



***NYMPHAEA ALBA*: A DETAILED STUDY**

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ABSTRACT

Nymphaea alba commonly known as white water Lily, is a hydrophyte having enormous medicinal properties. It is famous for its alluring white flowers. It is distributed across the globe in ponds, lakes and marshy areas. Its different parts have been used traditionally, to treat variety of ailment, in various medicinal systems including Arabic, Unani, Ayurvedic and Chinese medicines. By using contemporary pharmacological methods, traditional use of *Nymphaea alba* has been substantiated for curing different diseases. In-depth research provides an estimate of the pharmacological effects of different extracts or isolated compounds of *Nymphaea alba*. By using in vivo or in vitro methods is established that *Nymphaea alba* has therapeutic potential to treat diarrhea, hepatotoxicity, inflammation, anxiety and depression and convulsions etc. In addition, *Nymphaea alba* extracts also found to have a certain degree of anti-cancer and anti-bacterial activity. This review is an attempt to compile *Nymphaea alba*'s current ethnomedicinal, morphological, phytochemical and pharmacological data.

Keywords: Ethnobotanical, Flavonoids, *Nymphaea alba*, Quercetin, White water Lily

INTRODUCTION

Nymphaea alba belongs to Nymphaeaceae family which comprises of the several valuable medicinal plants with a wide range of pharmacological and biological actions

along with established to have important phytochemical components [1]. The genus *Nymphaea* comprises of about forty five species [2], out of which five species are

present in India, and some are grown as ornamental plant [3]. *Nymphaea alba* frequently referred to as "European White Water Lily or Nenuphar. It is a perennial hydrophyte having a black, Sturdy, almost horizontal, scarcely branched rhizome submerged in the mud [4]. It preferably grows in neutral to alkaline waters in puddle, stagnant or slightly moving lakes and marshy areas [5]. It grows at depth of about .5 – 3m., in water over mud, silt or Peat [4]. It is spread extensively throughout Europe, north Africa, north & central Asia, southwest Asia, Finland, India, China, Russia, Turkey and Poland [4, 6-8]. *Nymphaea alba* was thought to be a plant of lowland waters, but is also occurs at higher altitudes in Kashmir (India) at 1500 m., in Angle Tarn (England) at 456 m., in Isla (Scotland) at 426 m. and in Ireland at 335 m [4, 9]. It occurs in temperate and tropical regions [10]. In India it is widely distributed in the lakes and ponds of Bengal, Orissa to Kashmir [3, 11].

SYNONYMS [12]

Eng: European White Water Lily

Latin: Nenuphar

Arabic: Nilufar

Beng: Kumuda, Shandh shaluka

Guj: Piyanu

Hindi: Kanval, Kokka



Figure 1: *Nymphaea alba*

DESCRIPTION

Nymphaea albavaries in size considerably, it can spread upto 20 feet. Flower: *Nymphaea alba* has big white flowers consisting of 4 to 5 sepals, Two to three rows 12-33 of petals arranged in 2 to 3 or more rows [13]. Sepals are linear or ovate, oblong and nerves are reticulate Petals are outer linear-oblong equaling the sepals [13]. Anterior sepals represent bract and lateral sepals' bracteoles [4]. It has abundant anthers in the center which are of yellow in color [14]. During anthesis flowers closes at night and opens during day [15]. Leaves are oval, cordate, entire or sub-orbiculate can have a diameter of up to thirty centimeters and covers up 150 centimeters of area per plant[13, 16].Color of leavesvaries that is dark green at top and reddish brown below[17]. It has a smooth and slightly striated cuticle [18]. The fruits are fleshy spongy and capsular and ripe in water, it contains up to 1700 seeds per fruit, 2-5 mm long, punctuate, buried in pulp , dark olive green in color having smooth surface [4, 13]. *Nymphaea alba* has perennial rhizomes which helps it to survive and grow again [19].

ETHNOBOTANICAL USES

Nymphaea alba has a history of ethnobotanical applications in different cultures [10]. Almost each part of this plant has been used to treat variety of illness [20]. Its root and rhizome were used to treat or relief GIT, reproductive and lungs disorder [20]. Aerial parts specially leaves as well as roots of *Nymphaea alba* were utilized as a poultice to boils, inflamed skin and scrofulous ulcers. The pulp of its rhizome shows rubefacient effect when applied externally [21]. Seeds of *Nymphaea alba* used for its Diaphoretic action [22]. A decoction prepared from its root was used in irritable bowel syndrome for management of diarrhea. It was also utilized for the treatment of bronchial catarrh & kidney pain and for sore throat [6]. Moreover, this plant has been used from older times for various actions including aphrodisiac, anti-inflammatory action, anodyne, astringent, cardiogenic, demulcent, antioxidant, sedative action [19]. Apart from traditional usage of *Nymphaea alba* for its medicinal credence, it is also consumed as a food supplement for its nutritional importance like its soft part of leaves, stalks bearing flowers are part of diet of several ethnic groups. In addition its Starch rich rhizomes are consumed in raw form or boiled at several places. A combination of black pepper and its pistils are used for internal and external

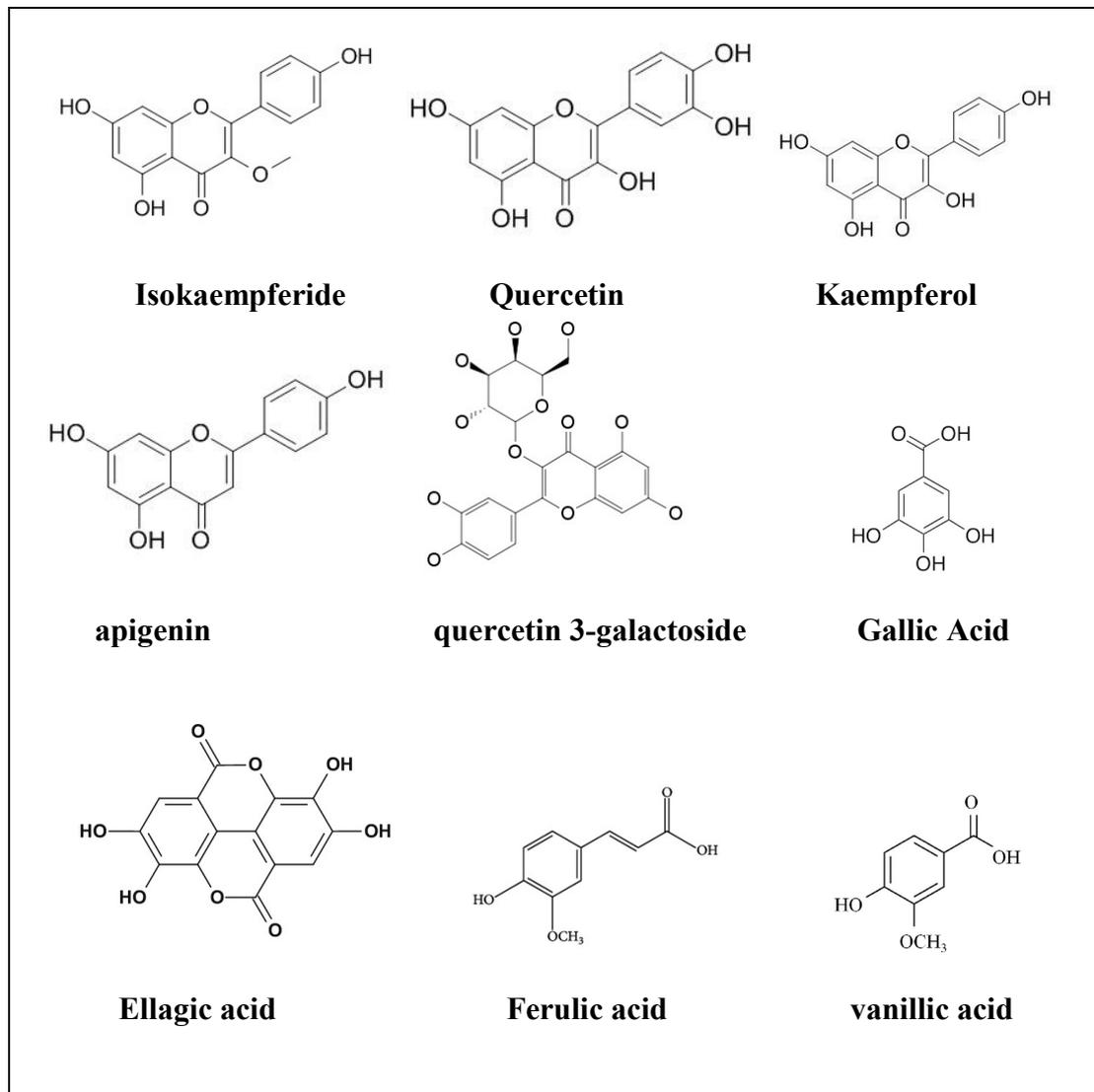
purposes. Flour of its seeds is mixed with wheat and barley flour [23]. During dearth, its rhizomes were boiled and parched seeds were consumed as meal in China and East Indies its dried seed flour with wheat flour was used in making mixed breads. In addition its rhizomes are used for tanning purposes [24].

PHYTOCHEMICAL STUDIES

Nymphaea alba is reported to have variety of chemical constituents including alkaloids, tannins, flavonoids, Phenolic content and glycosides [25-27]. Its flowers were established to have isolated aglycons including: quercetin, isokaempferide, kaempferol, and apigenin along with various glycosides moieties including quercetin 4'- β -xyloside, 3-methylquercetin 3'- β -xyloside as well as combination of quercetin 3-galactoside and 3-glucoside [26]. It was also established to have variety of phenolic acids like Gallic Acid, Ellagic acid, methyl and ethyl esters of gallic acid, also found to have traces of Ferulic, vanillic, p-cumaric and p-hydroxy benzoic acid [26, 27]. Its alcoholic extract of flowers was reported to have cardiac glycoside Nymphalin [23]. It was estimated from chemical composition of *Nymphaea alba* that it has abundance of proteins, essential inorganic compounds which provides energy and has less fiber [28]. In another research, presence of polyphenols and flavonoids is confirmed, a

total of 27 compounds were identified, having major proportion of rutin and p-coumaric acid along with caffeic acid, catechin, epicatechin, naringin, naringenin, vanillic acid, corilagin, tannic acid, gallic acid, ferulic acid, ellagic acid, quinic acid, kaempferol, castalin, orientin, apigenin, luteolin, brevifolin, ellagic acid rhamnosyl,

quercetin, HHDP-hexoside [29]. It has traces of some inorganic substances including copper, sulphate, chloride [13]. *Nymphaea alba* rhizomes were also proved to have five main phenolics including, gallic acid and its methyl and ethyl ester, ellagic acid and pentagalloyl glucose [30].



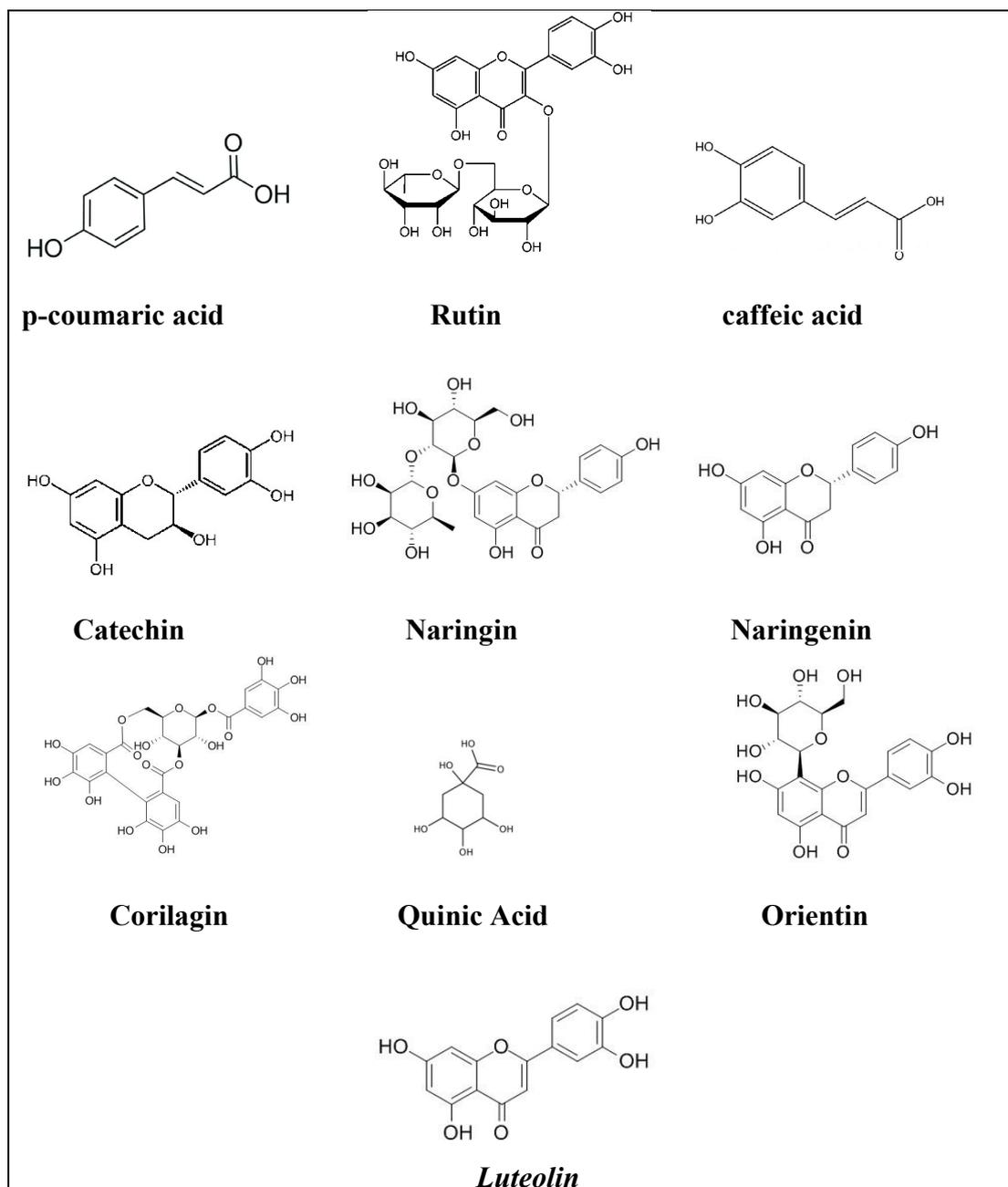


Figure 2: The structures of phytoconstituents of *Nymphaea alba*

PHARMACOLOGICAL ACTIVITIES

Anti - Inflammatory activity:

Ethanol extract of rhizome of *Nymphaea alba* was used to evaluate its analgesic activity. Male mice (20-30 g) were used in acetic acid-induced writhing in mice and Formalin-induced nociception. 200mg/kg, 400mg/kg and 600 mg/kg of extract was administered orally along with 100mg/kg

of standard drug paracetamol, the percent inhibitions assessed is 57.55%, 64.52%, 76.55% and 51.18%, respectively with comparison to control values. Similarly, same doses of extract showed significant results in the formalin-induced pain. Highest dose that is 600 mg/kg of the extract, showed better results in comparison

to standard drug, in formalin-induced pain [31].

Anti-inflammatory activity of *Nymphaea alba* flowers was evaluated using ethanol extract. Two anti-inflammatory models were employed to figure out acute and chronic anti-inflammatory activity. For acute inflammation, acetic acid induced vascular permeability model was used on the other hand for chronic cotton-pellet induced granuloma as taken. Dose of 100mg/kg and 200mg/kg of ethanol extract was administered orally in mice. The doses 100 and 200mg/kg exhibited inhibition of 10.1 percent and 41.5 percent respectively in granuloma formation, however standard diclofenac reflected 57.30 percent inhibition in contrast to control. Whilst, extract exhibited 20.35% and 33.54% inhibition in acetic acid-induced vascular permeability model, where diclofenac sodium showed 43.13 in comparison to control [16].

In another study, to substantiate anti inflammatory activity of hydroalcohol extract of *Nymphaea alba* flowers, HRBC membrane stabilization method was taken into account. Different concentrations including 200 µg/ml and 500 µg/ml represented remarkable stabilization of the HRBC membrane. Concentration 500µg/ml of extract exhibited higher percentage protection [1].

Anti-hepatitis C activity:

Anti- hepatitis C activity is done using methanol extract and acetone extracts of *Nymphaea alba* with its purified fractions. Study was carried out by utilizing transfection model on Huh-7 cell line. MDBK cell line was used to analyze Synergistic effects of purified fractions with interferon in transfection model. By using in-vitro transfection model, effect of two isolated acetone extract fractions 'N1' & 'N8' was observed on hepatitis C virus replication by studying viral gene expression. In addition, taking NS3 protease as an active target, interaction of NS3 protease with fourteen constituents of *Nymphaea alba* was carried out using Molecular Operating Environment (MOE) software, boceprevir was taken as standard NS3 protease inhibitor. Reported 84 and 94 percent fall hepatitis C virus NS3 gene expression. Further, combination of boceprevir with isolated fraction showed synergistic effects and increased inhibitory effect of hepatitis C virus replication [32].

Anti-diarrheal activity:

Castor oil induced diarrhoea model using Wistar rats were employed to find out anti-diarrheal properties of *Nymphaea alba*. Ethanol extract was prepared from Rhizomes and roots. 100 and 200 mg/kg dose of *Nymphaea alba* was administered through oral route that induced reduction in defecation rate, 5 mg/kg diphenoxylate was taken as standard. In comparison to

standard, 100 and 200 mg/kg ethanol extract expressed comparable percentage inhibition of 92.6% and 93.8% respectively [2].

Hepatoprotective activity:

Nymphaea alba flowers were evaluated for hepatoprotective activity using CCl₄ and acetaminophen induced hepatotoxicity methods. Wet liver mass and wet liver quantities are significantly inhibited by two doses of ethanol flowers extract that is 200 mg/kg & 400 mg/kg. Results of biochemical estimation reflected remarkable depletion in SGOT, SGPT, ALP, Bilirubin and cholesterol level in comparison to control group. Dose 400 mg/kg showed the highest inhibition in both models [33].

In another study *Nymphaea alba* leaf extract was involved for analyzing its hepatoprotective action. Carbon tetra chloride-induced hepatotoxicity model was used to evaluate efficacy of *Nymphaea alba* extract, on eight-week-old male Wistar albino rats, silymarin was taken as standard. Two doses 100 mg/kg and 200 mg/kg of aqueous ethanolic extract significantly enhanced liver functions oxidative stress parameter along with TNF- α . Results validated that aqueous ethanolic extract of *Nymphaea alba* has hepatoprotective activity concordant to standard drug silymarin [34].

Isoniazid Induced hepatotoxicity:

Hepatotoxicity was induced by isoniazid (50 mg / kg) in rats. In the study, 50 mg / kg of Silymarin was taken as standard drug. Dose of 200 and 400 mg/kg of *Nymphaea alba* flowers ethanol extract was administered along with Silymarin for 31 days. Isoniazid was administered from 4th to 31st day of the study in standard and test groups. All drugs have been given orally. Both doses considerably reduced rise of different markers like liver marker enzymes SGOT, SGPT along with serum bilirubin, catalase, malondialdehyde, glutathione in rats hence exhibits protective action in isoniazid induced hepatotoxicity in rats. In addition avoided the elevation of liver MDA content and increased GSH content resulting from rat liver intoxication with Isoniazid challenge [35].

Antibacterial activity:

The current research was conducted to assess the antibacterial activity of *Nymphaea alba*. Complete plant was used to make extracts, using ethanol and acetone. Three strains of bacteria were incorporated in the current study that is *E. coli*, *Vibrio sp.* and *S. aureus*. Both Acetone and ethanolic extract showed greater inhibition areas of 26.2 mm and 18.8 mm respectively against *Vibrio sp.* Minimum inhibition concentration values of acetone extract found to be between 20.0 mg / mL to 160.0 mg / mL in comparison to ethanolic extract which ranges from 10.0

mg / mL to 80.0 mg / mL. *Nymphaea alba* acetone extract exhibits greater antibacterial activity against *Vibrio sp.* [36].

In other studies antibacterial activity flowers of *Nymphaea alba* was carried out against four different strains of bacteria that were *Bacillus subtilis*, *Staphylococcus aureus*, *Klebsiella pneumonia* and *Escherichia coli*. For the screening, hydroalcohol extract flowers of nymphaea abla were used. Muller Hinton agar media was prepared then the cultures of respective bacteria grown in nutrient broth were swabbed on plates. After that 25µl each extract was taken to suffuse sterile discs of 6mm diameter. Inference of the whole study signified that *Nymphaea alba* has high activity for *staphylococcus aureus*, *Escherichia coli* and *Bacillus subtilis*. Plant extract showed concordant results against various bacteria, gentamycin was taken as standard [37]. *Nymphaea alba* was also reported to have activity against *Pseudomonas aeruginosa* [38]. Ethanol and methanol extracts of *Nymphaea alba* exhibited potent antibacterial activity in a research, on multiple plants taking 10 different bacterial strains using disc diffusion technique [39].

Ethanol extracts of *Nymphaea alba* was also evaluated to trace out its antibacterial potential against *Listeria monocytogenes* infection using mice. Animals were

exposed to 100 µl and 200 µl of the pathogen. *Listeria monocytogenes* infection causes changes in behavior, sunken eyes, eye secretions, hyperactivity, circumflex backbone, sedation, and mortality as signs of infection. Count of lymphocyte along with neutrophils elevates due to the infection, yet their levels found to be in a normal range in the infection pretreated with *Nymphaea alba* as it significantly inhibits infection, It also cause enhancement of the platelets production and stabilises WBC's count [40].

Anticarcinogenic effect:

Nymphaea alba methanol extract was researched to investigate the prophylactic action against oxidative stress on kidneys, renal carcinogenesis and hyperproliferative reaction on wistar rats. Two different protocols were used, first one was designed to analyze the preventive effect of *Nymphaea alba* on renal oxidative stress induced by ferric nitrilotriacetate and ornithine decarboxylase induction. In other the anticancer effect of *Nymphaea alba* was evaluated against Diethylnitrosamine, as well as ferric nitrilotriacetate induced renal tumor. 100mg/kg and 200 mg/kg oral doses of *Nymphaea alba* exhibited depletion of different parameters taken in the study along with reduction in incidence of tumor [20].

In another research, anticancer activity of *Nymphaea alba* was determined by using

Sulpharhodamine-B assay, four cancer cell lines were utilized including THP-1 (leukaemia), PC-3 (Prostrate), A-549 (lung) and HCT-15 (Colon). 100µg/ml and 50µg/ml of extract were screened for 48 hours, using 96-well plate reader; readings were taken at 540 nm. Exhibited inhibition of growth, during 48 hour incubation. Chloroform and petroleum ether extract exhibited consequential effects [3].

Cytotoxic activity of several isolated constituents from *Nymphaea alba* was reported including Methyl gallate that exhibited best results against HepG2- cell line with IC₅₀= 9.61µg/ml, whilst ethyl gallate along with pentagalloyl glucose showed IC₅₀ - 41.9µg/ml and 41.2 µg/ml, respectively. In comparison to standard Doxorubicin 0.56 µg/ml [30]. In another study ethanol extract of *Nymphaea alba* was analysed for antitumor activity using potato-disc tumor assay induced with *Agrobacterium tumefaciens*, and results reflected that it can significantly inhibit tumor [39].

Efficacy of methanol extract of *Nymphaea alba* in renal oxidative stress induced by potassium bromate as well as ornithine decarboxylase induction was evaluated. 125mg/kg of KBrO₃ was administered intra-peritoneal in unit dose to induce renal oxidative stress. Three groups of animals were pretreated with 100 mg/kg and 200 mg/kg prior to treatment with KBrO₃.

Animals that were treated with extract reduced renal glutathione, antioxidant enzymes along with phase-II metabolising enzymes and enhanced xanthine oxidase, glutamyl transpeptidase, lipid peroxidation and hydrogen peroxide. This study signifies that *Nymphaea alba* activity as chemo preventive agent against KBrO₃-mediated renal oxidative stress and exhibited depletion of tumor occurrence in Wistar rats [20].

Antiuro lithiatic activity:

Antiuro lithiatic potential of *Nymphaea alba* was evaluated using ethanol extract of dried leaves. Dose of *Nymphaea alba* was given orally. To induce urolithiasis zinc disc was inserted in the urinary bladder followed by supplementing drinking water having 1% ethylene glycol. Weight reduction of the stones was taken as criteria for estimating the preventive or curative regimen. Results determine that *Nymphaea alba* oral administration leads to concordant decrease of bladder stones weight in comparison to the control [19].

Uterotonic properties:

Uterotonic properties rhizomes of *Nymphaea alba* was investigated using ethanol extract of rhizomes of *Nymphaea alba*. Virgin female wistar rats (120-130 g) were incorporated into studies, 1 mg/kg of stilboesterol was administered subcutaneously for estrogenized uterus preparation. *Nymphaea alba* ethanol extract

exhibited uterine stimulant like effect in the presence of salbutamol and atropine from. Dose dependent elevation uterine contraction force was observed that is similar to Oxytocin. Oxytocin potentiated the activity of extract whilst atropine or salbutamol shows inhibitory effects on the activity of the extract represented that extract has uterotonic properties [11].

Anxiolytic activity:

Ethanol extract of *Nymphaea alba* plant was explored to trace out its anxiolytic activity using male albino mice. To assess the anxiolytic activity various models were incorporated during investigation: the elevated plus maze test, light and dark test and open field test. In addition to assess aggressive behavior and motor coordination foot shock induced aggression test along with rota rod test were involved in the research. Two doses 100 and 200 mg/kg were administered orally and Diazepam was taken as a standard. Both doses of ethanol extract of *Nymphaea alba* remarkably enhanced the duration of time spent, percentage and count of entries in open arm and elevated plus maze test. There is remarkable enhancement in time spent, crossing count and depletion in the interval of movement in light box. In addition, extract enhances count of rearings along with assisted rearings and count of crossed squares in open field test. In FSIAT, *Nymphaea alba* extract diminished

anxiety by reducing attacks showing aggression by animal [16].

Antidepressant activity:

Antidepressant activity of *Nymphaea alba* flowers was investigated in mice using Tail suspension test along with forced swim test. Two doses that are 100 mg/kg and 200mg/kg of ethanolic extract of *Nymphaea alba* flowers were taken and a comparative analysis was done taking Imipramine 10 mg/kg as standard. And it was observed that dose 100 mg/kg showed a more depletion in the time immobility in comparison to its higher dose(200 mg/kg) as well as more than standard drug [41].

CNS depressant activity:

Ethanol extract of *Nymphaea alba* rhizomes was evaluated for its CNS depressant activity. Different doses were administered to mice including 75 mg/kg, 150 mg/kg and 300 mg/kg to study behavioral effects. Diazepam induced sleep test, holeboard test, beam walking, staircase test, open field test and elevated plus maze were incorporated for evaluation. Results reflected that *Nymphaea alba* rhizome exhibits sedative properties and exhibits concordant results in comparison to the standard drug [10].

Anticonvulsant activity:

Anticonvulsant properties of *Nymphaea alba* flowers ethanol extract in rats was evaluated. MES induced seizures using Electroconvulsimeter and Pentylene

tetrazole (PTZ 70mg/kg i.p) induced seizure model were used to evaluate Anticonvulsant activity. For both of the methods, Phenytoin sodium and sodium valproate were used as standard drugs respectively. Two different doses were selected for ethanol extract of *Nymphaea alba* (200mg/kg and 100mg/kg of body weight) and given orally 1 hour before induction of seizures. Both significantly prevented tonic hind limb extension phase and also lower down the time interval of seizures in MES models. PTZ induced model revealed that extract showed little protection compared to control however, was insignificant statistically [42].

Antihyperlipidemic activity:

Nymphaea alba was studied for antihyperlipidemic activity. Methanol extract of *Nymphaea alba* leaves was tested against triton induced hyperlipidemia in rats. Dose of 100mg & 200mg /kg (p.o) methanolic extract of *Nymphaea alba* was administered to hyperlipidemic rats which is induced by triton (400mg/kg). Fenofibrate was taken as standard drug for reference. Biochemical Analysis reveals that *Nymphaea alba* shows a concordant cholesterol level depletion along with phospholipids, LDL, VLDL, triglyceride and significant rise in the serum HDL level at 100 and 200mg/kg. Total cholesterol serum level was reduced by 74.25% and

32.76% reduction of LDL cholesterol level [43].

Antioxidant activity:

Antioxidant activity of two different extracts (aqueous and ethanol extracts) of flowers of *Nymphaea alba* were examined by several antioxidant screening methods involving free radical scavenging by H₂O₂, total antioxidant and nitric oxide (NO) scavenging activities. Significant results were obtained from the assays indicating that both the extract have potent antioxidant properties. In contrast to aqueous extract ethanol extract exhibited more significant results [44]. An another study reveals the antioxidant potentials of different extracts of *Nymphaea alba* flowers determines its antioxidant potentials using DPPH radical scavenging assay. The results showed that methanol, ethyl acetate and aqueous extract of *Nymphaea alba* has promising antioxidants capacities [3].

MISCELLANEOUS:

Nymphaea alba was reported to have potency of accumulating heavy metals like lead cadmium and manganese at varying concentrations and pH [45, 46]. Manganese showed highest deposition that is 3.743 mg/g at 5 mg/L concentration and pH 6.5, however cadmium showed minimum value that is 0.464 mg/g at 1 mg/L concentration and pH 5.5 [45]. Its roots can also absorb mercury phenol as well as filter microorganisms hence it can be claimed

that *Nymphaea alba* can be used as biological filter for eliminating heavy metals from industrial wastes [45, 47]. Relationship between different concentrations of various elements like Barium, cobalt and copper has also been observed [48]. In another study absorption of Chromium by different parts of *Nymphaea alba* as well as its toxic effects over plant has been investigated 48. Effect of different factors including pH, Al and HCO_3^- were studied to trace out decomposition pattern as well as constitutions of leaves [49].

CONCLUSION

Natural products are attaining popularity worldwide, knowing their disease curing properties with rare side effects. Contemporary laboratory techniques exhibited their versatile role in

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development of herbal medicines. There are varieties of synthetic molecules which are derivatives of isolated plant constituents and are used for their therapeutic values. *Nymphaea alba* has been used from older times traditionally for treating different ailments. Moreover its applications were proven by ethnomedicine systems that were developed by different ethnic groups. By using latest techniques of investigation *Nymphaea alba* has been explored for a number of different disorders and shown promising results that is a testimony for their traditional applications. It has been reported to have variety of potentials ranging from antioxidant properties to chemo preventive agent. Although different research has been done on *Nymphaea alba*, still there is huge scope to explore its hidden potentials.

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