Aquatic Plants With Anti-Inflammatory And Anti-Oxidant Activities

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Abstract
Nature has rewarded the human beings with uncountable nutritious and medicinal plants. These medicinal plants are a nature's gift to us so that we can live a healthy and disease free life. Aquatic plants are those natural herbs that usually grow in or near water/aquatic environment and are considered as one of the most ancient source of food and medicine used by the human beings. These aquatic plants are unique in their nutritional composition and therapeutic potential and are widely used in traditional medicinal system in treatment of different unhealthy conditions. This review is designed to discuss some aquatic plants with established anti-oxidant and anti-inflammatory activities along with their possible mechanism of action and part responsible to possess this action. The recently updated information was collected from scientific journals, books, and globally accepted scientific databases via a library and electronic search such as PubMed, Elsevier, Google Scholar, Springer, Scopus, Web of Science, Wiley online library. All of the full-text articles and abstracts were screened. The most important and relevant articles were carefully chosen for study in this review. This review will help the researchers, traditional medical practitioners and marine pharmacologists to explore these aquatic plants in future to evaluate their true role and efficacy in acute and chronic inflammatory conditions.

Keywords: - Inflammation, marine pharmacology, aquatic plants, oxidative stress

INTRODUCTION

One of the major component of earth is water. Approximately more than 70% of the earth is surrounded by water in the form of lakes, rivers, seas, oceans etc. Prehistorically human civilizations were developed and established near the water areas in order to fulfill their basic needs. These water bodies were considered as a great source of food (such as fishes and aquatic animals), vegetables and aquatic medicinal plants. This is the main reason that these aquatic plants have had a very important social and economic impact on human beings in ancient eras. Today a large number of aquatic plants have been discovered with known pharmacological activities[1].

Aquatic plants are getting famous all over the world due to their unique composition and beneficial role in medicine. They are an excellent source of compounds with renowned biological and therapeutic potential [2]. Numerous biologically active metabolites have been isolated from aquatic plants which are being used as coloring agent, additive, flavoring agent, cosmetics, nutraceuticals and in discovery of new drugs and molecules [3]. Globally people are now very keen to know about the role of these aquatic plants in promoting health and preventing and treating unhealthy conditions. Aquatic plants are nowadays a center of attraction for many researchers as it is a treasure of biologically active compounds [4].

Terrestrial, semi-aquatic and aquatic plants are a rich sources of phytochemicals with pronounced anti-oxidant and anti-inflammatory actions. These phytochemicals possess different or multiple mechanisms through which they act as anti-inflammatory and anti-oxidant such as inhibition of COX pathway, down regulation of pro-inflammatory cytokines, reducing the translocation of NF-KB to the nucleus, reducing oxidative stress via free radicle scavenging action etc. [5]. This anti-inflammatory and anti-oxidant nature of phytochemicals isolated from natural origins have a vast role in medical sciences and are being tested and used in various inflammatory conditions including cancer, cardio-vascular diseases, dyslipidemia, arthritis, dermatitis etc. In this review, anti-oxidant and anti-inflammatory activity of various aquatic plants with reference to their potential mechanism of action and future role in medicine is discussed. This review will help the researchers, and marine biologist to further explore these aquatic plants in future to evaluate their role in different inflammatory diseases.

Following are some aquatic plants whose anti-oxidant and anti-inflammatory activity has been established.

***Ipomoea aquatica* Forsk**

Ipomoea aquatica Forsk also known as aquatic spinach belongs to the family of Convolvulaceae. It is an aquatic plant which grows and cultivated in regions of Southeast Asia and is mostly consumed as vegetable. Anti-oxidant, anti-inflammatory and anti-proliferative activity of leaves of this plant has been tested and reported both in-vitro and in-vivo and is thought to be due to its high phenolic, flavonoid content and natural carotenoids especially Violaxanthin, leutin and β-carotene [6,7]. The possible mechanism behind anti-oxidant and anti-inflammatory activity as proposed by the researcher is inhibition of COX pathway and free radicle scavenging potential [8,9].

Rorippa nasturtium-aquaticum

Rorippa nasturtium-aquaticum commonly known as watercress belongs to the family of Brassicaceae. It is an aquatic plant grown and cultivated in regions of Western Asia, Europe and Africa. It is consumed as vegetable in making salads and soups. It is a rich source of vitamins, phenolic compounds, carotenoids, fibers, minerals, proteins, folic acid and glucosinolates. Leaves of this plant possess strong anti-inflammatory and anti-oxidant activity by reducing inflammatory cells infiltration and decreasing pro-inflammatory cytokines both acutely and chronically. Due to this effect it has also shown to be effective in dermatitis and inflammatory swelling [10].

***Eleocharis dulcis* corm**

Eleocharis dulcis corm. another aquatic plant of family Cyperaceae is indigenous to Asia, Africa and Australia. It is commonly known as Chinese water chestnut in native language and is consumed as vegetable in China. It is considered as a low calorie food with carbohydrate as dominant nutrient followed by proteins. Also it is a good source of vitamins especially vitamin C, polyphenols, total flavonoids, saponins, minerals, phytosterols etc. The fruit of this aquatic plant is a potent anti-oxidant and anti-inflammatory agent which is due to its free radicle scavenging potential and ability to down regulate the expression of TNF-α, iNOS and COX-2 genes [11,12].

***Nelumbo nucifera* gaertn**

Nelumbo nucifera also known as sacred lotus belongs to the family of Nymphaeaceae. It is commonly grown in China, Japan and India and is utilized in food recipes in Asia. It is a rich source of bioactive phytoconstituents including steroids, terpenoids, glycosides, alkaloids, polyphenols etc. which are responsible for its pharmacological activities. Seeds and rhizomes of this plant have free radicle scavenging activity and potential to down regulate IL-4, IL-10, TNF-γ and CDK-4 genes due to which they are potent anti-oxidant and anti-inflammatory agent [13,14].

***Bacopa monnieri* L.**

Bacopa monnieri L. also known as water hyssop is a member of Scrophulariaceae family. It is commonly found in the regions of East Asia, Australia and United States. It is a good source of bioactive compounds including brahmine, nicotinine, herpestine, bacosides A and B, saponins A, B, and C, triterpenoid saponins, stigmastanol, β-sitosterol, betulinic acid, D-mannitol, α-alanine, serine, pseudojujubogenin glycoside, aspartic and glutamic acids, and other elements This whole aquatic plant is found to be a potent anti-oxidant and anti-inflammatory agent and this activity is due its effect in down regulating the expressions of COX-2, IL-6 and TNF-α and free radicle scavenging action [15,16,17].

***Enhydra fluctuans* Lour**.

Enhydra fluctuans Lour. is an aquatic plant belongs to the family of Compositae. It is very renowned aquatic herb in Indian traditional medicine system due to its nutritional and medicinal potential. Decoction of whole plant or tea is commonly consumed by various tribes of Asia including India, Burma, Bangladesh for the relief of kidney and urinary stones. Pharmacological activities of this plant is thought to be due to the presence of bio-active compounds like β-carotene, flavonoids, phenolic compounds, saponins, sesquiterpene lactones, phytosterols etc. Aerial parts of this aquatic herb possess analgesic, anti-oxidant and anti-inflammatory properties due to their ability to inhibit prostaglandin pathway and free radicle scavenging action [18].

***Rotula aquatica* Lour.**

Rotula aquatica Lour. is an aquatic plant of family Boraginaceae. It is considered as aromatic medicinal plant native to China, Malaysia and India. Roots of this plants are famous for their diuretic activity. It is a rich source of polyphenols, flavonoids, alkaloids, tannins, quinoline, 3-O-acetyl-11-keto-β-boswellic acid, gallic acid, p-coumaric acid, and vanillic acid. Roots and leaves of this herb possess anti-oxidant and anti-inflammatory activity, most probably due to their ability to suppress the expressions of prostaglandins, leukotrienes, NO, ROS, iNOS and TNF-α [19,20,21].

***Pistia stratiotes* L.**

Pistia stratiotes L. a floating aquatic plant commonly known as water lettuce is a member of family Araceae. It is commonly found in aquatic environment of subtropical Asia, Africa and America. It is considered to be a rich source of bio-active compounds including polyphenols, flavonoids, saponins which are major contributors in anti-oxidant and anti-

inflammatory activities. Leaves of this herb are potent anti-oxidant and anti-inflammatory due to their ability to suppress histamine, prostaglandins, bradykinins etc. [22,23,24].

***Nymphaea nouchali* Burm. F.**

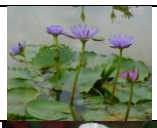
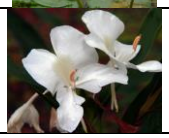
Nymphaea nouchali Burm. F. commonly known as blue water lily is an edible aquatic plant of family Nymphaeaceae. It is widely distributed in South Asian countries, Africa and Australia. Polyphenols, flavonoids, sterols, alkaloids, saponins, tannins, protein, nymphasterol, nymphayol have been considered as major constituents of this aquatic herb responsible for various pharmacological activities. Flower of this plant has shown anti-oxidant and anti-inflammatory activity both in-vivo and in-vitro most probably due to its ability to decrease oxidative stress and TNF-α [25,26].

***Hedychium coronarium* J.**

Hedychium coronarium J. commonly known as white butterfly ginger lily is an aquatic plant of family Zingiberaceae. It is native to Himaliyas region and China. Major secondary metabolites isolated from this herb includes aldehydes, ketones, esters, oxides, phenolics, flavonoids, saponins, glycosides, labdane diterpenes, and sesquiterpenes. Flower and rhizomes of this plant have significant anti-oxidant and anti-inflammatory activity. The main mechanism behind these activities is inhibition of prostaglandin pathway and COX enzyme and scavenging free radicles [27,28].

Table 1 summarizes the aquatic plants with potent anti-oxidant and anti-inflammatory activity and their parts responsible for this activity.

S.NO	Scientific Name of Aquatic Pant	Family	Part that possess anti-oxidant & anti-inflammatory activity	Picture of the plant
1.	*Ipomoea aquatica* Forsk	Convolvulaceae	Leaves	
2.	*Rorippa nasturtium-aquaticum*	Brassicaceae	Leaves	
3.	*Eleocharis dulcis* corm.	Cyperaceae	Fruit	
4.	*Nelumbo nucifera*	Nymphaeaceae	Seeds Rhizomes	
5.	*Bacopa monnieri* L.	Scrophulariaceae	Whole plant	
6.	*Enhydra fluctuans* Lour.	Compositae	Aerial parts	
7.	*Rotula aquatica* Lour	Boraginaceae	Roots Leaves	
8.	*Pistia stratiotes* L.	Araceae	Leaves	

9.	*Nymphaea nouchali* Burm. F.	Nymphaeaceae	Flower	
10.	*Hedychium coronarium* J.	Zingiberaceae	Flower Rhizomes	

CONCLUSION

This review has discussed 10 most famous aquatic plants with marked anti-oxidant and anti-inflammatory activity. These plants can be further explored in future to evaluate their true role and efficacy in various acute and chronic inflammatory diseases.

CONFLICT OF INTEREST

There is not conflict of interest.

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