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## Review on *Nelumbo nucifera* Gaertn



**Nanaware Dhanashri\*, Misal Prajakta, Jadhav  
Smita, Ashtage Shivani**

*Department of Pharmacognosy  
Sahyadri College of Pharmacy, Methawade, Sangola,  
413307, Solapur, Maharashtra, India*

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### ABSTRACT

China and India have both employed the aquatic perennial plant *Nelumbo nucifera* Gaertn (Nymphaeaceae) as a medicine. Over 400 years have passed since it was first mentioned in China's most well-known medical literature. Different plant parts (leaves, seeds, flowers, and rhizomes) can be employed in the conventional medical system. In the conventional medical system, there are various portions of plants are claimed to provide therapeutic benefits for the treatment of cough, spermatorrhoea, leukoderma, smallpox, dysentery, hemorrhagia, metrorrhagia, hematemesis, epistaxis, hemoptysis, hyperlipidemia, fever, cholera, hepatopathy, and hyperdipsia. Studies on the pharmacological properties of *N. Nucifera* have revealed that it has some noteworthy pharmacological properties, including anti-ischemic, antioxidant, anticancer, antiviral, anti-obesity, lipolytic, hypocholesteremic, antipyretic, hepatoprotective, hypoglycemic, antidiarrheal, antifungal, antibacterial, anti-inflammatory, and diuretic properties. The current review aims to compile all of the phytochemical and pharmacological data on *N. Nucifera* that is currently accessible.

## INTRODUCTION:

- *Nelumbo nucifera* Gaertn.
- **Synonym:** *Nelumbium speciosum* Willd.
- **Family:** Nymphaeaceae.
- **English Name:** Sacred Lotus, Lotus.
- **Sanskrit/Indian Name:** Kamala, Padma.
- **Habitat:** Throughout warmer parts of India, up to 1800 m.<sup>[1,2]</sup>
- **Physical Characteristics and Description:**

The aquatic rhizomatous herb *Nelumbo nucifera* has a slender, elongated, creeping stem with nodal roots. Lotus is a perennial plant that has aerial as well as floating orbicular leaves. While floating leaves have a flat appearance, aerial leaves have a cup-like shape. Its petioles are noticeably lengthy, tough, and covered in noticeable prickles. Flowers are solitary, hermaphrodite, and range in color from white to rose. They also have a lovely sweet aroma. The average flower has an oval shape, a 10–25 cm diameter, and is glabrous. Fruit that has seeds, is black, is firm and ovoid, and is grouped in whorls. As a result of the pod bending down to the water, the seeds ripened and were expelled. Tuberous roots have a diameter of 2 inches and a length of 8 inches. The lotus root's smooth, green exterior conceals numerous large air pockets that traverse the length of the tuber, helping it to float in the aquatic environment.<sup>[3,4]</sup>



**Figure no-1:** *Nelumbo nucifera* (lotus)

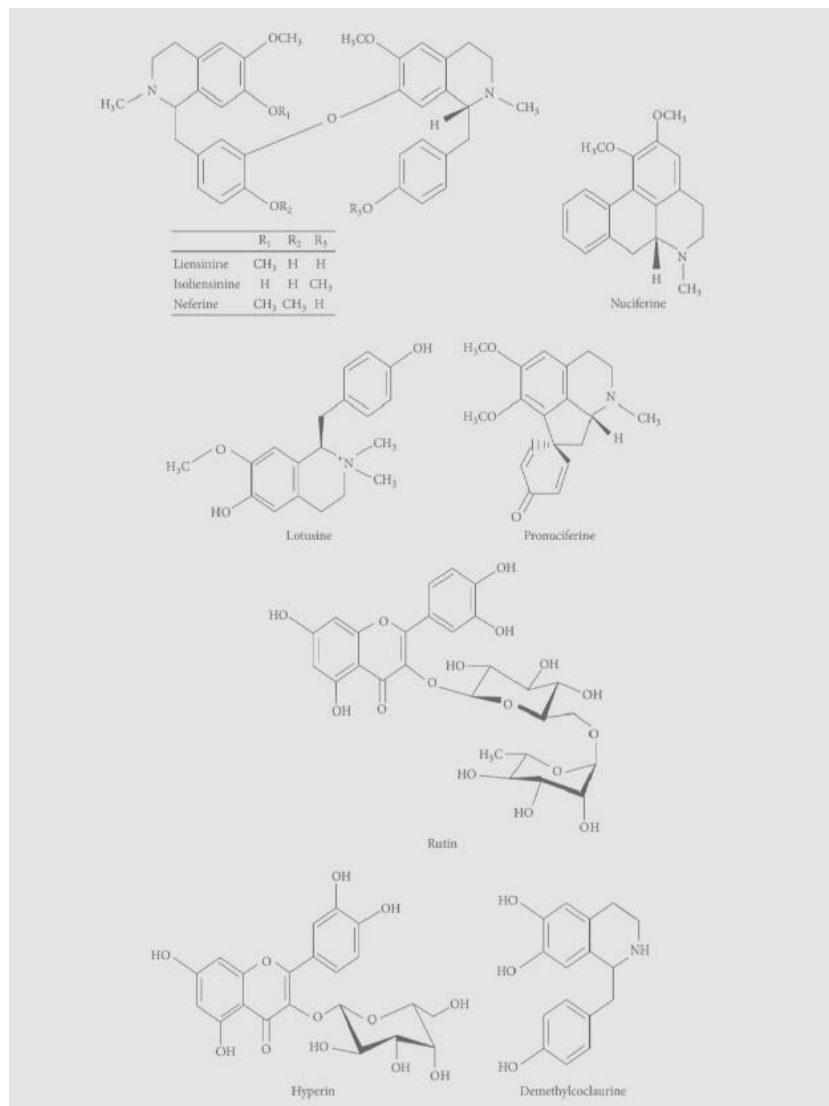
**Phytochemicals and Constituent:**

The chemical constituents reported in different parts of *Nelumbo nucifera* are as follows.

A. Embryo. The phytochemicals reported in the embryo of *Nelumbo nucifera* are shown in Figure 1.<sup>[5,6]</sup>

B. Flower. The phytochemicals reported in the flower of *Nelumbo nucifera* are shown in Figure 2.<sup>[7]</sup>

C. Seed. The phytochemicals reported in the seed of *Nelumbo nucifera* are shown in Figure 3.<sup>[3,7]</sup>



**Figure no-2: Major chemical constituents present in *Nelumbo nucifera* embryo.**

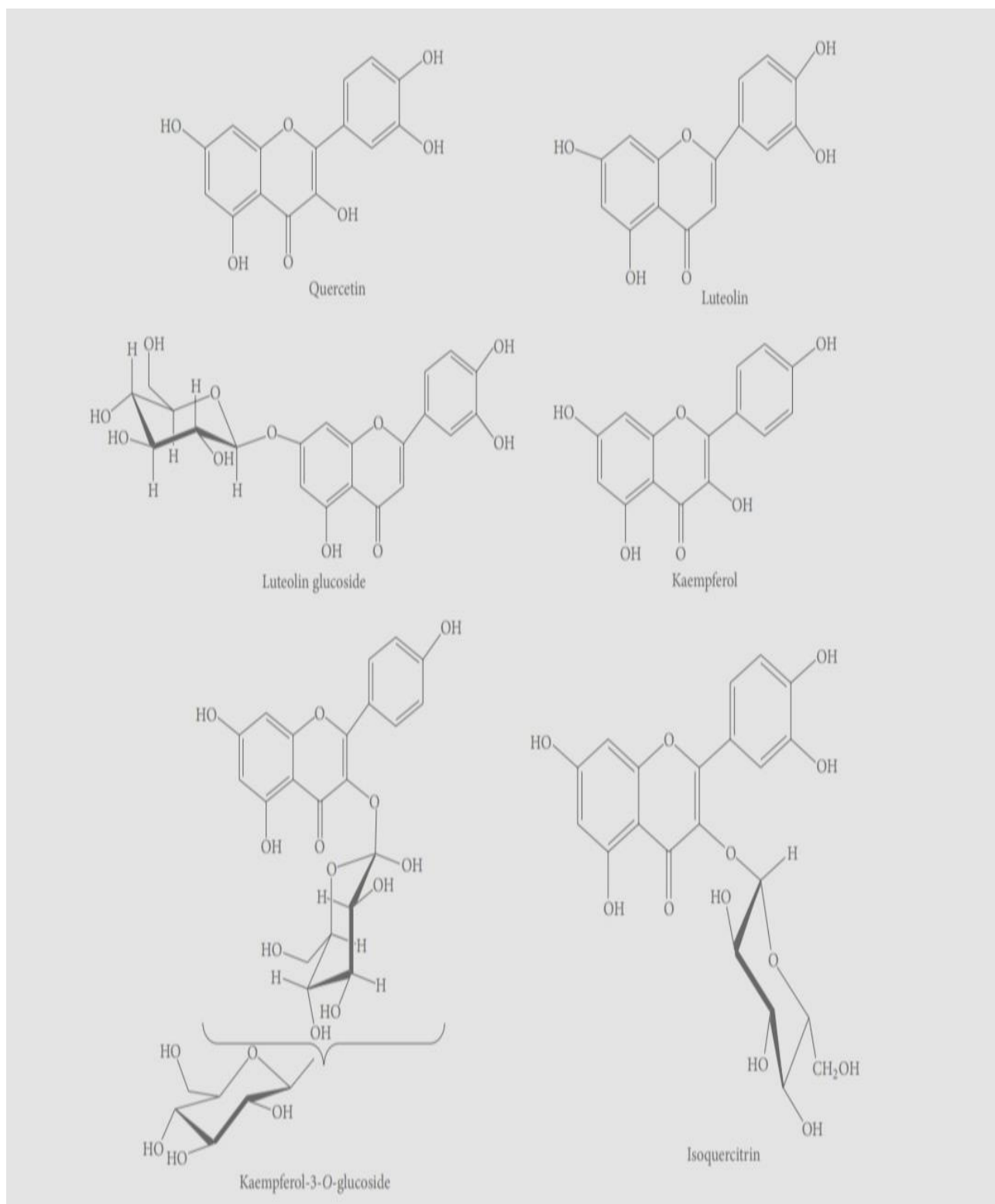
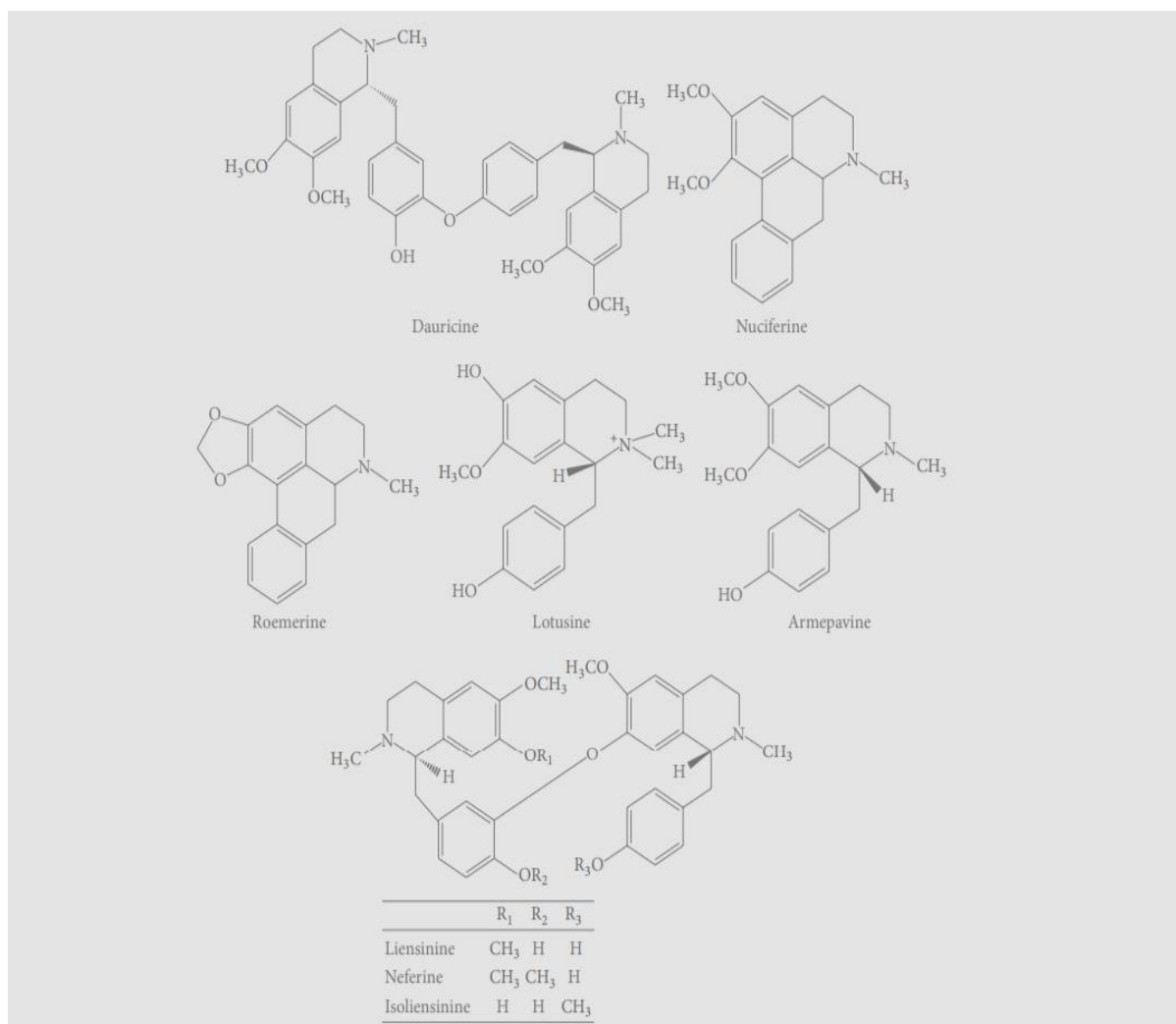


Figure no-3: Major chemical constituents present in *Nelumbo nucifera* flower.



**Figure no-4: Major chemical constituents present in *Nelumbo nucifera* seeds.**

### Pharmacological activities:

Scientific testing has been done on *N. nucifera* for a variety of pharmacological effects, including anti-ischaeamic, antioxidant, hepatoprotective, anti-inflammatory, anti-fertility, anti-arrhythmic, antiviral, antiproliferative, antidiarrheal, psychopharmacological, diuretic, antioxidant, antipyretic, immunomodulatory, and hypoglycemic effects.

### 1. Seeds

#### I. Anti-ischaeamic activity:

In the isolated rat heart, *N. nucifera* seed has strong anti-ischaeamic properties. Measurements of cardiac output, blood pressure, aortic flow, and coronary flow were used to determine the quantity of seed extract that was most efficient in preventing ischaemia in the isolated rat

heart. Doses ranging from 0.1 to 30 mg/ml were evaluated. By opposing calcium, *N. nucifera* extract has specific anti-ischemic properties. [8]

## II. Antioxidant activity:

Using the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) free radical assay, the antioxidant activity of the seed's ethanol extract has been assessed. A median inhibitory concentration (IC<sub>50</sub>) of 6.49 mg/ml [51] was observed, indicating strong free radical scavenging effects. Several pharmacological properties, such as lipid auto-oxidation, lipoxygenase inhibition, and free radical scavenging comparable to butylated hydroxytoluene (0.1%), are exhibited by procyanidin and condensed tannin that have been extracted from the seed pod of *N. nucifera*. [9,10]

## III. Hepatoprotective activity:

In models of hepatotoxicity caused by carbon tetrachloride and aflatoxin B<sub>1</sub>, the hepatoprotective properties of an ethanolic extract of *N. nucifera* seed were investigated. The ethanolic extract considerably reduced the amount of carbon tetrachloride-induced cell mortality at doses between 10 and 500 mg/ml in a dose-dependent manner. [10]

## IV. Anti-inflammatory activity:

*N. Nucifera* seed extract In female BALB/c mice with systemic inflammation brought on by an intraperitoneal injection of lipopolysaccharide, *nucifera* at a dose of 10 mg/kg decreased pro-inflammatory cytokine tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) production and boosted anti-inflammatory cytokine IL-10. [11]

## V. Anti-fertility activity:

Chauhan et al examined the effect of *Nelumbo nucifera* Gaertn. (Nymphaeaceae) on male reproductive function and fertility, 50% ethanolic extract of its seeds was provided orally to male rats at the dose levels of 50, 100 and 200 mg/rat per day for 60 days. The weights of the reproductive organs were substantially lighter following this therapy than the body weights, which were unaffected. The cauda epididymal sperm count and motility were significantly suppressed. Rats given this therapy with *Nelumbo nucifera* saw a 100% reduction in fertility. [12]

## **VI. Anti-fibrosis activity:**

On bleomycin-induced lung fibrosis in rats, the inhibitory impact of isoliensinine extracted from the seeds of *N. nucifera* was investigated. [60] The increase in hydroxyproline content was significantly reduced by isoliensinine administration, and the bleomycin-induced damage to the lung tissue was also reduced. In a concentration-dependent manner, it increased SOD activity while lowering malondialdehyde levels. [13]

## **VII. Antiviral activity:**

Action Herpes simplex virus-1 (HSV-1) multiplication was considerably inhibited by an ethanol extract of *N. nucifera* seed (100 mg/ml), with an IC<sub>50</sub> of 50 mg/ml. additionally, the *N. Nucifera* subfraction NNFR inhibits the HSV-1 virus. Inhibiting HSV-1 multiplication in HeLa cells by up to 85.9% at a dosage of 50 mg/ml of NNFR slowed the spread of acyclovir-resistant HSV-1. The inhibition of immediate early transcripts, such as infected cell protein (ICP) 0 and ICP4 mRNA, and subsequent blocking of the downstream accumulation of all viral products are therefore believed to be the mechanisms through which NNFR exerts its antiviral effects. [14]

## **VIII. Antiproliferative activity:**

In human peripheral blood mononuclear cells, the ethanolic extract of *N. nucifera* seed inhibited cell cycle progression, cytokine gene expression, and cell proliferation (PBMC). Resting cells or cells stimulated with phytohaemagglutinin (PHA) were treated with 100 mg/ml of an ethanolic extract of *N. nucifera* seed to examine the effects on PBMC proliferation. [15] Turbidimetry and radioimmunoassay were used to examine the impact of neferine on platelet aggregation, thromboxane A<sub>2</sub>/prostaglandin (PG) I<sub>2</sub>, and cAMP/cGMP balance. With IC<sub>50</sub> values of 16, 22, 193, and 103 mM, respectively, it effectively suppresses rabbit platelet aggregation brought on by ADP, collagen, arachidonic acid, and platelet-activating factor. Neferine was discovered to block platelet thromboxane A<sub>2</sub> release triggered by arachidonic acid, although it was found to raise vascular 6keto-PGF<sub>1</sub>a and platelet cAMP levels in a dose-dependent manner. [16]

## 2 Rhizomes

### I. Antidiarrhoeal activity:

It has been documented that *N. nucifera* rhizome extract has anti-diarrheal properties. A study was conducted to assess the effects of a methanolic extract of *N. nucifera* Gaertn's rhizomes for their ability to treat various experimental types of rat diarrhea. The extract greatly reduced the propulsive motions of a charcoal meal and had significant inhibitory effects against entering pooling and castor oil- and PGE<sub>2</sub>-induced diarrhea.<sup>[17]</sup>

### II. Hypoglycemic activity:

Using a methanolic extract of the rhizome, the oral hypoglycemic action of *N. nucifera* was proven. When compared to control rats, normal, glucose-fed hyperglycemic, and streptozotocin-induced diabetic rats had significantly lower blood sugar levels. In streptozotocin-induced diabetic rats, the extract (300 mg/kg and 600 mg/kg, orally) resulted in a reduction of blood glucose levels by 53% (p0.001) and 55% (p0.001), respectively, at the end of 12 hours. The findings of this investigation suggest that, when used as a standard in hyperglycemic animals, the rhizome's methanol extract has favorable hypoglycemic activity<sup>[18]</sup>. By analyzing spectroscopic data, an anti-diabetic component (tryptophan) has been identified from the nodes of the lotus rhizome.<sup>[19]</sup>

### III. Diuretic activity:

It has been shown that *N. nucifera* rhizome has diuretic properties. Rats were significantly decreased by the methanol extract of the rhizome at dosages of 300, 400, and 500 mg/kg. A dose-dependent rise in urine volume was seen, along with considerable excretions of K<sup>+</sup>, Na<sup>+</sup>, and Cl<sup>-</sup>. Compared to the usual diuretic Furosemide (20 mg/kg), there was a less dramatic increase in urine volume. Natriuretic and chloruretic activity both increased significantly, while kaliuresis was less pronounced.<sup>[20]</sup>

### IV. Anti-inflammatory activity:

On carrageenin and serotonin-induced rat paw oedema, the methanol extract of *N. nucifera* rhizome and betulinic acid, a steroidal triterpenoid derived from it, were assessed for their anti-inflammatory activity.<sup>[21]</sup>



## V. Antioxidant activity:

Using the DPPH assay, Yang and colleagues conducted in-vitro experiments on the antioxidant activity of methanol and acetone extracts of the *N. nucifera* rhizome. [22] At 66.7 and 133.3 mg/l, respectively, the methanol and acetone extracts had the highest levels of DPPH scavenging activity. Methanol also had a greater antioxidant activity coefficient than ascorbic acid. According to spectrophotometric and electron spin resonance measurements, the rhizome knot also displayed radical scavenging activity. [23]

## VI. Antipyretic activity:

Rats with pyrexia brought on by yeast exhibited antipyretic action in response to the methanolic extract of *N. nucifera* rhizome. After 19 hours of administration, the rectal temperature was raised by the yeast suspension (10 ml/kg, s.c.). In rats, oral administration of the extract at doses of 200, 300, and 400 mg/kg resulted in a notable dose-dependent reduction of normal body temperature and an increase in body temperature brought on by yeast. The outcome was comparable to that of paracetamol, a commonly prescribed antipyretic medication (150 mg/kg intraperitoneally). [24]

## 3 Flower

### I. Hypoglycemic activity:

In fasting normal albino rabbits, the sun-dried flower powder of *N. nucifera*, as well as the aqueous and alcoholic extract of the flower, significantly reduced blood sugar levels. The activities of 1000 mg/kg of the test substance (sun-dried flower powder) and equivalent amounts of the extracts did not differ noticeably. In studies on glucose tolerance in normal rabbits, oral doses of both extracts, corresponding to 1000 mg/kg of the test drug, significantly slowed the peak rise in fasting blood sugar after a glucose load; the effects of both extracts were 50% less pronounced than those of tolbutamide, which produced effects at a dose of 250 mg/kg. [25]

### II. Antioxidant activity:

The ability of *N. nucifera* stamens to neutralize peroxynitrites (ONOO-) and 1, 1-diphenyl-2-picrylhydrazyl (DPPH) free radicals was investigated, as well as the use of DCHF-DA to reduce the amount of total ROS produced by kidney homogenates [44]. The methanol extract had weak antioxidant activity in the DPPH and total ROS systems but strong antioxidant

activity in the ONOO- system. Seven recognized flavonoids were also found in lotus stamens, and the majority of them exhibited strong antioxidant activity.<sup>[26]</sup>

### III. Antipyretic activity:

Rats with normal body temperatures and pyrexia brought on by yeast were tested for the antipyretic efficacy of an ethanol extract of *N. nucifera* stalks. At oral dosages of 200 and 400 mg/kg, the stalk extract demonstrated notable efficacy in both models of yeast-provoked increase in body temperature. The results of the stalk extracts were analogous to those of paracetamol in that they demonstrated a dose-dependent reduction of body temperature for up to 4 hours.<sup>[27]</sup>

### IV. Aldose reductase inhibitory activity:

Two glycosides, isorhamnetin 3-O- $\alpha$ -L-rhamnopyranosyl-(1 $\rightarrow$ 6) and kaempferol 3- $\alpha$ -L-rhamnopyranosyl(1,6)- $\beta$ -D-glucopyranoside With IC<sub>50</sub> values of 5.6 and 9.0 mM, respectively, - $\beta$ -D-glucopyranoside, which was isolated from the methanol extract of *N. nucifera* stamens, had a significant level of inhibitory activity against rat lens aldose reductase in vitro.<sup>[28]</sup>

### V. Antibacterial activity:

According to in vitro studies, the hydroethanolic extract of *N. nucifera* Gaertn flowers has antibacterial properties. Different bacterial strains, such as *Escherichia coli* and *Klebsiella pneumonia*, were used to test the antibacterial activity. *Bacillus subtilis*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa* by determining the zone of inhibition and minimum inhibitory concentration (MIC). The largest zone of inhibition against *Escherichia coli* (14mm), *Bacillus Subtilis* (13mm), and *Staphylococcus aureus* were displayed by *N. nucifera* flowers (11mm). When tested against *Klebsiella pneumonia* (10 mm) and *Pseudomonas aeruginosa*, a moderate zone of inhibition was discovered (8mm). Contrary to earlier claims that plant extracts are more effective against gram-positive bacteria than gram-negative bacteria, gram-negative bacteria were more susceptible to the *N. nucifera* flower extracts than gram-positive bacteria. Chloramphenicol (30 g/ml), the gold standard antibiotic, was used as a comparison for these findings.<sup>[29]</sup>

## 4 Leaves

### I. Antioxidant activity:

The putative antioxidant activity of the *N. nucifera* leaf methanol extract was investigated using hydrogen peroxide-mediated cytotoxicity in Caco-2 cells. When Caco-2 cells were treated with 10 mM hydrogen peroxide along with the methanol extract of the *N. nucifera* leaf (0.1-0.3 mg/ml), a dose-dependent protective effect against reactive oxygen species (ROS)-induced cytotoxicity was seen. Additionally, the *N. nucifera* extract demonstrated concentration-dependent antioxidant effects against plasmid DNA oxidation caused by the Fenton reaction and haemoglobin-induced linoleic acid peroxidation.<sup>[30]</sup>

### II. Antiviral activity:

It has been noted that the *N. nucifera* extract in 95% ethanol exhibits anti-HIV action (EC<sub>50</sub> 20 mg/ml). *N. Nucifera* leaves contain certain anti-HIV compounds, including (+)-1(R)-cocclaurine, (-)-1(S)-norcocclaurine, and quercetin 3-O- -D-glucuronide.<sup>[31]</sup>

### III. Anti-obesity activity:

Using mice with obesity brought on by a high-fat diet, Ono et al. showed the effects of leaf extract on lipid metabolism, thermogenesis, and digestive enzymes as well as the anti-obesity impact. The extract increased lipid metabolism and the expression of uncoupling protein-3 mRNA in C2C12 (a mouse myoblast cell line) myotubes, and it inhibited the activities of  $\alpha$ -amylase and lipase in a concentration-dependent manner. Additionally, it inhibited rises in liver triacylglycerol levels, body weight, and parametrical adipose tissue weight.<sup>[32]</sup>

### IV. Hypocholesterolaemic activity:

In a rat model, the effects of the aqueous extract of *N. nucifera* leaves on serum lipids were investigated. A high-fat diet containing 1.5% cholesterol and 1% cholic acid was given to the rats. In comparison to the high fat-loaded control group, blood total cholesterol, free cholesterol, and phospholipids significantly decreased after oral administration of a crude aqueous extract of lotus leaves.<sup>[33]</sup>

### V. Hepatoprotective Activity:

The hepatoprotective effects of an ethanolic extract of *N. nucifera* leave against CCl<sub>4</sub>-induced liver toxicity in rats were investigated. According to a study, *N. nucifera* leaf

extract's (LLE) hepatoprotective activity at doses of 300 and 500 mg/kg was comparable to that of a standard regimen containing 100 mg/kg of silymarin.<sup>[34]</sup>

## CONCLUSION:

*Nelumbo nucifera*, a perennial aquatic herb that is a member of the Nymphaeaceae family and has medicinal and historical significance, is becoming more and more well-known. It was applied to the treatment of skin diseases, diabetes, cancer, tissue inflammation cardiovascular problems, blood issues, and other illnesses mentioned in the conventional medical system. As per pharmacological studies on *N. Nucifera*, its various organic and aqueous extracts have a wide range of multifaceted pharmacological effects, including anti-ischaemic, antioxidant, hepatoprotective, anti-inflammatory, anti-fertility, anti-arrhythmic, anti-fibrosis, antiviral, antiproliferative, antidiarrheal, and hypoglycemic, etc. properties. Today, it is essential to conduct and record evidence-based studies that show potential mechanisms of action for those impacts. Additionally, if it can be developed as a functional meal, it will have commercial significance.

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