Hygrophila spinosa: A comprehensive review

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ABSTRACT

Hygrophila spinosa T Ander, belonging to the family Acanthaceae, is a promising medicinal plant with great economic potential. The medicinal value of *H. spinosa* has been appreciated in the ancient medical literature. The plant contains terpenoids, alkaloids, flavonoids, and is traditionally known as an aphrodisiac, renal tonic, and for its health-promoting properties. The plant is cultivated throughout India. However, systematic information on the different aspects of this species is not available. In this review, an attempt has been made to present this information.

Key words: Antioxidant, diuretic, *hygrophila spinosa,* phytochemistry

INTRODUCTION

The role of traditional medicines in resolving health problems is invaluable on a global level. Medicinal plants continue to provide valuable therapeutic agents, in both modern and traditional medicine.[1] With the associated side effects of modern medicine, traditional medicines are gaining importance and are now being studied to find the scientific basis of their therapeutic actions[2] Research work on medicinal plants has intensified, and information on these plants has been exchanged. This research will go a long way in the scientific exploration of medicinal plants for the benefit of man and is likely to decrease the dependence on synthetic drugs.[3]

Hygrophila spinosa T. Anders belonging to the family Acanthaceae called Talimkhana is described in ayurvedic literature as Ikshura, Ikshugandha, and Kokilasha "having eyes like Kokila or the Indian cuckoo," common in moist places - on the banks of tanks, ditches, and paddy fields. It is believed to be indigenous to India from the Himalayas to Srilanka, Myanmar, Malaysia, and Nepal.[4-7] The plant contains various groups of phytoconstituents, namely, phytosterols, fatty acids, minerals, polyphenols, proanthocyanins, mucilage, alkaloids, enzymes, amino acids, carbohydrates, hydrocarbons, flavonoids, terpenoids, vitamins, and glycosides. The parts of this plant are widely used in traditional medicine for the treatment of various disorders, which include anasaraca, diseases of the urinogenital tract, dropsy from chronic Bright's disease, hyperdipsia, vesical calculi, flatulence, diarrhea, dysentery, leukorrhea, gonorrhea, asthma, blood diseases, gastric diseases, inflammation, cancer, rheumatism, painful micturition, menorrhagea.[8-11] It is also scientifically proved to have a variety of pharmacologic functions, which indicate its usefulness in the treatment of different types of diseases and disorders.

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TAXONOMY

Kingdom: Plantae
Division: Angiospermae
Order: Personales
Family: Acanthaceae
Genus: *Hygrophila*
Species: *Spinosa*
Vernacular names: Gokulakanta, Talimkhana, Nirmulli.

BOTANICAL DESCRIPTION

H. spinosa T. Anders syn. *H. auriculata* (Schum.) Hiene; *Asteracantha longifolia* (Linn.) Nees.[9] is a herb growing in wet places. A stout herb; stems fasciculate, subquadrangular, erect, 0.6–1.5 m tall, thickened at the nodes, hispid with long hairs; with axillary spines, leaves 9 × 1 cm, hairy, oblanceolate, in whorls. Flowers 2–3 cm long, purple-blue, bilabiate, in whorls. Fruits capsule, 8 mm long, 4–8 seeded.[12]

PHYTOCHEMISTRY

Phytochemically, the whole plant contains phytosterols, tannins, carbohydrates, flavonoids, terpenoids, and sterols. Phalnikar *et al,* analyzed the oil from the seeds and reported the presence of uronic, palmitic, stearic, oleic, and linoleic acids.[13,14] Apigenin-7-O-glucuronide and apigenin-7-oglucoside were isolated

from the flowers[15] and lupeol, betulin, and stigmasterol were isolated from the plant.[16] Alkaloids, steroids, tannins, proteins, flavonoids, carbohydrates, fats, and oils were isolated from the roots. Moreover, the leaves show the presence of alkaloids, carbohydrates, proteins, steroids, glycosides, flavonoids, tannins, phenolic compounds, fats, and oils.[17] The high-performance thin layer chromatography analysis revealed the presence of phytosterols, namely, β-sitosterol and lupeol. Maximum content of lupeol was found in the roots (0.25%), whereas the maximum content of β-sitosterol was found in the leaves (0.069%) of *Asteracantha longifolia*.[18] Other isolated chemical constituents include betulin, 25-oxo-hentriacontanyl acetate,[19] and methyl8-*n*-hexyltetracosanoate [Figure 1].[20]

TRADITIONAL CLAIMS FOR *H. SPINOSA*

The seeds are used as ingredients in various aphrodisiacs and tonic confections, and in the treatment of blood disorders, biliousness, gonorrhea, spermatorrhea, and fever. The seeds are ground into a paste and given in buttermilk for diarrhea. AKSIR-UL-IMRAZ, a preparation having Talamkhana (seeds) as one of the ingredients, is used for leukorrhea. The ashes of the plant are also used in dropsy and gravel. The tincture of the whole plant is beneficial in urinary affections, dysuria, and painful micturition. The roots are used in the form of decoction in rheumatism, gonorrhea, and hepatic obstruction. The leaves are sweet, tonic, aphrodisiac, hypnotic, and useful in the treatment of diarrhea, thirst, urinary calculi, urinary discharges, inflammations, eye diseases, pains, ascites, anemia, and abdominal disorders. The leaves are diuretic, good for treating cough and joint pains. Aqueous extract of the herb is diuretic, spasmolytic, and hypotensive. The herb exhibits antihepatotoxic activity in dogs. The oil extracted from the whole plant is antibacterial.[4-7]

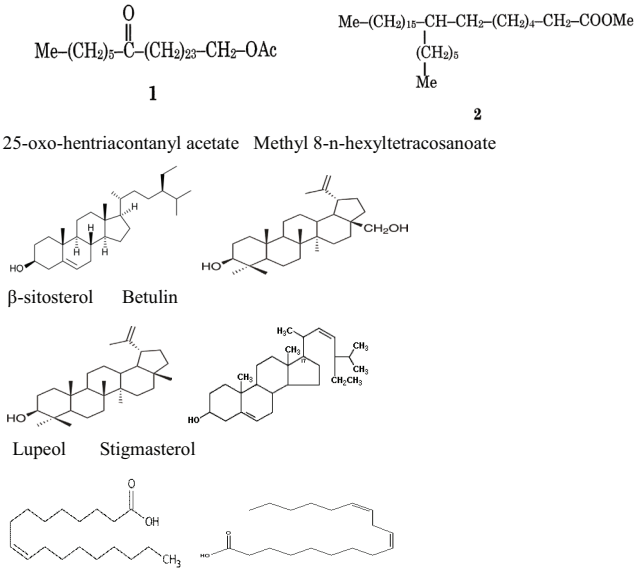

Figure 1: Major phytochemical constituents of *H. spinosa*

BIOLOGICAL AND PHARMACOLOGIC ACTIVITIES

Many pharmacologic studies have been conducted on *H. spinosa*. A summary of these findings by various investigators is described briefly in the following sections.

Antitumor activity

Petroleum ether extract of the roots exhibited antitumor activity in Ehrlich ascites carcinoma (EAC)- and sarcoma-180 (S-180)–bearing mice. The extract suppressed significantly the tumor fluid volume at the end of a 3 weeks experiment. It decreased about 50% of packed cell volume and increased the life span of EAC/S-180–bearing mice in a day-dependent manner. Red blood cell (RBC) count, hemoglobin content, and white blood cell count significantly increased to normal after extract treatment of the tumor-bearing mice. It also inhibited the rapid increase of the body weight of tumor-bearing mice. This finding supports its traditional use in cancer and blood disorders.[21]

Antiinflammatory activity

Petroleum ether, chloroform, alcoholic, and aqueous extracts of the leaves of *H. spinosa* were evaluated for their antiinflammatory effect in Wistar rats of both sexes. The results revealed that chloroform and alcoholic extracts significantly reduced carrageenan-induced rat paw edema in a dose-dependent manner, whereas petroleum ether and aqueous extracts did not show any significant antiinflammatory activity. The obtained result supports the traditional claim of the plant for its antiinflammatory properties.[22-24]

Antipyretic activity

Petroleum ether, chloroform, alcohol, and aqueous extracts of *H. spinosa* leaves were evaluated for their antipyretic activity on the basis of their effect on Brewer's yeast-induced pyrexia in rats[32,33] at doses of 200 and 400 mg/kg. The results showed that chloroform and alcohol extracts have significant antipyretic activity, but petroleum ether and aqueous extracts failed to lower the raised body temperature in rats. Chloroform extract significantly decreased the elevated rectal temperature 3 h after the administration of a dose of 400 mg/kg, whereas the alcoholic extract reduced the hyperthermia at both doses 1 h after administration.[22,25,26]

Hematopoetic activity

Hematopoetic activity of *H. spinosa* was evaluated using cyclophosphamide-induced anemia in rats. Chloroform extract of the leaves at both 250 and 500 mg/kg doses significantly improves RBC and hemoglobin counts for 7 days and cyclophosphamide-induced bone marrow suppression after 21 days of treatment. It is also found that it increases bone marrow cellularity.[27]

Hepatoprotective activity

Hepatoprotective effect of aqueous extract of *H. spinosa* root in carbon tetrachloride-induced liver damage was studied in albino rats to support the traditional claim. The roots were found

to be rich in antioxidants. Liver damage in rats was induced by carbon tetrachloride. To find out the hepatoprotective activity, the aqueous extract of the plant root samples were administered to rats for 15 days. The serum marker enzymes aspartate transaminase, alanine transaminase, and γglutamyl were measured in experimental animals. The increased enzyme levels after liver damage with carbon tetrachloride were nearing normal value when treated with aqueous extract of the root samples. Histopathologic observation also proved the hepatoprotective activity of the root samples. Hepatoprotective activity of *H. spinosa* stem is also reported.[16,28,29]

In another study, the antihepatotoxic effect with treatment of methanolic extracts of the seeds of this plant was studied on rat liver damage induced by a single dose of paracetamol (3 g/kg, p.o.) or thioacetamide (100 mg/kg, s.c.) by monitoring several liver function tests, namely, serum transaminases (SGOT and SGPT), alkaline phosphatase, sorbitol dehydrogenase, glutamate dehydrogenase, and bilirubin in the serum. Furthermore, hepatic tissues were processed for assay of triglycerides and histopathologic alterations simultaneously. A significant hepatoprotective activity of the methanolic extract of the seeds was observed. These studies support its traditional role as being hepatoprotective.[30]

Diuretic activity

The screening was performed according to the method described by Lipschitz *et al.* Male Wistar albino rats (150–200 g) were used for the experiment. The animals were divided into different groups: the control group received normal saline (25 mL/kg body weight, p.o.); the second group received frusemide (10 mg/kg, p.o.), and other groups received doses of extracts/fractions (200 mg/kg each), in normal saline. The volume of urine collected was measured at the end of 5 h and the total urine volume and concentrations of Na^+, K^+, and Cl^- in the urine were determined. The alcoholic extract of *H. auriculata* (Schum.) Hiene at doses of 200 mg/kg showed a significant increase in the total urine volume and concentrations of Na^+, K^+, and Cl^- in the urine in the rats. This finding supports its traditional use as a diuretic.[31,32]

Antidiabetic activity

In 1989, the hypoglycemic activity of *H. auriculata* in human subjects was reported. Treatment of streptozotocine-induced diabetic rats with ethanolic extracts from the aerial parts of *H. auriculata* at doses 100 and 250 mg/kg for 3 weeks showed a significant reduction in the blood glucose levels, thiobarbituric acid reactive substances, and hydroperoxide in both liver and kidney. This also significantly increased the glutathione, glutathione peroxidase, glutathione S-transferase, and catalase, which is comparable to those of the control group. This study shows the antidiabetic activity along with potent antioxidant potential in diabetic conditions. It is useful in treating diabetes as per the traditional system.[33]

Anthelminthic activity

Petroleum ether, chloroform, alcohol, and aqueous extracts of leaves of *H. spinosa* in different concentrations (25, 50, 100 mg/mL in 1% Tween 80 in normal saline) were evaluated for anthelminthic activity. The results revealed that the alcoholic extract produced significant anthelminthic activity, whereas chloroform and aqueous extract showed moderate activity and petroleum ether extract is having the least anthelminthic activity.[34]

Antibacterial activity

The antibacterial activity of petroleum ether, chloroform, alcohol, and aqueous extracts of leaves of *H. spinosa* were evaluated using disc-diffusion method. At a concentration of 100 mg/disc showed a significant increase in the diameters of the zone of inhibition (mm) for *Escherichia coli* (NCIM No. 2341), *Staphylococcus aureus* (NCIM No. 2654), *Bacillus subtilis* (NCIM NO. 2195), and *Pseudomonas aeruginosa* (NCIM No. 2914) in Petri dishes. This finding confirms its traditional use in bacterial infection.[34,35]

Analgesic activity

Analgesic activity of *H. spinosa* leaves was studied using hot plate and tail flick by thermal method and acetic acid-induced writhing test in chemical method in mice. The petroleum ether, chloroform, alcohol, and aqueous extracts of leaves at a dose of 200 and 400 mg/kg of b.w. significantly increased the pain threshold of mice toward the thermal source in a dose-dependent manner and also inhibited the abdominal constriction produced by acetic acid. This reveals its analgesic activity by central as well as peripheral mechanisms.[36]

Antimotility

The petroleum ether, chloroform, alcohol, and aqueous leaf extracts of *H. spinosa* at a dose of 200 and 400 mg/kg showed a dose dependent decrease in the distance traveled by charcoal meal through the gastrointestinal tract. This supports its traditional role in the treatment of diarrhea and dysentery.[36,38]

Antioxidant activity

Phytochemicals of *H. spinosa* have been shown to possess significant antioxidant properties that may be associated with lower incidence and lower mortality rates of degenerative diseases in human.[40] Various *in vitro* and *in vivo* antioxidant activities have been carried out on various extracts of different parts of *H. spinosa*. The root extracts showed the presence of the nonenzymatic antioxidants, total phenols, flavonoids, and tannins. This finding suggests its possible use in diseases in which free radicals play an important role.[39-41]

In vitro antioxidant activity

Ferric thiocyanate method

This method was used to determine the amount of peroxide generated at the initial stage of lipid peroxidation. During the linoleic acid oxidation, peroxides were formed, and these compounds oxidized Fe^{2+} to Fe^{3+}. The Fe^{3+} ions form a complex with SCN^-, which has a maximum absorbance at 500 nm. In this method, the concentration of peroxide decreases as the antioxidant activity increases. *H.auriculata* exhibited a significant

antioxidant activity at a concentration of 4 mg compared with standard Vitamins E and C. Lower the absorbance values exhibited, higher the antioxidant activities of the samples. The control had the highest absorbance value (0.85), followed by *H.auriculata* (0.38), Vitamin E (0.51), and Vitamin C (0.61). Based on the results, *H.auriculata* had the highest percentage inhibition of 55.29%, followed by Vitamin E (40%) and Vitamin C (38.83%).[42-44]

Thiobarbituric acid method

In this method formation of malonaldehyde is the basis for evaluating the extent of lipid peroxidation. At low pH and high temperature (100°C), malonaldehyde binds with thiobarbituric acid to form a red complex that can be measured at 532 nm. The increase the amount of red pigment formed correlates with the oxidative rancidity of the lipid. The control had the highest absorbance value (0.25), followed by *H.auriculata* (0.10), Vitamin E (0.13), and Vitamin C (0.15). Based on the results, *H.auriculata* had the highest percentage inhibition of 60% followed by Vitamin E (48%) and Vitamin C (44%).[42,45]

CONCLUSION

In this systematic review, the pharmacologic studies conducted on *H. spinosa* indicate the immense potential of this plant in the treatment of conditions, such as diarrhea; inflammatory ailments, including liver and kidney disorders, as well as microbial and bacterial infections; cancer, and others. Regarding the plant, the studies indicate that this has an important antioxidant activity due to the presence of water-soluble compounds with potent free radical-scavenging effects, such as flavonoids, terpenoids, alkaloids, steroids, tannins that may be associated with the lower incidence and lower mortality rates of degenerative diseases in human. In spite of all these activities, a major work has been carried out on the chemical, biochemical, pharmaceutic, and pharmacologic aspects of the plant and hence, an extensive investigation, especially on its clinical efficacy is needed to exploit its therapeutic utility to combat diseases. As the global interest toward traditional medicines over the conventional treatment is increasing, due to safe and well-tolerated remedies provided by them for the chronic illness with lesser side effects, this review targets *H. spinosa* as a potentially safe and effective plant that has important medicinal values and benefits.

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