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ROLE OF NELUMBO NUCIFERA (LOTUS) STEM AS IMMUNITY BOOSTER AND ANTI-INFLAMMATORY FOOD

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ABSTRACT

In China and India, Nelumbo nucifera, a perennial aquatic plant, has been used as a medicinal herb. The various sections of plants, such as leaves, seeds, flowers and rhizomes, have been reported to have beneficial effects in the treatment of pharyngopathy, pectoralgia, spermatorrhoea, leucoderma, smallpox, dysentery, cough, haematemesis, epistaxis, haemoptysis, haematuria, metrorrhagia, hyperlipidaemia, fever, cholera, hepatopathy and hyperdipsia in the traditional medicine system. Different pharmacological activities such as anti-ischaemic activity, antioxidant activity, hepato-protective activity, anti-inflammatory activity, anti-fertility activity, anti-arrhythmic activity, anti-fibrosis activity, antiviral activity, anti-proliferative activity, anti-diarrhoeal activity, psychopharmacological activity, antipyretic activity, immune-modulatory activity, hypoglycaemic activity, aldose reductase inhibitory activity, antibacterial, aphrodisiac activity, anti-platelet activity, cardiovascular activity, anti-obesity activity, lipolytic activity, hypo-cholesterolaemic activity, hepato-protective activity, anticancer activitydiuretic activity, antioxidant activity have been clinically evaluated for *N.nucifera*. Different pharmacological activities such as anti-ischaemic activity, antioxidant activity, hepato-protective activity, anti-inflammatory activity, anti-fertility activity, anti-arrhythmic activity, anti-fibrosis activity, antiviral activity, anti-proliferative activity, anti-diarrhoeal activity, psychopharmacological activity, diuretic activity, antioxidant activity have been clinically evaluated for *N.nucifera*. A wide number of phytoprinciples from the plant have been isolated. The present review seeks to consolidate the traditional, ethno-botanical, phytochemical and pharmacological data available on *N.nucifera* stem and to explore its role as an immunity booster and anti-inflammatory food.

KEYWORDS: Anti-ischaemic activity, Anti-diarrhoeal activity, Hypoglycemic activity, Hepato-protective activity.

INTRODUCTION

Nelumbo nucifera, commonly called lotus or holy lotus, is a perennial aquatic plant belonging to the Nelumbonaceaeae family. The plant grows up to a height of about 1.5meters and a horizontal spread of up to 3 meters. Its roots remain fixed within the muddy bottom of the water bodies and the leaves having diameter of around 60 cm float over the surface of water or are held above it. The flowers may have diameter and are found on stems rising above the leaves (1). The lotus plant grows by extending a creeping rhizome at bottom of the water body. The rhizome bears nodes and each of which produces a leaf. The petioles and the rhizome bear gas canals which channel air from the leaves throughout the petioles and rhizomes (2). The plant has some unique features like; the ability to regulate the temperature of its flowers within a narrow range, seeds with long viability periods (3) and in addition its leaves show the lotus effect, the self-cleaning property. For around 7,000 years in Asia, Lotus has been used as a food, and it is grown for its edible rhizomes/stems, seeds and leaves. For the treatment of many diseases including cancer, depression, diarrhoea, heart attacks, hypertension and insomnia, various lotus plant parts such as buds, flowers, anthers, stamens, fruits, leaves, stalks, rhizomes and roots have been used as herbal medicines (4). A number of significant secondary metabolites such as alkaloids, flavonoids, steroids, triterpenoids, glycosides and polyphenols, are developed by Lotus (5).

In India, it occurs from Kashmir in the north to Kanyakumari in the south, exhibiting enormous phenotypical diversity with various shapes, sizes and shades of 16-160 petals of pink and white flowers(6) and is the national flower of the country. In many religions, lotus is considered to be sacred. It is considered as the symbol of purity, divine beauty, resurrection and enlightenment.

Lotus stem, or kamalkakdi, is a common vegetable in Indian cuisine. The stem lies beneath the mud and is technically called the rhizome. It is usually crunchy and is fairly sweet and has a flavour like water chestnut. It has a

delicate flavour. Lotus stem offers a range of health and medical benefit. Almost all parts of the plant like root, flower stalks, seeds, etc. are edible. The stem is lime green in colour with a whitish flesh. Lotus stem is very healthy being a great source of dietary fiber. It contains minerals like copper, iron, zinc, magnesium and manganese. It boosts the production of red blood cells. It has a high content of vitamin C which helps to protect our body from scurvy and increases immunity. The stem packs a unique mix of nutrients and minerals, including potassium, phosphorous, copper, iron, and manganese, as well as thiamine, pantothenic acid, zinc, vitamin B6, and vitamin C.Stem have good vasodilator properties hence they help in blood circulation as well as lowering blood pressure (7).

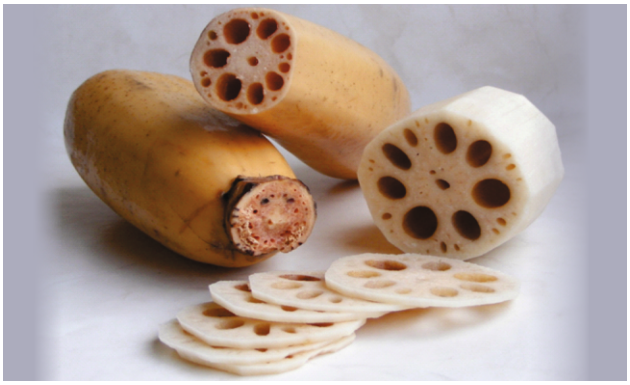

Fig. 1: Nutritional And Immunity Booster Properties Of Lotus Stem

NUTRITIVE VALUE

Covid-19 or Corona infection was announced as a worldwide pandemic by the World Health Organization. And keeping in mind that the nations are wrestling with up and coming risks that this infection postures to mankind, there are scarcely any key estimates that people can take to battle this pandemic. The food we eat plays a key role in deciding by and large well-being and insusceptibility. As the coronavirus spreads, we are finding out about how to lessen exposure. Our immune system is intended to fend off disorders and infections. But our immune system can get worn out by numerous factors like mental pressure, poisons, absence of activity and un-healthy eating. So it is progressively essential to help support the immune system. We can do this by making a couple of key adjustment like consuming citrus natural products, garlic, broccoli, and spinach. On the off chance, if immune system is feeble, it can likewise be useful to enhance with key nutrients and minerals that may have become exhausted like Vitamin C, Vitamin B, Vitamin D, and Zinc. There are various reports demonstrating that Vitamin C may influence the immune system, for instance enhancing the capacity of phagocytes, change of T lymphocytes and creation of interferon. Studies in several animals suggest that Vitamin alters vulnerability to different bacterial and viral contaminations. The span and seriousness of common cold is diminished by Vitamin C demonstrating that viral respiratory contaminations in people are influenced by Vitamin C levels.

VITAMIN C AND OTHER NUTRIENTS

Lotus stem is a rich source of Vitamin C, which helps support the invulnerability of an individual and battle viral diseases.83.80% water, 0.11% fat, 1.56% reducing sugars, 0.41% sucrose, 2.70% crude protein, 9.25% starch, 0.80% fibre, l.10% ash and 0.06% calcium is found in the fresh stem.Vitamins like thiamine (0.22 mg/100 g), riboflavin (0.6 mg/100 are niacin (2.10 mg/100 g) and ascorbic acid (1.5 mg/100 g), and asparagine-like amino acid (2%) are pre4sent in rhizomes. The content of stem oxalate was found to be 84.3 mg/100 gm (9-10).

ANTI-DIARRHOEAL ACTIVITY

The anti-diarrhoeal potential of *N. nucifera* rhizome extract has been reported. A study was undertaken to evaluate the effects of methanolic extract stems of *N.nucifera Gaertn* for its anti-diarrhoeal potential against several experimental models of diarrhoea in rats. The extract produced significant inhibitory effects against castor-oil-induced diarrhoea and PGE2-induced entero-pooling; the propulsive movements of a charcoal meal were also reduced significantly (11). The anti-diarrhoeal capacity of N. nucifera rhizome extract has been published. A research was conducted to test the effects of the N.nuciferaGaertn methanolic extract stems on their anti-diarrhoeal ability against several experimental diarrhoea models in rats. The extract developed substantial inhibitory effects against castor-oil-induced diarrhoea and entero-pooling caused by PGE2; the propulsive motion of the charcoal meal was also significantly reduced (11).

HYPOGLYCEMIC ACTIVITY

The amethanolic extract of N.nucifera stem was used to demonstrate the hypoglycaemic effect of *N.nucifera*. It significantly reduced the blood sugar level of normal glucose-fed, hyperglycaemic and streptozotocin-induced diabetic rats compared to control animals.The extract (300 mg/kg and 600 mg/kg, orally) caused a 53 percent ($p<0.001$) and 55 percent ($p<0.001$) decrease in blood glucose levels in streptozotocin-induced diabetic rats at the end of 12 hours respectively. The findings of this study suggest that rhizome methanol extract has beneficial hypoglycaemic behaviour in hyperglycaemic animals receiving standard chlorpropamide (12). By analysing spectroscopic data, an anti-diabetic constituent (tryptophan) was isolated from the lotus rhizome nodes. Methanolic extract of

nodes at a dosage of 400 mg/kg and 100 mg/kg of extracted tryptophan showed possible anti-diabetic activities in glucose fed hypoglycaemic mice (13).

PSYCHOPHARMACOLOGICAL ACTIVITY

An extract of methanol from the stem of N. Important psychopharmacological behaviour in rats and mice were produced by nucifera. Reduced spontaneous activity and decreased exploratory behaviour have been documented in head dip and Y-maze studies. The extract therefore possesses much of the pharmacological features of a mild tranquilizer(14). The methanol extract of the stem of *N. nucifera* produced significant psychopharmacological actions in rats and mice. Reduction in spontaneous activity and a decrease in exploratory behaviour in the head dip and Y-maze tests were reported. Thus, the extract possesses most of the pharmacological characteristics of a minor tranquilizer (14).

DIURETIC ACTIVITY

Diuretics assist the body in removing excess fluid. Diuretics work by assisting the kidneys to eliminate extra sodium into urine.

The diuretic action of *N.nucifera* stem was described. At doses of 300, 400 and 500 mg/kg, methanol extract from the stem induced severe diuresis in rats. Dose-dependent changes in urine volume were observed, with excretion of Na+ and Cl- followed by substantial excretion of K+. Urine volume was lower than that of Furosemide (20 mg/kg), a standard diuretic. The natriuretic and chloruretic activity increased significantly, but kaliuresis was lower than natriuresis (15).

ANTI-INFLAMMATORY ACTIVITY

The potential for specific foods and nutrients to affect COVID-19 severity and outcomes is gathering increasing interest from the scientific community, as well as the general population and mass media. Given that a common complication in patients with severe COVID-19, and individuals with non-communicable diseases, is excessive inflammation, foods with anti-inflammatory properties may possess a protective role.

The anti-inflammatory activity of both methanol extract of *N.nucifera* stem and betulinic acid, a steroidal triterpenoid isolated from it was assessed for carrageenan and serotonin-induced oedema of the rat paw(16). Important anti-inflammatory activity was demonstrated by stem extract at doses of 200 and 400 mg/kg and betulinic acid at doses of 50 and 100 mg/kg (administered orally); the effect was comparable to that of the standard drugs phenylbutazone and dexamethasone(17).

Inflammation of the tissue is a damaging reaction that causes tissue damage and can cause severe diseases such as asthma, atopic dermatitis, and rheumatoid arthritis. There is now compelling evidence that cytokines secreted in response to antigen stimulation by T cells such as IL-4, IL-10, and INF-γ play a role in atopic dermatitis, lung inflammation, and asthma. Phytochemical (NN-B-4) detected by bioassay-based screening with ethanol extract of *N.nucifera* extracts significantly attenuated phytohemagglutinin-induced PMBC proliferation, IL-4, IL-10 and INF-γ expression, and cdk-4 gene expression. By blocking PBMC from the G1 transition to the S step, NN-B-4 prevents the progression of the activated PBMC cell cycle.

Isolated Triterpenoidbetulinic acid extracted from methanol extract N. nucifera rhizome was assessed for its anti-inflammatory behaviour against oedema in rat paws caused by carrageenan and serotonin. At doses of 200 and 400 mg/kg p.o., methanol extract exhibited anti-inflammatory activity. Betulinic acid was similarly shown to have a major anti-inflammatory effect in inflammatory experimental models at 50 mg/kg and 100 mg/kg p.o. levels.

Extract and betulinic acid showsame effects as compared to two potential anti-inflammatory drugs, phenylbutazone and dexamethasone. (18)

ANTIOXIDANT ACIVITY

ZhiYong Peng, MD of the Department of Critical Care Medicine at Zhongnan Hospital of Wuhan University recently registered a phase 2 clinical trial on Clinical Trials.gov to test the efficacy of vitamin C infusions for the treatment of severe acute respiratory infection (SARI) associated with the novel coronavirus.

The study description notes that vitamin C is an antioxidant that may help prevent cytokine-induced damage to the lungs. Cytokines are small proteins released by cells, which trigger inflammation and respond to infections, according to MedicineNet author William C. Shiel Jr., MD, FACP, FACR. Severe lung inflammation with COVID-19 may result in respiratory distress and even death.

The clinical trial description states that vitamin C reduces the inflammatory response, and both prevents and shortens the duration of the common cold. The description further states that insufficient vitamin C is related to an increased risk and severity of influenza infections. *(www.medicinenet.com)*.

Lotus stem also enhances the intake of antioxidants. Lotus stem is demonstrated to contain tryptophan, which is an amino acid that stimulates activity of antioxidants in our body. In the meantime, lotus stem pharmacological activities, including anti-lipolytic, anti-cancer agent, anti-inflammatory, cardiovascular, hepatoprotective, hypoglycemic, hypolipidemic, antitumor, memory-improving and anti-viral role, have

likewise been evaluated, along with its applications in food industry. Yang and co-workers have performed in-vitro studies of the antioxidant activity of methanol and acetone extracts of the *N. nucifera*stem using the DPPH assay. The methanol and acetone extract showed highest DPPH scavenging activity, at 66.7 and 133.3 mg/l, respectively; the methanol extract exhibited a higher antioxidant activity coefficient than ascorbic acid. The stemknot also exhibited radical scavenging activity, measured spectrophotometrically and by electron spin resonance (19).

ANTIPYRETIC ACTIVITY

The methanolic extract of *N. nucifera* stem showed antipyretic activity in rats with yeast-induced pyrexia. Yeast suspension (10 ml/kg, s.c.) increased rectal temperature after 19 hours of administration. Oral doses of the extract of 200, 300 and 400 mg/kg produced significant dose-dependent lowering of normal body temperature and yeast-provoked elevation of body temperature in rats. The result was comparable to that of the standard antipyretic drug paracetamol(150 mg/kg intraperitoneally) (20). So lotus stem extracts can be used as alternative to lower temperature in corona suffering subjects.

IMMUNOMODULATORY ACTIVITY

The immune-modulatory activity of *N.nucifera*stem extract was evaluated using various in vivo models including the total and differential leukocyte count (TLC and DLC), nitrobluetetrazolium reduction (NBT) test, neutrophil adhesion test, phagocytic response and delayed type hypersensitivity (DTH) reaction. Sheep red blood cells (SRBC, 5×109 cells/ml) were used to immunize the animals. Stem extract at the doses of 100 and 300 mg/kg was administrated. The TLC and lymphocyte count increased significantly but the neutrophil count was decreased for rhizome extract treated groups compared to the control. A dose-dependent potentiation of DTH reaction induced by SRBC was observed from the extracts. The percentage of neutrophil adhesion to the nylon fiber was increased in rhizome extract treated groups (63.22 and 62.91%). This finding suggests that the extract of stem of *N. nucifera* stimulate defence system by modulating several immunological parameters (21).

Studies suggest that the lotus plant can potentially be used asan additional drug ingredient against certain inflammatory processes, as its extract stimulates the defence system by modulating several immunological parameters. The hydro-alcoholic extracts of the lotus caused significant increase in the totalleukocyte count and lymphocyte population, which indicated that theextracts have immunological effects. Moreover, increases in the percentage of neutrophil adhesion to the nylon fiber, together with phagocytic responses, were also observed in the formation of form a zone crystals after treatment with both extract. Besides, both antiproliferation and anti-inflammatory abilities are indicators of a good immune response. (22)

Considering the current pandemic of COVID-19 where no effective preventive and curative medicine is available, a healthy immune system is one of the most important weapons.

CONCLUSION

The pharmacological investigations carried on *N.nucifera* have demonstrated that it's various organic and aqueous extracts possess an array of multi-dimensional pharmacological activities such as anti-ischaemic, antioxidant, hepato-protective, anti-inflammatory, anti-fertility, anti-arrhythmic, anti-fibrosis, antiviral, anti-proliferative, anti-diarrhoeal, hypoglycaemic, psychopharmacological, diuretic, antipyretic, immune-modulatory, aldose reductase inhibitory, antibacterial, aphrodisiac, anti-platelet, cardiovascular, anti-obesity, lipolytic, hypo-cholesterolaemic, anti-cancer activities. The plant is also reported to contain a wide range of chemical constituents. These compounds could serve as leads in the search for novel medicinal agents.

FUTURE PROSPECTS

Further studies on *N.nucifera* should be designed to investigate the molecular mechanism of action of isolated phyto-principles using specific biological screening models and clinical trials, and also to discover novel leads from them. Also studies should be extended to standardize the various extracts of *N.nucifera* for the purpose of their use in specific herbal formulations.

So the need of the hour is to further evaluate the medicinal importance of *N.nucifera*, in view of its large scale use in traditional medicine and recently identified pharmacological activities and also to develop the protocols for efficient extraction and validation of the active principles for their use to combat different human disease conditions. Additionally, there is the need to conserve this treasure as the habitat of this plant is being polluted and threatened due to different anthropogenic activities.

Now the exploration should upgrade in this field to explore strategies for extraction, and utilizing this traditional and natural herb in curing different illnesses without any side reactions and ought to be advanced for clinical trials at human levels and further examination, particularly considering the on-going SARS pandemic.

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