**Sphaeranthus indicus** Linn.: A phytopharmacological review

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**ABSTRACT**

*Sphaeranthus indicus* Linn. (Asteraceae) is widely used in Ayurvedic system of medicine to treat vitiated conditions of epilepsy, mental illness, hemicrania, jaundice, hepatopathy, diabetes, leprosy, fever, pectoralgia, cough, gastropathy, hema, hemorrhoids, helminthiasis, dyspepsia and skin diseases. There are reports providing scientific evidences for hypotensive, anxiolytic, neuroleptic, hypolipidemic, immunomodulatory, antioxidant, anti-inflammatory, bronchodilatory, antihyperglycemic and hepatoprotective activities of this plant. A wide range of phytochemical constituents have been isolated from this plant including sesquiterpene lactones, eudesmenolides, flavonoids and essential oil. A comprehensive account of the morphology, phytochemical constituents, ethnobotanical uses and pharmacological activities reported are included in this review for exploring the immense medicinal potential of this plant.

**Key words:** *Sphaeranthus indicus* Linn., asteraceae, eudesmenolides, psychotropic activity

**INTRODUCTION**

Herbal medicines have been used by the mankind since time immemorial. *Ayurveda*, the oldest traditional system of India, reveals that ancient Indians had a rich knowledge of medicinal value of different plants. India has been endowed with a very rich flora owing to the extreme variations in climate and geographical conditions prevalent in the country. With the advent in science, many of the crude drugs used in traditional system have been investigated scientifically. *Sphaeranthus indicus* Linn. is a medicinal plant widely used in Indian traditional system of medicine for curing various ailments.[1] It grows in rice fields, dry waste places and cultivated lands in tropical parts of India. It is distributed throughout India, Sri Lanka, Africa and Australia from sea level to 1200 m altitude.[3] Synonyms of *S. indicus* Linn. are *Sphaeranthus hirtus* Willd. and *Sphaeranthus mollis* Roxb.

**Taxonomic Classification**

- Kingdom: *Plantae*
- Subkingdom: *Viridaeplantae*
- Phylum: *Tracheophyta*
- Subphylum: *Euphyllophytina*
- Infraphylum: *Radiatopses*
- Class: *Magnoliopsida*
- Subclass: *Asteridae*
- Superorder: *Asteranae*
- Order: *Asterales*
- Family: *Asteraceae*
- Genus: *Sphaeranthus*
- Species: *indicus*

**Vernacular Names**

In different parts of India *S. indicus* is known by different names.[1]

- Sanskrit: Mahamundi, shravani, tapasvini, mundi, hapus
- Hindi: Gorakhmundi, mundi
- Bengali: Chagulnadi, ghorkmundi
- Marathi: Barasavodi, gorakhmundi
- Gujarati: Bodikalara, mundi, dorakhmundi
Morphology

The herb *S. indicus* is much branched, strongly scented, and annual erect with branched tapering roots tap roots.[3] Stems are cylindrical with toothed wings. Leaves are sessile, decurrent, 2–7 cm long, 1–1.5 cm wide, obovate-oblong, rounded or subacute, glandular-hairy, spinous-serrate or dentate, narrowed at the base and greenish-brown in color. Flowers are borne in terminal, solitary, globose, clusters of heads. Heads of flowers are purple, bracts are short slender and acuminate. In each head, the outer flowers are females, few or many, fertile, the central flowers bisexual, fertile or sterile, involucre narrow, bracts paleaceous, spathulate, acute, ciliate; receptacle small, naked. Corolla of female flowers are purple, slender, tubular, minutely two to three toothed; corolla of hermaphrodite flowers are purplish white, tubular or funnel-shaped, four to five toothed, anther-base sagittate, auricles acute or tailed, style-armed, filiform, sometimes connate. Fruits are oblong and have compressed achenes in which pappus is absent. Odor of herb is slightly aromatic but disappears on long storage.

Microscopic Characters

Leaf

The leaf is dorsiventral and shows abundant trichomes of varying types on both the epidermis. Simple trichomes are three to four celled, thick walled and measure 130.8–145.2 μm in length and 29.0–43.5 μm in width. Trichomes are straight/knee shaped, with a swollen base and with collapsed cell at the middle or at the apex. Midrib shows three to four collateral vascular bundles associated with a group of sclerenchymatous cells on either side.[3]

Stem

The stem shows cork with two to three layers of parenchymatous cells covered with papillose cuticle having trichomes and can be distinguished by the presence of a discontinuous ring of lignified pericyclic fibers and a well-developed ring of bicollateral vascular bundle surrounding the pith. Medullary rays are pitted, lignified and about unitetrameriate.

Root

The root shows on its outer side metaderm, a typical brown colored tissue. It consists of suberized cells, arranged irregularly and forms a protective layer. Radial groups of pericyclic fibers and few stone cells are seen alternating with radially arranged secretory canals in the secondary cortex. Phloem is parenchymatous and radially arranged. Medullary rays are pitted, lignified and about two to five seriate.

Parts used

Whole plant, seeds, flowers and roots.

Ayurvedic preparations

Mundi churana, mundi panchang swarasa, mundi kavatha.[4]

Phytochemistry

A sesquiterpene lactone, 7-hydroxyeudesm-4-en-6,12-olide, and a sesquiterpene acid, 2-hydroxycostic acid, along with the known compounds, β-eudesmol and ilicic acid, have been isolated from the acetone extract of *S. indicus*.[5] Three 7-hydroxyeudesmanolides and two sesquiterpenoids, cryptomeridiol and 4-epicycromeridiol, have been isolated from this plant.[6] Eudesmanoids such as 11α,13-dihydro-3α,7α-dihydroxy-4,5-epoxy-6β,7-eudesmanolide, 11α,13-dihydro-7α-acetoxy-3β-hydroxy-6β,7-eudesm-4-enolide and 3-keto-β-eudesmol have been isolated from *S. indicus*.[7] A bicyclic sesquiterpene lactone has been isolated from petroleum ether extract of aerial parts of *S. indicus*.[8] Some other sesquiterpene lactones have also been reported to have been isolated from this plant.[9] Isolation and characterization of sterol glycoside, the β-d-glucoside of (24S)-24-ethylcholesta-4,22-dien-3-β-ol, has also been reported.[10] A flavanoid C-glycoside, namely, 5-hydroxy-7-methoxy-6-C-glycosylflavone has been isolated from the aerial part of *S. indicus*. The plant is reported to contain deep cherry colored essential oil having methyl chavicol, d-cadinene, α-ionone, p-methoxycinnamaldehyde, α-terpinene, citral, geraniol, geranyl acetate, β-ionone, ocsimene, eugenol, sphaeranthene, sphaeranthol, estragole, Indicusene[12,13] and alkaloid sphaeranthine.[14] Carbohydrates like arabinose, Carbohydrates such as arabinose, galactose, glucose, fructose, lactose, maltose, raffinose and rhamnose have been reported from leaves of *S. indicus*.[15] A novel isoflavone glycoside, 5,4′-dimethoxy-3′-prenylbiochanin 7-O-β-d-galactoside, has also been isolated from leaves.[16] Eudesmenolide type of sesquiterpene glycoside, sphaeranthanolide, with immunostimulant potential has been isolated from the flowers of *S. indicus*. A novel isoflavone glycoside, 5,4′-dimethoxy-3′-prenylbiochanin 7-O-β-d-galactoside, has also been isolated from leaves. Eudesmenolide type of sesquiterpene glycoside, sphaeranthanolide, with immunostimulant potential has been isolated from the flowers of *S. indicus*. Eudesmenolides such as frullanolide, 11-alpha-13-dihydro: 3, alpha-7-alpha-dihydroxy: frullanolide, 11-alpha-13-dihydro[18] and two sphaeranthus peptide alkaloids have been isolated from flowers.[19] The alcoholic extract of powdered caputula contains stigmasterol and β-sitosterol.[20] A flavone glycoside, 7-hydroxy-3′,4′,5,6-tetramethoxy-flavone 7-O-β-d-(1-4)-diglucoside, has been isolated from the stem of *S. indicus*[21] [Figures 1–4].

Galani, et al.: Sphaeranthus indicus Linn.

• Telugu: Boddatarupa, boddasoram
• Tamil: Kottakaranthai
• Urdu: Kamdaryus
• Malayalam: Adakkamanian, attakkamanni, mirangani
• Santal: Belaunjia
• Undari: Mundi
• Riya: Murisa, bokashungi
• Panjabi: Ghundi, khammadrus, mundibuti
• English: East Indian globe thistle
Galani, et al.: Sphaeranthus indicus Linn.

**ETHNOBOTONICAL CLAIMS**

All the parts of the *S. indicus* have medicinal uses. In *Ayurvedic* system of medicine, the whole herb is used in insanity, tuberculous glands, indigestion, bronchitis, spleen diseases, elephantiasis, anaemia, pain in the uterus and vagina, piles, biliousness, epileptic convulsions, asthma, leukoderma, dysentery, vomiting, urinary discharges, pain in the rectum, looseness of the breasts, hemicrania.[1] The whole herb is used in *Ayurvedic* preparations to treat epilepsy and mental disorders. Leaves dried in the shade and powdered are used in doses of 20 grains twice a day in chronic skin diseases as an antisyphilitic and a nerve tonic.[22-24] Hot water extract of the herb is used as an anethmimetic, as a diuretic, as a fish poison[25,26] and as an aphrodisiac.[27] Flowers are tonic, cooling, alterative and used in conjunctivitis[28] and give strength to weak eyes.[24] The oil prepared using the plant root is reportedly useful in treating scrofula and as an aphrodisiac. The external application of a paste of this herb is beneficial in treating pruritus and edema, arthritis, filariasis, gout and cervical adenopathy.[28] Pulverized seeds have antimicrobial property. It is also stuffed into holes of crabs to kill them. Aqueous extract is poisonous to American cockroaches.[29] In unani, the herb is used as a tonic, laxative, emmenagogue, and also it increases the appetite, enriches the blood, lessens inflammation, cools the brain and gives luster to the eye, is good for sore eyes, jaundice, scaling of urine, gleet, biliousness, boils, scabies, ringworm in the waist, diseases of the chest. The plant is traditionally used for diarrhoea.[30] The entire plant is used as an emmenagogue.[31] Hot water extract of the entire plant is used for glandular swelling of the neck and for jaundice.[32]

**PHARMACOLOGICAL ACTIVITY**

**Anxiolytic activity**

Petroleum ether, alcohol and water extracts (10, 30 and 100 mg/kg, p.o.) from the flowers of *S. indicus* were evaluated for
anxiolytic activity, using elevated plus maze, open field test and foot-shock induced aggression test. Petroleum ether extract (10 mg/kg), alcoholic extract (10 mg/kg) and water extract (30 mg/kg) of *S. indicus* flowers produced prominent anxiolytic activity in mice. The study showed an increase in the time spent, percent entries and total entries in the open arm of the elevated plus maze; increased ambulation, activity at center and total locomotion in the open field test and decreased fighting bouts in the foot-shock induced aggression test suggesting anxiolytic activity. Another study also reported the anxiolytic activity of hydroalcoholic extract of whole herb of *S. indicus* (100 mg/kg, p.o.) in the elevated plus maze test and open field test.[34]

Neuroleptic activity
Neuroleptic activity of petroleum ether, alcohol and water extracts of flowers of *S. indicus* (30, 100 and 300 mg/kg, i.p.) were evaluated using apomorphine induced cage climbing and catalepsy in mice model. Only the petroleum ether extract (300 mg/kg, i.p.) reduced total time spent in apomorphine induced cage climbing. Aqueous (300 mg/kg, i.p.) and alcoholic (300 mg/kg, i.p.) extracts showed catalepsy while petroleum ether extract was devoid of it.[35] Neuroleptic activity of hydroalcoholic extract of whole plant of *S. indicus* has also been reported. Hydroalcoholic extract of whole herb of *S. indicus* (100, 200 and 500 mg/kg, p.o.) produced catalepsy, potentiated haloperidol-induced catalepsy and antagonized apomorphine-induced stereotypy.[36]

Sedative effect
The sedative potential of hydroalcoholic extract of whole herb of *S. indicus* (100, 200 and 500 mg/kg, p.o.) has been reported using experiments in which it reduced locomotor activity of mice, exploratory activity and potentiated pentobarbital induced sleep in mice.[36]

Immunomodulatory activity
The immunomodulatory activity of *S. indicus* was explored by evaluating its effect on antibody titre titer, delayed type hypersensitivity response, phagocytic function and cyclophosphamide-induced myelosuppression in mice. Administration of methanol extract and its fractions (100 and 200 mg/kg, p.o.) showed immunostimulating activity. Methanol extract, and petroleum ether, chloroform and remaining methanol fractions of flower heads of *S. indicus* Linn. were found to be effective in increasing the phagocytic activity, haemagglutination antibody titre and delayed type hypersensitivity, whereas only remaining methanol fraction was found active in normalizing total WBC levels in the case of cyclophosphamide-induced myelosuppression in mice.[37] Eudesmanolide type of sesquiterpene from *S. indicus* was reported to have immunostimulating activity.[17]

Antioxidant activity
In an *in vitro* study, ethanolic extract of *S. indicus* (1000 µg/mL) showed maximum scavenging of the radical 2,2-azinobis-(3-ethylbenzothiazoline-6-sulfonate) (ABTS), 1,1-diphenyl, 2-picryl hydrazyl (DPPH), superoxide and nitric oxide radical. The extract also showed moderate scavenging activity of iron chelation.[38] In an *in vivo* study, methanolic extract of *S. indicus* exhibited a significant antioxidant effect showing increasing levels of superoxide dismutase, catalase, and glutathione peroxides by reducing malondialdehyde levels in rats.[39]

Anti-inflammatory activity
The herb showed anti-inflammatory activity by suppressing the capacity of *Propionibacterium acnes* induced reactive oxygen species and pro-inflammatory cytokines, the two important inflammatory mediators in acne pathogenesis. To prove the anti-inflammatory effects of *S. indicus*, polymorphonuclear leukocytes and monocytes were treated with culture supernatant of *P. acnes* in the presence or absence of the herb *S. indicus* (5 and 50 µg/mL). This caused a smaller, still significant, suppression of reactive oxygen species. The aqueous extract obtained from the root of *S. indicus* was found to be moderately active in down-regulating *P. acnes* induced TNF-α and IL-8 production.[40] Another study has also reported its anti-inflammatory activity.[41]

Analgescic and antipyretic activity
Petroleum ether, benzene, chloroform, ethanol and triple distilled water extracts of whole plant of *S. indicus*, obtained by successive solvent extraction, were screened for analgesic and antipyretic activity (200 and 400 mg/kg, p.o.) using Eddy’s hot plate, tail immersion and breuer’s yeast induced pyrexia methods, respectively. The petroleum ether, chloroform and ethanol extracts showed significant analgesic activity at both the doses from 1 hour onward as compared to the standard drug diclofenac sodium. The chloroform and ethanol extracts showed potential significant antipyretic activity from 1 hour onward, whereas aqueous extracts exhibited this activity from 2 hours onward as compared to the standard drug paracetamol amongst various extracts.[42]

Mast cell stabilizing action
Ethanol extract (150 and 300 mg/kg) and ethyl acetate extract (100, 150 and 300 mg/kg) of *S. indicus* showed better protective action of mast cell degranulation in sheep serum induced allergy test and compound 48/80 induced allergy.[43]

Antihyperglycemic activity
The 50% ethanolic extract of plant was reported to have hypoglycemic activity.[44] Antihyperglycemic effect of alcoholic extract of *S. indicus* was evaluated in the nicotinamide (120 mg/kg, i.p.) and streptozotocin (60 mg/kg, i.p.) induced diabetes in rats. Fasting plasma glucose levels, serum insulin levels, serum lipid profiles, magnesium levels, glycosylated hemoglobin, changes in body weight and liver glycogen levels were evaluated in normal and diabetic rats. Fasting normal rats treated with the alcoholic extract of *S. indicus* showed significant improvement in oral glucose tolerance test. Oral administration of *S. indicus* for 15 days resulted in a significant decrease in blood glucose levels
Hepatoprotective activity
The hepatoprotective effect of aqueous and methanolic extracts of flower heads of *S. indicus* on acetaminophen-induced hepatotoxicity was studied in rats. A significant decrease in liver function markers such as serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), acid phosphatase (ACP) and alkaline phosphatase (ALP), bilirubin and total protein, was observed while using methanolic extract of *S. indicus* (300 mg/kg, p.o.) in comparison with the same dose of aqueous extract. This fact was also confirmed by studying the liver histopathology of treated animals. Moreover, the methanolic extract of *S. indicus* enhanced the activities of antioxidant enzymes such as superoxide dismutase, catalase and glutathione peroxidase and diminished the amount of lipid peroxides against acetaminophen-induced hepatotoxicity in these animals.

Skin disease
Ethanol extract of aerial part of *S. indicus* Linn. was evaluated for wound healing activity in guinea pigs. The cream containing the extract was applied in vivo on the paravertebral area of six excised wounded models once a day for 15 days. The cream significantly enhanced the rate of wound contraction and the period of epithelialization and this effect was comparable to neomycin. Various ointments of ethanol extract of flower head of *S. indicus* in various proportions were screened for the assessment of wound healing activity in albino rats. Based on the comparison made of the wound healing activity of various formulations, the formulation comprising 2% (w/w) alcoholic extract of flower head of *S. indicus* was found to be superior to that of control and standard formulation. Hydroxyproline content was also found greater in healed wounds as compared to control and standard formulation.

Antimicrobial activity
A bicyclic sesquiterpene lactone isolated from the petroleum ether extract of the aerial part of the *S. indicus* was reported to have antimicrobial activity against *Staphylococcus aureus*, *Escherichia coli*, *Fusarium* sp., *Helminthosporium* sp. and other microorganisms. Antimicrobial activity of alkaloidal and nonalkaloidal fractions of alcoholic extract of flowers has also been reported.

Antibacterial and antifungal activities
Alcohol and water extracts of *S. indicus* were reported to have antibacterial activity against *Alternaria solani*, *Fusarium oxysporum* and *Penicillium pinophilum*. Ethanol extract of *S. indicus* has antibacterial activity against enteropathogens. Aerial parts of *S. indicus* show antibacterial activity against *Bacillus cereus* var. *mycoides*, *Bacillus pumilus*, *Bacillus subtilis*, *Bordetella bronchiseptica*, *Micrococcus luteus*, *S. aureus*, *Staphylococcus epidermidis*, *Klebsiella pneumoniae* and *Streptococcus faecalis*. Essential oil from the leaves of *S. indicus* has antibacterial activity against *Salmonella paratyphi* A, *Salmonella paratyphi* B, *Salmonella paratyphi* C, *Schigella Flexneri*, *Salmonella Enteritidis*, *Salmonella typhimurium*, *Shigella sonnei* and *Vibrio cholerae*. The fruits of *S. indicus* exhibited excellent antibacterial activity against gram positive as well as gram negative bacteria. It also possesses antifungal property. Petroleum ether, acetone, methanol (90%) and water extracts of flowers were tested for antibacterial and antifungal activities by diffusion method in bacterial and fungal test cultures. All the extracts showed considerable antibacterial and strong antifungal activities. In another study, *n*-hexane, benzene, chloroform, ethylacetate and acetone extracts of aerial parts and flowers of *S. indicus* were tested for antibacterial and antifungal activities using *in vitro* disk diffusion method at concentrations of 5, 2.5 and 1.25 mg/disk. The *n*-hexane extract of flowers showed significant activity against *S. aureus* and *Candida albicans*.

Antiviral activity
Methanol extract of *S. indicus* showed inhibitory activity against mouse corona virus and herpes simplex virus at a concentration as low as 0.4 μg/mL. The plant extract also exhibited antiviral activity against vaccinia and ranikhet viruses.

Larvicidal action
Acetone extracts of root and leaves of the plant (at concentrations of 750 and 1000 ppm) were shown to cause more than 50% mortality in a predominant Indian mosquito species which acts as a vector of filarial worm. Larvicidal activity was found to be higher in root extract than leaves extract. Purified fraction of acetone extract of *S. indicus* showed mosquito larvicidal effect. Methanolic extract of *S. indicus* showed repellent and feeding deterrent activities against *Tribolium castaneum* at 1% concentration. Complete feeding deterrent activity was observed at 5 mL dose, whereas repellent activity was noticed at 4 mL dose.

Macrofilaricidal activity
The methanolic extract of *S. indicus* (1–10 mg/mL) was screened for *in vitro* macrofilaricidal activity by worm motility assay against adult *Setaria digitata*, the cattle filarial worm. It showed macrofilaricidal activity at concentrations below 4 mg/mL and an incubation period of 100 minutes.

Nemotocidal action
It produced toxic effects on the second and fourth instar larvae of *Culex quinquefasciatus* mosquito at 100–500 ppm concentration. The fourth instar larvae were more susceptible than the second instar larvae. Methanolic extract of dried fruit of the plant is reported to have nemotocidal activity.

Bronchodilatory effect
The methanolic extract of whole plant of *S. indicus* Linn. and its various fractions (87 and 174 mg/kg, p.o.) were tested for their bronchodilatory effect against histamine-induced acute
bronchospasm in guinea pigs. The methanolic extract and its fractions, viz., petroleum ether, benzene, chloroform and ethyl acetate exhibited significant protective action against bronchospasm induced by histamine in guinea pigs.[64]

**Antihyperlipidemic activity**

Antihyperlipidemic activity of alcoholic extract of *S. indicus* Linn. flower heads in atherogenic diet induced hyperlipidemia was studied in rats. *S. indicus* extract (500 mg/kg/day, p.o. for 8 days) caused a marked decrease in body weight, total cholesterol, triglyceride, and low density lipoprotein and very low density lipoprotein. A significant increase in the level of high-density lipoprotein was observed after treatment with *S. indicus* extract.[65]

**Renoprotective effect**

The ethanolic extract of *S. indicus* was evaluated for nephroprotective screening in gentamicin-induced acute renal injury in rats. Gentamicin-induced renal injury resulted in elevated biochemical markers, namely, blood urea and serum creatinine followed by a decrease in total protein and serum albumin. The histopathologic feature was that of acute tubular necrosis. The ethanolic extract of *S. indicus* at a dose level 300 mg/kg was found to normalize the above mentioned biochemical markers and bring about near to normal recovery in the kidneys as evidenced microscopically.[66]

**Miscellaneous activity**

Extract of *S. indicus* has been reported to inhibit hyaluronidase.[67]

The alcoholic extract of flowers of *S. indicus* is reported to have hypotensive, peripheral vasodilatory and cathartic activities.[68]

The plant is also reported to have anticancer activity and antiprotozoal activity against *Entamoeba histolytica*.[58]

**Conclusion**

*S. indicus* Linn. is widely distributed throughout India. The plant appears to have a broad spectrum of activity on several ailments. Various parts of the plant have been explored for anxiolytic activity, neuroleptic activity, immunomodulatory activity, anti-inflammatory activity, mast cell stabilizing action, antihyperglycemic activity, hepatoprotective activity, larvicidal action, bronchodilatory effect, antihyperlipidemic activity, renoprotective effect and many other miscellaneous activities. It is reported to contain eudesmanoids, eudesmanolides, sesquiterpene lactone, sterol glycoside, flavanoids, and essential oil. The pharmacological studies reported in this review confirm the therapeutic value of *S. indicus* Linn. However, less information is available regarding the clinical, toxicity, and phytoanalytical properties of this plant. Several phytochemical studies have been reported but still it needs to progress. With the availability of primary information, further studies can be carried out like clinical evaluation, phytoanalytical studies and toxicity evaluation. The plant is preclinically evaluated to some extent; if these claims are scientifically evaluated clinically, then it can provide good remedies and help the mankind in various ailments.

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