

**NELUMBO NUCIFERA THE PHYTOCHEMICAL PROFILE AND TRADITIONAL USES**Sandip G. Buddhadev\*<sup>1</sup> and Sheetal S. Buddhadev<sup>2</sup><sup>1</sup>Associate professor Dravyaguna, Govt. Ayu. College, Junagadh-Gujarat.<sup>2</sup>Assistant professor Pharmaceutics, Atmiya Pharmacy College, Rajkot-Gujarat.**ABSTRACT**

*Nelumbo nucifera* is well known plant in ayurved. So many researchers have been done since. Here we are trying to update the phytochemical profile and traditional uses of the plant *Nelumbo nucifera*. The phytochemical profile of the plant is different by part to part. There are numerous therapeutic profits of this plant for which different parts are used. The extracts of rhizomes, seeds flowers and leaves have been reported to have varied therapeutic potential. So it is needed to know the phytochemical and traditional uses of the plant.

**KEYWORDS:** *Nelumbo nucifera*, Phytochemical studies, Traditional uses.

**INTRODUCTION**

*Nelumbo nucifera*, now placed in the mono-generic family Nymphaeaceae, has numerous common names (e.g. Indian lotus, Chinese water lily and sacred lotus) and synonyms (*Nelumbium nelumbo*, *N. speciosa*, *N. speciosum* and *Nymphaeanelumbo*). [1] All parts of *N. nucifera* have many medicinal uses. The leaf, rhizome, seed and flower are traditionally used for the treatment of pharyngopathy, pectoralgia, spermatorrhoea, leucoderma, smallpox, dysentery, cough, haematemesis, epistaxis, haemoptysis, haematuria, metrorrhagia, hyperlipidaemia, fever, cholera, hepatopathy and hyperdipsia. In Ayurved this plant is also used as a diuretic and anthelmintic and in the treatment of strangury, vomiting, leprosy, skin diseases and nervous exhaustion. [1–3] In popular medicine it is used in the treatment of tissue inflammation, cancer, skin diseases, leprosy and as a poison antidote. [4,5] Several pharmacologically active constituents that are responsible for the medicinal values have been isolated from the leaf, rhizome, seed and flower. Different classes of phytoconstituents has been isolated from various parts of *N. nucifera*. The most important classes include alkaloids, steroids, triterpenoids, flavonoids, glycosides and polyphenols. [6–12] Studies on different parts of *N. nucifera* have shown a variety of pharmacological activities. Extracts of different parts have shown anti-ischaemia, [13] antioxidant, [14–19] anticancer, [5,11] antiviral, [20,21] anti-

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obesity,[22] lipolytic,[23] hypocholesterolaemic,[24] antipyretic,[25] hepatoprotective,[26] hypoglycaemic, antidiarrhoeal, antifungal,antibacterial, anti-inflammatory and diuretic activities.[8,27–34]

### **Aims and objectives**

A systematic review was conducted with an objective to search and explore the phytochemical profile and traditional uses of plant *Nelumbo nucifera*.

### **Collection of data**

For the collection of data various Ayurvedic journals, books and the electronic database has been used.

### **Ecology**

Although historically the genus *Nelumbo* was considered to be closely related to Nymphaeales, new systematic work has allied *Nelumbo* with the lower eudicots, particularly *Platanus*. [37]

Worldwide, there are only two species of *Nelumbo*: *N. lutea* Willd. (Synonyms: *N. pentapetala* (Walter) Fernald and *Nelumbium luteum* Willd.) and *N. nucifera* (synonyms: *N. speciosa* Willd, *Nelumbium speciosum* Willd, *Nelumbium N. Druce* and *Nymphaea N. L.*) [32,38] *N. nucifera* Gaertn., the Indian or sacred lotus, is found throughout Asia and Australia, whereas *N. lutea*, the American lotus or water chinquapin, occurs in eastern and southern North America. [39] *N. lutea* is considered to be a subspecies of *N. nucifera*. [40] In India, *N. nucifera*, commonly known as lotus, *kamala* or *padma*, is an aquatic species, requiring plenty of space and full sun in order to thrive. It has stout, creeping, yellow rhizomes and green fruits. The leaves are enormous, reaching 2 feet in diameter. There are two varieties of 'kamala': one has white flowers and is commonly called 'pundarika' or 'sveta kamala'; the other has pink or reddish-pink flowers and is called 'raktakamala'. [41] The whole plant with flowers is known as 'padmini', the rhizomes as 'kamalkand', the tender leaves as 'sambartika', the peduncle as 'mrinal' or 'visa', the stamens as 'kirijalaka', the torus as 'padmakosa', the seed as 'karnika' or 'padmaksya', and the honey formed in the flowers by the bees feeding upon *padma* is known as 'makaranda' or 'padma- Madhu'. [42] The plant is often cultivated for its elegant sweetscented flowers, which are the national flower of India. Almost all parts of lotus are eaten as a vegetable, consumed all over the world, especially in South-east Asia, Russia and some countries in Africa. It is used not only as an ornamental plant and dietary staple, but also as a medicinal herb in Eastern Asia, particularly in China. *N. nucifera* has been cultivated as a crop in Far-East Asia for more than 3000 years,

where it was used for food and medicine and played a significant role in religious and cultural activities.[43] Almost all parts of *N. nucifera* are marketed; the rhizome holds the largest share.

### **Fruit and seeds**

The fruit of this plant is an aggregate of indehiscent nutlets. Ripe nutlets are ovoid, roundish or oblongish, up to 1.0 cm long and 1.5 cm broad, with a hard, smooth, brownish or greyish black pericarp which is faintly longitudinally striated, pedunculated and single seeded. Seeds fill in the ripe carpel. The seeds are sold as a vegetable in Indian markets, under the name of 'kamalgatta'. [40]

### **Leaves**

The leaves are large and orbicular, 20–90 cm in diameter and non-wettable. Leaves are of two types: aerial and floating, and are petiolated and entirely glaucous. The aerial leaves are cup-shaped whereas the floating leaves are flat. The petioles of the aerial leaves are erect, smooth, greenish or greenish brown in colour with small brown dots and are sometimes rough. The aerial leaves are usually 24–33 cm in length, and the floating leaves 23–30 cm. Odour is distinct; fractures are fibrous. [40] The young leaves are eaten as vegetables and used in traditional medicine.[42]

### **Flowers**

The flowers are solitary, large, 10–25 cm in diameter, white, pink or pinkish white, fragrant and have peduncles arising from the nodes of the rhizome, and 1–2 cm long sheathing at the base. The sepals, petals and stamens are spirally arranged, passing gradually one into another. [43]

### **Rhizome**

The rhizomes are 60–140 cm long, 0.5–2.5 cm in diameter, yellowish white to yellowish brown, smooth, with longitudinal striations and brown patches, and with nodes and internodes. Transverse section of the rhizome shows an outer layer of epidermis, surrounded by cuticle followed by a dense sub-epidermal layer, a spongy layer and an inner dense layer, continuous with the parenchyma cells. [44] When freshly cut, the rhizome exudes mucilaginous juice and shows a few large cavities surrounded by several larger ones. Fracture is tough and fibrous, and the odour is indistinct. [40]

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**Taxonomy**

Kingdom:	Plantae -Plants
Subkingdom:	Tracheobionta - Vascular plants
Superdivision:	Spermatophyta - Seed plants
Division;	Magnoliophyta - Flowering plants
Class:	Magnoliopsida - Dicotyledons
Subclass:	Magnoliidae
Order:	Proteales
Family:	Nymphaeaceae /Nelumbonaceae - Lotus-lily family
Genus:	Nelumbo Adans. - Lotus
Species:	nucifera Gaertn. - Sacred lotus

**Synonyms**

Nelumbiumnelumbo, Nelumbiumspeciosum, Nelumbo speciosa

**Sanskrit name**"Padma"**Part used**

Petals, Fruits, seeds, leaves, Rhizomes

**Phytochemical studies****I. Fruits and seeds**

The seeds of *N. nucifera* are rich in asparagin, fat, protein, starch and tannin [45]. The lotus seed is composed of three parts – integuments, plumule and cotyledons, which comprise 3.74%, 3.03% and 93.23% of the mass, respectively. The average weight of 100 seeds is 87.35 g. A large amount of glutathione is contained in the plumule (13 g per plumule) and cotyledons (164 g per cotyledon) of *N.nucifera*; the amount of total plumule increases gradually in the maturing seed. The reduced form of glutathione is dominant in the early stages, while the amount of oxidised form exceeds that of the reduced form at the end of maturation. The amount of the reduced form of glutathione in the unripe fruit decreases markedly upon storage for 1 year. In general, the rate of germination of the stored seeds seems to be closely related to the content of reduced glutathione [32, 45]. Normally, lotus seeds are rich in protein, amino acids, unsaturated fatty acids and minerals[46]. *Nelumbo* seeds have also been found to contain a variety of minerals such as chromium (0.0042%), sodium (1.00%), potassium (28.5%), calcium (22.10%), magnesium (9.20%), copper (0.0463%), zinc (0.0840%), manganese (0.356%) and iron (0.1990%). Other relevant nutritional elements include total ash (4.50%), moisture (10.50%), crude carbohydrate (1.93%), crude fibre (10.60%), fat (72.17%), and protein (2.70%); its energy

value is 348.45 cal per 100 g.[47] The major secondary metabolites present in the seeds are alkaloids such as dauricine, lotusine, nuci-ferine, pronuciferine, liensinine, isoliensinine, roemerine, neferine and armepavine.[48, 49, 9, 50, 11, 51, 52] Procyanidin was isolated from the seedpod of *N. nucifera*. Seeds also contain gallic acid (11), D(-)-3-O-bromo-O-methyl-armepavine, D-1,2,3,4-tetrahydro-6-methoxy-1-(p-methoxybenzyl)-2-methyl-7-isoquinolinol, saponins and carbohydrates[34]. The seed polysaccharides have also been isolated and characterized. Acid hydrolysis and methylation showed that seed polysaccharides are mainly composed of four types of monosaccharide: D-galactose, L arabinose, D-mannose and D-glucose[53]. <sup>13</sup>C-NMR and in-source pyrolysis-mass spectrometry analysis showed that the fruit wall and seed coat of *N. nucifera* are composed of a complex of polysaccharides, based primarily on galactose and mannose units and insoluble tannins. Curie-point pyrolysis-gas chromatography-mass spectrometry analysis of the fruit wall and seed coat of *Nelumbo* produced some pyrolysis polysaccharide products, including 2-furaldehyde, 2-hydroxy methyl furan, (SH)-furan-2-one, 2,3-dihydro-5-methylfuran-2-one, 2-hydroxy-3-methyl-2-cyclopenten-1-one, 5-hydroxymethyl-2-furaldehyde, anhydrosugar(levogalactosan), 1,2benzenediol 4-methyl-1, 2-benzenediol, 1,6-anhydro- $\alpha$ -D-glucopyranose, 2,6-dimethoxy 4-ethylphenol and 4-carboxy-2-methoxyphenol[54].

## II. Leaves

Combined gas/liquid chromatography-mass spectroscopy has shown that the leaves are rich in a number of alkaloids. In the analysis of non-phenolic fractions of the leaf extract, the major components had retention data and mass spectra identical to those of nuciferine, roemerine, anonaine, pronuciferine and N-nornuciferine. Two benzyloquinoline alkaloids, (+)-1(R)-cocclaurine and (-)-1(S)-norcocclaurine, were also found in leaf extract of *N. nucifera*[21]. Six non-phenolic bases were identified: roemerine, nuciferine, anonaine, pronuciferine, N-nornuciferine and liriodenine and two phenolic bases, armepavine and N-methyl-cocclaurine, were also found in *N. nucifera* leaf extract.[56] Dehydroemerine, dehydronuciferine, dehydroanonaine, N-methylisococclaurine, anonaine, pronuciferine, N-nornuciferine, O-nornuciferine, nuciferine, roemerine, armepavine, liensinine, isoliensinine, negferine, asimilobine and liridin were isolated from leaves and petioles[55, 57, 58, 59, 60]. The leaves also contain a glycoside, nelumboside, and flavonoids such as quercetin and leuco-anthocyanidin which were identified as leucocyanidin and leucodelphinidin [57, 62]. The presence of some other flavonoids in the leaves such as quercetin 3-O- $\alpha$ -arabinopyranosyl-(1 $\rightarrow$ 2)- $\beta$ -galactopyranoside, quercetin-3-O- $\beta$ -D-glucuronide, rutin, (+)-catechin, hyperoside, isoquercitrin

and astragalin has also been reported[38,41]. Scanning electron microscopy and chemical analysis of the chloroform extract of leaves showed that the wax was composed of a mixture of aliphatic compounds, principally nonacosanol and nonacosanediols. Analysis of gas chromatography spectra of lotus leaves waxes showed a much lower proportion of the secondary alcohol nonacosan-10-ol (16.2%by weight) compared with nonacosanediols (64.7%). Gas chromatographic analysis of the extracted leaf waxes revealed nonacosan-10-ol (16.2 ± 1.1%), triacontan-7-ol (2.4 ± 0.4%), nonacosane-4, 10-diol (18.6 ± 0.5%), nonacosine -5, 10-diol (34.1 ± 1.9%), nonacosane-10, 13-diol (12.0 ± 0.7%), hentriacontane- 12, 15-diol (1.8 ± 0.0%), tritriacontane-9, 10-diol (0.7 ± 0.0%) and octadecanoic acid (0.7 ± 0.0)[63].

### III. Flower

Several flavonoids have been identified in the stamens of *N.nucifera*. These include kaempferol and seven of its glycosides: kaempferol 3-O- β -D-galactopyranoside, kaempferol 3-O-β-D glucopyranoside, kaempferol 7-O-β -D- glucopyranoside, kaempferol 3-O-a-L-rhamnopyranosyl-( 1-6)-β -D-glucopyranoside, kaempferol 3-O-a-L-rhamnopyranosyl-(1-2)- β -D-glucopyranoside, kaempferol 3-Oa-L-rhamnopyranosyl -(1-2)- β- D-glucurono-pyranoside (44), kaempferol-3- O- β- D-glucurono-pyranoside, kaempferol 3-O-β-D-glucuronopyranosylmethylester, myricetin 3 O ,5 O -dimethylether 3-O- β -D-glucopyranoside, quercetin 3-O- β -D-glucopyranoside, nelumboroside A and nelumboroside B. It also contains two isorhamnetin glycosides: isorhamnetin 3-O-β-D-glucopyranosideand isorhamnetin 3-O-a-L-rhamnopyranosyl- (1→6) -β -D-gluco- pyranoside[16, 18, 64]. Some non-flavonoid compounds, including adenine, myo-inositol, arbutin and β-sitosterolglucopyranoside, have also been identified in stamen extract[64].

### IV. Rhizomes

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[66]. The methanol extract of the rhizome has been found to possess a steroidal triterpenoid – betulinic acid [8]. 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

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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[65].

### **Traditional and folklore uses**

In Ayurveda this plant is used as a diuretic and anthelmintic and in the treatment of strangury, vomiting, leprosy, skin diseases and nervous exhaustion[1, 2, 3]. In popular medicine it is used in the treatment of tissue inflammation, cancer, skin diseases, leprosy and as a poison antidote [4, 5]. Rhizomes are prescribed as demulcents for haemorrhoids and are beneficial in dysentery, chronic dyspepsia, and have nutritive, diuretic and cholagogueactivities [68, 69]. The stem is used in indigenous Ayurvedic medicine as a diuretic, anthelmintic, to treat strangury, vomiting, leprosy, skin disease and nervous exhaustion. The leaves are used for the treatment of haematemesis, epistaxis, haemoptysis, haematuria, metrorrhagia and hyperlipidaemia[24]. The flowers are useful in the treatment of diarrhoea, cholera, fever and gastric ulcers. [4] The seeds and fruits are used as a health food in Asia and to treat many ailments, including poor digestion, enteritis, chronic diarrhoea, insomnia, palpitations, spermatorrhoea, leucorrhoea, dermatopathy, halitosis, menorrhagia, leprosy, tissue inflammation, cancer, fever and heart complaints, and as an antiemetic, poisoning antidote, diuretic and refrigerant[4,32, 67, 70]. Lotus seedpods are sometimes used as a traditional medicine for haemostatic function [71]. The seed powder mixed with honey is useful in treating cough [2]. Embryos of lotus seed are used in traditional Chinese medicine to overcome nervous disorders, insomnia, high fevers (with restlessness) and cardiovascular diseases (e.g. hypertension, arrhythmia) [12].

### **Formulation and preparations**

### **CONCLUSION**

The paper concludes that the plant is having various kinds of constituents in different parts, which is having various medicinal uses. The traditional and folklore uses of the plant are also wide. Ancient systems like Ayurved used the plant in different-different ways. There are so many formulations are also available in classical text of Ayurved.

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