



Indian Aquatic Plants: Untapped Resources for Novel Therapeutic Agents

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ABSTRACT

In pond environments, many aquatic plants have special roots or structures that help them stay anchored and thrive in water. These plants aren't found only in ponds — they also grow in lakes, streams, marshes, and rivers. For a long time, they were often dismissed as useless or weedy since they weren't seen as productive or practical. However, India's waterways contain a surprising variety of these plant species, even though research on their possible medicinal uses is still quite limited. Recent studies have shown that many aquatic plants may have valuable health benefits. Some of them have been found to show antibacterial, anti-inflammatory, cholesterol-lowering, blood sugar-reducing, and antifungal effects. Because of this, it's worthwhile to explore their potential therapeutic uses. This review aims to summarize what is currently known about the medicinal potential of common aquatic plants found in different parts of India. It may be helpful for readers and researchers who are interested in studying plant extracts or isolated compounds to better understand how these species could be used in medicine.

INTRODUCTION

For millennia, humans have relied on nature to fulfill fundamental needs such as medicine, nutrition, flavoring, clothing, shelter, and transportation. Medicinal plants, in particular, have played a pivotal role in healthcare systems, especially within developing countries (Dar *et al.*, 2017). Empirical evidence suggests that natural products often demonstrate therapeutic efficacy comparable to, or even surpassing, that of synthetic molecules (Subramaniam *et al.*, 2019; Imtiaz *et al.*, 2020). As a result, they have been

employed in the treatment of a wide range of disorders, from minor fevers to severe infections, and are widely recognized for their significant pharmacological effects in humans. The "Materia Medica" includes approximately 2,000 natural products with therapeutic value, of which around 400 are of mineral and animal origin, while the remainder are of vegetable origin. Ayurveda, the traditional system of medicine in India, recommends the use of approximately 1,250 Indian medicinal plants as adjunctive, supportive, or prophylactic therapeutic agents. Herbal medicines are increasingly favored over modern synthetic pharmaceuticals due to their accessibility, greater therapeutic potential, and lower cost (Sarma *et al.*, 2014; Pathak *et al.*, 2019). Historically, plants from aquatic ecosystems were often regarded as unproductive or even detrimental. However, with advances in ecological understanding, their numerous ecological roles and values have become apparent (Dubey *et al.*, 2025). The critical functions performed by aquatic ecosystems for maintaining sustainable life have long been recognized globally. Aquatic angiosperms, in particular, play an essential role in enhancing the efficiency and maintaining the equilibrium of aquatic ecosystems. Despite this, these plants remain understudied, and their potential therapeutic applications are largely unexplored. Aquatic plants are characterized by highly flexible morphologies and unique developmental patterns, which are adaptive responses to their environmental conditions. India hosts some of the world's most extensive aquatic ecosystems, owing to its diverse climate, perennial rivers, fertile soils, dense forests, and vast meadows (Niroula *et al.*, 1990). Despite the abundance of aquatic vegetation in the country, scientific literature addressing their therapeutic utility is limited. This review aims to assess the medicinal potential of aquatic flora found in India and compiles information on selected aquatic plants with significant therapeutic importance (Dubey *et al.*, 2023).

Aeschynomene aspera

Aeschynomene aspera is a species of flowering plant in the Fabaceae family, commonly known as Sola, Sola Pith Plant, Pith Plant, Laugauni, or Netti (Tamil). The plant's low-density pith is traditionally used for making pith helmets and various insulation products, in addition to green manure or as a cover crop (Karimulla *et al.*, 2014). In Indian traditional medicine, the roots and leaves are applied in the treatment of jaundice, joint pain, and swelling (Imtiaz *et al.*, 2020). The roots and aerial parts are also used for conditions such as mumps, colds, coughs, and fever. Crude extracts of the plant have been shown to enhance semen consistency (Panda *et al.*, 2011) and are recommended for painful micturition and the dissolution of uric acid calculi. Phytochemical analysis reveals the presence of secondary metabolites such as tannins, glycosides, carbohydrates, gums, reducing sugars, flavonoids, alkaloids, and steroids, some of which exhibit free radical scavenging activity. Furthermore, hepatoprotective effects of *A. aspera* have also been reported.

Aponogeton crispus

Aponogeton crispus, a species within the obligate freshwater aquatic genus *Aponogeton* (family *Aponogetonaceae*), is distributed throughout tropical and subtropical regions of Africa, Asia, and Australia. Approximately 57 species have been identified globally, such as *A. undulatus*, *A. ulvaceus*, *A. natans*, *A. crispus*, and *A. appendiculatus*, being well-known (Chowdhury *et al.*, 2019). In Sri Lanka, four species—*A. rigidifolius*, *A. jacobsenii*, *A. crispus*, and *A. natans*—are prevalent, and "Kekatiya" is the vernacular name (Manawaduge *et al.*, 2016). In India, *A. crispus* has been reported in Andhra Pradesh, Kerala, Karnataka, Tamil Nadu, West Bengal, and Maharashtra (Sujana *et al.*, 2016). The whole plant and tubers are utilized in traditional medicine for conditions such as burning sensations, cardiac diseases, nausea, diabetes, wounds, and polydipsia. In Ayurveda, it is indicated to reduce "pithadosa," increase "vatha" and "kaphadosha," and improve vision. Additionally, hypoglycemic activity has been recorded.

Ceratophyllum demersum

Ceratophyllum demersum, commonly known as hornwort or coontail, is a perennial, cosmopolitan submerged macrophyte from the family *Ceratophyllaceae* (Syed *et al.*, 2018). Its dense whorls can impede water flow, disrupt aquatic oxygen balance, reduce biodiversity, and cause fish mortality. It thrives at depths of 0.5– 8.5m, propagating primarily through stem and seed fragmentation. Native to tropical America, it rapidly invades new habitats, often forming dense colonies (Garlich *et al.*, 2016). Notably, it has a high capacity for biomass production and nutrient and cadmium removal from water, making it valuable for phytoremediation.

Enhydra fluctuans

Enhydra fluctuans, known as water cress or marsh herb, is a hydrophytic annual plant prevalent from November to January along wet roadside canals and marshlands. It is distributed in Bangladesh, China, Malaysia, Southeast Asia, and tropical Africa, with northeastern India, especially Assam and Meghalaya, having significant populations (Sarma *et al.*, 2014). The plant is traditionally used for inflammatory conditions, dermatological disorders, smallpox, dropsy, anasarca, snakebite, and ascites. Pharmacological evaluations have revealed antioxidative, analgesic (Ruhul *et al.*, 2012), cytotoxic, antimicrobial, hepatoprotective, hypotensive, CNS depressant, antidiarrheal, anticancer, anti-inflammatory, and antidiabetic activities (Kuri *et al.*, 2014). Phytochemically, it is rich in β -carotene, proteins, sesquiterpenes, lactones, gibberellins, flavonoids, stigmasterol, saponins, diterpenoid acids, myricyl alcohol, and various sesquiterpene lactones.

Hygroryza aristata

Hygroryza aristata is an aquatic floating grass native to tropical Asia, commonly referred to as Asian water grass. It proliferates in sun-exposed, tidally inundated wetlands

and canals. The grass forms spongy stems with feathery, whorled roots at nodes, providing habitat for aquatic invertebrates and serving as a protein source for grass carp (**Hossain *et al.*, 2020**). It is traditionally used as an emollient, galactagogue, and remedy for diarrhea, fatigue, and general weakness. Seeds possess cooling, astringent, and soothing properties for urinary and biliary disorders (**Rashid *et al.*, 2019**).

Ipomoea aquatica

Ipomoea aquatica (syn. *Ipomoea reptans* Linn.), commonly known as water spinach, is a perennial herb native to China, widely found across tropical Asia, Africa, and Australia. Its flowers and leaves exhibit antioxidant and oral hypoglycemic activities, and its methanolic leaf extract demonstrates hypolipidemic properties. In traditional medicine, it is employed for fever, jaundice, bronchitis, hepatic disorders, and as a carminative and nervine tonic. Phytochemically, it is rich in proteins, carotenes, essential amino acids, minerals, sugars, fibers, lipids, organic acids, vitamins, polyphenols, and flavonoids. Additionally, it has demonstrated antimicrobial and anthelmintic activities (**Singh *et al.*, 2016**).

Ludwigia adscendens

Ludwigia adscendens (L.)—water primrose—is an invasive perennial herb forming dense mats in stagnant waters. The plant is traditionally employed as a poultice for ulcers, skin disorders, as an emetic, astringent, anthelmintic, antidysenteric, diuretic, and for infections of the skin, scalp, eyes, and throat (**Oyedeggi *et al.*, 2011**). Ornamental uses are also notable in Europe due to its attractive yellow flowers. It is reported to possess anti-inflammatory and febrifugal activities.

Nelumbo nucifera

Nelumbo nucifera (Indian or sacred lotus; family Nymphaeaceae) is well-known for its ornamental and medicinal properties. All parts—leaf, rhizome, seed, flower—are employed in traditional medicine for a variety of conditions including pharyngoplasty, spermatorrhea, leukoderma, dysentery, hemorrhage, hyperlipidemia, hepatopathy, and fever (**Mukherjee *et al.*, 2009**). It is also recognized for unique features such as long seed viability, temperature regulation in flowers, and a self-cleaning lotus effect.

Neptunia oleracea

Neptunia oleracea Lour. (family Fabaceae), known as water mimosa, is native to tropical and subtropical Asia, thriving in moist, swampy environments. It is utilized as an edible plant in India, though health risks remain under investigation. The plant demonstrates rapid vegetative growth and is capable of phytoremediation by removing heavy metals from contaminated water (**Bhunja *et al.*, 2012**). Pharmacologically, it

exhibits astringent, antimicrobial, and anticancer properties, while roots are used in the later stages of syphilis (**Wahab et al., 2014**).

Nymphoides hydrophylla

Nymphoides hydrophylla, or white-water snowflake, is a perennial aquatic herb found in lakes and ponds across Cambodia, Bhutan, Bangladesh, and India (**Kumar et al., 2021**). The plant is traditionally used as a substitute for Chiretta in treating fever and jaundice. Leaves and stalks are applied to ulcers and insect bites, while seeds are used for anthelmintic purposes. The plant is rich in essential amino acids, crude fat, carbohydrates, fiber, and proteins.

Rotala rotundifolia

Rotala rotundifolia is a perennial, amphibious herb commonly found in paddy fields and wetlands across South and Southeast Asia. It is widely used in aquascaping due to its aesthetic appeal (**Navya et al., 2018**). Although its therapeutic efficacy remains underexplored, it is valued for its ornamental and ecological contributions.

Sagittaria trifolia

Sagittaria trifolia (Chinese arrowhead) is an herbaceous wetland species with a wide distribution across Asia and parts of Europe. It is used both as food and traditional medicine in China and is noted for its role in water purification by absorbing phosphorus and nitrogen. Nutritionally, it is rich in carbohydrates, proteins, minerals, and vitamins. Extracts from the leaves are used to treat skin disorders, while corms are associated with inducing premature birth (**Ahmed et al., 2019**).

Spirodela polyrhiza

Spirodela polyrhiza (greater duckweed; family Lemnaceae) is a rapidly growing aquatic monocot found in Asia. It forms dense mats on water surfaces and is used for food, animal feed, and phytoremediation due to its ability to accumulate heavy metals (**Rahman et al., 2007**). It contains significant protein and flavonoids with potent antioxidant activities.

Trapa natans

Trapa natans L. (water chestnut) is an edible aquatic herb widely cultivated for its seeds, which are a rich source of carbohydrates, minerals, and vitamins (**Kutschera et al., 2015**). Medicinally, it is valued for its antioxidant, antibacterial, antifungal, anti-diabetic, analgesic, anti-inflammatory, and hepatoprotective properties. It is extensively used in traditional systems to treat a wide range of ailments including sexual weakness, dysentery, and general debility.

Nymphaea stellata

Nymphaea stellata (family Nymphaeaceae) is recognized for its star-shaped flowers and is an important constituent of Ayurvedic formulations. It contains a variety of bioactive compounds, including sterols, alkaloids, saponins, tannins, and flavonoids. The plant exhibits antihyperglycemic, antihepatotoxic, and hepatoprotective activities, and is traditionally used for a wide range of ailments such as diarrhea, fever, piles, and tumors. Ethnic communities in India also consume its roots and seeds as part of their diet (Chowdhury *et al.*, 2013).

Hydrilla verticillata

Hydrilla verticillata (water thyme; family Hydrocharitaceae) is a submerged perennial aquatic herb native to central Africa and Australia and is now widely distributed. It is rich in essential nutrients, including vitamins B12, calcium, iron, and polysaccharides, and is considered a valuable "green food." It is traditionally used for neurological, cardiovascular, and gastrointestinal disorders and possesses antibacterial, antimicrobial, and wound healing properties (Annie *et al.*, 2016).

Pistia stratiotes

Pistia stratiotes (water lettuce) is a stoloniferous floating aquatic plant widely distributed in tropical and subtropical regions. It can form dense mats that disrupt aquatic ecosystems and agricultural activities. Traditionally, it is used as an antiseptic, antidysenteric, and antitubercular agent. Extracts are also used to treat eye and ear complications, skin diseases, and gastrointestinal disorders. The plant exhibits notable antibacterial and antifungal activities (Khan *et al.*, 2014).

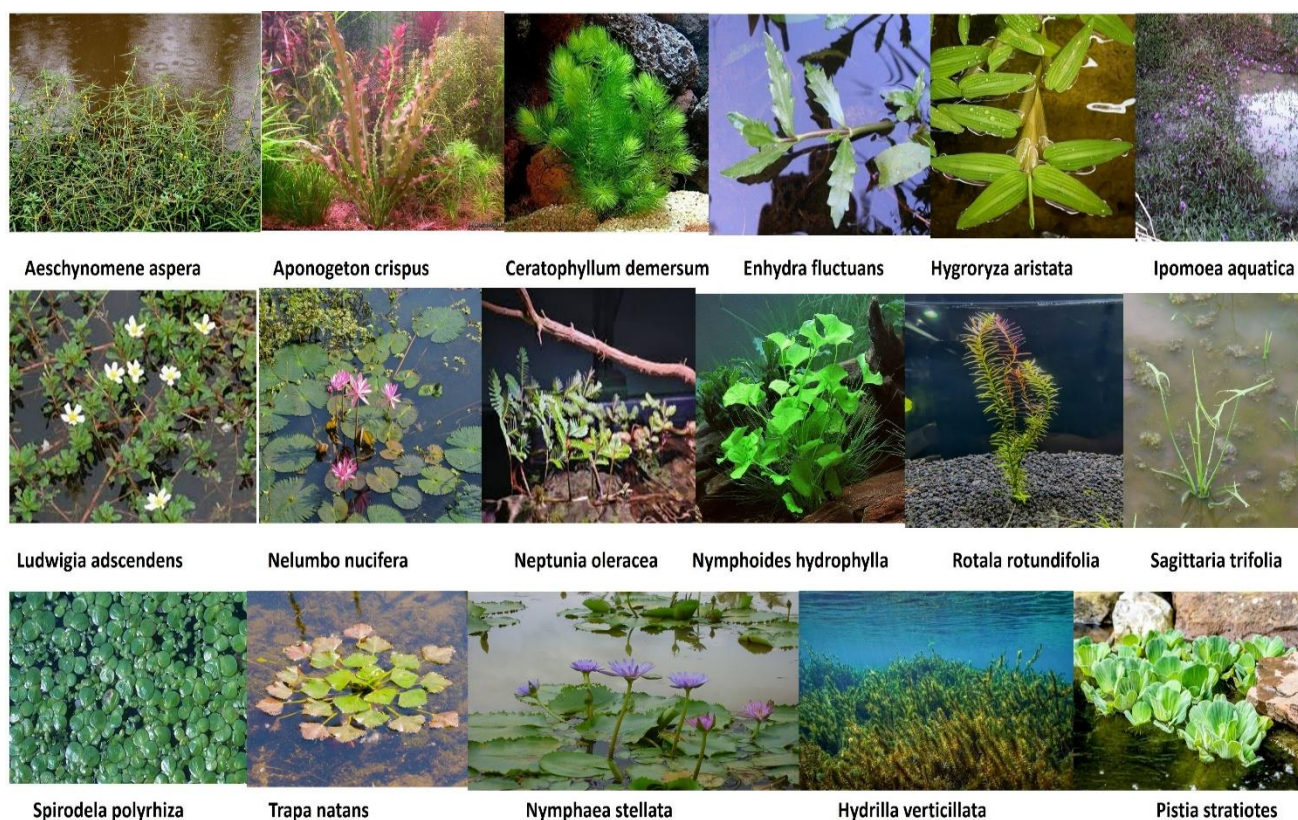


Fig. 1. Different types of Indian aquatic plants

Table 1. Diversity, ecology, and biogeographical distribution of aquatic macrophytes in India

Sl. No.	Plant Species	Locations in India	Secondary Metabolites	References
1	<i>Aeschynomene aspera</i>	Assam, Bihar, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Odisha, Sikkim, Tamil Nadu, Uttar Pradesh,	Tannins, glycosides, carbohydrates, gums, reducing sugars, flavonoids, alkaloids, and steroids	Imtiaz <i>et al.</i>, 2020
2	<i>Aponogeton crispus</i>	Kerala (Wayanad District)	Protocatechuic acid, chlorogenic acid, caffeic acid, trans- <i>p</i> -coumaric acid, hydroxybenzoic acid,	Aruna <i>et al.</i>, 2012

			hydroxycinnamic acid, and flavonoids	
3	<i>Ceratophyllum demersum</i>	Assam, Bihar, Madhya Pradesh, Maharashtra, Punjab, Rajasthan	Alkaloids, phenols, and flavonoids	Mohamedomar et al., 2017
4	<i>Enhydra fluctuans</i>	Assam, Eastern Himalaya	β -carotenes, proteins, lactones, sesquiterpenes, gibberellins, flavonoids, stigmasterol, saponins, myricyl alcohol, diterpenoid acids and their isovalerate and angelate derivatives	Deb et al., 2016
5	<i>Hygroryza aristata</i>	Assam, Punjab, Uttar Pradesh	Cycloeucalenol, β -sitosterol, stigmasterol mixture, eicosanoic acid 2,3-dihydroxypropyl ester, butcosanoic acid 2,3-dihydroxypropyl ester, coumaric acid, methyl coumarate	Chung et al., 2011
6	<i>Hydrilla verticillata</i>	Andhra Pradesh, Arunachal Pradesh, Assam, Uttar Pradesh, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, ,	Hexadecanoic acid ethyl ester, phytol, linoleic acid e	Rajkumar et al., 2015
7	<i>Ipomoea aquatica</i>	Assam, Bihar, Madhya Pradesh, Odisha,	Proteins, carotenes, amino acids (aspartic acid, threonine, serine, glutamic acid,	Singh et al., 2016

		Rajasthan, Uttar Pradesh	proline, glycine, alanine, leucine, tyrosine, lysine, luteolin, apigenin, kaempferol,	
8	<i>Ludwigia adscendens</i>	Assam, Bihar, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh	Squalene, betulonic acid, betulin, betulinic acid, quercetin, protocatechuic acid, afzelin, quercitrin, methyl gallate, gallic acid, myricitrin	Shilpi et al., 2010
9	<i>Nelumbo nucifera</i>	Assam, Bihar, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh	Alkaloids, steroids, triterpenoids, flavonoids, glycosides, and polyphenols	Mukherjee et al., 2009
10	<i>Neptunia oleracea</i>	Northeastern India, Maharashtra (Konkan region)	Catechin, derivatives of quercetin, kaempferol, myricetin, apigenin, phenolic acids	Lee et al., 2019
11	<i>Nymphoides hydrophylla</i>	Assam, Maharashtra, Madhya Pradesh, Odisha, Kerala	Fat, carbohydrate, fibres, and proteins	Kumar et al., 2021
12	<i>Pistia stratiotes</i>	Assam, Bihar, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh	Alkaloids, flavonoids, tannins, phenolic compounds, steroids, saponins, and glycosides	Tyagi et al., 2017
13	<i>Rotala rotundifolia</i>	Assam, Madhya Pradesh, Meghalaya	Flavonols and their glycosides	Zhang et al., 2011
14	<i>Sagittaria trifolia</i>	Kerala, Maharashtra, Odisha	Flavonoids, phenols, saponins, tannins, glycosides, and steroids	Ahmed et al., 2019

15	<i>Spirodela polyrhiza</i>	Moist temperate and tropical regions (Kerala)	Alkaloids, steroids, flavonoids, saponins, manool, biformen, and phytol	Kurashov et al., 2016
16	<i>Trapa natans</i>	Assam, Bihar, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh	Thiamine, riboflavin, nicotinic acid, vitamin C, vitamin A, D-amylase	Chowdhury DU et al., 2016
17	<i>Nymphaea stellata</i>	Assam, Bihar, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, Chhattisgarh,	Sterols, alkaloids, saponins, tannins, flavonoids, astragalin, corilagin, gallic acid, gallic acid	Chowdhury DU et al., 2016

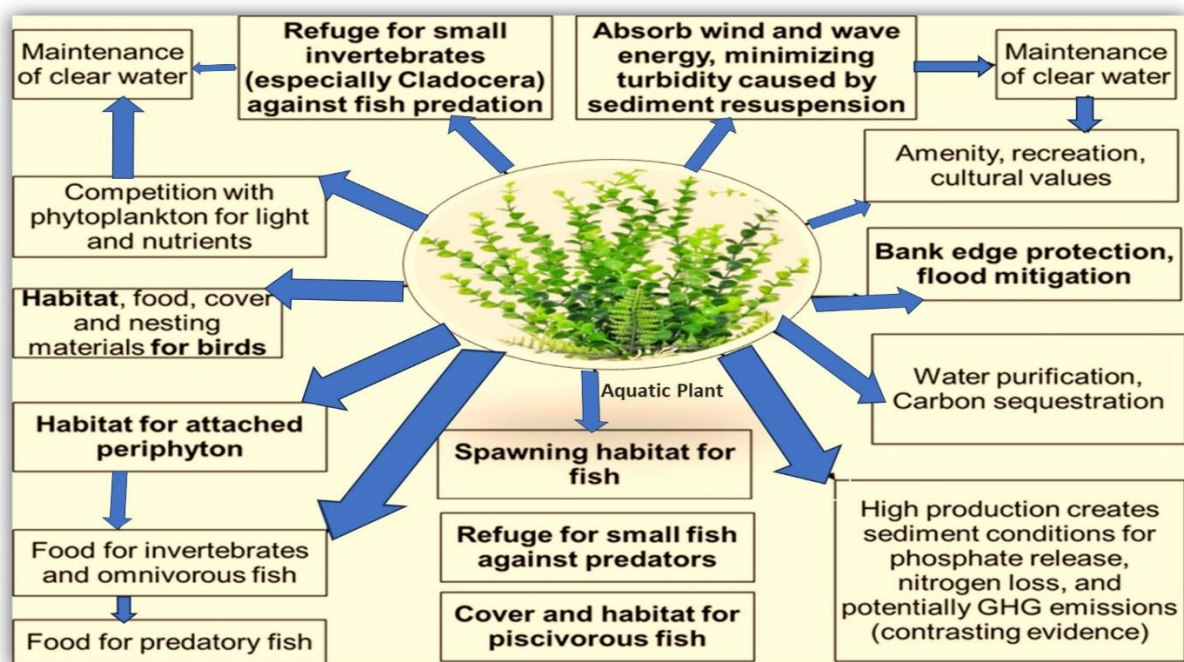


Fig. 2. Influence of aquatic plants on the physical, chemical, and biological processes in shallow lakes and ponds, and their role in supporting ecosystem services

CONCLUSION

Terrestrial plants have historically been the predominant source of medicinal agents in India and globally, primarily due to their greater abundance, accessibility, and long-standing ethnobotanical documentation. In contrast, the therapeutic potential of aquatic macrophytes remains comparatively underexplored, as references to their medicinal applications are limited within ethnopharmacological and phytochemical literature. Systematic ethnomedicinal investigations among indigenous and local communities inhabiting regions adjacent to wetlands, rivers, and other aquatic ecosystems could provide valuable primary data regarding the traditional uses of aquatic plant species. Moreover, existing phytochemical analyses and pharmacological evaluations of several aquatic taxa indicate the presence of diverse bioactive secondary metabolites with potential therapeutic significance. These findings underscore the necessity for extensive, multidisciplinary research aimed at the isolation, characterization, and mechanistic evaluation of bioactive compounds derived from India's aquatic flora. Such efforts could facilitate the discovery and development of novel drug candidates from an underutilized botanical resource pool.

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