

PHARMOCOGNOSTIC STUDIES ON NYMPHAEA SPP**Archana Pareek*¹ and Ashwani Kumar²**¹Department of Botany, Vedic Kanya PG Girls College, Jaipur.²Department of Botany, University of Rajasthan, Jaipur- 302004.Article Received on
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Corresponding Author*Archana Pareek**Department of Botany,
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College, Jaipur.**ABSTRACT**

Wetlands provide a unique habitat for several medicinal plants. Attempts has been made to document some of the little known medicinal properties of wetland plants used by local community of India. Nymphaea is a genus of aquatic perennial plants having showy flowers (white, blue, pink, or yellow, often fragrant), including the white water lily currently Nymphaea, they grow from an under water stem. which is buried in the mud and sends rootlets for anchorage. Water lily, the member of the Nymphaeaceae family, is the symbol of Buddhism and Brahmanism in India. The plant has great medicinal

value. Present review deals with various species and their applications in traditional medicines.

KEYWORDS: Aquatic angiosperms, Biodiversity, Medicinal value and Wetlands of India.**1. INTRODUCTION**

It has been realized that all systems of traditional Indian Medicine had their roots in one way or another in folk remedies and household remedies. Aquatic plants have great nutritional value (Pareek and Kumar 2014). Useful compilations of medicinal plants of India were published by Kumar (2008). Kumar and Sopory, (2008) reviewed the studies on traditional Indian Ayurvedic Medicines and some potential plants for bioenergy, medicine from India. Pareek (1994a, 1994b, 1996) carried out detailed investigations on several aquatic species from Rajasthan and also studied their medicinal properties. Shreevastava and Kumar (2007) characterized wetlands of Rajasthan as potential source for cultivation of Medicinal plants. Though the aquatic situations of India are rich repositories of various plant species, not much work has been under taken to enumerate the medicinal uses of them.

Nymphaeales, or the water lilies, are a cosmopolitan order that comprises three families: Cabombaceae, Nymphaeaceae and Hydatellaceae. Together, these families include eight to nine genera and less than 100 species (Borsch *et al.*, 2008). Water lilies have long been considered to be among the oldest independent lineages of angiosperms (Doyle, 1998) and the majority of molecular phylogenetic analysis indicate that Nymphaeales diverged from the second basal most node of the extant angiosperm phylogenetic tree (Drew *et al.*, 2014). Paleobotanical evidence also supports an early origin for water lilies. Nymphaeales are represented in the early angiosperm fossil record and as many as three early Cretaceous fossils can be placed within the nymphaealean crown group (Doyle and Endress, 2014). Family Nymphaeaceae belongs to earlier land plants and includes a wide range of flowering plants. Plants of this family are called water lilies and are distributed in tropical areas around the world, found on the banks of ponds lakes and rivers. Ancient rituals in Maya and Egyptian civilizations used of the flowers of *Nymphaea* (Nymphaeaceae). The lotus plant *Nelumbo nucifera* and *Nymphaea caerulea*, have been used by cultures, both past and present, for their medicinal properties (Emboden 1981). In eastern medicine, one of the cited potential medical effects of the lotus is “calming emotional disturbance” (Zhang *et al.*, 2003). The species implicated are *Nymphaea caerulea* Sav., in Egypt and *N. ampla* D.C., were used by the Maya civilization (Emboden, 1981).

2. MATERIAL AND METHOD

The sample of selected plants were collected from different parts of Rajasthan from water bodies and marshy areas. For the study of medicinal property of wetland plants frequent trips were made in wetland area, bird sanctuary, lakes, ponds, puddles, ditches, canal, swamps etc. During the survey, plants occurring in different water saturated areas were collected, photographed and identified. Their nature of growth, habit, habitat and medicinal property were noted from local, rural and tribal people of different area. To acquire detailed knowledge on the utilization of plant resources, old and experienced persons, village heads and farmers were also contracted, besides, making personal observation on spot; the species are identified with the help of relevant literatures and deposited in Herbarium, University of Rajasthan, Jaipur. Besides this a review of medicinal plants of family Nymphaeaceae is also presented here.

3. Classification

Kingdom Plantae – Plants

Subkingdom Tracheobionta – Vascular plants

Superdivision Spermatophyta – Seed plants

Division Magnoliophyta – Flowering plants

Class Magnoliopsida – Dicotyledons

Subclass Magnoliidae

Order Nymphaeales

Family Nymphaeaceae – Water-lily family

Genus Nymphaea L. – waterlil

4. Taxonomy

There are about 50 species in the whole world, five of which originate from China: *N. alba* L., *N. candida* Presl., *N. tetragona* Georgi., *N. lotus* L. var. *pubescens* and *N. stellata* Willd. (Beckett 1984; Zhu *et al.*, 2012). The plants have a broad range of flower colors, including white, yellow, red and blue (Beckett 1984).

5. Key to the important species

NYMPHAEA (key to species)

1a. Root stock creeping; leaves. glabrous adaxially and velvety pubescent abaxially; lamina not sharply dentate; calyx not ribbed: stamens upto 29; anthers having appendages; stigmatic rays without appendages. *N. nouchalli* Burm f.

1b. Root stock erect; leaves. glabrous on both surfaces; lamina sharply dentate; calyx ribbed; stamens not less than 40; anthers not having appendages; stigmatic rays having appendages. ***N. pubescens*.**

6. Water purifier plant

Despite its limited researches on flower color variations and formation mechanism, water lily has background of blue flowers and displays an exceptionally wide diversity of flower colors from purple, red, blue to yellow, in nature. Like lotus, water lily is not only an ornamental plant but also an important water purification plant also. Because the roots of water lily can absorb the poisonous substances like mercury, lead, phenol, etc and filter the microorganism in water, it plays an important role in decontaminating water, afforesting and landscaping (Li *et al.*, 2005; Shi *et al.*, 2009).

7. Pharmacological assays

They are a perennial rhizomatous herb and many species of *Nymphaea* in India, China and Nepal are thought to act as functional drug plants. These include extracts of the rhizomes and flowers, which have anti-diabetic and anti-inflammatory effects (Raja *et al.*, 2010). Besides this extracts of the rhizomes and seeds, which have the immunomodulatory activity (Mukherjee *et al.*, 2010). Extracts of the stalks have an anti-pyretic effect (Sinha *et al.*, 2000). Extracts of the flowers, stamens and leaves have been shown to have anti-oxidant effects (Jung *et al.*, 2003; Wu *et al.*, 2003; Agnihotri, *et al.*, 2008).

Extracts of seeds have been reported to have hepatoprotective and free radical scavenging effects (Sohn *et al.*, 2003; Bhandarkar and Khan 2004). Polysaccharides have long been believed to have many different biological properties and certain polymers have recently been revealed to act as effective immunomodulating agents.

8. Different species of *Nymphaea*

2.1 *Nymphaea rubra* Roxb. ex Andrews syn *Nymphaea pubescens* Willd. Red water lily. The hairy water lily is known as Shapla in Bengali, Kokaa in Hindi and Kumuda in Sanskrit.

Nymphaea rubra Roxb. ex Andrews is the accepted name of a species in the genus *Nymphaea* (family Nymphaeaceae) is known under a number of different synonyms. Red Water lily is a beautiful floating plant native to India. Red Water lily is found virtually throughout India. The most common of which is *Nymphaea rubra* for the reddish variant known under the commercial name Red water lily (Fig.1). It often has also purplish leaves. This plant is common in shallow lakes and ponds throughout temperate and tropical Asia: India, Bangladesh, Sri Lanka, Yunnan, Taiwan, Philippines, Cambodia, Laos, Thailand, Myanmar, Vietnam, Malaysia and Indonesia. It is widely cultivated in other countries. Leaves are around, sharply toothed, downy on the underside. Flowers are intensely red or rose-colored. Sepals are usually 4 and petals are many. The lobes of the leaves diverge away from each other. Stigma has 10-20 rays.

(<http://www.flowersofindia.net/catalog/slides/Red%20Water%20Lily.htm>)



Fig.1. *Nymphaea rubra* has red flowers.

(Source:<https://www.google.co.in/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=nymphaea+rubra>).

The leaves of this plant have hairy or fuzzy undersides and the stems are covered by the same hairs as well, hence the name "pubescens" or "hairy" of the species. This has plant having erect perennial rhizomes or rootstocks that anchor it to the mud in the bottom. The rhizomes produce slender stolons.

Cheng *et al.*, (2012). reported immunopotentiating effects of *Nymphaea rubra* Roxb. Polysaccharides.

2.2. *Nymphaea thermarum* Eb. Fisch

Nymphaea thermarum. is considered as Extinct in the Wild. It disappeared from this location due to over-exploitation of the hot spring that fed its fragile habitat and apparently no plant is known to have survived in the wild. Habitat restoration for reintroduction of the species is recommended. (<http://www.iucnredlist.org/details/185459/0>).

2.3 *Nymphaea nouchalli* Burm. f. syn *Nymphaea stellata* Willd. or blue lotus Mohan *et al.* (2010).

N. nouchalli is used as an ornamental plant because of its spectacular flowers (Fig 2 and 3). Sometimes this water lily is often referred as 'blue lotus of India', but it is not a lotus (Slocum 2005). (Dezhi Fu 2015). It is native to southern and eastern parts of Asia and is the national flower of Sri Lanka and Bangladesh. Widely distributed in India; common and

locally dominant in permanent and temporary water. *Nymphaea nouchalli*, often known by its synonym *Nymphaea stellata*, or by common names blue lotus is a perennial aquatic herb belonging to the family Nymphaeaceae., (USDA GRIN Taxonomy, retrieved April 20, 2015) star lotus, red and blue water lily, blue star water lily is a water lily of genus *Nymphaea*. Verdcourt has quoted that *N. nouchalli* should be a synonym for *N. stellata* and not for *N. pubescens* as some have stated (Verdcourt *et al.*, 2003; Simmonds *et al.* 2006) However, in some literature and books *N. stellata* and *N. nouchalli* have been differentiated as two species (Singh *et al.*, 2003).

A large, aquatic herb with tuberous rhizome and peltate leaves, flowers solitary, fragrant, variable in colour, deep red to pure white, fruit a spongy berry. Part of the leaves is submerged, while others rise slightly above the surface. The leaves are round and green on top; they usually have a darker underside. The floating leaves have undulating edges that give them a crenellate appearance. Their size is about 20–24 cm and their spread is 0.8 to 1.9 m. All parts of the plant are eaten in times of scarcity. *Nymphaea nouchalli* is a day-blooming nonviviparous plant with submerged roots and stems. In the last few decades there has been an increasing interest in the study of medicinal plants, as knowledge on ethnopharmacology, its holistic system approach, supported by the experiential base, can provide safer and affordable medicines (Patwardhan 2005).



Fig 2: *Nymphaea nouchalli* Photo Kumar Botanical garden San Antonio Texas USA.



Fig 3. *Nymphaea nouchalli* Photo Kumar Botanical garden San Antonio Texas USA.

2.3.1. Medicinal properties

Nymphaea nouchalli is considered a medicinal plant in Indian Ayurvedic and Siddha systems of medicine under the name Ambal. Not only is that it most commonly used for the traditional and cultural festivals in Sri Lanka. It was mainly used to treat indigestion. The rhizome is considered demulcent and used for dysentery and dyspepsia. Flowers are astringent and cardiotoxic. Seeds are used as a cooling medicine in cutaneous diseases (Wealth of India, Vol. VII). Rhizome along with roots of *Lawsonia inermis* grinded in rice washed water is taken to cure diabetes. Flowers are soaked in water overnight; decanted water is drunk for various cardiac problems. Seed decoction soaked in cloth is applied for the treatment of skin infection. Raw rhizome is the best medicine for dysentery (Panda and Misra, 2011).

Like all waterlilies or lotuses, its tubers and rhizomes can be used as food items; they are eaten usually boiled or roasted. In the case of *N. nouchalli*, its tender leaves and flower peduncles are also valued as food. The dried plant is collected from ponds, tanks and marshes during the dry season and used in India as animal forage.

It is used as medicines for the treatment of diabetes, inflammation, liver disorders, urinary disorders, menorrhagia, blenorrhagia, menstruation problem, as an aphrodisiac and as a bitter tonic (Mohan *et al.* 2010). Its hepatoprotective, anti-inflammatory and particularly antidiabetic activity has been confirmed using modern methods. Nymphayol, a steroid isolated from the flowers has been scientifically proved to be responsible for the traditionally

claimed antidiabetic activity; it reverses the damaged endocrine tissue and stimulates secretion of insulin in the β -cells. To date sterols, alkaloids, saponins, tannins and flavonoids are reported from different parts. Recently, nymphasterol, a new steroid has been isolated and identified from the seeds (Verma *et al.* 2012).

2.3.2. Antimicrobial activities

Flowers of *N. nouchalli* were effective against *Pseudomonas aeruginosa*, *Bacillus cereus*, and *Staphylococcus aureus* (Vasu and Singaracharya 2008; Mohan *et al.*, 2008). The zone of inhibition was extremely great for *P. aeruginosa*, *S. aureus*, *K. pneumoniae*, *S. dysenteriae* and *E. coli* and for fungi: *C. albicans* and *T. mentagrophytes* (Parimala *et al.* 2014). The results therefore clearly indicates that the crude extract from *N. nouchalli* seeds could be used as a potential source of natural antimicrobial agent owing to the presence of the phytoconstituent catechin in abundance along with other active compounds and supports the traditional use of the plant in the treatment of infections (Dash *et al.*, 2013; Parimala *et al.*, 2014).

3. *Nymphaea alba* Linn: White water lily

Nymphaea alba (family Nymphaeaceae), commonly known as white water lily in English and kumuda in Sanskrit, is an aquatic herb with perennial rhizomes or rootstocks anchored with mud (Fig 4 and 5). *Nymphaea alba* is rich in tannic acid, gallic acid, alkaloids, sterols, flavonoids, glycosides, hydrolyzable tannins and high-molecular-weight polyphenolic compounds (Eliana *et al.*, 2008). It is globally distributed in Europe, North Africa, Southwest Asia, India, China and Russia.



Fig. 4 *Nymphaea alba* L: Photo Kumar from the Giessen Botanical Garden Germany.



Fig 5. *Nymphaea alba* L: a single flower in close-up: Photo Kumar from the Giessen Botanical Garden Germany.

Anxiety disorder is increasingly recognized as a highly prevalent and chronic disorder in all ages. Pharmacotherapeutic approaches for the management of anxiety disorders include psychotropic drugs, but these agents are limited by their side-effect profile, the need for dietary precautions, and drug interactions. Recently interest of many researchers to evaluate new compounds from plant origin in the hope to identifying other anxiolytic drugs with fewer unwanted side effects has grown. *N. alba* has potential clinical applications in the management of anxiety and muscle tension disorders (Thippeswamy *et al.*, 2011). Thippeswamy *et al.*, (2011) suggested that the ethanolic extract of *N. alba* possesses anxiolytic and muscle relaxant properties. Khan and Sultana (2005) reported anticarcinogenic effect of *Nymphaea alba* against oxidative damage, hyperproliferative response and renal carcinogenesis in Wistar rats.

4. *Nymphaea tetragona* Georgi

Nymphaea tetragona water lily (wl) is found in Europe, Asia, and North America. It has white flowers (Fig 6). The plant is used in the treatment of diarrhea, dysentery, eruptive fevers and infections (Hossain *et al.*, 2014; 2015). In India, the original distribution of *N. tetragona* was confined to the States of Jammu & Kashmir and Meghalaya but came under threat due to mainly unplanned human activities, such as road construction, agricultural

conversion, deforestation, animal grazing and other factors that ruin its natural habitats (Tandon, *et al.*, 2010:<http://www.plant-talk.org/nymphaea-tetragona-india.htm>).



Fig 6. *Nymphaea teragona*

<https://www.google.co.in/search?q=nymphaea+tetragona&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwj4KuEtKfMAhVMcY4KHYYAuByMQ7AkIJg&biw=1280&bih=699#imgsrc=kgF69wJ8SuqhYM%3A>).

The anti-infectious activities of this herb have already been assessed to clarify its traditional use as a medicine. Park *et al.*, (2016) reported for the first time protection on skin aging due to the mitochondria-mediated antiapoptosis effects of wl rhizome extract (wlre) on human epidermal keratinocytes.

5. *Nymphaea candida* J. Presl

Nymphaea candida is traditional Uighur medicine that is commonly used to treat head pains, cough, hepatitis and hypertension in Xinjiang of China. Liver is considered a key organ in the metabolism, secretion, storage and detoxifying functions in the body and hepatic damage is associated with distortion of these function (Wolf, 1999) (Fig 7 and 8).



(Fig 7. *Nymphaea candida*

<https://www.google.co.in/search?q=Nymphaea+candida&espv=2&biw=1280&bih=699&site=webhp&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwjR84zzuqPMAhXMW44KHdzKCd0QiR4IdA#imgrc=kxt2kcdBg-ugIM%3A>).



Fig 8. *Nymphaea candida*

<https://www.google.co.in/search?q=Nymphaea+candida&espv=2&biw=1280&bih=699&site=webhp&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwjR84zzuqPMAhXMW44KHdzKCd0QiR4IdA#imgrc=kxt2kcdBg-ugIM%3A>).

Liver diseases are mainly caused by toxic chemicals, excess consumption of alcohol, infections and autoimmune disorders. Liver produces large amounts of oxygen free radicals reactive oxygen species (ROS) in the course of detoxifying xenobiotic and toxic substances, and oxidative stress caused by ROS has been shown to be linked to liver diseases, such as

hepatotoxicity and other liver pathological conditions (Mehendale *et al* 1994; Stohs 1995). The immunological hepatotoxicity of primary cultured rat hepatocytes can be induced by Bacille Calmette-Guerin (BCG) combined lipopolysaccharide (LPS) treatment in vitro and this model has implicated the involvement of release of various cytokines and active free radicals (Zheng *et al* 2002). Thus, immunological mechanisms and oxidative stress play important role in liver injury induced by BCG plus LPS (Wang *et al.*, 2004). At present, this model has frequently been used as useful experimental means for testing and developing new drugs (Zou *et al.*, 2006). *Nymphaea candida* Presl (or snow-white waterlily) is a herbaceous hydrophyte native to the southern Xinjiang province in China and the flowers of *N. candida* has been used as a folk medicine for head pains, common cold, cough, hepatitis and hypertension (Liu 1999).

6. *Nelumbo nucifera* Gaertner (Nelumbonaceae) Indian lotus, sacred lotus. It is the *Thamara*, *Lotus*

Nelumbo nucifera, also known as Indian lotus, sacred lotus, bean of India, or simply lotus, is one of two species of aquatic plant in the family Nelumbonaceae (Fig 9). It is widely distributed in India; cultivated as a crop, found growing in ponds, tanks, etc; It has stout, creeping rhizome, leaves peltate, glaucous, petioles long, smooth or with small prickles, flowers large, white or rosy. The Linnaean binomial *Nelumbo nucifera* (Gaertn.) is the currently recognized name for this species, which has been classified under the former names, *Nelumbium speciosum* (Willd.) and *Nymphaea nelumbo*, among others. However these old names should be avoided.



Figure 9. *Nelumbo nucifera* (Gaertn.) syn. *Nymphaea nelumbo*

The rhizomes are eaten as vegetable or preserved in sugar. A paste of the rhizome is applied in ring worm and other cutaneous affections. Carpels are demulcent and used to check vomiting. Flower petal decoction is given against diarrhea. The fruiting torus is sold for the edible carpels embedded on it and are considered superior to cereals in nutritive value. Nelumbo honey is much in demand. The milky viscid juice of leaves and flowers bacteriostatic action against Gram positive and Gram negative bacteria (Wealth of India, Vol. VII). Rhizomes are also ground as a starch (Lotus meal). Young seed powder is taken along with fresh cow milk against headache. Young seed paste is used externally as a cooling medicine for skin diseases The seed kernels are also used as a source of starch or eaten dry (Usher, 1984). Young flower paste is prescribed as cardiac tonic and also in fever and liver ailments. Paste of young leaf, along with fruits of *Embllica myrobalan* is applied on forehead to get relief from headache. Powdered root is taken for expelling ring worms. Root paste in lemon juice is taken for the treatment of piles (Panda and Misra, 2011).

Nuciferine, an alkaloid component of *Nelumbo nucifera* and *Nymphaea caerulea*, had a predicted molecular profile similar to antipsychotic compounds. Macko and colleagues (Macko *et al.*, 1972) observed that nuciferine produces effects similar to those of the antipsychotic chlorpromazine in rodents. Farrell *et al.*, (2016) characterized nuciferine using *in vitro* and *in vivo* pharmacological assays. They suggested that Nuciferine, an alkaloid component of *Nelumbo nucifera* and *Nymphaea caerulea*, have a predicted molecular profile similar to antipsychotic compounds.

DISCUSSION

The lotus is often confused with the water lilies (*Nymphaea*, in particular *Nymphaea caerulea*, sometimes called the "blue lotus"). In fact, several older systems, such as Bentham and Hooker (which is widely used in the Indian subcontinent) call the lotus *Nymphaea nelumbo* or *Nymphaea stellata*. This is, however, evolutionarily incorrect (https://en.wikipedia.org/wiki/Nelumbo_nucifera). *Nymphaea nouchalli* N.L. Burman (*Nymphaeaceae*). is Indian Water lily. It is native to southern and eastern parts of Asia, and is the national flower of Sri Lanka and Bangladesh. *Nymphaea nouchalli*, often known by its synonym *Nymphaea stellata*, or by common names blue lotus is a perennial aquatic herb belonging to the family *Nymphaeaceae*, (*USDA GRIN Taxonomy*, retrieved April 20, 2015) star lotus, red and blue water lily, blue star water lily is a water lily of genus *Nymphaea*. Verdcourt has quoted that *N. nouchalli* should be a synonym for *N. stellata* and not for *N.*

pubescens as some have stated (Verdcourt *et al.*, 2003; Simmonds *et al.* 2006) However, in some literature and books *N. stellata* and *N. nouchalli* have been differentiated as two species (Singh *et al.*, 2003).

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