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Review

Exploring *Nelumbo Nucifera* As Traditional Medicine: A Review Of Its Phytochemistry And Ethnopharmacological Activity

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	Abstract
Published on: 25 July 2025	<i>Nelumbo nucifera</i> Gaertn. (Sacred Lotus), a revered aquatic plant in Asia, it exhibits a broad spectrum of ethnomedicinal and pharmacological properties. Traditionally valued for its cooling, cardiotonic, diuretic, and anti-inflammatory effects, every part of the plant from rhizomes and leaves to seeds and flowers has therapeutic potential. Rich in alkaloids (e.g., nuciferine, neferine), flavonoids, and phenolic acids, it shows diverse pharmacological actions: anti-inflammatory, antioxidant, anticancer, hepatoprotective, hypoglycemic, neuroprotective, and anti-obesity effects. Notably, it demonstrates antiviral (anti-HIV, anti-HSV-1), anti-Alzheimer, antiplatelet, and anti-epileptic activity. Lotus extracts also show promise in reproductive health and skin pigmentation modulation. Recent studies have highlighted its anti-osteoclastogenic potential, isolating 18 compounds from leaves and stems two of which are novel effective in inhibiting osteoclast formation by up to 78%. These findings underscore <i>Nelumbo nucifera</i>'s phytopharmacological significance and support its traditional use while paving the way for further drug discovery and development.
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	Keywords: <i>Nelumbo nucifera</i> , medicinal plant, phytochemicals, traditional medicine, pharmacological activity, therapeutic potential.

INTRODUCTION

Based on some literature and sites of different regions there are varieties of botanical names for Lotus are *Nelumbium nelumbo* (L.) Druce, *Nelumbo speciosa* Willd, *Nelumbo speciosa* Willd., *Nymphaea nelumbo* Willd.^[1] The Nelumbonaceae family includes the lotus (*Nelumbo nucifera* Gaertn.), a water plant with huge umbrella-shaped leaves carried on long stalks and thick, fleshy rhizomes that grow in the mud. Usually red or pink, but occasionally white, the enormous, single, waxy blossoms are aromatic and visually appealing. The cup-shaped fruits, which each contain several hard but edible seeds, are another trait. Around the world, it is cultivated as a decorative plant in lakes and ponds. In Buddhism and Hinduism, the plant is revered as a representation of life and purity. A large, handsome aquatic herb with slender, elongated, branched, creeping rhizomes that send out roots at the nodes; peltate leaves that are 60 to 90 cm in diameter or more, with petioles that are very long, smooth, or have small prickles, and that are raised out of the water; solitary, large, fragrant, white or rosy flowers with a yellow obconical spongy torus in the center, where the carpels are sunken; and ovoid, nut-like achenes.^{[2][3]} Based on blossom colour, there are three types of lotuses: *Padma* (white), *Nalina* (red), and *Utpala* (blue). They are all helpful for heart illness, vomiting, syncope, thirst, burning sensations, and hemorrhagic diseases.^[4]

Taxonomical classification ^[1]

Kingdom: Plantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Dicotyledonae
Order: Nelumbonales
Family: Nelumbonaceae
Genus: *Nelumbo*
Species: *nucifera*

Occurrence and Distribution ^{[2][3]}

Tropical Australia to southern Asia, primarily China, Tibet, and India. It is no longer found in Egypt, where it was first introduced to the Nile. China has a long history of commercial food and traditional medicinal farming. Occurs in the freshwater tanks of West Bengal, Assam, Tripura, Manipur, Bihar, Rajasthan, Uttar Pradesh, and Kashmir. in ponds and marshes all over India, up to 1,800 meters.

According to various regions of India different vernacular names has given to the plant: ^[3]

Tamil: Tamarai, Ventamarai, Centamarai

English: Sacred Lotus, Indian lotus, Chinese water lily

Hindi: Kamal, Kanval

Sanskrit: Padmam, Pankajam

Kannada: Kamala, Tavare

Malayalam: Tamara, Centamara, Ventamara

Telugu: Tamara, Erratamara, Damara

Ethnomedical uses ^[3]

The entire plant has cooling, emollient, diuretic, sudorific, astringent, bitter, sweet, antifungal, antipyretic, and cardiotonic properties. Hyperdipsia, cholera, diarrhea, helminthiasis, vomiting, burning sensations, hemorrhoids, nervous exhaustions, ringworm, dermatopathy, intermittent fever, strangury, and cardiac debility are among the disorders for which it is beneficial.

Usually cylindrical in shape, the rhizome can reach lengths of 10–20 cm and diameters of 3–5 cm. The interior is creamy white with a noticeable pattern of hollow air tubes arranged in a symmetrical, wheel-like arrangement, while the exterior is smooth and light brown. Additionally, it has astringent, cooling, aromatic, diuretic, and anthelmintic properties. It is also helpful for helminthiasis, nervous weariness, leprosy, vomiting, and skin conditions.

Though it is technically a thick, extended rhizome rather than a genuine root, the root is the edible rhizome (underground stem). Lotus roots are usually cylindrical and grow in segments that are 3–5 cm in diameter and 10–20 cm long. The interior has a distinctive radial pattern of perforations and is a pale white or cream color, while the exterior is light brown.

The orbicular, glaucous, floating, peltate leaves have a diameter of 60 to 90 cm or more. The bitter, cooling, and diuretic leaves help with leprosy, fever, strangury, hemorrhoids, burning sensations, and hyperdipsia.

The seeds are smooth, round, black, exalbuminous, and slightly elongated. Hyperdipsia, dermatopathy, halitosis, burning feeling, vomiting, menorrhagia, leucorrhea, fever, pectoral illness, leprosy, and itching are among the conditions for which they are helpful.

The fruits are top-shaped, torus-spongy, and 5–10 cm across. They have aphrodisiac, cooling, diuretic, tonic, bitter, astringent, and sweet properties.

The waxy flower is solitary, bisexual, big, fragrant, white or pink, and has a yellow obconical spongy torus in the center where the carpels are submerged. Its diameter is 10.2-25.4 cm. The flowers have cardiogenic, refrigerant, astringent, and sweet properties. Diarrhea, cholera, fever, hepatopathy, hyperdipsia, internal injuries, bronchitis, cough, skin eruptions, and pitta-vitiated diseases are among the disorders for which they are beneficial.

In addition to being helpful for diarrhea, hyperdipsia, hemorrhoids, inflammation, stomatitis, and menorrhea, the stamens are cooling, astringent, diuretic, and aphrodisiac.



Fig 1: (Whole Plant *Nelumbo nucifera*)



Fig 2: (Flower of *Nelumbo nucifera*)

Phytochemistry

The plant *Nelumbo nucifera* contains vast amounts of chemical constituents, which are reviewed below:

The whole plant contains various alkaloids like roemerine, dehydroroemerine, nuciferine, dehydronuciferine, anonaine, dehydranonaine, N-methylisococlaurine, pronuciferine, N-nornuciferine, N-methylcoclaurine, oxoushinsunine, armepavine, N-norarmepavine, asimilobine, lirinidine, liesinine, isoliesinine, neferine and nelumbine. ^[4]

The flower contains kaempferol-3-galactohamnoglucoside (robinin); quercetin and luteolin are also present in the flower's receptacle. Isoquercitrin and glucoluteolin are found in the petals and stamens. Alpha-amyrin, lupeol, beta-sitosterol, n-triacontanol, D-glucose and free amino acids, lysin, hydroxyproline, proline, beta-phenylalanine, and arginine are all said to be present in flowers. ^[4]

Water, crude protein, fat, reducing sugar, sucrose, starch, fiber, ash, calcium, and vitamins thiamine, riboflavin, niacin, ascorbic acid, and asparagine are all present in fresh rhizomes. Nuciferine, neferine, liesinine, isoliesinine, and armepavine are important alkaloids of the aporphine type. comprises proanthocyanidins, epicatechin, catechin, gallic acid, chlorogenic acid, kaempferol, vicenin, orientin, rutin, isoquercetin, and quercetin. Rhizome extracts including saponins, tannins, cardiac glycosides, coumarins, and quinones, as well as betulinic acid, phytosphingosine, and phospholipids, are detected by phytochemical screening. ^{[5][6]}

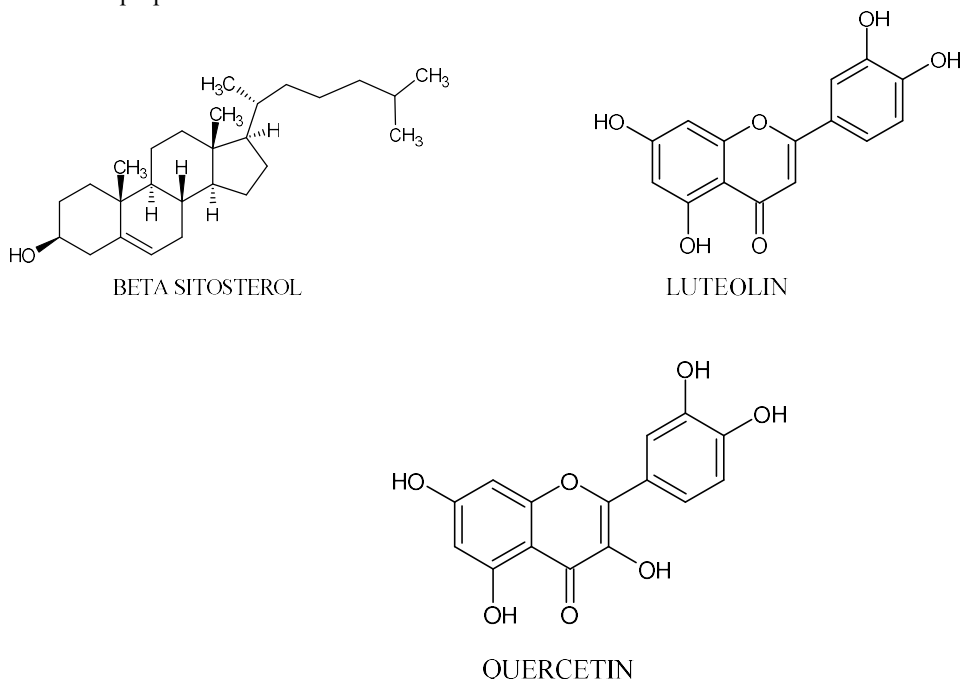
The roots were found to contain leucocyanidin, leucodelphinidin, neochlorogenic acid, catechol, and galocatechol. The root has been shown to include various phenolic acids, including gallic acid, catechol, chlorogenic acid, (+)-catechin, (–)-epicatechin, and galocatechin. About 86 phenolic components, including 20

phenolic acids, 51 flavonoids, lignans, stilbenes, and other polyphenols, were found using broad profiling. Though in far smaller quantities than in leaves or seeds, lotus roots do contain trace levels of aporphine-type alkaloids such nuciferine, neferine, liensinine, and isoliensinine. [7]

Glucolutolin and isoquercitin are found in petals. Protein, carbohydrates, phenols, tannins, and saponins more especially, isoquinoline alkaloids, flavonoids, terpenoids, alkaloids, cardiac glycosides, coumarins, and steroids are all present in *Nelumbo nucifera* petals. [4]

Seeds were found to contain beta-sitosterol, glucose, linolenic acid, palmitic acid, oleic acid, and 10-nonacosanol. Benzylisoquinoline alkaloids, including lotusine, nuciferine, pronuciferine, liensinine, isoliensinine, and neferine, are found in seeds. Flavonoids that have been identified include flavonoid C glycosides (the main class) and O glycosides, such as kaempferol 7 O glucoside and luteolin 7 O neohesperidoside. B-type condensed tannins, which are a combination of procyanidins, prodelphinidins, and propelargonidins, are especially abundant in the seed epicarp (seed coat). [5][8] [9]

Nuciferine, Liensinine, Neferine, and Isoliensinine are among the several benzylisoquinoline alkaloids found in leaves. N methylasimilobine, pronuciferine, armepavine, normuciferine, roemerine, dehydronuciferine, and other aporphine alkaloids. [10]



Pharmacological activities

Scientific screening has been done on *Nelumbo nucifera* for a variety of pharmacological properties.

Anti-inflammatory activity

Rhizome

This study assessed the *in vitro* anti-inflammatory activity of aqueous and hydroalcoholic extracts of *Nelumbo nucifera* rhizomes using RBC membrane stabilization and protein denaturation assays. Both extracts, rich in flavonoids, triterpenoids, tannins, and steroids, showed concentration-dependent effects. At 500 µg/mL, hydroalcoholic and aqueous extracts inhibited protein denaturation by 54.18% and 49.50%, and protected RBCs by 78.32% and 70.46%, respectively, compared to 84.12% by aspirin (200 µg/mL). Results suggest *N. nucifera* extracts possess notable anti-inflammatory potential via membrane stabilization and protein protection. [11]

Fruit

The use of vitamin- and flavonoid-rich natural anti-inflammatory treatments has increased due to their safety and affordability compared to allopathic drugs. Previous studies have explored the anti-inflammatory potential of *Nelumbo nucifera* fruit (NNF) to support its traditional and therapeutic use. [12]

Leaves

Alkaloids from *Nelumbo nucifera* leaves, traditionally used in Asian herbal teas, show antioxidant and anti-inflammatory effects. In LPS-induced RAW 264.7 cells, total alkaloids (TAs), phenolic alkaloids (PAs), and non-PAs inhibited DPPH radicals and nitric oxide (NO) production. Among five isolated alkaloids, asimilobine and roemerine showed strong NO scavenging, while N-methylcoclaurine had the highest DPPH activity. [13]

Antioxidant activity

Flower petals

This study examined aqueous (NAE) and ethanolic (NEE) extracts of red and white *Nelumbo nucifera* petals for phytochemicals, antioxidant activity, and effects on sperm viability. White NAE showed the highest antioxidant, tannin, and phenolic content; white NEE had the most flavonoids. Quercetin was present in aqueous extracts. Both red and white NAE (0.22–1.76 mg/mL) improved sperm vitality, with white NAE reducing oxidative stress. These findings suggest potential fertility benefits and value-added use of lotus petal waste. ^[14]

Stamen

Nelumbo nucifera stamens showed antioxidant activity, especially in the ONOO⁻ system. The EtOAc fraction had the strongest effect across all models (DPPH, ROS, ONOO⁻). Several flavonoids, including kaempferol and myricetin derivatives, were isolated. Compounds 1, 2, and 7 showed broad antioxidant activity, while compound 8 was inactive. ^[15]

Leaves

Methanol extract of *Nelumbo nucifera* leaves showed dose-dependent protection against H₂O₂-induced cytotoxicity in Caco-2 cells, unlike α -tocopherol. It also exhibited free radical scavenging, metal binding, and DNA protective effects, suggesting strong antioxidant potential. ^[16]

Seeds

The hydroalcoholic extract of *Nelumbo nucifera* seeds (HANN) showed strong antioxidant activity *in vitro* (low IC₅₀ in DPPH and NO assays) and *in vivo*. HANN boosted catalase and SOD levels and reduced TBARS in CCl₄-treated rats, like vitamin E. It was non-toxic up to 1000 mg/kg in mice. HANN contains alkaloids, saponins, phenolics, and carbohydrates, confirming its antioxidant potential. ^[17]

Anti-cancer activity

Embryo

Neferine, a bisbenzylisoquinoline alkaloid from *Nelumbo nucifera* embryos, showed selective cytotoxicity against Hep3B liver cancer cells, sparing normal liver cells and other HCC lines. It induced G1/S cell cycle arrest, ER stress, apoptosis (via caspase activation), autophagy (GFP-LC3B expression), and inhibited cell migration and angiogenesis. These results highlight neferine's potential against HBV-positive hepatocellular carcinoma. ^[18]

Leaves and Flowers

Nelumbo nucifera leaf and flower extracts contained alkaloids, flavonoids, phenols, and other phytochemicals. Methanol and acetone leaf extracts showed low anticancer activity against MCF7 cells. The leaf's super-hydrophobic upper surface showed structural resilience, with cell rupture observed in NaCl but not glucose treatment. ^[19]

Anti- malarial activity

Leaves

Eleven known metabolites and a novel compound were isolated from *Nelumbo nucifera* leaves. (R)-roemerine and N-methylasimilobine showed antifungal and antimalarial activity without cytotoxicity to Vero cells. NMR data for two compounds were reported for the first time. Substituents at C-1 and C-2 of aporphine alkaloids are key for antimalarial effects. ^[20]

Leaves

Nelumbo nucifera leaf extracts and green-synthesized silver nanoparticles showed larvicidal activity against *Anopheles subpictus* and *Culex quinquefasciatus*. Silver nanoparticles were most effective (LC50 < 2 ppm). This study is the first to report mosquito control potential of *N. nucifera* extracts and nanoparticles, suggesting eco-friendly vector control options. ^[21]

Anti-fungal

Leaves

Eleven known and one novel metabolite were identified from *Nelumbo nucifera* leaves. (R)-roemerine and N-methylasimilobine showed antifungal and antimalarial activity without Vero cell toxicity. New NMR data for two compounds were reported. C-1 and C-2 substituents of aporphine alkaloids are key for antimalarial effects. ^[20]

Anti- obesity and Hyperlipidaemic effect

Seeds

NSEE inhibited adipocyte differentiation by reducing lipid buildup and downregulating leptin, GLUT4, and PPAR γ . In rats, NSEE reduced fat mass, weight gain, serum triglycerides, and leptin levels on a high-fat diet. The high-fat diet + NSEE group's serum triglyceride and leptin levels were considerably lower than those of the high-fat group using seed extract of *Nelumbo nucifera*. ^[22]

Leaves

Nelumbo nucifera leaf extract (NNE) showed anti-obesity effects by boosting lipid metabolism and UCP3 expression, inhibiting α -amylase and lipase, and reducing body weight, liver fat, and adipose tissue in high-fat diet mice. NNE also enhanced energy expenditure and fat/carbohydrate digestion, supporting obesity prevention. [23]

Hepatoprotective

Leaves

Ethanollic lotus leaf extract (LLE) showed hepatoprotective and antioxidant effects in CCl₄-treated rats, comparable to silymarin. Key flavonoids identified included miricitrin-3-O-glucoside, hyperin, isoquercitrin, quercetin-3-O-rhamnoside, and astragalin. [24]

Seeds

Ethanol extracts of *Nelumbo nucifera* seeds (ENN) showed strong antioxidant activity (IC₅₀ = 6.49 μ g/ml) and protected hepatocytes from CCl₄ and aflatoxin B1-induced damage, likely due to their antioxidative properties. [25]

Flower

A 50% aqueous ethanolic extract of *Nelumbo nucifera* flowers showed significant, dose-dependent hepatoprotective effects against CCl₄- and paracetamol-induced liver damage in rats, comparable to silymarin. Biochemical and histopathological analyses confirmed its liver-protective action, supporting its traditional use in liver disease management. [26]

Anti-viral infection

Leaves

Lotus leaf water extract (WLL) strongly inhibited influenza A virus (IAV) by blocking neuraminidase and hemagglutinin activities, reducing viral proteins and infection in a dose-dependent manner. Isoquercitrin was identified as a key antiviral component, suggesting WLL's potential as a natural flu treatment. [27]

Seeds

NN-B-5, isolated from *Nelumbo nucifera* seeds, strongly inhibited HSV-1 replication in HeLa cells without cytotoxicity. It blocked viral DNA synthesis and reduced immediate early gene (ICP0, ICP4) expression by preventing multiprotein/DNA complex formation, halting viral multiplication. [28]

Neuroprotective effect

Embryo

Methanol extracts of *Nelumbo nucifera* seed embryos, especially the chloroform fraction containing neferine, reduced mice's locomotor activity and induced hypothermia and sedation without affecting muscle coordination or seizures. Neferine showed anxiolytic effects but acted differently from diazepam, suggesting distinct central nervous system mechanisms. [29]

Anti-Platelet activity

Flower

Hydroethanolic extracts of white and pink *Nelumbo nucifera* flowers showed dose-dependent antiplatelet activity, with white flowers being more potent, inhibiting platelet aggregation by up to 50% compared to aspirin. Differences in phytochemical content likely explain the variation in their effects. [30]

Melanogenesis

Flower Bud

A liquid chromatography-mass spectrometry method quantified ten alkaloids from *Nelumbo nucifera* flower extracts responsible for melanogenesis inhibition. Analysis showed strong correlation between total alkaloid content and activity, with nornuciferine forming a carbamate salt upon air exposure. [31]

Hypoglycaemic activity

Rhizome

Ethanollic extract of *Nelumbo nucifera* rhizomes significantly lowered blood sugar in diabetic, normal, and glucose-fed rats, improved glucose tolerance, and enhanced insulin effects, showing 67–73% activity compared to tolbutamide. [32]

Leaves

For the past 1300 years, *Nelumbo nucifera* Gaertn. leaves have been used as medical herbs, particularly to treat obesity, hyperglycemia, and hyperlipidemia. The current investigation is to determine the flavonoids extracted from *Nelumbo nucifera* leaves' possible medicinal uses. [33]

Seeds

Lotus seed ash (200 mg/kg) showed significant hypoglycemic effects in diabetic rats over 30 days, comparable to gliclazide. Trace elements in the seeds may support or enhance insulin action. [34]

Sperm viability

Flower petals

White *Nelumbo nucifera* petal tea improved sperm motility in male rats without affecting viability. Rats given 0.55 mg/kg showed significantly more motile sperm, suggesting potential benefits for male reproductive health. [35]

Atherosclerosis

Leaves

Nelumbo nucifera leaf extract (NLE) reduced triglycerides by 30% and LDL-C by 46.6% in rabbits on a high-cholesterol diet. It also inhibited aortic atherosclerosis, foam cell formation, and LDL oxidation, suggesting strong cardioprotective and lipid-lowering effects. [36]

Anti- HIV activity

Leaves

From *Nelumbo nucifera* leaves, compounds like coclaurine, norcoclaurine, and quercetin 3-O-glucuronide showed strong anti-HIV activity ($EC_{50} \leq 0.8 \mu\text{g/mL}$). Other alkaloids such as nuciferine, liensinine, and neferine also exhibited potent effects, confirming their therapeutic potential. [37]

Anti -Alzheimer activity

Nuciferine and norcoclaurine from *Nelumbo nucifera* significantly reduced blood glucose, restored antioxidant enzyme levels, and improved memory-related AChE activity in diabetic rats. Both compounds also showed strong inhibitory effects on α -glucosidase and α -amylase, indicating potential against diabetes, Alzheimer's, and oxidative stress. [38]

Anti- epileptic effect

Fruit

Nelumbo nucifera fruit extract (200 mg/kg) significantly delayed seizure onset, reduced intensity, and improved survival (42.85%) in strychnine-induced epileptic rats, showing effects comparable to diazepam. Findings suggest its potential as an anti-epileptic agent. [39]

Anti- osteoclastogenic

Leaves and stems

From *Nelumbo nucifera* leaves and stems, 16 known and 2 new compounds were isolated, including a novel glycoside and eudesmane-type sesquiterpenoid. Compounds 1 and 11 significantly inhibited RANKL-induced osteoclast formation (up to 78% at 10 μM), suggesting antiosteoclastogenic potential linked to specific aporphine structural features. [40]

CONCLUSION

Nelumbo nucifera, commonly known as the sacred lotus, holds immense significance in traditional medicine and modern pharmacological research. Every part of the plant from rhizomes to seeds exhibits a broad spectrum of therapeutic properties, including anti-inflammatory, antioxidant, anticancer, anti-obesity, hepatoprotective, neuroprotective, and anti-viral effects. Rich in diverse phytochemicals such as alkaloids, flavonoids, and phenolic acids, *N. nucifera* continues to offer promising bioactive compounds for drug development. With its long-standing ethnomedicinal use and growing scientific validation, the plant represents a vital link between traditional healing systems and modern pharmacotherapy. Further in-depth studies, especially clinical trials, are essential to fully explore its pharmacodynamics, mechanisms of action, and potential applications in integrative medicine.

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