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Ethno-medicinal uses and pharmacological activities of lotus (*Nelumbo nucifera*)

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Abstract

Nelumbo nucifera is grown in many parts of the globe including India for its medicinal and nutritional value. In Kashmir, the plant grows naturally in the lakes and its stem is being extensively used in many famous Kashmiri cuisines. In addition, its fruits and seeds are also consumed, but to a lesser extent. Many studies have established a wide range of the pharmacological activities of this plant. The current review highlights the importance of *Nelumbo nucifera* in traditional medicines and its pharmacological activities.

Keywords: *Nelumbo nucifera*, Lotus stem, Traditional medicine, Pharmacological activities.

1. Introduction

Nelumbo nucifera, ($2n = 16$) commonly known as lotus or sacred lotus is an aquatic perennial plant belonging to family *Nelumbonaceae*. The plant grows up to a height of about 1.5 meters and a horizontal spread of up to 3 meters. Its roots remain fixed within the muddy bottom of the water bodies and the leaves as large as 60 cm in diameter float over the surface of water or are held above it. The flowers can be up to 20 cm in diameter and are found on stems rising above the leaves. Lotus is propagated by the division of rhizomes and by seeds. The seeds are about 1 cm in diameter and are located in the woody receptacle that looks like a showerhead [1]. The lotus plant grows by extending a creeping rhizome through anaerobic sediments at the bottom of the water body. The rhizome bears nodes and each of which produces a leaf. The petioles and the rhizome bear gas canals which channel air from the leaves throughout the petioles and rhizomes. The petiole has two canal pairs and the rhizome has three canal pairs. Air from a leaf flows to a rhizome through one of two petiolar canal pairs and flows in the atmosphere through the second petiolar canal pair [2]. The plant has some unique features like; the ability to regulate the temperature of its flowers within a narrow range [3], seeds with long viability periods [4] and in addition its leaves show the lotus effect, the self-cleaning property. Lotus has been used as a food for about 7,000 years in Asia, and it is cultivated for its edible rhizomes/stems, seeds and leaves. Various lotus plant parts like buds, flowers, anthers, stamens, fruits, leaves, stalks, rhizomes and roots have been used as herbal medicines for treatment of many diseases including cancer, depression, diarrhea, heart problems, hypertension and insomnia [5, 6]. Lotus produces a number of important secondary metabolites, like alkaloids, flavonoids, steroids, triterpenoids, glycosides and polyphenols [7]. The genus *Nelumbo* is represented by only two species, *Nelumbo nucifera* and *Nelumbo lutea*. *Nelumbo nucifera* is widely distributed in South-East Asia. In India, it occurs from Kashmir in north to Kanyakumari in south, showing huge phenotypic diversity with different shapes, sizes and shades of pink and white flowers having 16-160 petals [8] and is the national flower of the country. *Nelumbo lutea* commonly known as American lotus is distributed in North and South America [9]. The natural habitat for lotus has been destroyed in certain areas and the plant populations have dramatically decreased [10]. Lotus is listed as endangered and threatened in many parts of America [11]. In many religions, lotus is considered to be sacred. It is considered as the symbol of purity, divine beauty, resurrection and enlightenment.

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2. Taxonomy Position

Kingdom	Plantae
(unranked)	Angiosperms
Order	Proteales
Family	Nelumbonaceae
Genus	Nelumbo
Species	<i>Nelumbo nucifera</i> Gaertn.

3. Nutritional Use

Parts of the lotus plant are consumed in many parts of the

world for their nutritional and medicinal importance. Lotus rhizome being rich in starch, vitamins, minerals, dietary fiber (Table 1), is widely consumed by the Asian people [11]. Many forms and products of the lotus rhizome, fresh, salted, lotus rhizome starch, drinks, teas etc. are very popular [12, 13]. In China and Japan, raw or roasted lotus seeds and rhizome are extensively consumed as food, besides seeds are also used as an ingredient in a large number of traditional pastries and desserts [14].

Table 1: Nutritional value

Nutritional value per 100 g, Lotus root, cooked, no salt					
Constituent	Quantity	Constituent	Quantity	Constituent	Quantity
Energy	278 kJ (66 kcal)	Thiamine (B1)	0.127 mg	Calcium	26 mg
Carbohydrates	16.02 g	Riboflavin (B2)	0.01 mg	Iron	0.9 mg
Sugars	0.5.2 g	Niacin (B3)	0.3 mg	Magnesium	22 mg
Dietary fiber	3.1 g	Pantothenic acid (B5)	0.302 mg	Manganese	0.22 mg
Fat	0.07 g	Vitamin B6	0.218 mg	Phosphorus	78 mg
Protein	1.58 g	Folate (B9)	8 µg	Potassium	363 mg
Water	81.42 g	Choline	25.4 mg	Sodium	45 mg
-	-	Vitamin C	27.4 mg	Zinc	0.33 mg

Source: USDA Nutrient Database

In India also, the lotus stem is eaten in many areas. Lotus stem called Nadru in Kashmir is deeply related to the culture and economy. Lotus grows naturally in two main lakes i.e Dal lake and Wullar lake, of the Kashmir valley, from where it is harvested and supplied to the whole valley. Nadru based cuisines are the integral part of every Kashmiri feast including those made at religious, social and cultural occasions. In Kashmir lotus is used in the form of lotus stem (Nadru) and yoghurt curry, lotus stem kabab, lotus stem-fish, lotus stem rogan josh, lotus stem pickles, lotus stem-Palakh etc. Besides, some popular snacks are also made from the lotus stem. Many of the Kashmiri Nadru based cuisines are famous throughout India and are one of the tourist attractions to the Jammu and Kashmir state. Nadru (lotus stem), contributes significantly to the economy and is the source of the livelihood to thousands of people directly or indirectly in Kashmir.

4. Traditional Medicine and Pharmacological Activities

Lotus is used in traditional medicine by people for its tremendous health benefits in many parts of the world. It is used to treat sunstroke, diarrhea, dysentery, hemorrhoids, dizziness, vomiting of blood, uterine bleeding disorders, promoting conception, improving the skin condition, controlling burning sensation, against infections, cough, hypertension, fever, urinary problems, hematemesis, epistaxis, hemoptysis, hematuria, and metrorrhagia etc [15, 16].

Many pharmacological studies on lotus have proven its antidiarrheal, anti-inflammatory, antipyretic, hypoglycemic, immunomodulatory, psychopharmacological, antioxidant, aphrodisiac, lipolytic, antiviral, anticancer and hepatoprotective activities [17].

Table 2: Summary of Ethno-Medicinal Uses and Pharmacological Activities of *Nelumbo Nucifera*.

S. No	Part Used	Ethno-medicinal use /Pharmacological activity	Reference
1	Leaves	Diarrhea	[18,19]
2	Leaves	High fever	[18,19]
3	Leaves	Hemorrhoids	[18,19]
4	Leaves	Leprosy	[18,19]
5	Leaves	Lipolytic	[20]
6	Leaves	Anti-obesity	[21]
7	Leaves	Cardiovascular activity	[22]
8	Leaves	Hypocholesterolaemic	[23]
9	Leaf extracts	Analgesic activity	[24]
10	Leaf extract	Anthelmintic activities	[25]
11	Leaf extract	Antiobesity and hypolipidemic	[26]
12	Leaves and Stem	Haematopoietic	[27]
13	Leaf, Flower, Seed	Cosmetic agent	[28]
14	Lotus liquor from leaves & blossoms	Antioxidant activities, Reducing oxidative stress and the risk of chronic diseases	[19]
15	Rhizome	Diuretic activity	[29]
16	Rhizome	Psychopharmacological	[30]
17	Rhizome extract	Anti-diabetic	[31]
18	Rhizome extract	Anti-obesity	[21]
19	Flowers Rhizome	Hypoglycemic	[32, 33]

20	Flower, Rhizome	Antipyretic activity	[34, 35]
21	Rhizome & Flower	Antidiabetic	[36]
22	Leaves, Flower, Rhizome	Antioxidant	[37-39]
23	Flower	Antimicrobial activity	[40]
24	Flower	Vasodilating effects, antihypertensive and antiarrhythmic abilities	[19]
25	Flower beverages	Hypertension, cancer, weakness, body heat balance	[41]
26	Flower	Antioxidant	[42]
27	Flower	Anti-bacterial and antioxidant	[43]
28	Flowers	antioxidant and free radical scavenging capacity	[44]
29	Stamens	Consolidation of kidney function, male sexual disorders and female leucorrhea	[18]
30	Stamen	Aphrodisiac	[45]
31	Pounded petals	For syphilis	[46]
32	Flower stalk	Uterine Bleeding	[46]
33	Flower receptacles	To stop bleeding and to eliminate stagnated blood	[19]
34	Seed	Anti-proliferative	[47]
35	Seed	Anti-fibrosis	[48]
36	Seeds	Antidepressant, Anti-inflammation	[49]
37	Seed	Cardiovascular symptoms	[50]
38	Ripe seeds	Astringent action, Chronic diarrhea	[18]
39	Ripe seeds	Spleen tonic	[51]
40	Seed powder	Cough	[52]
41	Seed extracts	Hepatoprotective and free radical scavenging	[21]
42	Seed extract	Anti-obesity and hypolipidemic effects	[53]
43	Plumule from ripe seed	Nervous disorders, insomnia, high fevers with restlessness and hypertension	[18]
44	Seed, Rhizome	Anti-inflammatory	[54, 55]
45	Seed, Rhizome	Immunomodulatory	[56]
46	Seed, Leaves	Hepatoprotective	[57]
47	Seed, Leaves	Antiviral	[58, 59]
48	Plant extract	Anti Hyperlipidemic Activity	[60]

5. Leaves

In traditional medicine, lotus leaves are used against diarrhea, high fever, hemorrhoids, leprosy [18, 19] weakness, skin inflammation, and body heat imbalance [15], hematemesis, epistaxis, hemoptysis, hematuria, and metrorrhagia [16]. Lotus leaves have been reported to have lipolytic, anti-obesity, cardiovascular and hypocholesterolaemic activity [20-23]. The leaf extract has been reported to have analgesic, anthelmintic, antiobesity and hypolipidemic activity [24-26]. Lotus liquor made of blossoms and leaves has been reported to possess antioxidant activities and is effective for reducing oxidative stress [19].

6. Rhizome

Lotus rhizome and its extracts have shown diuretic, psychopharmacological, anti-diabetic, anti-obesity, hypoglycemic, antipyretic and antioxidant activities [29-36]. The antioxidant property of rhizome knot extracts has been reported to be higher than those from the whole rhizome [12].

7. Flowers

Lotus flowers, floral parts or their extracts have also been used against many diseases like hypertension, cancer, weakness, body heat imbalance, consolidation of kidney function, male sexual disorders, syphilis, stopping bleeding and to eliminate the stagnated blood. Flowers, with their parts or extracts have shown to possess antimicrobial activities [40], vasodilating effects, antihypertensive and antiarrhythmic abilities [19], aphrodisiac activity [45], antioxidant and free radical scavenging capacity [43, 44].

8. Seeds

In traditional medicine Lotus seeds are used as spleen tonic [51] and seed powder is used against cough [52]. Plumule from the ripe seed is used for the treatment of many diseases, including nervous disorders, insomnia, high fevers with restlessness and hypertension [18]. The seeds or their extracts have been reported to possess anti-proliferative [47], anti-fibrosis [48], antidepressant, anti-inflammation [49], astringent [18], hepatoprotective and free radical scavenging [21], anti-obesity and hypolipidemic effects [53], anti-inflammatory [54, 55] immunomodulatory [56] and antiviral activities [58, 59].

9. Conclusion and Future Prospectus

Ethno-medicinal knowledge has already helped the man to combat many diseases. *Nelumbo nucifera* has also been extensively used for nutritional and traditional medicinal purpose by people in many parts of the world. Further, the pharmacological studies have shown tremendous potential of the plant against a wide range of diseases and infections. So the need of the hour is to further evaluate the medicinal importance of *Nelumbo nucifera*, in view of its large scale use in traditional medicine and recently identified pharmacological activities and also to develop the protocols for efficient extraction and validation of the active principles for their use to combat different human disease conditions. Additionally, there is the need to conserve this treasure as the habitat of this plant is being polluted and threatened due to different anthropogenic activities.

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