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Hydrophytic flora of our environment: Their ethnic uses and pharmacological evaluation

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Abstract
Aquatic plants are those which live in water, can actively grow on the water surface as well as submerged in the water or can grow in marshy lands. The objective of the present communication is to evaluate the potency of hydrophytes towards nutritional, in agriculture, ecosystem pollution management and the most prominent pharmaceutical industry. Human infections caused by pathogens transmitted from fish and aquatic environments are quite common. And now to fight against these pathogens by using some aquatic plants are also quite achievable. The use of herbal medicine has long been considered as more effective and beneficial throughout the world than the synthetic drugs including antibiotics. It was reported that some hydrophytes such as *Trapa natans* (with antidiabetic, antibacterial, neuroprotective effect), *Nymphoides indica* (anticonvulsant, antioxidant, hepatoprotective, cytotoxic, antitumour, antimicrobial effect), *Lippia javanica* (anticancer, antiamoebic, antidiabetic, antimalarial, antioxidant, antiviral properties) are with potent curative properties. These hydrophytes are not only possess medicinal properties but also known to be responsible for various such effects like nutritional and economical properties with pollution management. *Hydrilla verticillata* is rated as the richest food source of calcium and used to improve digestion, gastrointestinal function, circulation, neurological health and blood sugar control. As any part of the plant contain some bioactive components and the knowledge of these components is important for making the drugs. This communication will give an indication to the future researchers to evaluate the secondary metabolites and find out the different antimicrobial as well as other curative properties of some unexploited hydrophytes which have ethnobotanical claims.

Keywords: Ethnomedicinal hydrophytes, identification, phytoconstituents, Pharmacological evaluation.

1. Introduction
Hydrophytes are those plants which live in water, capable of synthesizing their food, that can actively grow on the water surface as well as submerged in the water or under the water bodies which can be seen in the naked eye [1]. Aquatic biodiversity has a lot of trade and industry as well as aesthetic value (Fig. 1). It is deeply liable for maintaining and supporting the ecosystem. It was believed that the hydrophytes have evolved from many diverse groups and have extreme flexibility in structure and morphology concerning changing environmental conditions [2]. Humans have been depending on aquatic resources for food, food supplements, medicines, and minerals as well as for commercial purposes such as fishing and tourism (Table 1). According to the World Health Organization, more than 2.2 million deaths per year were recorded globally due to the leading cause of waterborne diseases [3].
Though water-borne diseases are transmitted through fish and aquatic environments, aquatic plants help to fight against them [4]. Antibiotics were once considered the most promising solution for combating diseases caused by microbes. Antimicrobial resistance (AMR) is now a global threat that causes economic loss due to increased mortality and morbidity as a result of medicine ineffectiveness and infections persistent, thus increasing the risk of spread to others [5]. Therefore, to stop the risk of spreading these microorganisms, it is imperative to adopt an alternative way to fight against these microorganisms. And from various literature surveys, it was found that apart from a large number of plant species, hydrophytes also have a great medicinal value which can be taken into an account as herbal medicine for various serious diseases (Table 1). The isolation of compounds of these aquatic plants should be done and should be used for further studies to elucidate the molecular mechanism of interaction of its various compounds with the human body for different diseases.
In the past few decades, many research groups invested their time in searching for new anti-infection agents in the field of ethnopharmacology [6]. Since long, the use of herbal medicine is always considered as more effective and beneficial throughout the world as compared to commercially used antibiotics. Besides medicinal properties, hydrophytes are known to be responsible for various such effects like nutritional as well as pollution management. Any part of the plant may contain some bioactive components and the knowledge of these secondary metabolites is important for making the drugs.

Table1: List of Hydrophytes with curative properties.

Botanical Name, Family, Habitat	Extract type(s)	Chemical constituent(s)	Ethno-botanical use(s)	Physiologic effects	Reference
Acanthus illicifolius L. [Acanthaceae] Mangrove herb	Chloroform	Steroid, Tannin, Glycosides, Saponin, Sterol, Terpinoid,	Asthma, rheumatism.	Antimicrobial	Govindasamy and Mani, 2013 [31]
Aeschynomene	Aqueous	Saponins Tannins,	Skin infections,	Antibacterial.	Chittamuri *et al.*

aspera L. [Fabaceae] Amphibious	Methanol	Alkaloids, Flavonoids, Terpinoids, Glycosides,	antidote to snake venom, menstrual disorders.		(2012) [32]
Alisma plantago L. [Alismataceae] Amphibious	Methanol	Triterpenes, Diterpenes, Sesquiterpene,Steroids, Alkaloids, Phenolic acid.	---	Antichronic prostatitis, Immune-modulator, Antitumour, Anti-inflammatory, Antibacterial.	Huang *et al*. (2017)[33]
Aloysia citriodora Palau [Verbenaceae]	Ethanol	Essential oil.	Infusion used as anti-inflammatory and to treat digestive tract disorders.	Antifungal (*Candida* sp.).	Duarte *et al*. (2005)[34]
Alternanthera philoxeroides (Mart.) Griseb. [Amaranthaceae] Amphibious	Ethanol Methanol	Alkaloids, Flavonoids, Aminoacids, Phenols, Steroids, Terpenoids, Saponins, Glycosides.	Tender shoot as leafy vegetable.	Antibacterial (*Salmonella typhi, Bacillus subtilis, E. coli, Staphylococcus aureus*).	Sivakumar and Sunmathi (2016)[23]
Alternanthera sessilis (L.)R.Br. ex DC. [Amaranthaceae] Marshy	Ethanol Methanol	Alkaloids, Flavonoids, Phenols, Steroids, Terpenoids, Saponins, Glycosides.	Tender shoot as leafy vegetable.	Antibacterial (*Salmonella typhi, Bacillus subtilis, Escherichia coli*).	Sivakumar and Sunmathi (2016)[23]
Chamaemelum nobile (L.)All. *Anthemis nobilis* L. [Asteraceae]	Ethanol	Essential oil	Infusion used as anti-inflammatory and to treat digestive tract disorders.	Anti-fungal (*Candida* sp.)	Duarte *et al*. (2005)[34]
Bacopa monnieri (L.) Pennell [Scrophulariaceae] Marshy	Methanol	---	Analgesic, Anti-inflammatory, Antipyretic, Sedative, Antiepileptic. Edible as leafy vegetable.	Antibacterial (*Klebsiella pneumoniae, Proteus vulgaris, Bacillus subtilis*).	Verma (2014)[35]
Centella asiatica (L.) Urban [Apiaceae] Marshy	Ethanol Aqueous Chloroform	Glycoside, Triterpene acid, Flavonoid, Alkaloids, Fatty oil	Leaf extract given against dysentery.	Antimicrobial (*E.coli, Staphylococcus aureus, Streptococcus pyogenes, Psedomonas aeruginosa, Sreptococcus pneumoniae, Microsporium boulardii*)	Nasution *et al*. (2018) [36]
Ceratophyllum demersum L. [Ceratophyllaceae] Submerged	Acetone Butanol Methanol	Alkaloids, Tannins, Steroids, Glycosides, Flavonoids, Phenolic compounds	Cooling against boil.	Anti microbial (*Staphylococcus aureus, E. coli, Aspergillus niger*)	Malathy and Stanley (2015)[24]
Colocasia esculenta (L.) Schott. [Araceae] Amphibious	Methanol Aqueous	Flavonoids, β-sitosterol, Steroids.	Rhizome, petiole & leaf edible as vegetables	Antibacterial (*Vbrio* sp.), Anti-hepatotoxic.	LEE *et al*. (2010)[37]
Commelina benghalensis L. [Commelinaceae] Marshy	Ethanol, Petroleum-ether, Methanol Aqueous	---	Leaves applied in wounds and roots filtrate given to treat liver troubles	Analgesic, Anti-inflammatory Antibacterial (*Staphylococcus aureus, Enterococcus faecalis, Salmonella. typhi, E. coli, Pseudomonas aeruginosa*),	Hossain *et al*. (2014) [38] Khan *et al*. (2011)[39]
Cymbopogon martinii (Roxb.)Wats. [Poaceae] Marshy	Ethanol	Essential oil	Infusion used as anti-inflammatory and to treat digestive tract disorders.	Antifungal (*Candida* sp.)	Duarte *et al*. (2005)[34]
Cyperus difformis L. [Cyperaceae] Marshy	Methanol Aqueous	----	Root extract in fever, cold, cough.	Antibacterial (*Pseudomonas aeruginosa*).	Anis and Ali(2017)[40]
Cyperus rotundus L. [Cyperaceae] Marshy	Ethanol	Essential oil	Infusion used as anti-inflammatory and to treat digestive derangements.	Antifungal (*Candida* sp.).	Duarte *et al*. (2005)[34]
Eclipta prostrata (L.) L. [Asteraceae] Marshy	Hexane, Ethyl acetate, Ethanol Aqueous	Alkaloids, Flavonoids, Tannins, Terpenoids, Steroids, Glycosides	Leaf extract in liver disorder, scorpion sting and also as dye.	Antioxidant, Antibacterial (*E. coli, Klebsiella pneumoniae, Salmonella. typhi, Pseudomonas*	Karthikumar *et al*. (2007) [41]

				aeruginosa, *Bacillus. subtilis*, *Staphylococcus aureus*).	
Eichhornia crassipes (Mart.) Solms -Laub. [Pontederiaceae] Free floating	Aqueous, Chloroform, Ethanol Ethyl acetate	Alkaloids, Flavonoids, Phenols, Sterols, Terpenoids, Anthoquinone	As organic fertilizer.	Antioxidant, Antimicrobial (*Micrococcus luteus*, *Rhodospirillum rubrum*, *Rhodospirillum rubrum*).	Thamaraiselvi *et al*. (2012)[42]
Enydra fluctuans Lour. [Asteraceae] Amphibious	Methanol	β-carotene, Saponins, Cholesterol, Glucoside, Enhydrin.	Used as leafy vegetable & in hypertension.	Antioxidant, Hepatoprotective, CNS Depressant, Analgesic, Anti-bacterial (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*).	Ali *et al*. (2013)[43]
Euryale ferox Salisb. [Nymphaeaceae] Fixed floating	Methanol	---	Fruit edible	Antibacterial (*Staphylococcus aureus*, *E. coli*, *Pseudomonas. aureoginosa*, *Citrobacter freundi*, *Shigella. flexneri*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Salmonella typhi*).	Parray *et al*. (2010)[44]
Gnaphalium polycaulon Pers. [Asteraceae] Marshy	Methanol	---	---	Antimicrobial & Antioxidant	*Shanmugapriya et al. (2015)[45]*
Heliotropium curassavicum L. [Boraginaceae] Marshy	Alcohols	Alkaloids, Flavonoids	---	Antibacterial (*Enterococcus hirae*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aueroginosa*, *Acetobacter motfi*).	Gokulnath *et al*. (2014) [46]
Hoslundia opposita Vahl [Lamiaceae]	Ethanol	4-ethylnonacosane, (E)-2(3)-tagetenone Epoxide, Myrcenone, Piperitenone, Cirsimaritin (6), 6-methoxyluteolin 40-methyl ether, 6-methoxyluteolin, 3',4',7-trimethyl ether.	---	Antibacterial and Antiviral (*Mycobacterium tuberculosis* and HIV-1 reverse transcriptase).	Silva *et al*. (2008)[47]
Hydrilla verticillata (L.f.)Royle [Hydrocharitaceae] Submerged	Alcohols	Saponnin, Vitamins, Aminoacids.	Used to improve digestion, circulation, neurological health, blood sugar control.	Antioxidant, Detoxifying agent.	Pal and Nimse (2006)[48]
Hydrocotyle sibthorpioides Lamk. [Apiaceae] Marshy	Aqueous, Methanol	Stigmasterol,Daucosterol, Genistein, Daidzein	Leaf extract tonic.	Antidengue activities	Husin *et al*. (2015)[49]
Hydrolea zeylanica (L.) Vahl [Hydrophyllaceae] Amphibious	Alcohols	Flavonoid Catalase, Superoxide dismutase, Ascorbate peroxidises.	Leaf antiseptic, useful in healing ulcer.	Antioxidant.	Sahoo and Kanhar (2017) [25]
Ipomoea aquatica Forssk. [Convolvulaceae] Marshy	Aqueous, Methanol	Tannins, Flavonoids, Saponins, Amino acids, Steroids.	Leafy vegetable.	Antibacterial (*Staphylococcus aureus*, *E. coli*, *Pseudomonas aeruginosa*).	Das *et al*. (2018)[50]
Lemna minor L. [Lemnaceae] Free floating	Methanol		---	Antibacterial (selected waterborne bacteria)	Li *et al*. (2018)[51]
Lippia javanica (Burm.f.) Spreng. [Verbenaceae] Marshy	Aqueous, Hydrodistillation	3-methyl-6-(1-methylethylidene)-cyclohex-2-en-1-one.	---	Antimicrobial.	Nkhumeleni *et al*. (2004) [52]
Lippia javanica (Burm.f.) Spreng. [Verbenaceae] Marshy	Alcohols	Alkaloids, Amino acids, Flavonoids, Iridoids, Triterpenes.	Herbal tea and used in colds, fever, malaria, chest pains, bronchitis asthma, wounds, diarrhoea.	Anticancer, Antiamoebic, Antidiabetic, Antimalarial, Antimicrobial, Antioxidant.	Alfred (2017)[53]
Ludwigia octavalvis	Phenol Methanol	---	A kind of tea made	Antioxidant,	Yakob *et al*. (2012)[54]

(Jacq.)Raven [Onagraceae] Amphibious			from leaves.	Antibacterial (*Bacillus cereus, Bacillus licheniformis, Bacillus spizizenii, Staphylococcus aureus*).	
Mentha arvensis L. [Lamiaceae] Marshy	Ethanol	Essential oil	Infusion used as anti-inflammatory and to treat digestive tract disorders.	Antifungal (*Candida* sp.).	Duarte *et al*. (2005)[34]
Monochoria hastata Solms-Laub. [Pontederiaceae] Amphibious	Methanol	Alkaloid, Flavonoid, Glucoside, Phenol, Tannin, Terpenoids.	Flowers edible.	Antioxidant, Antibacterial (*Bacillus cereus, B. Paraflexus, E. coli*).	Misra *et al*. (2017)[55]
Nelumbo nucifera Gaertn. [Nymphaeaceae] Fixed floating	Phenol	Phenolic content, Flavonoid	Flowers used in skin diseases; thalamus edible; flowers in rituals.	Antioxidant Cytoprotective	Lee *et al*. (2015)[26]
Nymphaea nouchali Burm.f. [Nymphaeaceae] Fixed floating	Methanol Acetone, Ethyl acetate, Petroleum spirit	---	Fruit and seed edible.	Antibacterial (*Bacillus subtilis*, E. *coli*, *Klebsiella pneumoniae*, *Sarcina lutea* & one phytopathogen *Xanthomonas campestris*).	Dash *et al*. (2013)[56]
Nymphoides indica (L.) Kuntze [Menyanthaceae] Fixed floating	Alcohols	Polyphenolic component, Flavonoids, Triterpenes, Glycosides, Ephedrine, Coumarin, Secoiridoid glucosides, Methyl quercetin, Ferulic acid, Foliamenthoic acid.	Tubers eaten in fever and jaundice.	Anticonvulsant, Antioxidant, Hepatoprotective, Cytotoxic, Antitumour, Antimicrobial (*Microsporum canis, Staphylococcus aureus*).	Amin *et al*. (2016)[57]
Pistia stratiotes L. [Araceae] Fixed floating	Methanol n-hexane	Flavonoids, Tannins, Alkaloids, Steroids, Glycosides, deoxy sugars, Saponins.	Leaves used in piles and reducing sugar content in blood.	Anti oxidant, Antibacterial (Gram +ve bacteria).	Adeyemi and Shonekan (2016)[58]
Salicornia brachiata Roxb [Chenopodiaceae] Salty marshy	Methanol	Phenols, Tannins, Flavonoids, Alkaloids, Steroids, Saponins.	---	Antibacterial	Sathish *et al*. (2016)[59]
Sesuvium portulacastrum (L.)L. [Aizoaceae] Salty marshy	Methanol	Tannins, Flavonoids, Alkaloids, Steroids, Saponins.	---	Antibacterial	Sathish *et al*. (2016)[59]
Spilanthes paniculata Wall. ex DC. [Asteraceae] Marshy	Petroleum ether	Flavonoid, Alkaloid, Phenolic compounds.	Leafy vegetable. Against skin diseases.	Antibacterial	Thomas (2011)[60]
Spinifex littoreus (Burm.f) Merr. [Poaceae] Salty marshy	Methanol	Alkaloids, Flavonoids.	---	Antibacterial (*Enterococcus hirae, Bacillus cereus, Escherichia coli, Pseudomonas aueroginosa, Acetobacter motfi*)	Gokulnath *et al*. (2014) [46]
Spirodela polyrrhiza (L.)Sch. [Lemnaceae] Fixed floating	Methanol	Catalase, Superoxide dismutase, Ascorbate peroxidises.	As duck and fish food.	Antibiotics, Antioxidant.	Singh *et al*. (2018)[61]
Suaeda maritima (L.)Dumort [Chenopodiaceae] Salt marshy	Methanol	Phenols, Tannins, Flavonoids, Alkaloids, Steroids, Saponins.	---	Antibacterial activity	Sathish *et al*. (2016)[59]
Trapa natans L. var. *bispinosa* (Roxb.) Makino Free floating	Methanol	CarbohydratesPhytosterols, Saponins, Fixed oils & fat in seed extracts, Tannins, Flavonoids & Glycoside in pericarp extract of fruits.	Fruit edible.	Antidiabetic, Antibacterial, Anti-ulcer, Neuroprotective, Immunomodulator.	Mendhekar and Punit (2019)[20]
Typha angustifolia L. [Typhaceae] Amphibious	Aqueous, Methanol, Petroleum ether,	Alkaloids, Tannin, Steroids, Phenol, Saponins, Flavonoids,	---	Antimicrobial (*Enterobacter aerogenes, Salmonella typhimurium*,	Londonkar *et al*. (2013)[62]

	Chloroform	Carbohydratesoils & fats		*Klebsiella pneumoniae*, *Pseudomonas aeruginosa* & *Escherichia coli*).	
Vallisneria spiralis L. [Hydrocharitaceae] Submerged	Alcohols	2-Ethyl-3-methyl-maleimide, Dihydroactinidiolide & 4-oxo-beta-Ionone.	As organic fertilizer and decreasing eutrophication of water body.	Antialgal : inhibit the growth of blue green algae.	Xian *et al*. (2006)[63]

2. Role of hydrophytes

Nutraceutical and Commercial Importance

Though the nutritional value of hydrophytes is not much explored they are loaded with lots of macro- and micronutrients and vitamins. The wild edible hydrophytes like *Echinochloa stagnina*, *Eichhornia crassipes* and *Ceratophyllum demersum* contain nutrients as the highest concentrations of Na, Ca, Mg, N, K, C and carbohydrate as well as proteins [7]. Lasyaja *et al*. (2017)[8] reported about another hydrophyte *Hydrilla verticillata*, a submerged aquatic plant is appreciated by many for its amazing nutritional properties. *Hydrilla* is rich in vitamin B12 along with essential minerals such as Zn and Se. It is also loaded with antioxidants for which it can be considered as strong immune support for human being including world's most concentrated source of Ca which helps to strengthen the skeleton system of the body and also can detoxify the digestive tract removing waste particle.

According to myth, Lotus (*Nelumbo nucifera*) flower is a symbol of eternity, plenty and good fortune and Goddess of wealth Laxmi. Besides traditional value, *Nelumbo nucifera* has various nutritional values along with medicinal properties. Various part of this plant is edible like young leaves, petioles and flowers are eaten as vegetables. Medicinally, it helps to cure diarrhoea, cough, cold and flowers are used as a cardiotonic and can cure liver, urinary and venereal disorders. For blood disorder this plant's seed can be used and rhizome is prescribed for the treatment of piles.

Pollution Management

By the mechanism of biomagnifications, heavy metals even at very low concentrations, can pose a serious problem for living organisms [9]. Now-a-day's water scarcity is a big problem due to population growth and pollution. Therefore, simple, practical, economical, environmentally friendly technologies should be adopted for wastewater management. Using hydrophytes is the best way to eliminate contaminants from water bodies keeping physicochemical parameter in good status to improve water transparency without using chlorides. One example is that the 'lotus' (*Nelumbo nucifera*) can be planted in large tubs/pots and placed in swimming pools which provides an attractive feature and purifies the water naturally. The floating hydrophytes like *Eichhornia crassipes* and *Elodea Nutalli* can purify efficiently and also can control nutrient level reducing eutrophication effect in the water body [10]. Other floating hydrophytes such as *Azolla pinnata*, *Azolla microphylla*, *Lemna monor*, *Pistia stratiotes*, *Spirodela polyrrhiza*, *Salvinia cucullata* and *Salvinia molesta* are also reported to have hyperacumulating ability to remediate waste waters including sewage, industrial effluents and mine's waste water [11,12,13,14,15,16,17].

Medicinal properties

1. Antibacterial

Natively growing hydrophytes are more resistant to external stress and has rapid multiplication rate, potential to phytorimediation and the most important thing is that they have nutriticeutical potential with antimicrobial properties. The all-embracing journalism review revealed that *Lippia javanica*, a marshy plant is used as herbal tea and has many ethnomedicinal properties to treat colds, cough, fever, malaria, wounds, diarrhoea, chest pains, bronchitis, and asthma. The main volatile components were geranial, limonene, germacrene-D, camphor, linalool, β-caryophyllene and myrcene have been identified. And these bioactive compounds are mainly responsible for the wide range of pharmacological activities. This plant can be used against cancer, amoebic disease, diabetes, malarial, microbial disease and also as antioxidant, antiplasmodial, and pesticidal effects [18,19].

Mendhekar *et al*., (2019) [20] explored the pharmacognostic and pharmacological studies of leaves, stem, fruit and roots of *Trapa natans*. *Eleocharis dulcis* an annual aquatic floating herb occurring throughout the Indian subcontinent and used traditionally for several medicinal purposes. Extract of aqueous and organic solvent like chloroform, ethanol and methanol of four different hydrophytes *Ceratophyllum demersum*, *Eichhornia crassipes*, *Potaviogenton crispus* and *Potamogeton pectinatus* were used to check the antimicrobial property against different types of microorganisms.

The ethalonic leaf extract of *Nymphaea lotus* was used against methicillin resistant *Staphylococcus aureus* (MRSA) and Vancomycin resistant *Staphylococcus aureus* (VRSA) and this effectiveness is due to the presence of the bioactive compounds - anthraquinones, terpenes, and cardiac glycoside [21]. Arjun *et al*. (2012) [22] found that the methanolic leaf extract of *Nelumbo nucifera* showed maximum antibacterial activity against *Bacillus subtilis* whereas hexane and acetone exhibited maximum antifungal activity against *Candida albicans*.

2. Antifungal activity

The ethanolic leaf extracts *of Alternanthera sessilis* and *Alternanthera philoxeroides* were evaluated and the preliminary phytochemical screening revealed the presence of alkaloids, flavonoids, aminoacids, carbohydrates, phenols, steroids, terpinoids, saponnins and glycosides in both the plant extracts. Antifungal activity was done by agar well diffusion method which showed a significant inhibition zone for *Candida albican* MTCC 227 [23].

The phytochemical analysis along with antimicrobial activities studies were done with three different aquatic plants namely *Cabomba aquatica*, *Ceratophyllum demersum* and *Hygrophila corymbosa*. In preliminary phytochemical screening, secondary metabolites like

tannins, steroids, glycosides, flavonoids, phenolic compounds and alkaloids were found and the acetone, butanol and methanol crude extracts of these plants proved to have significant antifungal activity against *Aspergillus niger*. The methanol extract of *Cabomba aquatica* showed highest antifungal activity against *A. niger* with inhibition zone of 18 mm [24].

3. Antioxidant activity

Hydrolea zeylanica, an aquatic edible medicinal plant is useful in healing ulcer. The presence of antioxidant principle with antiulcer activities in *H. zeylanica* is established in ulcer induced in rats. In order to explain the role of antioxidant principles in anti-ulcerogenic activities, *in vitro* 1, 1-diphenyl-2-picryl hydrazyl (DPPH), nitric oxide (NO), superoxide anion (SOD) and hydroxyl (OH) free radical scavenging activities of successive solvent extracted fractions of leaves were performed. Presence of phenols and flavonoids in the leaves of this plant could be responsible for anti-ulcerative properties [25].

In another study, phenolic rich ethyl acetate fraction (EAF) from lotus (*Nelumbo nucifera*) leaves was prepared and its bioactive components, antioxidant and cytoprotective effects were investigated. EAF showed the presence of high total phenolic and flavonoid content in the leaf of the plant. In cultured hepatocytes, EAF exerted a cytoprotective effect against oxidative stress by inhibiting intracellular reactive oxygen species formation and membrane lipid peroxidation. In addition, depletion of glutathione under oxidative stress was remarkably restored by treatment with EAF. The results suggest that EAF have great potential to be used against oxidative stress-induced health conditions [26].

(iv) Antiviral

The reaction mechanism of the plant's bioactive compounds for all antimicrobial activity is different from the antiviral activity. Unlike antibiotics, antiviral drugs cannot destroy their target pathogen; instead they target their developmental pathway. Eight phytochemicals were isolated from *Lippia javanica* and three from *Hoslundia opposita*, aromatic herbs well known for their medicinal properties. The phytochemicals like 4-ethylnonacosane, apigenin and 3′,4′,7-trimethyl ether of these two plants tested against *Mycobacterium tuberculosis* and HIV-1 reverse transcriptase for bioactivity. It was found that (E)-2(3)-tagetenone epoxide, piperitenone and 5,7-dimethoxy-6-methylflavone inhibited the HIV-1 reverse transcriptase enzyme by 91, 53 and 52% respectively [27].

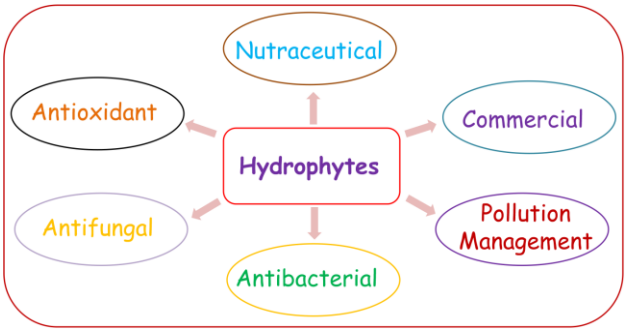

Fig 1: Showing the different utilities of Hydrophytes

3. Conclusion

As any parts of the plant contain some bioactive components and the knowledge of these phytoconstituents is important for formulation of drugs by the pharmaceutical industries. This review article will give a clue to the future researcher to isolate, identify and evaluate the secondary metabolites and find out the different curative properties such as antibacterial, antifungal, antiviral, antidiabetic, antioxidant etc. of some unexploited hydrophytes which have an ethnobotanical claim. Some less known free floating, marshy and submerged plants with ethnomedicinal claims described in this article also could form a strong basis for further studies especially in extracting bioactive molecules of therapeutic and immunomodulatory importance. Thus, further studies should be conducted in order to validate the medicinal or immune boosting properties of some widely used hydrophytic medicinal plants by of the tribes and rural communities.

The authors have noted that several wetland plants help in purifying the water body, limit erosion as well as nourish the fish, tadpoles, and aquatic insects. Wetland plants due to its exploit characteristic take away nitrogen, phosphorus, and some toxic pollutants from eutrophic lakes by biological filtration. Water lettuce (*Pistia stratiotes*) and water hyacinth (*Eichhornia crassipes*) are an infamous example for the removal of nutrients and become invasive and crowd out native species. Apart from the various acts of hydrophytes starting from the phytoremediation to pharmaceutical sector, they are also beneficial in the crop field [28,29]. The duckweed-like aquatic fern *Azolla*, used as biofertilizer and is considered a "super-plant" because of its symbiotic relationship with a blue-green alga (*Anabaena azollae*) for nitrogen fixation and also has another capability to suppresses the weeds in the crop field [30]. Some climatologists have interpreted fossilized layers of *Azolla* in arctic sediments as an 800,000-year bloom, which could have caused the simultaneous, dramatic decline in Earth's temperature. According to their calculations, the amount of carbon "sequestered" in *Azolla* fossils could explain the documented decline in atmospheric CO_2 - and the corresponding change from "Greenhouse Earth" to "Icehouse Earth".

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