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## Ethno-medicinal and pharmacological activities of lotus rhizome

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**Abstract**

*Nelumbo nucifera* is grown in many parts of the globe including India for its medicinal and nutritional value crediting to its rhizome, seed, flower and leaf extracts. Lotus plant extensively grows in lakes of Kashmir and its stem mainly finds importance in many famous Kashmiri cuisines which makes it worthy of cultural, social and economic importance in Kashmir. In addition, its fruits and seeds are also consumed, but to a lesser extent. Several bioactive compounds have been consequential from these plant parts belonging to different chemical groups, including alkaloids, flavonoids, glycosides, triterpenoid, and vitamins etc., which all have their own therapeutic impact. The current review highlights the importance of *Nelumbo nucifera* in traditional medicines and its pharmacological activities and its potential as important nutraceutical source.

**Keywords:** *nelumbo nucifera*, lotus stem, traditional medicine, pharmacological activities, nutraceutical

**Introduction**

Lotus (*Nelumbo nucifera* GAERTN.) is one of the oldest plants on earth, also called Sacred Lotus and/or Indian Lotus, belonging to family *Nelumbonaceae*. originated in Asia, Persia, India (Makino, 1979) and has spread to China and North Eastern areas of Australia (Hoshikawa,1970; Herklots,1972). The plant attains a height of about 1.5meters with a horizontal spread of up to 3 meters. The roots remain fixed within the muddy bottom of the water bodies and the leaves of about 60 cm in diameter float over the surface of water. The flowers can be up to 20 cm in diameter and are found on stems rising above the leaves. Lotus can be propagated by the division of its seeds and rhizomes. The seeds have a diameter of 1 cm and are located in the woody receptacle that looks like a showerhead <sup>[1]</sup>. The growth of lotus plant occurs by extending a creeping rhizome through anaerobic sediments at the bottom of the water body. The rhizome bearing nodes, produces a leaf at each node. The petioles and the rhizome bear gas canals which channel air from the leaves throughout the petioles and rhizomes. The lotus plant shows some striking features which include the ability to regulate the temperature of its flowers within a narrow range <sup>[3]</sup>, seeds with long viability periods <sup>[4]</sup> the self-cleaning property of lotus leaves <sup>[25]</sup>.

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, diarrhoea, heart problems, hypertension and insomnia <sup>[5, 6]</sup>. Lotus produces a number of important secondary metabolites, like alkaloids, flavonoids, steroids, triterpenoids, glycosides and polyphenols <sup>[7]</sup>. 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 <sup>[8]</sup> and is the national flower of the country. Lotus is a perennial, aquatic crop that is grown and consumed throughout Asia and cultivated in many countries in the world, especially in India, China, Japan, Korea, South East Asia, Russia and some countries in Africa. Lotus grown in Europe and America are mainly used for ornamental purposes but rarely for food. In India, it is wide spread and known even from Himalayan lakes at altitude up to 1400 m. Lotus seeds sold in the Indian markets ('kamal gatta') as vegetable or raw material for Ayurvedic drug preparation <sup>[16]</sup>. Seeds and roots of lotus are regarded as popular health food and the alkaloid (liensinine) extracted from them is effective to treat arrhythmia <sup>[24]</sup>. The lotus stem is eaten in many areas. Leaves, flowers,

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seeds and rhizomes are all edible and flowers are also used in religious ceremonies. The leaves, flowers, seeds and rhizomes are all utilised but rhizomes hold the largest market share.

Lotus stem/rhizome called Nadru in Kashmir is related to the culture and economy of the state. Lotus mainly grows in two lakes of Kashmir i.e Dal lake and Wullar lake. It is harvested from there and supplied to the whole valley. Lotus stem or Nadru based cuisines are the integral part of every social, religious and cultural occasions in Kashmiri feasts. 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. In addition of being an important part of Kashmiri cuisines, lotus stem is used in the preparation of some popular snacks. 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.

### Morphology

The rhizome/ stem of Lotus has a similar shape to a wooden sausage, is usually creamy-white in colour but occasionally is found in a light-brown buff colour with smooth longitudinally striated with brown patches. The rhizomes are 60-140 cm long 0.5 to 2.5 cm in diameter. Lotus rhizomes form from terminal roots of the lotus root system. A special feature of the Lotus rhizome is the air passages, which run along the length of the segment, giving the appearance of a wagon-wheel design in cross section. Lotus rhizomes are bland but crisp in texture, are edible and are the major marketable part of the plant. Nodes and internodes are present. When freshly cut it exudes mucilaginous juice and show a few large cavities surrounded by several larger ones, fracture is tough and fibrous. Odour is indistinct. A special feature of the Lotus rhizome is the air passages, which run along the length of the segment, giving the appearance of a wagon-wheel design in cross section. Lotus rhizomes are bland but crisp in texture, are edible and are the major marketable part of the plant.

Lotus stem contains abundant starch grains throughout the tissue, Alkaloids sterols and reducing sugars have been detected on preliminary phyto-chemical study from various extract of rhizomes [17]. A special feature of the Lotus rhizome is the air passages, which run along the length of the segment, giving the appearance of a wagon-wheel design in cross section. Lotus rhizomes are bland but crisp in texture, are edible and are the major marketable part of the plant.

### Nutritional value of Lotus Rhizome

The rhizomes of lotus are consumed as a vegetable in Asian countries. They are used as health foods because of their mineral content. Abundant starch grains are present throughout the tissue. Fresh rhizome contains 31.2% starch, which shows no characteristic taste or odour. The binding and disintegration properties of isolated *Nelumbo* starch have been compared with maize and potato starch; *Nelumbo* starch was found to be superior as an adjuvant in the preparation of tablets. It has been reported that 50% (v/v) alcohol is required for maximum extraction of the constituents [48]. The methanol extract of the rhizome has been found to possess a steroidal triterpenoid – betulinic acid [10]. Fresh rhizome contains 83.80% water, 0.11% fat, 1.56% reducing sugar, 0.41% sucrose, 2.70% crude protein, 9.25% starch, 0.80% fibre, 1.10% ash and 0.06% calcium. The vitamins thiamine (0.22

mg/100 g), riboflavin (0.6 mg/100 g), niacin (2.10 mg/100 g) and ascorbic acid (1.5 mg/100 g) and an asparagine-like amino acid (2%) are also present in the rhizomes. The oxalate content of rhizome was found to be 84.3 mg/100 g [9].

**Table 1:** Nutrient value of per 100 g edible rhizome

Components	Raw	Boiled
Water	81.2	81.0
Energy, Kcal	66.0	68.0
Protein(g)	2.1	1.8
Fat(g)	0.0	0.0
Sugars(g)	15.1	15.8
Dietary fibre (g)	0.6	0.6
Calcium (mg)	18.0	17.0
Phosphorous (mg)	60.0	55.0
Iron (mg)	0.6	0.5
Sodium (mg)	28.0	19.0
Vitamin B <sub>1</sub> (mg)	0.09	0.07
Vitamin B <sub>2</sub> (mg)	0.02	0.01
Niacin, mg	0.2	0.2
Vitamin C, (mg)	55.0	37.0

### Rhizome Seed

#### Pharmaceutical value and Health Benefits

##### Traditional knowledge

Traditional knowledge reveals many medicinal uses of lotus plant. The whole plant serves as astringent, emollient, diuretic and sudorific and possesses antifungal, antipyretic and cardiotoxic [23]. The rhizome extract has anti-diabetic and anti-inflammatory properties due to presence of steroidal triterpenoid. Rhizomes are used for pharyngopathy, pectoralgia, spermatorrhoea, leucoderma, small pox, diarrhoea, dysentery and cough. The stem is used in indigenous Ayurvedic medicines as diuretic, anthelmintic and to treat strangury, vomiting, leprosy, skin disease and nervous exhaustion [23].

##### Antidiarrhoeal activity

The antidiarrhoeal potential of *N. nucifera* rhizome extract has been reported. A study was undertaken to evaluate the effects of methanolic extract of rhizomes of *N. nucifera* Gaertn for its antidiarrhoeal potential against several experimental models of diarrhoea in rats. The extract produced significant inhibitory effects against castor-oil-induced diarrhoea and PGE<sub>2</sub>-induced enteropooling; the propulsive movements of a charcoal meal were also reduced significantly [11].

##### Hypoglycaemic activity

The extract of *N. nucifera* (300 mg/kg and 600 mg/kg, orally) caused a reduction of blood glucose levels in streptozotocin-induced diabetic rats at the end of 12 h. The results of this study indicate that the methanol extract of the rhizome possesses favourable hypoglycaemic activity in hyperglycaemic animals taking chlorpropamide as a standard [12]. An anti-diabetic constituent (tryptophan) has been isolated from the nodes of lotus rhizome by the analysis of spectroscopic evidence [13].

##### Diuretic activity

The diuretic activity of *N. nucifera* rhizome was reported. The methanol extract of the rhizome induced significant diuresis in rats at doses of 300, 400 and 500 mg/kg. There was a dose-dependent increase in the volume of urine, with Na<sup>+</sup> and Cl<sup>-</sup> excretion, accompanied by a significant excretion of

K<sup>+</sup>. There was a significant increase in natriuretic and chloruretic activity but kaliuresis was less than natriuresis <sup>[14]</sup>.

#### Anti-inflammatory activity

The anti-inflammatory activity of the methanol extract at doses of 200 and 400 mg/kg, and betulinic acid at doses of 50 and 100 mg/kg (administered orally) showed significant anti-inflammatory activity; the effect was comparable to that of the standard drugs phenylbutazone and dexamethasone <sup>[10]</sup>.

#### Antioxidant activity

The methanol and acetone extract of lotus rhizome showed free-radical scavenging activity, at 66.7 and 133.3 mg/l, respectively; The rhizome knot also exhibited radical scavenging activity, measured spectrophotometrically and by electron spin resonance <sup>[15]</sup>.

#### Antipyretic activity

The methanolic extract of *N. nucifera* rhizome showed antipyretic activity in rats with yeast-induced pyrexia. Yeast suspension (10 ml/kg, s.c.) increased rectal temperature after 19 hr of administration. Oral doses of the extract of 200, 300 and 400 mg/kg produced significant dose-dependent lowering of normal body temperature and yeast-provoked elevation of body temperature in rats. The result was comparable to that of the standard antipyretic drug paracetamol (150 mg/kg intraperitoneally) <sup>[9]</sup>.

#### Conclusion

India is a country where lotus can be found abundantly in wetlands, ponds, lakes, canals etc. The leaves, rhizomes, seeds and flowers, of it have been reported to have therapeutic potential in traditional medicine for the treatment of various diseases. The pharmacological investigations demonstrated that it's various organic and aqueous extracts possess an array of multidimensional pharmacological activities such as anti-ischaemic, antioxidant, hepatoprotective, antiinflammatory, anti-fertility, anti-arrhythmic, anti-fibrosis, antiviral, antiproliferative, antidiarrhoeal, hypoglycaemic, psychopharmacological, diuretic, antipyretic, immunomodulatory, aldose reductase inhibitory, antibacterial, aphrodisiac, antiplatelet, cardiovascular, anti-obesity, lipolytic, hypocholesterolaemic, anticancer activities. The plant is also reported to contain a wide range of chemical constituents. These studies have shown tremendous potential of the plant against a wide range of diseases and infections and also to develop the protocols for efficient extraction and validation of the active principles for their use to combat different human disease conditions.

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