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Chapter- 4

Aquatic Macrophytes: An Untold and Valuable Panoramic Resource of Ethnomedicine

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Abstract:

Medicinal plants have been used in healthcare since ancient times by different societies, tribes and communities worldwide. From ancient times human beings started to acquire knowledge about medicinal plants that helped to improve health conditions through observation and experiments. Phytomedicines and herbal drugs obtained from medicinal plants are a primary source for treating several diseases. These medicinal plants contain several secondary metabolites and bioactive compounds that are the main source of the plant's therapeutic properties. Several products from ethnomedicinal plants are cost-effective, safe, and have fewer side effects. Therefore, they are becoming the main targets for the production of herbal drugs in the pharmaceutical industry. Moreover, aquatic macrophytes are also being considered as a source of medicine nowadays and are used by several tribes for medicinal purposes. This review deals with the aquatic macrophytes that are usually used by different tribes worldwide for treating several diseases and their bioactive compound present in plants and provide protection against diseases.

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Introduction:

J. W. Harshberger first used the term "Ethnobotany" in 1895. This term is derived from two words, "ethno" which means the study of people and "botany" that means study of plants. So, ethnobotany deals with the study and evaluation of the direct relationship between plants and humans and the effects of plants on human society (Prance, 1991; Himanshu & Ashwani, 2011; Sanyal et al., 2018; Kundu, 2022). The term Ethnobotany is often used as a synonym for traditional medicine and economic botany. The use of processed plant parts or whole plant for business purposes is called economic botany. But traditional medicine is not synonymous with ethnobotany. Earlier, at the time of the origin of traditional medicine there were some roots of ethnobotanical folklore, but nowadays traditional medicine includes several systems that are well organized and have undergone different diagnostic tests (Prance, 1991).

According to the WHO, over 80% of the total world's population depends on plants to cure primary health issues. Plants are a great source of medicines and have been used from prehistoric times (Bhattacharjee, 2021; Sarkar et al., 2016; Sarkar, 2017; Maiti et al., 2010; Maity et al., 2013). The earliest record of the healing properties of plants was found in Rig-veda in India (Mazid et al., 2012).

Many folk medicinal practices are verbally transmitted from one generation to another and sometimes confined to a particular region or within a group of tribal people (Mazid et al., 2012; Erfani, 2021; Kar et al., 2022). But nowadays due to industrialization and life-style, this process has become faded. For this reason, many ethnobotanical and ethnopharmacological research works and documentation processes have been undertaken to conserve the native information (Banerjee et al., 2014; Bouasla & Bouasla, 2017; Acharya, 2016; Acharya et al., 2021).

Aquatic macrophytes normally herbaceous, are one of the most important parts of the aquatic ecosystem. Aquatic macrophytes include some macroalgae, several bryophytes such as mosses, ferns and many angiosperms that are found either particularly in one or some seasons or throughout the entire year in wetlands, streams, ponds or lakes. These are highly productive with a fast growth rate. These plants are being used as phytomedicine throughout the world. In India, Russia, and China, these are also used as ethnomedicine for respiratory problems, kidney disease, and some other diseases such as gastrointestinal, liver, and skin diseases. These medicines show remarkable positive effects on cancer and diabetic patients (Unadkat & Parikh, 2021). Different parts of aquatic macrophytes such as leaves, roots and stems, possess medicinal properties. For example, the leaves are thought to have diuretic, blood purifying properties. Different plants are different in their effectiveness against any one kind of disease like Brahmi is more effective than Madukparni as brain tonic (Mazid et al., 2012). Moreover, aquatic macrophytes protect against diseases as they have different and diverse phytochemicals such as alkaloids, flavonoids, terpenoids, carotenoids, proteins, steroids and minerals. These compounds have several biological properties like antioxidant, antidiabetic and anticancerous properties. From ancient times, these aquatic plants have been used in the treatment of various diseases on the basis of their availability, low cost, compatibility etc. (Poddar et al., 2020).

Classification of Aquatic Weeds According to Zonation:

The aquatic weeds can be categorized according to different pond zones: Floating, Emergent, Marginal and Submerged (Sanyal, 2017).

Floating:

There are several families found in this category such as Pontideriaceae, Araceae, Salviniaceae, Lemnaceae etc.

Pontederiaceae:

Various plants of Pontederiaceae family play an important role in the sector of ethnomedicine. *Monochoria vaginalis* (Pond weed) is native to Sri Lanka and also found in Philippines, China, Korea, Vietnam, Bhutan, Cambodia, India, Indonesia, Malaysia, Myanmar, Nepal, Pakistan and Taiwan. Neelyaadi oil, made from *Monochoria vaginalis*, is used as wound and fracture healing component and helps lower blood pressure and headache, curing skin disease. This plant's leaf extract helps cure many diseases such as cough, asthma, toothache, and stomach and liver problems. The root extract of this plant is also used as anti-inflammatory and anti-nephrotoxic agent (Narathota et al., 2020). *Monochoria hastata* is another plant of this family which has some pharmacological properties such as diuretics, blood cleaning, and anti-gingivitis activity. It also exhibits anti-asthmatic anti-inflammatory, anti-nephrotoxic, analgesic, fever suppressing properties, as well as toothache relief action (Haq et al., 2021). *Pontederia crassipes* (water hyacinth), a representative plant of this family, also have some medicinal value. The extraction of this plant prevents the growth of gram-negative and gram-positive bacteria. This plant is also used in the textile industry (Abe et al., 2014).

Araceae:

Caladium bicolor is a member of Araceae family. It has antidiarrheal, antiseptic, emetic and insecticidal properties. This plant's leaf extract greatly affects gastrointestinal disorders (Salako et al., 2015). *Amorphophallus konjac* is another medicinal herb of Araceae family that acts as analgesic and antihemorrhagic and exhibits anti-tumor activity (Liu et al., 2019).

Salviniaceae:

Azolla pinnata is a very popular species of this family. Plant extract of this plant is used to treat sore throat and cough (Kumar et al., 2022). The mixture of leaf extract of *Salvinia natans* (floating fern) and ethanol or acetone exhibit antibacterial activity on *Escherichia coli*, *Vibrio sp*., *Staphylococcus aureus* (Al-Maliki et al., 2017). Methanolic extract of *Salvinia minima* (Water spangles) shows antimicrobial activity on *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Achromobacter spp*., *Candida albicans*, *Aspergillus niger*, *Aspergillus flavus* and chloroform extract of this plant act as an anti-growth factor against *Salmonella Typhi*, *Proteus mirabilis*, *Candida albicans* (Panda et al., 2014).

Lemnaceae:

Spirodela polyrhiza is an aquatic weed of this family. It contains fibrinolytic protease which hydrolyze fibrin and fibrinogen that ultimately helps in blood coagulation (Cho & Choi, 2003). This plant act as an oriental drug and is used for many diseases such as nephritis, oedema, urticarial. This plant has anticoagulant activity and acts as immunomodulatory, gastroprotective and anti-hypersensitive (Jeon, 2010).

Emergent:

Many emergent plants are found in the aquatic ecosystem, but the most important family is Nymphaeaceae. *Nymphaea* is an important member of this family which comprises many species such as *Nymphaea rubra* (Red water lily), *Nymphaea thermarum* (Extinct), *Nymphaea nouchali*, *Nymphaea alba* (White water lily), *Nymphaea tetragona*, *Nymphaea candida* and *Nelumbo nucifera*. These plants exhibit various medicinal properties. Rhizome of *Nymphaea nouchali* has pharmacological effect on dysentery, dyspepsia. Extraction of root and rhizome of *Nymphaea nouchali* is used for treatment of diabetes and cutaneous disease. Seed extract, flower extract of this plant, is used as astringent, cardiotonic agent and acts as an antibiotic against *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Shigella dysenteriae* and *Escherichia coli* and also inhibit fungal (Candida albicans, Trichophyton mentagrophytes) growth. *Nymphaea alba* is used in the case of anxiety disorder and it also acts as an anti-carcinogenic agent (Al-Maliki et al., 2017; Pareek & Kumar, 2016).

Marginal:

Cyperus rotundus is a type of marginal plant of the family Cyperaceae. This plant shows immunomodulatory properties and it also exhibits a positive effect on lactating mothers for milk secretion as well as it reduces menstrual cycle irregularity. Methanol, chloroform and acetate extract of rhizome of this plant acts as an antibiotic against *Staphylococcus aureus*, *Aspergillus niger*, *Klebsiella pneumonia*, *Candida albicans* and *Escherichia coli*. Ethyl acetate or methanolic extract of rhizome shows antifungal activity against *Aspergillus flavus* and *Aspergillus niger* (Aeganathan et al., 2015).

Submerged:

Hydrilla sp. is a type of submerged plant of Hydrocharitaceae family. It is used in case of neurological diseases and gastrointestinal diseases and helps improve blood circulation and cardiovascular complications. Otteliones A and B present in this plant show antitubercular and anticancer properties (Unadkat & Parikh, 2021).

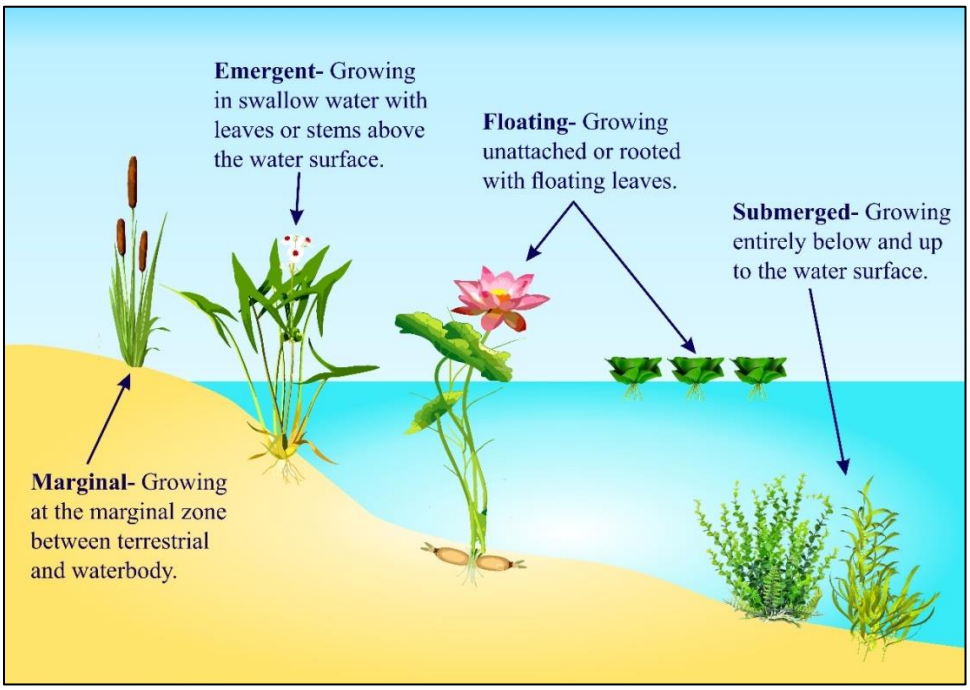

Figure 1. Different types of aquatic macrophytes are distributed at different zones of aquatic ecosystems.

Utilization of Aquatic Macrophytes by Various Tribal Communities:

Many aquatic macrophytes are distributed throughout the world and are being used by several tribes across the globe. *Enhydra fluctuans* is used by the Shan tribe of Assam and the Meitei-pangal community to treat diabetes. In Meghalaya, this plant is used by the Jaintia tribe for treating skin diseases and liver problems. Muslim herbalists use this as a cure for kidney diseases (Sarma et al., 2014, Saha & Paul, 2019). *Anagallis arvensis* is mainly found in rural areas of Egypt, Palestine, South America, Taiwan and this plant is generally used for treating different types of kidney problems (Yasmeen et al., 2020). *Bacopa monnieri* is generally used by many tribal communities in Rajasthan to treat many diseases. The tribals of eastern Rajasthan and Kathodias (a monkey-eating tribe) use this plant for its medicinal value (Verma, 2014). Tribes of Himachal Pradesh like, Gaddis, Pangwal, Kinnayris, Lahaulis, Bhots, Gujjars use *Chenopodium album* as a medicinal source (Radha, 2022). *Commelina benghalensis* is used by the Jawhar tribes in Rajasthan for treating various diseases (Deshpande et al., 2019). *Eclipta alba* is used by tribes of Manipur, Tamil Nadu and Sagar tribes of Madhya Pradesh (Kumari et al., 2021). *Heliotropium indicum* plant is mainly used by twelve clans of Santals such as the Soren clan in Rajshahi of Bangladesh (Rahmatullah et al., 2012). *Homonoia riparia* is used by the Irula tribes of Tamil Nadu (Binu et al., 2003). *Portulaca oleracea* is mainly used by Turi tribe of north-west Pakistan (Abbas et al., 2020). *Rungia repens*, is used as medicine for various purposes by different communities such as Dimasa, Vaiphei, Biate, Hamar, Mizo, Kukis of Dima Hasao District of Assam (Roy & Nath, 2019). *Ammannia baccifera* is used in several parts of India by

different tribes such as Jhara, Keura, Dhivara tribe of Orissa, Sugali tribe of Andra Pradesh, Muthuvas tribe of Kerala, Gujjars, Bhotiyas tribe of North-west Himalaya, Maher tribe of Gujrat, Santal- Kantabania tribe of Jaipur, Kanikkars tribe of Western ghat etc. (Poornima et al., 2014).

Table 1. Some ethnomedicinal plants along with their medicinal uses, parts which are responsible for medicinal use, major bioactive compound, pharmacological activity.

Name	Family	Common Name	Parts Used	Medicinal Uses	Major Bioactive Compounds	Pharmacological Properties	Ref.
Ammania baccifera L.	Lythraceae	Dadmari	Leaf, whole plant	Leaves have purgative, stomachic and aphrodisiac activities. Used for treating rheumatic pains, leukorrhea, snake-bites and ulcers.	Isoquercitrin, Luteolin 7-O-β-D-glucoside, Isorhamnetin 3-rutinoside, Apigenin-7-O-β-D-glucopyranoside, Kaempferol-3-rhamnoglucoside.	Anti-oxidant, anti-inflammatory, antimicrobial.	Verma & Singh, 2008
Anagallis arvensis L.	Primulaceae	Krishna neel	Whole plant, seed, leaf.	Treatment of liver complications, skin problems, conjunctivitis, rabies.	Kaempferol-3-rhamnoglucoside, Cucurbitacin, α-Spinasterol, ß-sitosterol, Linoleic acid.	Antimicrobial, anti-oxidant, anti-inflammatory, cytotoxic, antiviral.	Verma & Singh, 2008
Bacopa monnieri (L.) Wettst.	Scrophulariaceae	Brahmi	Whole plant, leaf, roots.	Used as memory booster and to treat asthma, bronchitis, piles, dysentery etc.	Anthraquinone glycosides, saponins, flavonoids, steroids, tenins.	Antimicrobial activities.	Jeyasri et al., 2020

Chenopodium album L.	Chenopodiaceae	Bathua saag	Whole plant, leaves, roots, seeds.	To treat fever, influenza, gastroenteritis, skin dieases, venereal diseases and rheumatic disorders	Phenolics (Gallic acid, Benzoic acid, Caffeic acid), Flavonoids (Querectin, Apigenin), Terpenoids (Linalool, limonene).	Antibacterial, antifungal, antiviral, antiparasitic, anticancer, antidiabetic, antioxidant, anti-inflammatory activities.	Verma & Singh, 2008
Commelina benghalensis L.	Commelinaceae	Dholpata	Whole plant, stem	Used for curing several eye diseases like night blindness, conjunctivitis, skin diseases like eczema, acne and to treat infertility in women.	Salicylic acid, p-Coumaric acid, 8-Hydroxyquinoline, Caffeic acid, Ascorbic Acid, α-carotene, β-carotene, β-sitosterol.	Anti-inflammatory, anti-microbial, larvicidal, anti- diarrheal, anti-helminthic activities.	Jeyasri et al., 2020
Commelina diffusa Burm. F.	Commelinaceae	Kanshira	Whole plant, leaf, stem.	Used to treat high blood pressure, frequent urination, diarrhoea.	Anthocyanins, stigmasterol, n-octacosanol, n-triacontanol, campesterol.	Anti-proliferative, anti-microbial, antioxidant activity.	Verma & Singh, 2008

Cyperus rotundus L.	Cyperaceae	Motha	Rhizome	Used to treat vomiting, indigestion, stomach disorders, irritation of bowl, dysentery, fever, cough, bronchitis	β-patchoulene, Rotundone, β-caryophyllene, Isorhamnetin, Salicylic acid, Caffeic acid, β -Sitosterol 3-O-beta-D-galactopyranoside.	Anti-inflammatory antipyretic, hypolipidaemic, antidiarrheal, antimicrobial, antioxidant, antidiabetic activity.	Seethapathy et al., 2014
Eclipta alba (L.) Hassk	Asteraceae	Bhringraj	Whole plant, leaf.	Used to treat jaundice and skin diseases, cirrhosis of liver and gall bladder, minor cuts, hepatic and spleen enlargement etc.	Desmethylwedelolactone glucoside, 20-epi-3-dehydroxy-3-O-5,6-dihydro-4,5-dehydroverazine, Ecliptalbine, Ursolic acid.	Anti-hepatotoxic, antioxidant, immunomodulatory, analgesic, antidiabetic, anticancer activities.	Verma & Singh, 2008
Enhydra fluctuans Lour	Asteraceae	Helencha saag	Leaf, stem, whole plant	Used to treat gastric ulcers, constipation, diabetes, pimples, kidney stones and nervous problems.	β-carotenes, Stigmasterol, Enhydrin, Farnesyl acetate, Baicalein-7-O-glucoside.	Antidiabetic, antimicrobial, anti-inflammatory, antioxidant, anti-cancer, neuroprotective activity.	Jeyasri et al., 2020
Heliotropium indicum L.	Boraginaceae	Hanthi sur	Entire plant, flower, stem, leaves and roots.	Used in treatment of fever, ulcers, sore throat, menorrhagia, herpes, whooping cough, dysmenorrhea.	Lasiocarpine, Retronecine, Cynoglossine, Heliotrine N-oxide, β-amyrin, β-sitosterol, stigmasterol and campesterol.	Antifungal, antibacterial, anti-tumor, anti-inflammatory, antipyretic, diuretic, antioxidant activity.	Verma & Singh, 2008

Homonoia riparia Lour.	Euphorbiaceae	Willow-leaved water croton	Leaves, root, flower, fruit	Inhibitory effects on advanced glycation end product (AGE) formation that cause diabetic complications. It is also used to treat ulcer , skin disease etc.	Amentoflavone, Astragalin, quercitrin, Myricetin-3-O-glucoside, Desmanthin-1, corilagin, (-)-Epigallocatechin-3-O-gallate and (-)-Epicatechin-3-O-gallate	Angiogenesis inhibitory activity, antioxidant, nephroprotective, antifungal, anticancer activity.	Jeyasri et al., 2020
Hygrophila auriculata (K. Schum.) Heine.	Acanthaceae	Kulekhara	Seed, root, stem, leaves, whole plant	To treat diarrhea, cancer, body pain, jaundice, tuberculosis, fistula, urinogenital complications and liver diseases.	Apigenin-7-O-β-D-glucuronide, Luteolin 7-rutinoside, Ellagic acid, Gallic acid, Lupenone, Hentriacontane, Stigmasterol.	Antimicrobial, anticancer, antidiabetic, antioxidant, diuretic, anti-inflammatory, antipyretic activity.	Verma & Singh, 2008
Nymphoides indica (L.) Kuntze	Menyanthaceae	Chandmala	Roots and leaves	Used to treat skin infections, sunstroke, vomiting, fever, diarrhea etc.	-	-	Verma & Singh 2008

Oldenlandia corymbosa Linn.	Rubiaceae	Diamond flower	Whole plant, leaves, root.	Used to treat sore eyes, stomach problems and high fever.	Geniposide, 6-α-Hydroxygeniposide, Scandoside methyl ester, Asperuloside, Lyoniresinol 3α-O-β-D-Glucopyranoside, bifloron and biflorin.	Antibacterial, hepato-protective, antimalarial, antioxidant, antidiabetic activity.	Verma & Singh 2008
Portulaca oleracea L.	Portulacaceae	Golgola saag	Whole plant, leaves, seeds	Used to treat lung, liver, kidney diseases, asthma, urogenital infections and inflammation, dysentery, skin rash, fever, mouth ulcers, toothache, excessive menstrual flow.	1,5-dimethyl-6-phenyl-1,2-dihydro-1,2,4-triazin-3(2H)-one, Aurantiamide acetate, Portulacanones A-D, Kaempferol, Apigenin, Myricetin, Portuloside A, Portuloside B, Pyridoxine, Quercetin, Portulene.	Antioxidant, hepatoprotective, analgesic, anti-inflammatory, hypocholesterolemic.	Verma & Singh 2008

Rungia repens (L.) Nees	Acanthaceae	Creeping rungia	All parts	Used in treatment of snake bite, fever, cough. Fresh leaves are crashed and mixed with castor oil and used to remove *Tinea capitis* (Ringworm of the scalp).	Luteolin 7-glucoside, delphinidin, chrysoeriol.	-	Seethapathy et al., 2014
Saccharum spontaneum L.	Poaceae	Kaash	Stem, whole plant, roots, leaf	To treat mental illness, vomiting, anaemia, burning sensation, gynecological troubles, respiratory problems	Coumarins, 3',4',5,7-Tetrahydroxy-3,8-dimethoxyflavone, 3,5-Dihydroxy-4'-methoxy-7-oxyglucopyronoside flavone.	Antioxidant, antifungal, cyototoxic, antibacterial activities.	Verma & Singh, 2008
Scirpus grossus L.	Cyperaceae	Kasheruka	Leaf	Used to treat constipation, respiratory problems, eye diseases, leucorrhea, burning sensation etc.	Alkaloids, phenols, flavonoids, terpenoids, saponin, steroids.	Anti-oxidant activity.	Verma & Singh, 2008
Sphaeranthus indicus L.	Asteraceae	Gorakmundi	Leaf, stem, root, bark, flower etc.	Used to treat piles, cough, jaundice, dysentery, rheumatic pains, mouth ulcer, leucorrhoea.	Sparteine, β-sitosterol, 7α-Hydroxyeudesm-4-en-6-one, 5-Hydroxy-3',4',6,7-tetramethoxyflavone.	Ovicidal, analgesic, anti-helminthic, anti-diabetic, antimicrobial activities.	Verma & Singh, 2008

Spilanthes acmella	Asteraceae	Toothache plant	Leaf, flower, whole plant	Used to treat rheumatism, fever, cough, tuberculosis, skin diseases, toothache etc.	Spilanthol, Ferulic acid, Vanillic acid, Coumarin, Stigmasterol, α-Amyrin	Antipyretic, anti-inflammtory, diuretic, antioxidant.	Verma, 2014
Vallisneria spiralis L.	Hydrocharitaceae	Eel weed	Leaf, whole plant.	The leaves are used to cure stomach pain and leucorrhoea.	-	-	Jeyasri et al., 2020

Conclusion:

This study focuses mainly on the medicinal uses of aquatic macrophytes in folklore which usually deals with the primary healthcare needs used by most of the world's population. The medicines obtained from these plants are cost-effective, easy to use, and have no serious side effects. They have been the source of various phytochemicals since ancient times. The plant derived medicines are well acknowledged as an origin of therapeutic agents. The worth and demand of plant-derived ethnobotanical and traditional medicine are gradually increasing for curing diseases. But, many aquatic macrophytes' medicinal practices by different tribes have not been properly studied. Therefore, detailed screening and surveys have to be made and the tribal uses must be verified through scientific experiments so that it would be beneficial in future drug discovery and combating different fatal diseases.

Conflicts of Interest:

None

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