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The rapeutic Potential of Some Aquatic Macrophytes: An Overview

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Abstract

In ancient times herbal plants have been using as traditional medicine as they are incredible sources of biologically active compounds with therapeutic properties. Though herbal plants play a vital role in prevention and treatment, diverse groups of people were using herbal plants for treatment of various human diseases. Globally, several plants in various ethnicities have been associated with the development of human civilization. However, phytochemical ingredients within plants increase medicinal value of it. Recently, conceivable source for the development of new herbal drugs are known to be medicinal plants as they possess immense healing properties. In the 21st century, management of healthcare against various emerging diseases is a real big challenge. Therapeutic effects of medicinal plants act as convivial for optimistic future medicine. In recent years, there has been a renaissance of interest to rediscover potential of medicinal plants as a source of medicament. Moreover, aquatic plants are considered as menace as they are often resulting of eutrophication, but this is also an illusion. Many aquatic plants are precious for mankind as they possess alleviating properties which are worth mentioning since several years. Therefore, the aim of the present review is to understand the therapeutical properties of selected aquatic plants (*Lemna minor L., Hydrilla verticillata L., Ceretophyllum demesrum L. Ipomea aquatica, Salviia minima L.*) as a future source of herbal drugs.

Keywords: Medicinal plants; Antimicrobial activity; Antioxidant activity; Therapeutical properties

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Introduction

Nature is a key reservoir of salvation for human being as it conserves various remedies in plants, animals and other sources to heal infirmity of mankind [1]. Medicinal plants are one of the most significant contributors amongst all of them. Medicinal plants as raw material, refined crude extracts and mixture has been used in the preparations of herbal medicine. In prehistoric times, all the major systems of medicine such as Ayurveda, Western medicine, Unani and those of orient medicines had used plants to treat various diseases. Hence, the plant kingdom has got extensive alertness as a speculative source of new drugs which results development of new protocol and technologies for the extraction of plant components based on biological activities rather than chemical compounds. In present day, allopathic system of medicine also believe that many important life saving medicines are plant origin only. From the last 50 years, majority of significant drugs using in modern medicinal practice have been isolated/derivated from plants. These chemical components illustrate therapeutic properties of either plants or animal drugs. Augmentation of herbal drugs accomplished in various national health care programs as per the recommendation and encouragement of WHO because they are simply cost effective, within the reach of ordinary people and are time tested so, much safer [2]. Therefore, by the screening of natural resources such as plant and animal extracts/oil detection of precious drugs obtained which facilitate the treatment of numerous human diseses [3].

In modern researches on bioactive molecules, plants are usually analyzed by comparring of sophisticated bioassay with bioassay of the fraction of medicinal plants used by traditional healers. As a result, several new therapeutically essential compounds isolated from plants. Several new pharmacologically active components and huge number of effective drugs with curative properties have been developed by the efforts and dedication of researchers [4]. Aquatic plants are the most important component of aquatic ecosystem. Human survival depends on aquatic biodiversities and their ecological niche. For instance an aquatic microorganism

helps to break down detrimental toxins as well as nutrients from human waste products. These microorganisms are also helpful in secondary and tertiary process of removing contaminants from municipal wastewater containing mainly household sewage and some industrial wastewater [5].

A fresh water plant biodiversity includes phytoplanktons as well as aquatic macrophytes. An aquatic macrophytes consist of some macroalgae, several bryophytes like mosses and liverworts, ferns and angiosperms that occur in seasonally or permanently wet environments. In aquatic environment this aquatic macrophytes have an important structural role and are highly productive [6]. Apart from this the people of Europe and Asia widely used aquatic plants as medicine. In Russia, China and some European countries family *Lemnaceae* are commonly used in preparation of folk medicine. Chinese and Russian folk medicine, a tincture of *Lemna minor* is used in hives, vitiligo, asthma, influenza and as a general tonic [7]. The aim of this review is to enhance awareness regarding medicinal value some aquatic macrophytes with the help of authentic publications and by the incorporation of traditional knowledge of local communities in this aspect.

Literature Review

Therapeutic properties of aquatic plants

Healthy life of people is a one of the best services provide by medicinal plants. Therapeutic properties of medicinal plants are unique characteristics as it helps in the healing of various human diseases. Antibacterial, antifungal and antiviral activities are crucial therapeutical properties of medicinal plants which noticeable by many researchers since hundreds of years.

Lemna minor

They are perennial or exceptionally annual. Generally found in a very wide range of aquatic habitats. Fronds solitary or usually remaining in groups of 2-10 or more [8].

Antioxidant activity

Protocol of different in vitro models followed to analyzed antioxidant activities of duckweed by many investigators. Lyophilized water extract and ethanol extract of duckweed used on lipid peroxidation of linoleic acid emulsion, inhibition of 100% and 94.2% obtained at 45 ug/ml concentrations by the lyophilized water extract and ethanol extract respectively while Butylated Hydroxyanisole (BHA), Butylated Hydroxytoluene (BHT), α-tocopherol, and trolox confirmed inhibition of 92.2%, 99.6%, 84.6%, and 95.6%, respectively. H2O2 scavenging activity, Ferrous ion chelating activity and Superoxide scavenging activity of lyophilized water extract and ethanol extract were 92.3 ± 2.8 and 85.7 ± 1.1, 63.0 ± 6.9 and 61.0 ± 6.0, and 38.8 ± 3.1 and 23.0 ± 2.4%, respectively [9]. Parikh and Unadkat reported enhanced level of antioxidant enzymes like catalase and guaiacol peroxide *in L. polyrhiza* on exposure to various Zinc metal ion concentration indicating oxidative stress in the test plants.

Antimicrobial activity

Two extracts of duckweed namely lyophilized water extract and ethanolic extracts were experimented for checking antimicrobial activities against different species of Staphylococcus *(S. epidermidis, , S. saprophyticus and S. warneri); Citrobacter (C. freundii and C. koseri) Neisseria (N.lactamica, N. sicca); Bacillus (B.cereus and B. subtilis)* as well as *Micrococcus luteus* and *Streptococcus pneumoniae*. These were also studied for anti candidal effect against *Candida parapsilosis* and *C. glabrata*. The results envisaged that mostly all the gram-positive and gram-negative bacteria and Candida species showed inhibition by both extracts. In the similar experiment, the aqueous extract of *Lemna minor* was studied against isolates of four bacterial strains; i.e. *Pseudomonas fluorescens, Salmonella typhi, E. coli and Bacillus subtilis*) and one fungal strain for its antimicrobial activity. All the tested strains including fungal strain shows maximum inhibition at higher concentration of the plant extract as compared to control.

Hydrilla verticillata L.

They are mostly perennial but sometimes annual. Totally submerged and growing in still or slowly flowing water.

Results and Discussion

Antioxidant activity

The percent inhibition of 2,2-Diphenylpicrylhydrazyl (DPPH) free radicals was measured at various concentrations. If free radical scavenging activity of *Hydrilla verticillata L.* were compared with standard ascorbic acid, dose response curve were obtained in which highest activity marked at 100 µg/ml. Inhibition of DPPH radicals found a maximum of 29.60% in the ethanolic extract of *Hydrilla verticillata L.* Vitamin E and Vitamin C showed about 47.30% and 80.38% inhibitory effect within the concentration range (100 µg/ml) respectively. Just as antioxidant enzyme activity gets enhanced in response to various stresses on the plants, Proline, an amino acid also accumulates in plants to the imposition of a wide range of biotic and abiotic stresses.

Antimicrobial activity

A positive inhibitory effect against bacteria and negative effect against fungi obtained by using an ethanolic extract of *Hydrilla verticillata*. The antimicrobial activity is less effective against gram negative bacteria than gram positive bacteria. But it has no antifungal activity. A zone of inhibition increasing in all bacterial strains with increasing concentration of ethanolic extract of plant. A concentration of 250 µg/ml and 500 µg/ml of plant extract had no inhibitory effect on E. Coli while concentration of 750 µg/ml and 1000 µg/ml showed zone of clearance 9 mm and 11 mm respectively. In E.Coli zone of clearance were 11 mm at concentration of 1000 ug/ml while 9 mm at a concentration of 750 µg/ml and 250 µg/ml. Similarly, in B. subtilis zone of clearance was 15 mm at concentration of 1000 ug/ml while 9 mm at a concentration of 750 µg/ml and 250 µg/ml.

Antitumor activity

Hydrilla medicinally used for used for digestion and gastrointestinal function, improves blood circulation, helps in detoxification, good for neurological health and cardiovascular function. It increases endurance, help in blood sugar control strengthen immunity to protect the body from invaders and slows ageing. *Hydrilla* contains otteliones A and B which are

biologically important, structurally novel natural products and exhibit potent antitumor activity.

Ceratophyllum desmersum L.

They are perennial or sometimes annual, totally submerged, rootless, free swimming plants. Shoot tips often with the shorten internodes giving it a 'bottle brush' appearance.

Antioxidant activities

Antioxidant contents (β-carotene, flavonoid, lycopene and total phenols) of methanol and water extracts obtained from *C. demersum* de-termined. Among these extracts, the highest component levels were detected in water. Considering total phenolic contents, water extract of *C. demersum* was reported to posses the highest quantity (76.55 µg/mg).

Anti microbial activities

The process of extraction of *Ceratophyllum demersum L* with other plants was carried out with aqueous and some organic solvent such as chloroform, ethanol and methanol. This plant extract was examined against seventeen different microorganisms, including Gram-positive and Gram-negative bacteria and fungi. From different sources nine of these known organisms were import such as *Bacillus subtilis* 1020, *Bacillus cereus* 1080, Staphylococcus aureus, *Erwiniacarotovora* NCPPB 312, Candida *albicans*, *Candida tropicalis*, *Aspergillus niger*, *Fusarium oxysporum and Penicillium italicum*. API 20E strip system (BioMereux) was used for isolation and identification of eight microbial genera. Species level identification of One hundred pathogenic bacteria isolates belonging to eight genera was performed. These organisms are Escherichia coli (20%), *Pseudomonas aeruginosa* (16%), *Klebsiella pneumoniae* (14%), *Salmonella colerasuis* (13%), *Shigella sp.* (11%), *Serratialique faciens* (10%), *Proteus vulgaris* (9%) and *Brennerianigri fluens* (7%). In pilot experiments, various solvent used for the extraction of test microorganisms and efficiency of the extracts may vary with solvent used in the extraction. This extract used for antimicrobial activity against test microorganisms. The reported zone of inhibition for *Fusarium oxysporum* was 48 ± 0.01 mm; for *Pseudomonas aeruginosa* 59 ± 0.02 mm and for *Salmonella cholerasuis* it was 55 ± 0.01 mm, Aqueous extract being the highly effective one while using C. demersum. Except *Aspergillus niger*. ethanolic extract of *C. demersum* recoded antimicrobial activities against all tested organisms On using chloroform extracts *Escherichia coli*, *Aspergillus niger and Penicillium italicum* showed resistance.

Anti-inflammatory Properties

The carrageen induced rat paw edema model at the doses of 250 mg/kg and 500 mg/kg with 1% CMC (10 mg/kg p.o) as a control and *Nimesulide* (50 mg/kg p.o) was used to analyze anti-inflammatory activity of methanol extract of whole plant of *C. demersum*. The methanol extract of *C. demersum* at the dose of 250 mg/kg and 500 mg/kg body weight showed significantly ($p<0.01$) reduction paw volume.

Anti pyretic Properties

Brewer's yeast (*Saccharomyces cerevisiae*) induced pyrexia method in Wistar rats were used to check antipyretic activity. The rats were nurtured in separate cages with food and water for 7 days before the experiment. For experimental study animals with constant rectal temperature (37.5 -38.40) were selected. Male wistar albino rats weighing, 150-200 gm was divided into four groups of six animals each. The first group of the animals received 1% CMC (10 ml/kg of b.w., p.o.) served as control, second group served as the reference standard received Paracetamol (50 mg/kg of b.w.,p.o) while third and fourth group received a methanol extract (250 mg/kg and 500 of mg/kg b.w., p.o.), respectively. Fever was induced by injecting 2 ml/kg of 20% aqueous suspension of Brewer's yeast in distilled water and 18 h after yeast injection the vehicle, extract and standard drug were administered. Rectal temperature was recorded by clinical thermometer at 0, 1, 2, 3 h after drug administration. The methanol extract of *C.demersum* (MECD) at the dose of 250 mg/kg and 500 mg/kg body weight showed significantly ($p<0.01$)reduction in the number of writhes and paw volume and at the dose 500 mg/kg body weight showed significantly ($p<0.05$) reduction in pyrexia.

Ipomea aquatica Forsk

They are perennial usually floating on stagnant water but sometimes found on the banks of pools, canas and rivers. It is often cultivated for its edible shoots and as medicine.

Antioxidant properties

It was reported that high level of polyphenolic compounds is a key component of plants. The presence of vitamin C and phenolic compounds in the plants provides an excellent antioxidant activity of the plant. It was reported that 1-Diphenyl-2Picrylhydrazyl (DPPH) study of ethanolic extract of *I. aquatica* leaves shows IC50 value of 0.387 mg/mL, whereas 2,2'-azino-bis 3-ethylbenzothiazoline-6-sulfonic acid (ABTS) method displays IC50 values of 0.394 mg/ml. However, highest radical-scavenging activity was recorded in the ethanol extract of stem as compared to water extract of leaf and stem, but methanol extract IA showed outstanding DPPH free radical scavenging activity (85%), which is very close to the synthetic antioxidant butyl hydroxyanisole (95%).

Anti microbial activity

The preliminary phytochemical screening of methanol extracts of leaves of *I. aquatica* showed the presence of flavonoids while that of the flowers showed the presence of flavonoids and anthocyanins. Thus the flavanoids present in methanol extracts of leaves and flowers of *I. aquatic* may responsible for antibacterial activity. The therapeutic potential of plants could serve the purpose with lesser side effects and confirmed with the help of antimicrobial activities as they are often associated with synthetic antimicrobial agents. Primary screening illustrated that phytochemicals are components of plants as they are less toxic and more effective medicines in controlling the growth of microorganism.

Pharmacological properties

From the traditional point of view such as Ayurveda and homeopathy, leaves extracts of *I. aquatica* are directed orally to cure antioxidant related ailments.

Salvinia minima

They are free floating aquatic fern and contains a horizontal rhizome lying just below the surface of water with floating leaves.

Anti microbial properties

The antimicrobial activity was fairly well distributed among pteridophytes. The selected fern species (*Salvinia minima*) examined exhibited antimicrobial properties against various test pathogens used.

Antinociceptive activity

Plant extract reveals a dose dependent increase in the latency time with control. In hot plate method, high potent antinociceptive activity observed by aqueous extract of *Salvinia minima* (100 mg/kg, 200 mg/kg and 300mg/kg orally). However, the extract (200 mg/kg and 300mg/kg) administered for 60 min to 90 min it reach to significant analgesic effect.

Conclusion

The importance of phytochemicals, strategies, guidelines and standards for botanical medicine was recognized by the World Health Organization (WHO). Medicinal plants have been a source of variety of phytochemicals since ancient times. In various diseases treatment pure compounds and extensively as crude material of plants was used. Plant-based natural products have been recognized for many years as a source of therapeutic agents. They are often responsible for the discovery of new drugs. Value and demand of traditional remedies for curing various diseases has been increased universally in different communities. But detailed screening of novel biologically active compounds of aquatic plants is required for the discovery and development of modern medicine. These would help in reducing human suffering against fatal disease.

Significance Statement

The study discovers the anateptic potential of Aquatic plants that can be beneficial to a lay man of a society for their health improvement because recent researches on nutrition and food science have focused on plant products/extracts with potential antioxidant and antimicrobial activities. The results serve as a scientific basis to further development of drug from Aquatic plants. Additionally, the Aquatic plants of this study could serve as a source for antimicrobial agents against food spoilage and pathogens. Thus a new theory on bioactive compounds/phytochemicals of Aquatic plants, the development of safer antioxidants from natural origins and antimicrobial potential of aquatic macrophytes that enhances the shelf-life and food safety may be arrived.

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Competing Interest

The authors have declared that no competing interest exists.

Data Availability

All relevant data are within the paper and its supporting information files.

Author's Contribution

Prof. Punita Parikh Designed the study, aided in interpreting the results and worked on the manuscript, conceived the study and was in charge of overall direction and planning, helped shape the research and manuscript.

Dr. Krupa Unadkat wrote the manuscript, conceived, planned and performed the experiments (self cited), Literature survey.

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