3,4',5,7-tetrahydroxyflavone)	Flavonoid	WP

[Table/Fig-4]: Major phytoconstituents present in various parts of *Ustrakantaka* [37-43].
*AP: Aerial part; **WP: Whole plant; ***FL: Flower; St: Stem

4. Research studies conducted:

a) **Pharmacognostical studies-** Few studies have been reported so far that feature the pharmacognostical aspects of *Ustrakantaka*. Organoleptic characteristics, gross macroscopy and microscopic characterisation of the root, stem and leaves were conducted [44,45]. A pharmacognostic evaluation of the root revealed one to three layered cork cells with irregularly shaped parenchyma, a 20-30 layered parenchymatous cortex, a single-layered endodermis and pericycle. The vascular bundles are open, endarch and divided by medullary rays [46]. The transverse section of the stem showed the presence of the outermost epidermal layer surrounded by a thick cuticle and uniseriate multicellular trichomes. The cortex is heterogeneous with collenchymatous and parenchymatous cells, a single-layered endodermis, endarch vascular bundles and pith cells containing spheraphides [47]. The transverse section of the leaves comprises a single-layered epidermis covered with cuticle and trichomes, a two-layered mesophyll differentiated into palisade and spongy parenchyma and a 3-5 ridged midrib containing endarch vascular bundles [48].

b) **In-vitro, In-vivo pharmacological studies-** The plant has been studied for its anti-inflammatory, antidiabetic, antifertility, antimicrobial, antioxidant, diuretic, analgesic, hepatoprotective and antiulcer activities, as enumerated in [Table/Fig-5] [49-63].

c) **Toxicity studies-** Acute oral toxicity studies of *Ustrakantaka* root and whole plant extracts were conducted in rats and mice. The studies revealed that its extracts are non toxic in nature and do not reflect behavioral changes or mortality, even up to doses of 2000 and 3000 mg/kg body weight [49,50,57,64].

Ustrakantaka offers a wide array of medicinal properties, which are substantiated by its diverse therapeutic uses in traditional practices by various ethnic groups. The data reviewed herein show that *Ustrakantaka* plays a vital role in treating disorders of deranged *Kapha* and *Vata dosha*, such as kasa, *hridyaroga*, *prameha*, *prasav*, *vrana-apachi*, *mukha-danta-netraroga*, *agnimandhya*, *trishna*, *mutrakrichta*, *jwar* and *klaibyata*. According to the Ayurvedic pharmacodynamic principle, *Ustrakantaka* pacifies *Vata dosha* due to its *Ushna virya and Kapha dosha due to its ruksha guna, katu vipaka and ushna virya*, thus alleviating *Vata* and *Kapha* disorders. Furthermore, its seeds have immense medicinal importance in impotency and seminal debility due to their *vrishya* and *shukrala* properties.

However, while the plant has been referenced in classical Ayurvedic and Unani literature for a long time, it remains largely unexplored in the scientific domain. Although some of its ascribed uses in Ayurvedic classics have been scientifically validated through pharmacological studies conducted so far, confirmatory research trials are still required to validate these claims in preclinical and clinical settings. Limited data is available concerning the molecular mechanism of action, analytical and pharmacokinetic studies, as well as the acute and chronic toxicity profiles of the various useful parts of the drug, highlighting the need for rigorous research trials.

S. No.	Pharmacological activity	Study design and model used	Form/type of drug	Results
1.	Anti-inflammatory [49]	In-vivo Carrageenin and formaldehyde induce paw oedema and adjuvant induced acute and chronic arthritis in albino rats Groups 6: Control, standard drug Phenylbutazone 50 mg per kg ip, Ether Extract (EE) 4 groups in oral dose of 25, 50, 100, 200 mg per kg	Ethanol extract of complete plant	In all models, the EE exhibited promising anti-inflammatory effects. Ip administration of EE in higher dose (200 mg/kg) shows better activity.
2.	Antidiabetic and Antidyslipidemic [50]	In-vivo Alloxon induced (type 1) and fructose fed insulin resistance (type 2) model Glucose-induced hyperglycaemia Animal used- Swiss albino mice and Sprague Dawley albino rats Groups 6 : G1- Control (normal Saline 1 mL/kg) G 2: Positive Control (Alloxan 140 mg/kg+Normal Saline 1 mL/kg) Group 3: Standard Control (Alloxan+Glibenclamide 10 mg/kg) Group 4, 5, 6 : Alloxan+EE extract in dose of 100 mg/kg, 200 mg/kg, 500 mg/kg	Aqueous and methanolic root extract	The extract-treated groups demonstrated a dose-dependent reduction in serum total cholesterol, triglycerides, LDL and enhanced HDL. EE extract in 500 mg/kg showed significant potency in comparison to Glibenclamide.

3.	Antifertility [51,52]	In-vivo Male wistar albino rats Duration of study 8 days Groups- 3 1. Control 2. EE 30 mg/kg bwt 3. EE 60 mg/kg bwt	Root (Terpenoid fraction of petroleum ether extract)	Serum testosterone and sperm count (epididymal) showed significant reduction in the EE treated group. Testicular histology revealed inhibitory effects on spermatogenesis and seminiferous epithelium development.
4.	Antifertility [53]	In-vivo 20 spraguedaweley male albino rats Duration of study 60 Days Groups 4: Normal control and 3 Ethanol (EtOH) root extract treated group Oral dose: 50, 100, 200 mg/kg b.w. once daily	Ethanolic root extract	Drug treated group significantly reduce the weight of the reproductive organs, motility anddensity of sperm.
5.	Antimicrobial [54]	In-vitro Bacteria strain used- *Escherichia coli, Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klebsiella pneumoniae*	Methanolic extract of root, stem, leaves, flowers	Stem extract doesn't exhibit activity against all bacterial strains. Leaves showed maximum inhibition zone against Klebsiella, flowers against *S. aureus* and root against *E. coli*, *S. aureus*, *Pseudomonas*.
6.	Antifungal [55]	In-vitro Fungal strain used- *A. tenuissima*	Phenolic compounds extracted from the entire plant: echinacin, echinaticin, apigenin and apigenin -7-O-glucoside	All the 4 phenolic compounds show anti-fungal activity against the *A. tenuissima* and at 150 µg mL-1 concentration, echinacin is highly effective.
7.	Diuretic [56]	In-vivo Lipschitz test model 36 Albino rats either sex 6 groups, 6 animal each G1 control, G2 furosemide 20 mg/kgorally, G3 and G4 MetR extract in oral dose of 250, 500 mg/kg, G5 and G6 Aerial part methanolic extract 250, 500 mg/kg orally	Methanolic extract (root and aerial part)	In comparison to the control, the methanolic extracts of both groups shows considerable enhancement in volume of urine and electrolyte output in both dosage form.
8.	Benign prostatic hyperplasia [57]	An in-vitro study in which 5 alpha reductase inhibitory potential of the extracts were assessed by measuring concentration of testosterone	Petroleum ether root extract, Ethanolic extract, Butanolic fraction, acetone soluble and insoluble fraction, water insoluble and soluble fraction	Out of all the extract, the butanolic fraction of the ethanolic extract shows significant inhibition of 5 alpha reductase activity.
9.	Antioxidant [58]	In-vitro 3 models used: Superoxide anion scavenging, 2,2-diphenyl 1-picrylhydrazyl (DPPH) free radical scavenging, reducing power Groups 4: Control, standard drug Metformin HCl- 250 mg/kg, Methanolic root extract in dose of 100 mL/kg and 200 mL/kg	Methanolic extract of root powder	Methanolic root extract in higher dose exhibit significant antioxidant activity in all the 3 models.
10.	Anti-irritant [59]	In-vivo 8 Male albino rabbits Irritant dermatitis was induced by rubbing the ear with sand paper Dose of extract used: 100 µg/10 mL and 200 µg/10 mL	Methanol (ME), Petroleum Ether (PE), Chloroform Extract (CE) of aerial part	Chloroform extract showed marked wound healing and anti irritant activity. ME showed weak response while PE didn't showed significant anti irritant activity.
11.	Analgesic activity [60]	In-vivo Wistar albino rats Hot plate, tail immersion and tail flick model Groups 6 G1: Control, G2: Positive control Pentazocine 30 mg/kg, G3 and G4: Methanolic root extract in 250 and 500 mg/kg, G5 and G6: Methanolic aerial parts extract in 250 and 500 mg/kg	Methanolic extract (aerial parts and roots)	According to the study, there is a noticeable increase in reaction time when methanolic extracts at 250 mg/kg and 500 mg/kg body weight are compared to the control.
12.	Free radical scavenging [61]	In-vitro DPPH free radical, superoxide anion radical andnitric oxide radical	Ethanolic Extract Roots (ERE)	Ethanolic extract shows remarkable free radical scavenging activity in all three models.
13.	Hepatoprotective [62]	In-vivo 30 Rabbits CCL4 induced hepatotoxicity Study duration 7 days 3 groups Silymarin 100 mg/kg/day and 2 groups of ethanolic extract in oral dose of 500 and 750 mg/kg once daily	Ethanolic extractaerial parts	The ethanolic extract in both the doses produces significant histological hepatoprotective changes in comparison to normal control and standard drug Silymarin.
14.	Antiulcer activity [63]	In-vivo Wistar rats Study duration: 7 days Models: Acetic acid induced ulcers and Methylene Blue (MB) induced ulcers Groups 4- G1 control, G2 Omeprazole 20 mg/kg, G3 and G4 MB+EE in dose of 200 and 400 mg/kg	Ethanolic Extract (EE) wholeplant	At 400 mg/kg, the EE of the whole plant inhibits stomach ulcers, acid concentration, gastric volume and enhances pH levels.

[Table/Fig-5]: Reported pharmacological activities of *Ustrakantaka* [49-63].

CONCLUSION(S)

Ustrakantaka has been a pivotal traditional medicine, particularly in rural areas, where it is used in the treatment of common ailments such as hoarse cough, dysuria, seminal debility, dyspepsia, hysteria, difficult labour, inflammatory diseases, wounds, scrofula, joint pain, fever and as a nervine tonic. The plant is relatively safe, potent, easily accessible and affordable to stakeholders. Thus, initiatives to bring this unexplored plant into mainstream practice, supported by evidence-based research, are the need of the hour.

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