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A review on pharmacological potential of *asteracantha longifolia*

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***Abstract*---**Acanthaceae plant *Asteracantha longifolia* (L.) Nees is used to make the ayurvedic medication 'Kokilaaksha' and the Unani drug Talimakhana. The seeds are aphrodisiac, bitter, tonic, and sedative, and are used to treat blood problems. Antitumor, hypoglycemic, aphrodisiac, antibacterial, free radical scavenging and lipid peroxidation, hepatoprotective, and haematopoietic activity are all known properties of the plant. Lupeol, stigmasterol, butelin, fatty acids, and alkaloids are all found in it. The focus of this review paper is on Talimakhana's phytochemical, pharmacological, and other relevant characteristics.

Keywords*---Astercantha longifolia*, Rasayana, aphrodisiac, tonic.

Introduction

Rasayana is a subcategory of medications in the Ayurvedic medicine system of India. The word Rasayana is made up of two words: Rasa, which means elixir, and Ayana, which means dwelling. As a result, the term refers to a plant feature that aids in system rejuvenation. Many plants have been widely employed as rejuvenators, immunomodulators, aphrodisiacs, and tonics in Ayurveda for the treatment of neurodegenerative illnesses [1-4]. *Asteracantha longifolia*(L.)Nees, Acanthaceae, is mentioned as a Rasayan or rejuvenator in Ayurvedic treatises such as the "Sushruta Samhita" and "Charak Samhita." In ayurvedic literature, *A. longifolia* is known as Ikshura, Ikshugandha, and Kokilasha, which means

"having eyes like the Kokila or Indian Cuckoo." They're included in the ayurvedic formulations "Striravallabhpugpak" and "Rativardhanyog," which are used to promote sexual behaviour and as a general tonic, according to ancient texts. As an attempt to propose a direction for future research, the current article includes a detailed exploration of the pharmacological and phytochemical features of *A. longifolia*. Synonyms *Hygrophila spinosa* (Schumach.)*Hygrophila auriculata* (Schumach.) Heine. Anders, T. Sanskrit: Iksura; Bengali: Kuliyakhara; Gujarati: Ekharo; Hindi: Talmakhana; Malyalam: Nirmuli; Marathi: Talimakhana; Tamil: Golmidi and Urdu: Talmakhana are some of the vernacular names sources from various locations. The plant can be found in India, Sri Lanka, Burma, Malaysia, and Nepal, among other places.It's a prickly, sturdy annual herb that grows in wet areas. Flower yellowish brown, fruit two celled, linear oblong, compressed about 8 cm long, pointed, 4-8 seeded, leaves subsessile, oblong-lanceloate or linear lanceolate, spines yellowish brown, 2-3 cm long, flower yellowish brown, flower yellowish brown, flower yellowish brown, flower yellowish brown, flower yellowish brown, flower yellowish brown, flower yellowish brown, flower yellowish brown, flower yellowish brown, flower (Figure 1). Seeds are oval, flat or compressed, 0.2-0.25 cm long and 0.1-0.15 cm wide, hairy but appear smooth when wet; when wet, they become coated in mucilage and turn light brown: The flavour is slightly bitter, and the odour is unremarkable [5].

Quantitative benchmarks a foreign substance

Not more than 2% w/w of the total. No more than 8.5 % w/w ash. Not more than 3.5 % w/w acid-insoluble ash Extractive solubility in ethanol: not more than 13.0% w/w. Not more than 17.0 % w/w water soluble extractive

Taxonomical information
Class: Equisetopsida*C. Agardh*
Subclass: MagnoliidaeNovák ex Takht.
Superorder: AsteranaeTakht.
Order: LamialesBromhead
Family: AcanthaceaeJuss.
Genus: AsteracanthaNees
Species:*Asteracantha longifolia*(L.) Nees

Fig. 1 Plant of *Asteracantha longifolia* (L.)Nees

Uses in the past

The entire plant, as well as its roots, seeds, and ashes, are widely used in traditional medicine to treat rheumatism, inflammation, jaundice, hepatic blockage, discomfort, urinary infections, oedema, and gout. It is classed as seethaveeryam, mathuravipaka in the Ayurvedic system and is used to treat premeham (diabetes), athisaram (dysentry), and other ailments.

Phytochemistry

Phytosterols, tannins, sugars, flavonoids, terpenoids, and sterols are all found in the complete plant. The oil from the seeds was studied by Phalnikar*et al*, who found uronic, palmitic, stearic, oleic, and linoleic acids. [13,14] Flowers yielded apigenin-7-O-glucuronide and apigenin-7-oglucoside [15], while the plant yielded lupeol, betulin, and stigmasterol [16]. The roots yielded alkaloids, steroids, tannins, proteins, flavonoids, carbs, lipids, and oils. Alkaloids, carbohydrates, proteins, steroids, glycosides, flavonoids, tannins, phenolic chemicals, lipids, and oils are also found in the leaves [17]. The existence of phytosterols, especially -sitosterol and lupeol, was discovered using high-performance thin layer chromatography. The roots of *Asteracantha longifolia*had the highest concentration of lupeol (0.25 %), whereas the leaves had the highest concentration of -sitosterol (0.069 %) [18]. Betulin, 25-oxo-hentriacontanyl acetate,[19] and methyl8-n-hexyltetracosanoat [20] are some of the other chemical compounds that have been discovered.

Pharmacological activities
Antitumor properties

In Ehrlich ascites carcinoma (EAC) and sarcoma-180 (S-180)-bearing mice, a petroleum ether extract of the roots has anticancer action. After a three-week testing, the extract considerably reduced tumour fluid volume. It enhanced the life span of EAC/S-180–bearing mice in a day-dependent manner by roughly 50% of packed cell volume. The tumor-bearing mice's RBC count, haemoglobin content, and white blood cell count all increased to normal levels after extract administration. It also slowed the rapid growth of tumor-bearing mice's body weight. This discovery backs up its long-standing usage in cancer and blood problems. [21]

Anti-inflammatory properties

The anti-inflammatory effects of petroleum ether, chloroform, alcoholic, and aqueous extracts of *Asteracantha longifolia* leaves were tested in Wistar rats of both sexes. The findings showed that chloroform and alcoholic extracts reduced carrageenan-induced rat paw edoema in a dose-dependent manner, but petroleum ether and aqueous extracts had little anti-inflammatory action. The findings back up the plant's traditional claim to have anti-inflammatory qualities [22–24].

Antipyretic properties

On the basis of their effect on Brewer's yeast-induced pyrexia in rats [32,33], petroleum ether, chloroform, alcohol, and aqueous extracts of *Asteracantha longifolia* leaves were assessed for their antipyretic effectiveness at doses of 200 and 400 mg/kg. The findings revealed that chloroform and alcohol extracts have strong antipyretic effects; however petroleum ether and aqueous extracts failed to lower the elevated body temperature in rats. The chloroform extract considerably reduced the raised rectal temperature 3 hours after a dose of 400 mg/kg was administered, whereas the alcoholic extract significantly reduced hyperthermia 1 hour after delivery at both doses [22, 25, 26].

Activation of the hematopoietic system

Cyclophosphamide-induced anaemia in rats was used to test *Asteracantha longifolia*'s hematopoetic function. RBC and haemoglobin counts are greatly improved for 7 days following treatment with chloroform extract of the leaves at both 250 and 500 mg/kg doses, and cyclophosphamide-induced bone marrow suppression is significantly improved after 21 days of treatment. It's also been discovered that it boosts bone marrow cellularity [27].

Hepatoprotective properties

To back up the traditional claim, the hepatoprotective activity of an aqueous extract of *Asteracantha longifolia*root in carbon tetrachloride-induced liver injury was examined in albino rats. Antioxidants were discovered to be abundant in the roots. Carbon tetrachloride caused liver injury in rats. The aqueous extract of plant root samples was given to rats for 15 days to test for hepatoprotective effects. Experimental animals had their serum marker enzymes aspartate transaminase, alanine transaminase, and glutamyl assessed. When treated with aqueous extract of the root samples, the elevated enzyme levels following carbon tetrachloride-induced liver injury were close to normal. The root samples' hepatoprotective effect was also confirmed by histopathologic examination. *Asteracantha longifolia* stem has also been shown to have hepatoprotective properties [16,28,29]. In another study, the antihepatotoxic effect of methanolic extracts of this plant's seeds on rat liver damage induced by a single dose of paracetamol (3 g/kg, p.o.) or thioacetamide (100 mg/kg, s.c.) was investigated by monitoring several liver function tests, including serum transaminases (SGOT and SGPT), alkaline phosphatase, sorbitol dehydrogen Furthermore, hepatic tissues were treated simultaneously for triglyceride analysis and histopathologic changes. The methanolic extract of the seeds showed considerable hepatoprotective action. These studies back to its traditional hepatoprotective role [30].

Diuretic Property

The screening was carried out according to Lipschitz et al procedure. The rats utilised in the experiment were male Wistar albino rats weighing 150–200 grammes. The animals were separated into four 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 the remaining groups received extracts/fractions doses of 200 mg/kg each in normal saline. At the conclusion of 5 hours, the volume of urine collected was measured, and the total urine volume as well as the concentrations of Na+, K+, and Cl^- in the urine was determined. The alcoholic extract of *Asteracantha longifolia* increased the total urine volume and concentrations of Na+, K+, and Cl– in the urine of rats at doses of 200 mg/kg. This discovery backs up its long-standing use as a diuretic [31,32].

Antidiabetic properties

Human hypoglycemic action of *Asteracantha longifolia*was first reported in 1989. The treatment of streptozotocine-induced diabetic rats with ethanolic extracts from the aerial parts of *H. auriculata* at doses of 100 and 250 mg/kg for 3 weeks resulted in significant reductions in blood glucose, thiobarbituric acid reactive substances, and hydroperoxide in both the liver and kidney. This also boosted glutathione, glutathione peroxidase, glutathione S-transferase, and catalase levels to levels comparable to the control group. In diabetic settings, this study demonstrates antidiabetic action as well as high antioxidant capability. It can be used to treat diabetes using the standard method [33].

Activity against helminths

The antihelminthic activity of petroleum ether, chloroform, alcohol, and aqueous extracts of *Asteracantha longifolia* leaves in various quantities (25, 50, 100 mg/ml in 1 % Tween 80 in normal saline) was tested. The results revealed that the alcoholic extract had high anthelminthic activity, while the chloroform and aqueous extracts had moderate activity, and the petroleum ether extract had the least amount of anthelminthic activity [34].

Antibacterial properties

The disc-diffusion method was used to test the antibacterial activity of petroleum ether, chloroform, alcohol, and aqueous extracts of *Asteracantha longifolia* leaves. In Petri dishes, 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) increased significantly at a dose of 100 mg/disc. This discovery backs up its long-standing usage in bacterial illness [34, 35].

Analgesic effect

In mice, the analgesic effect of *Asteracantha longifolia* leaves was investigated using a hot plate and tail flick thermal approach, as well as an acetic acid-induced writhing test utilising a chemical method. At doses of 200 and 400 mg/kg b.w., petroleum ether, chloroform, alcohol, and aqueous extracts of leaves dramatically enhanced the pain threshold of mice toward the thermal source and prevented the abdominal constriction caused by acetic acid. This demonstrates that it has analgesic properties through both central and peripheral pathways [36]**.**

Antimotility

At doses of 200 and 400 mg/kg, the distance travelled by charcoal meal through the gastrointestinal tract was reduced by petroleum ether, chloroform, alcohol, and aqueous leaf extracts of *Asteracantha longifolia*. This lends credence to its long-standing use in the treatment of diarrhoea and dysentery [36, 38].

Antioxidant properties

Asteracantha longifolia phytochemicals have been proven to have high antioxidant activities, which have been linked to a lower incidence and mortality rate of degenerative disorders in humans [40]. On several extracts of different sections of *Asteracantha longifolia*, diverse in vitro and in vivo antioxidant properties have been carried out. Nonenzymatic antioxidants, total phenols, flavonoids, and tannins were found in the root extracts. This finding suggests that it might be useful in disorders where free radicals play a key role [39-41].

Antioxidant activity in vitro
Method of ferric thiocyanate

This method was used to calculate the amount of peroxide produced at the beginning of the lipid peroxidation process. Peroxides were produced during the oxidation of linoleic acid, and these molecules oxidised Fe2+ to Fe3+. The Fe3+ ions combine with SCN– to form a complex with a maximum absorbance of 500 nm. The concentration of peroxide decreases as the antioxidant activity rises in this approach. When compared to normal Vitamins E and C, *Asteracantha longifolia*showed considerable antioxidant activity at a dosage of 4 mg. The antioxidant activityof the samples is higher when the absorbance values are lower. The absorbance value of the control was the greatest (0.85), followed by *Asteracantha longifolia* (0.38), Vitamin E (0.51), and Vitamin C (0.52). (0.61). According to the findings, *Asteracantha longifolia* exhibited the highest percentage inhibition (55.29%), followed by Vitamin E (40%) and Vitamin C (35 %). (38.83%) [42-44].

Method of thiobarbituric acid

The production of malonaldehyde is used to determine the amount of lipid peroxidation in this procedure. Malonaldehyde combines with thiobarbituric acid at low pH and high temperature (100°C) to generate a red complex that may be detected at 532 nm. The amount of red pigment generated increases in proportion to the lipid's oxidative rancidity. *Asteracantha longifolia* (0.10), Vitamin E (0.13), and Vitamin C (0.13) had the greatest absorbance values (0.25), followed by the control (0.25). (0.15). According to the findings, *Asteracantha longifolia*had the highest percentage of inhibition (60%) followed by Vitamin E (48%) and Vitamin C (44%) [42, 45].

Conclusion

The pharmacologic studies conducted on Asteracantha longifoliain this systematic review indicate that this plant has enormous potential in the treatment of

conditions like diarrhoea; inflammatory ailments, such as liver and kidney disorders, as well as microbial and bacterial infections; cancer, and others. Studies suggest that the plant has significant antioxidant activity due to the presence of water-soluble compounds with potent free radical-scavenging effects, such as flavonoids, terpenoids, alkaloids, steroids, and tannins, which may be linked to a lower incidence and mortality rate of degenerative diseases in humans. Despite these efforts, little research has been done on the plant's chemical, biochemical, pharmaceutic, and pharmacologic features, necessitating further research, particularly on its clinical efficacy, in order to fully utilise its medicinal potential. This review focuses on Asteracantha longifolia as a potentially safe and effective plant with important medicinal values and benefits, as global interest in traditional medicines over conventional treatment is increasing due to the safe and well-tolerated remedies provided by them for chronic illness with fewer side effects.

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References

[1] A. J. Krentz and C. J. Bailey, “Oral antidiabetic agents: Current role in type 2 diabetes mellitus,” Drugs, vol. 65, no. 3, pp. 385-411, 2005 [doi:10.2165/00003495-200565030-00005].
[2] Y. K. Gupta and S. Briyal, “Animal models of cerebral ischemia for evaluation of drugs,” Indian J. Physiol. Pharmacol., vol. 48, no. 4, pp. 379-394, 2004.
[3] C. K. Amadou, “Promoting alternative medicine,” Afr. Health J, vol. 2, pp. 20-25, 1998.
[4] A. K. Nadkarni, Indian Materia Medica, vol. 1. Mumbai: Popular Prakashan, 2007, pp. 668-669.
[5] R. N. Chopra et al., Indigenous Drugs of India. Calcutta: UN Dhur & Sons Pvt, Ltd, 1958, p. 353.
[6] R. N. Chopra et al., Glossary of Indian Medicinal Plants. New Delhi: CSIR, 1986, p. 29.
[7] K. R. Kirtikar and B. D. Basu, Indian Medicinal Plants, vol. 3. Dehradun: International Book Distributors, 2005, pp. 1863-1865.
[8] L. V. Asolkar et al., Second Supplement to Glossary of Indian Medicinal Plants With Active Principles. New Delhi: NISCAIR, CSIR, 2005, p. 362.
[9] C. P. Khare, Indian Medicinal Plants: An Illustrated Dictionary. Springer Publications, 2007, pp. 317-318.
[10] P. C. Sharma et al., “Database on medicinal plants used in Ayurveda,” vol. 4, New Delhi: Central Council for Research in Ayurveda and Siddha, 2002, pp. 320-331.
[11] R. P. Rastogi and B. N. Mehrotra, “Compendium of Indian medicinal plants,” vol. 3, New Delhi: Publication and Information Directorate. CSIR, 1993, p. 351.
[12] C. K. Atal and B. M. Kapur, “Cultivation and utilization of medicinal plants,” Jamu-Tawi. Regional Research Laboratory, CSIR, 1982, p. 548.
[13] R. P. Rastogi and B. N. Mehrotra, Compendium of Indian Medicinal Plants. I. New Delhi: Publication and Information Directorate. CSIR, 1993, p. 220.

[14] N. N. Godbole et al., “An investigation of oil from seed of Hygrophila spinosa,” J. Am. Oil Chem. Soc., vol. 18, pp. 206-207, 1941.
[15] P. Balraj and S. Nagarajan, “Apigenin-7-O-glucuronide from the flowers of Asteracantha longifolia Nees,” Indian Drugs, vol. 19, pp. 150-152, 1982.
[16] K. Usha et al., “Hepatoprotective effect of Hygrophila spinosa and Cassia occidentalis on carbon tetrachloride induced liver damage in experimental rats,” Indian J. Clin. Biochem., vol. 22, pp. 132-135, 2007.
[17] A. Patra et al., “Pharmacognostical standardization of leaves of Hygrophila spinosa T. Anders Phcog J,” vol. 1, pp. 82-87, 2009.
[18] S. Sunita and S. Abhishek, “A comparative evaluation of phytochemical fingerprints of Asteracantha longifolia Nees. Using HPTLC,” Asian J. Plant Sci., vol. 7, no. 6, pp. 611-614, 2008 [doi:10.3923/ajps.2008.611.614].
[19] T. N. Misra et al., “Constituents of Asteracantha longifolia,” Fitoterapia, vol. 72, no. 2, pp. 194-196, 2001 [doi:10.1016/s0367-326x(00)00269-0].
[20] U. K. Mazumder et al., “Chemical and pharmacological evaluation of Hygrophila spinosa root,” Indian J. Exp. Biol., vol. 61, pp. 181-183, 1999.
[21] U. K. Mazumdar et al., “Antitumor activity of Hygrophila spinosa on Ehrlich ascites carcinoma and sarcoma-180 induced mice,” Indian J. Exp. Biol., vol. 35, no. 5, p. 473-477, 1997.
[22] A. Patra, et al, “Anti-inflammatory and antipyretic activities of Hygrophila spinosa T. Anders leaves (Acanthaceae),” Trop. J. Pharm. Res., vol. 8, pp. 133-137, 2009.
[23] W. Borgi et al., “Antiinflammatory and analgesic activities of Zizyphus lotus root barks,” Fitoterapia, vol. 78, no. 1, pp. 16-19, 2007 [doi:10.1016/j.fitote.2006.09.010].
[24] W. L. Lipschitz, “Activity on urinary tract” in Drug Discovery and Evaluation. New York: Verlag Berlin Heidelberg Springer, H. G. Vogel and W. H. Vogel, Eds., 1997, pp. 390-417.
[25] B. B. Jain et al., “Antipyretic activity of aqueous extract of leaves of Cocculus hirsutus,” Indian J. Nat. Prod., vol. 23, pp. 26-29, 2007.
[26] K. Metowogo et al., “Anti-ulcer and antiinflammatory effects of hydro-alcohol extracts of Aloe buettneri A. Berger (Liliaceae),” Trop. J. Pharm. Res., vol. 7, pp. 907-912, 2008.
[27] R. S. Pawar et al., “Haematopoetic activity of Asteracantha longifolia on cyclophosphamide induced bone marrow depression,” Indian J. Pharm. Sci., vol. 3, pp. 337-340, 2006.
[28] P. Shanmugasundaram and S. Venkataraman, “Hepatoprotective and antioxidant effects of Hygrophila auriculata (K.Schum) Heine Acanthaceae root extract,” J. Ethnopharmacol., vol. 104, no. 1-2, pp. 124-128, 2006 [doi:10.1016/j.jep.2005.08.058].
[29] A. D. Kshirsagar and P. Ashok, “Hepatoprotective and antioxidant effects of Hygrophila spinosa (K.Schum.) Heine Acanthaceae stem extract,” Biosci. Biotechnol. Res. Asia, vol. 5, pp. 657-662, 2008.
[30] A. Singh and S. S. Handa, “Hepatoprotective activity of Apium graveolens and Hygrophila auriculata against paracetamol and thioacetamide intoxication in rats,” J. Ethnopharmacol., vol. 49, no. 3, pp. 119-126, 1995 [doi:10.1016/0378-8741(95)01291-5].
[31] W. Haddian and A. Kerpscar, “Bioassay of diuretics,” J. Pharmacol.ExpTher., vol. 79, pp. 97-110, 1943.

[32] N. Ahmed et al., “Preliminary studies on diuretic effect of Hygrophila auriculata (Schum) Heine in rats,” Int. J. Health Res., vol. 2, pp. 59-64, 2009.
[33] M. Vijayakumar, et al, “Action of Hygrophila auriculata against streptozotocin-induced oxidative stress,” J. Ethnopharmacol., vol. 104, no. 3, pp. 356-361, 2006 [doi:10.1016/j.jep.2005.09.030].
[34] A. Patra et al., “Anthelmintic and antibacterial activities of Hygrophila spinosa T Ander.,” Res. J. Pharm. Technol., vol. 1, pp. 531-532, 2008.
[35] R. G. Mali et al., “Evaluation of Capparis decidua for anthelmintic and antimicrobial activities,” Indian J. Nat. Prod., vol. 20, pp. 10-13, 2004.
[36] A. Patra et al., “Analgesic and antimotility activities of leaves of Hygrophilia spinosa T Anders.,” Pharmacologyonline, vol. 2, pp. 821-828, 2008.
[37] L. Sagar et al., “Evaluation of antimotility effects of Lantana camara L. var. acuelata constituents on neostigmine induced gastrointestinal transit in mice,” BMC Complement. Altern. Med., vol. 5, no. 1, p. 18, 2005 [doi:10.1186/1472-6882-5-18].
[38] S. Biswas, et al, “Antidiarrhoeal activity of Strychnospotatorum seed extract in rats,” Fitoterapia, vol. 73, no. 1, pp. 43-47, 2002 [doi:10.1016/s0367-326x(01)00368-9].
[39] K. Usha et al., “Hepatoprotective effect of Hygrophila spinosa and Cassia occidentalis on carbon tetrachloride induced liver damage in experimental rats,” Indian J. Clin. Biol., vol. 22, pp. 132-135, 2007.
[40] C. P. Malick and M. B. Singh, Plant Enzymology and Histoenzymology. New Delhi: Kalyani Publishers, 1980, p. 286.
[41] S. H. Shandrel, Method in Food Analysis. New York: Academic Press, 1970, p. 709.
[42] P. Shanmugasundaram and S. Venkataraman, “Hepatoprotective and antioxidant effects of Hygrophila auriculata (K.Schum) Heine Acanthaceae root extract,” J. Ethnopharmacol., vol. 104, no. 1-2, pp. 124-128, 2006 [doi:10.1016/j.jep.2005.08.058].
[43] H. Kikuzaki and N. Nakatani, “Antioxidant effects of some ginger constituents,” J. Food Sci., vol. 58, no. 6, pp. 1407-1410, 1993 [doi:10.1111/j.1365-2621.1993.tb06194.x].
[44] A. Ottolenghi, “Interaction of ascorbic acid and mitochondria lipids,” Arch. Biochem. Biophys., vol. 79, pp. 355-363, 1959 [doi:10.1016/0003-9861(59)90414-X].
[45] Widana, I.K., Sumetri, N.W., Sutapa, I.K., Suryasa, W. (2021). Anthropometric measures for better cardiovascular and musculoskeletal health. Computer Applications in Engineering Education, 29(3), 550–561. https://doi.org/10.1002/cae.22202
[46] P. D. Duh et al., “Antioxidant activity of water extract of HarugJyur (Chrysantheummorifoliumramat),” LebensonWiss Technol., vol. 32, pp. 269-277, 1999.