



A COMPREHENSIVE REVIEW ON PHARMACOLOGICAL AND BIOLOGICAL PROPERTIES OF NYMPHAEA LOTUS

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Abstract

The aquatic plants that modulate wetlands' creatures organization and purpose are among the most fascinating water lilies and lotuses. It is thought to be a healing plant in Ayurvedic medication from India. Since the majority of aromatic plants create pleasing volatile organic compounds (VOCs), they are widely farmed and used in seasonings, fragrances, ethereal oils. Also thought of beneficial in treating dyspepsia, enteritis, fever, diarrhea, urinary problems, and irregular heartbeat. Many well-known herbal extracts or active compounds, such as Ginkgo biloba extract, bilobalide extracted from Ginkgo biloba, and silybin derived from milk thistle, have been successfully enhanced through the application of phytosome technology (Silybummarianum), Curcumin can be created for a variety of therapeutic applications or dietary supplements using turmeric and green tea extract (*Camellia sinensis*). This investigation seeks to shed light within the botanical specifics, historical applications, buildup of antioxidation, flavonoids, and other significant potential biological activities possible biological processes, as well as forthcoming research issues in the manufacture of *Nymphaea lotus* produce for cosmetic uses. Yet, as certain infections evolve mechanisms for resistance, the effectiveness of a certain medical.

Key words: *Nymphaea lotus*, Pharmaceutical Activity, Medicinal Properties, Cosmetic value.

1. Introduction

For thousands of tax year, nature has provided a source for healing substances and a significant portion of today's medications have been cut off from the environment. The oldest existing kind of healthcare in existence is herbal medicine. India is home to about 7500 types of medicinal plants. 4635 of these species are employed economically on a considerable basis¹⁰. Despite the great advancements over 25% of medicines developed during the 20th century used synthetic organic chemistry. that are prescribed in

industrialized nations are directly or indirectly derived from plants⁹.

The aquatic plant, water lily, is appropriately referred to be the queen flower because it is beloved by both ordinary people and artists like Claude Monet. The *Nymphaea* species, well-known as ornamentals, are also a traditional source of medicine and cosmetics^{5, 6, 15}. In Taraba State, notably in the Ibi and Gindin-Doruwa regions of the state (where samples for this research were acquired), In the majority of habitats, the white water lily type predominates and is

unrestricted in its growth. The plant's broad, spherical leaves lay flat on the water's surface. They can perform photosynthesis because of the greenish hue

on their skin. The mature blossoms of these white water lilies give rise to bulbs^{9, 10,16}.

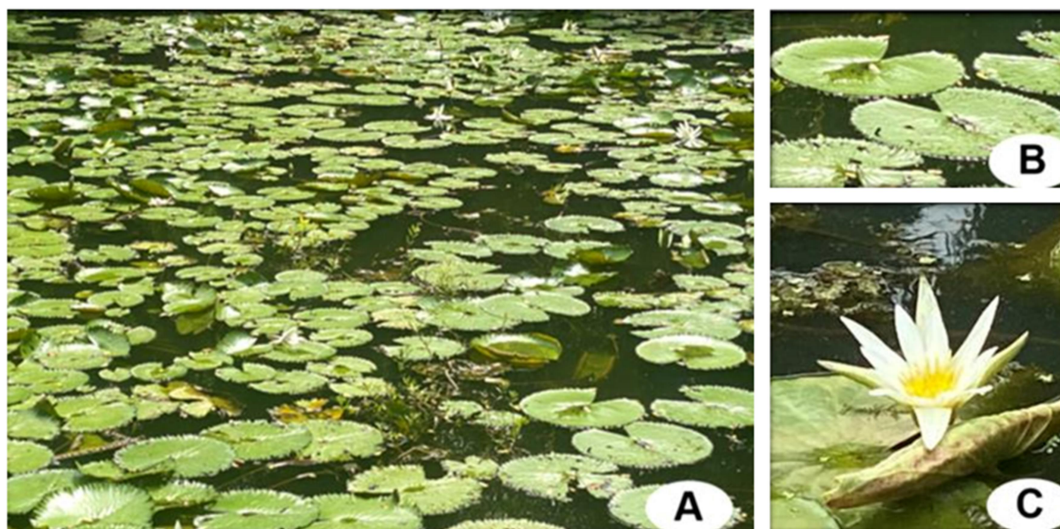


Fig. 1: Lotus *Nymphaea L.* (A) In its organic environment (B) with its leaf (C) and blossom (D)¹⁴.

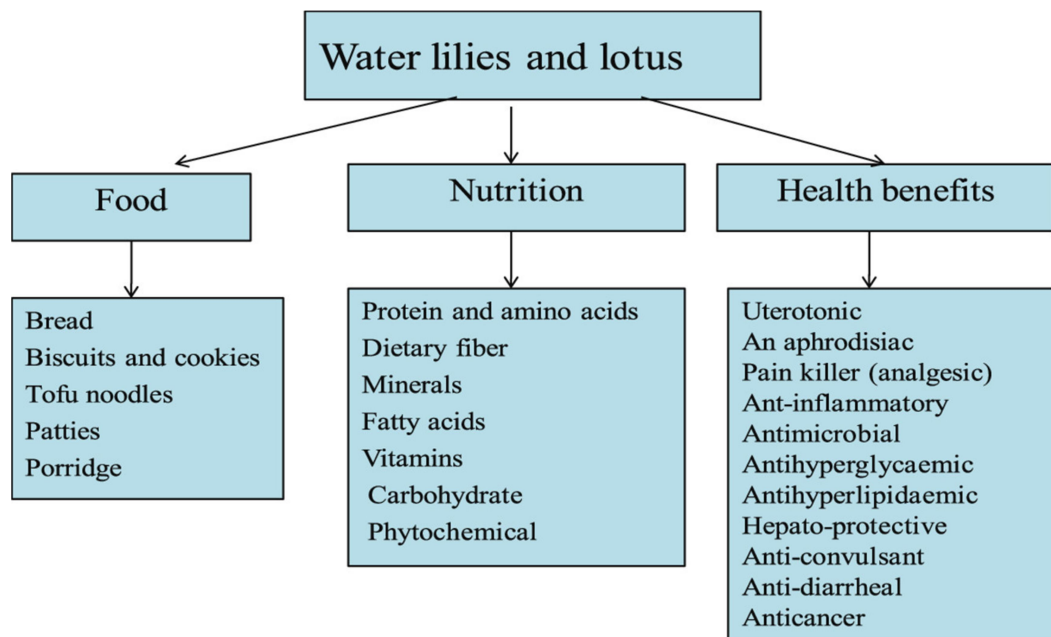


Fig. 2. Various applications of water lilies and review of consumable lotus and water lilies: potential for food, aliment, and health advantages ².

The biological characteristics of aromatic plants have been studied recently, and they have applications in the food, cosmetics, and pharmaceutical sectors. The production

of volatile organic compounds (VOCs) by aromatic plants that people are drawn to pleasing things. Grown all over the world and utilized in ethereal oils, perfumes, and

seasonings other products. The majority of these plants have unique traits of their own, thus it takes time for researchers to separate them in order to learn more about them. Among the terms cited were nutraceutical, allergy, Alzheimer's, cardiovascular, cancer, diabetes, anti-oxidative, anti-inflammatory, eye, immunological, inflammatory, or Parkinson's. Since ancient times, many Disease treatment and prevention have both benefited from the usage of plant parts, such as roots, leaves, barks, fruits, seeds, tubers, and flowers. Regardless of the philosophical presuppositions used to explain them, plants are now a part of all major medical systems because of their ubiquity in curing diseases. They have also drawn attention because of their potential for therapeutic, nutritional, and safety

benefits in both developed and developing nations. According to the World Health Organization, traditional treatment is used by 80% of the world's inhabitants. The majority of this therapy uses plant extracts and their active ingredients⁸.

The Nymphaeaceae Salisbury family of aquatic plants, sometimes known as water lilies, is widely cultivated in Asia and used to make food, cosmetics, medications, and tea. This family's *Nymphaeaceae* Savigny is one of the most popular varieties of water lily. worldwide. Humans have historically relied on plants, animals, and minerals for fundamental needs including food, protection from danger and hunting, cure for contagious diseases, and health issues⁵.

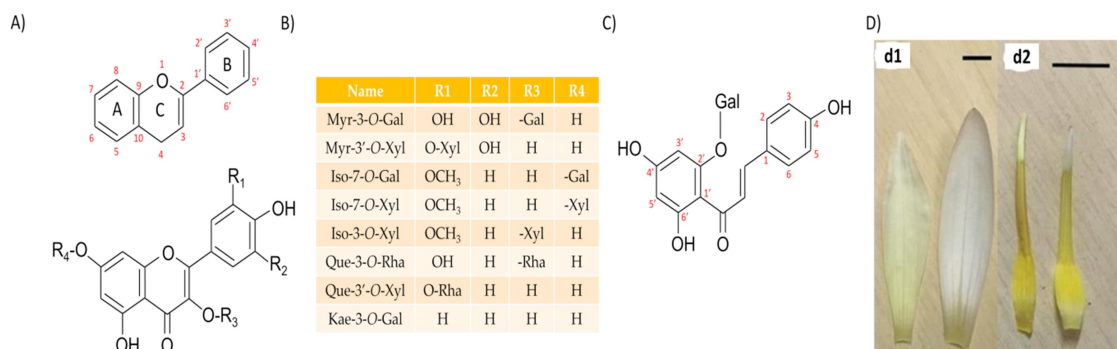


Fig 3. The primary antioxidant flavonoids from *N. lotus* stamen preparations, along with their chemical identities. (A) A flavonoid's general chemical structure and atom numbering. (B) The primary glycosides of flavonols isolated from *N. lotus* antonyms remove are shown in this diagram. (C) Chalconaringenin-2''-O-galactoside's chemical composition in *N. lotus* stamen remove. It stands for galactoside, xyloside, rhamnoside, kaempferol, isorhamnetin, quercetin, and myricetin. (D) d1: Lotus petals from *N.* (1 cm on the bar scale); d2: *N. lotus* stamens (1 cm on the bar scale)¹⁶.

As a result of the high mortality rate from bacterial illnesses and diseases in the human population, man has long employed plants as a form of medicine to treat illness. For instance, While *Vibrio cholera* and *E. coli* cause diarrhea, *Mycobacterium* spp. causes tuberculosis, *Salmonella* spp. causes typhoid fever, *Clostridium perfringens* releases toxins that cause

putrefactive degradation of the diseased tissue with gas production. One method to prevent antiseptic opposition to in harmful species is to employ new compounds that are not bas novel substances that don't rely on synthetic antimicrobial factor already in use. The Nymphaeaceae family includes *Nymphaea lotus*. It is a perennial herbaceous aquatic plant with a height of

up to 45 cm, and its leaves can float or sink in water. Numerous bioactive chemicals, including Alkaloids, flavonoids, antioxidants, anti-inflammatory drugs, anti-pyretics, anti-cancer drugs, antiviral drugs, and anti-obesity drugs activities, are present in lotus plants. Lotus seeds are abundant in protein

2. Type of water lily and its properties

The *Nymphaea lotus*, *Nymphaeanouchali*, *Nymphaeapubescens*, *Nymphaeapetersiana*, *Nymphaeastellata*, *Nymphaeaodorata*, and *Nymphaeaalba* species of water lilies were among those examined. *Nerine hybrid*, *Nerineindica*, *Nerine lotus*, *Nerinecaerulea*, *Nerinemicrantha*, *Nerinetragona*, *Nerineantares*, and *Nerine candida* (*Nelumbonucifera*)⁴. *Nymphaeacolorata* is appreciated for its aesthetic attractiveness due to the blue colouring of the petals, which is unusual among ornamentals. In order to comprehend the chemistry behind the colour blue, we discovered that the primary blue anthocyanidin pigment is delphinin chloride. By comparing expression profiles of the genetics in a renovate anthocyanidin biosynthesis pathway between two *N. colorata* cultivars with white and blue petals, Anthocyanidin synthase and delphinidin-modification genes were discovered, and we observed that the expression of these genes was considerably higher in blue petals compared to white petals. As the final two steps in the biosynthesis of anthocyanidin are catalysed by these two enzymes, they are essential enzymes with a focus on the manufacture of blue pigments. It is critical to look into alternative nutritious ingredients because a number of edible aquatic plants are crucial for human nutrition. The edible aquatic plants have a key role in providing essential nutrients for diet, health, and pharmaceutical needs. Aquatic plants that are edible can provide benefits to the ecology as well as food, nutrition, nutraceuticals, functionality, medicine,

and minerals and contain significant concentrations of flavonol chemicals with strong antioxidant potential. These seeds have the potential to be used as nutraceuticals and are advantageous in the treatment or prevention of a number of ailments.

culture, social interaction, and economic growth. Aside from its nutritional qualities, many different diseases are frequently treated with water lilies. However, edible aquatic plants are mishandled as a result of social, economic, and lifestyle changes, as well as ignorance and a lack of education. Aquatic lilies and lotuses grow everlasting or yearly rhizomes that can be eaten or used in historical medicine to treat a figure of fatal illness. However, edible aquatic plants are mishandled as a result of social, economic, and lifestyle changes, as well as ignorance and a lack of education. Annual or perennial rhizomes that are produced by water lilies can be consumed or utilised in traditional medicine to treat a number of fatal diseases¹³. A perennial aquatic herb in the *Nymphaeaceae* family, *Nymphaeanouchali* is sometimes referred to as blue lotus or by its synonym, *Nymphaeastellata*. The red and blue water lily, sometimes referred to as star lotus and blue and red water lily, is a species of water flower in the *Nymphaea* genus. Its scientific name is *Nymphaearubra* Roxb. ex Andrews, and it is a member of the *Nymphaeaceae* family (genus *Nymphaea*). The term also goes by several other names, including Red water lily in the area and *Nymphaeapubescens* Willd. The Red Water Lily is a beautiful floater that is native to India. India is home to many Red Water Lilies. The most widespread of them is *Nymphaearubra*, which is commercially marketed as Red Water Lily due to its reddish variation. The leaves are typically purple. Plant material Water lily mature entire plants that were procured

from Upper Jebba were the only plants used in this investigation.

2.1 Botanical Information

Perennial herb with several tall, slender rhizomes. Suborbicular or ovate-elliptic leaves are 18–50 cm long, with an acute border, and have pubescent teeth on both the glabrous (dark green) and abaxial (dark purple) surfaces. It has a cordate base. Simple, emergent bloom with rectangular, conspicuously veined outer and inner perianths, and a thin, 2–7 m long petiole; Numerous stamens with connective apically unappended and an inner filament that is almost as long as an anther. 1, many connected carpels, a half-inferior ovary, and a parietal placentation make up the pistil. Fruit: ovoid, 3 to 5 cm long. 1-2 mm ellipsoid seeds with multiple longitudinal ridges.

2.2 Pharmaceutical Activity

According studies conducted in vivo and in vitro, the existence of different phytochemicals such phenolic acids and pigment is what gives water lilies and lotuses their therapeutic potential. Comprehensive research on seven different *Nymphaea* species revealed that they had anti-inflammatory, antioxidant, nephroprotective, and cardiovascular protective properties^{12, 13}. The phytochemicals phenolic, flavonoids, alkaloids, and other random compounds are responsible for a wide spectrum of pharmacological effects. These traits may reduce the incidence of postprandial hyperlipidemia and hyperglycemia caused by diet. The results of this study show that tubers and seeds can be used as a crucial dietary supplement to stop diet-induced hyperlipidemia and hyperglycemia from progressing. The ethanol extract of the leaves has been discovered to have dose-dependent hypoglycemic effects in addition to decreasing cholesterol and triglyceride levels in alloxan-induced diabetic rats. The flower's ethanol extract showed antihyperlipidemic and antihyperglycemic properties in diabetic

rats made by alloxan, as well as lowering levels of urine sugar and blood urea and raising levels of body weight, protein, and plasma insulin. *N. stellata* flower, which is beneficial in avoiding hyperglycemia in diabetic patients without posing any harm. According to the research, *N. nouchali* is a reliable source of a natural antidiabetic drug.

2.3 Medicinal Properties

In addition to their nutritional significance, water lilies are frequently employed in the treatment of a number of ailments. Water lily The rhizome and seed of holy lotus and (*Nymphaea*) are potential sources of carbs, proteins, and dietary fiber, nutrients, and vitamins that are used as practical additives in meat, infant food, and bakery goods^{12, 13}. It is used to treat liver problems in Ayurveda. As a stimulant, narcotic, aphrodisiac, emollient, diuretic, cardio tonic, and aphrodisiac for diabetes, balled illnesses, antifertility, heart issues, diarrhea, eruptive fevers, and stomach disorders, the leaves, roots, and flowers are also employed. The roots and blossoms are used to change moods since they have a mild sedative effect. The entire plant is used as a heart stimulant and anti-periodic. Important water lilies like *Nephrotic*, poisonous, blood purifier, aphrodisiac, haemorrhoids, leucorrhoea, diabetes, inflammatory urological problems, menorrhagia, blenorrhagia, and anti-cancer are among the conditions that *N. nouchali* as well as *N. stellata* are frequently used to treat in Ayurvedic and Siddha medicines. Compounds in the blooms of food plants support healthy health. Additionally, the *N. lotus* flower's aqueous extract has androgenic and fertile properties. *Nymphaea* is widely used for events other than festivals and customs. Additionally, it was frequently suggested for the treatment of illnesses. It is also used to treat diabetes, inflammation, liver ailments, urinary disorders, menorrhagia, and blenorrhagia in addition to being used as an aphrodisiac

and a bitter tonic, and menstrual issues. Modern methods have demonstrated the water lily's hepatoprotective, anti-inflammatory, antioxidative, and particularly anti-diabetic effects.

2.4 Antioxidant Activity

In-depth research into the protective agent capacity of *N. lotus* remove has revealed their critical function as free total collector to stop and lessen the harm resulting from reactive oxygen species. In vitro antioxidant activity of extracts from several *N. lotus* sections was assessed. To test the antioxidant action of *N. lotus* flower hot water extracts in vitro, ABTS,

FRAP, and DPPH tests were utilised. The resulting antioxidant activity was comparable to those of the artificial antioxidant BHT (butylated hydroxytoluene). According to these findings, DPPH, ABTS, and FRAP assays on cord ethanolic take out revealed a alike antioxidant capacity to BHT, and DPPH assays on ethanol extracts from flowers revealed a similar antioxidant volume to vitamin C³. This antioxidant activity, which was These *N. lotus* extracts were linked with the various flavonoid components, was found to be strongly correlated with the flavonoid content.

Table 1. Overview of *N. lotus* extracts' antioxidant properties¹⁵

Extract	Type	Remark	Reference
IN VITRO ASSAYS			
Flowers	DPPH, ABTS, FRAP	antioxidant capacity similar to BHT	[16]
Stamens	DPPH, ABTS, FRAP	antioxidant capacity at least similar to BHT	[5]
Petals	DPPH	antioxidant capacity similar to vitamin C	[29]
Rhizomes	DPPH	showed the highest free radical scavenging activity among 60 plants screened	[32]
Leaves	DPPH, ABTS, FRAP, NO radical and H ₂ O ₂ scavenging	antioxidant capacity at least similar to vitamin C and rutin	[23]
Seeds	DPPH, FRAP	antioxidant capacity similar to vitamin C	[31]
CELLULAR ASSAYS			
Petals	Red blood cells	protection against oxidative stress-induced hemolysis	[29]
Stamens	Yeast cells	inhibition of UV-induced oxidative stress	[5]
Whole plants	B16 melanoma cells	cellular antioxidant action	[33]
ANIMAL STUDIES			
Flowers	Albino male rats	inhibition of oxidative stress markers	[6]
Whole plants	Wistar male rats	inhibition of carbon tetrachloride-induced oxidative stress	[34]

DPPH: 2,2-diphenyl-1-picrylhydrazyl;
 ABTS: 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid);
 FRAP: Ferric Reducing Antioxidant

Power Assay; BHT: Butylated hydroxytoluene.

2.5 Antidiabetic Property

The effectiveness of *Nymphaeaceae* flower hydroethanolic extracts as antidiabetic medications was examined in both healthy and martyr rats make with Alloxan. Both healthy and diabetic rats induced with alloxan were used to study the effects of 30 days of Using the hydro ethanolic extract extract orally on blood sugar, glycosylated hemoglobin,

Triglycerides, phospholipids, and overall cholesterol, very decreased glucose-6-phosphatase, hexokinase, lactate dehydrogenase, density lipoprotein, and high density lipoprotein. The hydro-ethanolic extract decreased high blood sugar, glycosylated hemoglobin, cholesterol, triglycerides, phospholipids, LDL, and VLDL levels while raising insulin, glucose-6-phosphatase, and

hepatic glycogen, and HDL levels. On diabetic rats, *Nymphaea* flowers have a promising anti-diabetic effect. Aqueous and ethanolic solutions extracts of *Nymphaea pubescens* were given to rats with alloxan-induced diabetes at a dose of 400 mg/kg. Blood glucose levels were decreased, with percentage reductions of 21.97% and 19.94%, respectively.

2.6 Cosmetic value

For millennia, this plant's flower, root, leaves, and components have all been applied as vital ingredients in traditional Asian medicines, especially for circulatory system disorders. Both Asian and Egyptian cultures have used *N* for cosmetic purposes. *N* is historically used for skincare and fragrances. For homemade natural cosmetic products, locals still employ water or ethanolic extracts nowadays. We can see that this plant has a lot of cosmetic potential because of its high flavonoid content, which is mostly found in its floral portions. Furthermore, numerous analyses have affirmed its toxin-free status, providing a compelling case for potential uses^{6, 15}.

2.7 Antimicrobial activity

In order to trial the crude extract of *Nymphaea lotus* has antimicrobial properties. The entire herb was used. The antibacterial activity was examined utilizing agar well diffusion. Fresh 10ml of soft agar was added to agar plates, and 100ml of a 10⁸cfu/g bacterial culture was obtained. It drilled an 8mm hole across the previously mentioned petri plate with a clean cup borer and then added 100ml of the typical plant's aqueous extract. For better outcomes, a second run of the bioassay was done. The rhizomes and seeds of *Lotus N*. are claimed to contain phytochemicals, including polyphenols, steroid hormones, proanthocyanidins, tannins, saponins, and flavanols, which function as powerful antimicrobials. The *N. lotus*'s functional classes of phytochemicals extracts prepared with

Using this method, water, ethanol, and *N*-hexane were found to be the best for transformation. Spectroscopy in the infrared. These compounds are therapeutic for diseases in people and animals caused by gut bacteria that are multidrug resistant because of their antibacterial properties. Additionally, it was asserted that the Terpenes, alkaloids, and anthraquinones, glycosides and deoxy-sugar from *N. lotus* could stop middle ear infections brought on by such as *Enterobacter* species, *C. albicans*, and *A. flavus*. Salisu and Nura have demonstrated that the stem extract of *N. lotus* contains phytochemicals that inhibit *Salmonella typhi* and *Enterococcus faecalis* expansion.

3. Evaluation of phytochemicals

According to phytochemical investigation, both *lotus* and water lilies contain a variety of bioactive chemicals, such as polyphenols, steroid hormones, carbohydrates, glycosides, triterpenes, tannins, flavonoids, and other substances. Superior phytochemical analyses investigations for phenolics, cardiac risk factors, and glycosides, catechins, anthraquinones, tannins, saponins, alkaloids, and. Numerous water lilies' phytochemicals and *lotuses* can be recognized and measured using a variety of extraction solvents and analytical devices. According to studies, *N. antares* extracts in ethyl acetate and methanol included *p*-coumaric acid, catechin, epigallocatechin, kaempferol, quercetin, rutin, myricetin, and quercetin.

Discussion

The nutritional makeup of both water lily tubers is maintained by the higher moisture percentage of tuber found in this study than petal and seed samples of both species.

As a result, the petal samples from both species can be recommended as a protein supplement to fulfill the body's daily requirements for protein. Certain necessary amino acids are mostly found in protein, which also has a number of other uses.

Function, which includes manufacturing antibodies, acting as enzymes and hormones, healing wounds and regenerating tissue, maintaining fluid and electrolyte balance, and, most significantly, providing energy when carbohydrate and fat intake is insufficient.

4. Conclusions

Because of the unrivalled a wide variety of chemicals, natural items like plant extracts, or pure compounds or as standardized take out; provide numerous opportunities for the development of new drugs. Due to the rapid depletion natural resources and the ever-increasing population needs, it is now imperative to diversify present agricultural products by cultivating a few wild kinds of rhizomes, corms, and edible tubers satisfy a variety of human nutritional needs. There is proof that lotuses and water lilies are beneficial providers of phytochemicals, vitamins, minerals, amino acids, dietary fiber, carbohydrate, and other nutrients. Greater than 150 chemicals there have found in the water lily rhizome, seed, leaf, stem, bloom, and seed and lotuses. Antibacterial activities of *Nymphaea lotus* can be attributed to a number of substances, including saponins, alkaloids, and carbohydrates that are present in its extracts. In order to present the medicinal perspective of the genus *Nymphaea*, this study makes an effort to evaluate the disparate literatures that are currently available and organise them into several categories in a systematic manner. Numerous novelties are anticipated to quickly add to our understanding of the genus *Nymphaea*, its components, and the corresponding pharmacological effects.

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Conflict of Interest

We, authors of this research article declare no conflict of interest.

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