

A Comprehensive Review on Therapeutic Properties of Lotus Seeds

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Abstract: Nymphaeaceae, a mono-generic family is the origin of *Nelumbo nucifera*. It has some common name for example- Sacred lotus, Indian lotus and Chinese water lily. In china lotus seed is used as a food ingredient and throughout Asia it has been used as a functional food for more than 2000 years. Though Lotus is an aquatic ornamental economic plant but it is also used for its herbal properties like astringent, antiseptic, cooling etc. Traditional medicine claimed lotus seed to have quite a number of therapeutic beneficial effect for the cure of diseases such as cough, small pox, fever, hepatopathy, hyperdipsia, hematuria, hyperlipidemia, leucoderma, metrorrhagic, cholera etc. Therefore the Objective this review is to cover the review is to cover all the available and accessible literature of lotus (*Nelumbo nucifera*) seed's therapeutic activities, nutritional components and its unique bioactive properties.

Keywords: lotus seeds; therapeutic properties; bioactive components; nutrition profile

1. Introduction

Nymphaeaceae, a mono-generic family is the origin of *Nelumbo nucifera*. It has some common name for example- Sacred lotus, Indian lotus and Chinese water lily (Mukherjee et al, 2008). In china lotus seed is used as a food ingredient and throughout Asia it has been used as a functional food for more than 2000 years (Rajalakshmy, 2019). Though Lotus is an aquatic ornamental economic plant but it is also used for its herbal properties like astringent, antiseptic, cooling etc. In many countries all over the world, the various part of lotus plant is used for various purposes like leaves as thali or plate, stalks as pickle, thalamus at fruit and petals as color extraction (Pal and Dey, 2013). Traditional medicine claimed lotus seed to have quite a number of therapeutic beneficial effect for the cure of diseases such as cough, small pox, fever, hepatopathy, hyperdipsia, hematuria, hyperlipidemia, leucoderma, metrorrhagic, cholera etc (Baghel et al, 2017).

Therefore the Objective this review is to cover the review is to cover all the available and accessible literature of lotus (*Nelumbo nucifera*) seed's therapeutic activities, nutritional components and its unique bioactive properties.



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Figure 1: Lotus Plant (Source: Wikipedia)

1. Seed Nutritional Profile:

Lotus seed is considered as one of the highly balanced, enriched nutritious seed. It contains composition like protein, carbohydrate, lipid and enormous quality of minerals like calcium (Ca), Iron (Fe), Magnesium (Mg), Phosphorus (P) and many vitamins such as B1, B2, B6, C & E. Fresh seed consist a satisfy amount of vitamin C that is 31.24 mg/kg (Arooj et al, 2021). Lastly, according to studies it also contains water soluble polysaccharides, alkaloid and flavonoids (Bangar et al, 2022).

Table 1: Nutritional Compositions:

Composition	Percentage	Composition	Content in mg/kg	Composition	Percentage
Carbohydrate	61.3-70.1%	Thiamine	5.4	Zn	0.084
Protein	16.2-28.19%	Riboflavin	0.16	Fe	0.199
Lipids	0.22-3.68%	Vitamin B6	6.0-8.2	Ca	31.24
Water	8.17-14%	Vitamin C	87-106	Mg	9.2
Ash content	3.07-4.1%	Vitamin E	8.7-9.5	K	28.5

(Bangar et al, 2022; Arooj et al, 2021)

2. Lotus Production in India & all over the Globe:

India, China, Japan, South East Asia, Russia and some of the countries of Africa are the major harvesters of lotus plant. Approximately greater than 2 million mu (133,400 ha) is used for the cultivation of lotus plant in china which makes it one of the highest producer of this plant around the globe. China has capacity to accumulate up to 3 million ton of rhizomes per annum. As for India, Bihar is responsible for 85% of the makhana produced by the country with a approximate estimated area of 15,000 Ha and capitulate 1, 20, 00 MT seeds of makhana. The whole cultivation of lotus seed is around 200-250 kg/Ha which sold at US \$ 1.35/kg as snacks (Bhat & Sridhar, 2008).

Details about Lotus Plant and it's Medicinal Properties:

Humans are using lotus plant as a medicine since ancient time. Various part of this plant can be used to treat different diseases. For the treatment for cough, honey is mixed with lotus seed powder and seedpod for haemostatic function. Flower of lotus that can be large or small (10-25 cm in diameter and 1-2 cm long) and pinkish white or white in color can be used for remedy of fever, cholera, diarrhea, hepatopathy and other bleeding disorders. Habitually monotonous and crumbly rhizomes with yellowish brown or creamy white in color are used for nasal bleeding, haematuria, bleeding from uterus lotus etc. (Mukherjee et al, 2008). Fruit part as a healthy functional food which apparently aid to prohibit poor digestion, insomnia, tissue inflammation, enteritis, heart complications. And lastly leaves with its strong radical and anti-oxidant properties regulate and suppress the complication of diabetes and also assist from diseases like infection, epistaxis, skin inflammation, obesity, metrorrhagia (Moro et al, 2012).

3. Types of Lotus Seed:

The evaluation of lotus seed mainly includes five different stages which are cell division, expansion, reserve accumulation, desiccation at lastly maturation. It comprise of three different parts- epicarp, embryo and cotyledons (Zhu et al, 2016). Lotus seed can be classified into two types- white peel and brown peel. White peel is cultivated after borderline development while it is entirely green in color. Brown peel is cultivated when seed is completely plump or just about to ripe and as it is adhered to its membrane it turns gross brown in color (Hajela et al, 2018). A traditional Indian snack Makhana is constructed when lotus seed is ripened which is enriched with high medicinal properties as well as mineral content makes it a arising global super food. It is also known for its diverse pharmaceuticals and healing properties such as aiding leucorrhea, high blood pressure, kidney problems, hypo-function of spleen, obesity.



White Peel

Brown Peel

Makhana (Source: Wikipedia)

Figure 2: Different product made from lotus seed

Table 2: Pharmacological compound and components present in Lotus Seed:

Compound	Seed Part	Components	Author
Flavonoids	seed embryo	c-glycoside, o-glycoside, astragalin, rutin	Zhu <i>et al</i> , 2017; Arooj <i>et al</i> , 2021
Alkaloids	seed embryo	Nefreine,leinsinine, isoliensinine, nelumboferine	Zhu <i>et al</i> , 2016
Antioxidants	seed oil	Lupeol, eicosane	Bangar <i>et al</i> , 2022
	seed embryo	Butanol, hexane	Kim & Shin, 2012
Additional Components	Seed embryo & seed pot	D-glucose, D-galactose, D-mannose, D-arabinose	Arooj <i>et al</i> , 2021

4. Bio-activity of Lotus Seed:

There are numerous amounts of biological and health promoting effect from lotus seed that help human health in so many beneficial ways. The major pharmacological and phytochemical activities are anti-cancer, anti-inflammatory, anti-adipogenic, anti-diabetic, anti-oxidant, anti-depressant and many others.

4.1. Anti-cancer Activity:

Cancer is an illness which occurs when the abnormal or malignant cells grow uncontrollably and spread throughout the body. More than 10 million people die from this deadly disease every year. Neferine, a bisbenzylisoquinoline alkaloid found in lotus seed which prohibit the growth of lung cancer cells in human and can be used as an anti-cancer drug for patients diagnose with cervical cancer. Ethanolic alkaloid extraction from Ba lotus seed have shown anti-cancer properties in nasopharyngeal carcinoma by conducting apoptosis and is used as clinical therapy (dose-related manner) for cancer suffers (Arooj *et al*, 2021; Bangar *et al*, 2022).

4.2. Anti-inflammatory Activity:

When immune blood cells of body response against harmful invaders like pathogens, virus and bacteria by stimulating body's complex repair mechanism, the process is called inflammation. The cells associated with inflammation are particularly macrophages, neutrophils, phytocytes (Arooj *et al*, 2021). Protein isolates in lotus seed prohibited the anti-inflammatory effect in lipopolysaccharide macrophages in a dose dependent manner. Presence of nitric oxide is accountable for severe inflammation and its obstruction can be a plan of action to decrease inflammatory reactions. Whereas the flavonoids are responsible for the construction of pro-inflammatory cytokines and inflammatory mediators (Cao *et al*, 2018; Bangar *et al*, 2022).

4.3. Anti-obesity and hypolipidemic Effect: 131

Obesity is a condition when excessive amount of fat accumulated in the body resulting in the other complex health problems. Studies have shown, purified lotus seed epicarp can subdue the body weight of white adipose tissue by reducing the cell size. Liver lipid profiles comprising triglyceride, cholesterol, HDL-C, LDL-C level and serum leptin level can be significantly improved by lotus seed pot administration (Cao et al, 2018; Pal, Dey, 2013).

4.4. Anti-diabetic & Hypoglycemic Effect: 138

In today's modern fast forward life-style diabetes is a very well-known term which can be describe as a chronic metabolic condition occur when body's blood sugar level is too high. According to studies lotus seed can help in the discouragement of lipolysis and can assist in insulin resistance and avert the interference of insulin signaling pathway (Bangar et al, 2022). The ash part of seed can notably modulate the regulation of insulin by stimulating β -cells which is apparently as effective as Gliclazide (anti-diabetic drug). The attendance of inorganic elements in lotus seed like calcium, magnesium, sodium, potassium, manganese also takes part in the secretion of insulin hormone and control the level of blood glucose within the body (Mani et al, 2010; Arooj et al, 2021).

4.5. Anti-depressant Activity: 148

Depression is quite well-known term in today's day and age. Lotus seed contain anti-depressant aporphine, alkaloids and proaporphine alkaloids like alkyl 4-hydroxybenzoates, bisbenzylisoquinoline and benzylisoquinoline which are helpful for the aid of depression, anxiety, restlessness, insomnia and hypothermia (Chung et al, 2012). Also presence of alkaloid neferine in the embryo of lotus may be useful for the psychopharmacologic activity by its anti-immobility effects (Pal, Dey, 2013).

4.6. Hepatoprotective Activity: 155

Liver is one of the largest solid critical organs of the body which function is to break down food and turn it into energy. But when hepatic complications arise, it can result in crisis of health and sometimes even death. Lotus seed have shown to have anti-oxidative power which defends tissue from oxidation. Research has also conducted that flavonoid rich extraction from the seed pods prohibits cytokines pro-inflammatory effect using its hepatoprotective effect. (Arooj et al, 2021).

5. Phytochemical Activity 162

1. Anti-oxidant: 163

Many complicated diseases such as diabetes, cancer, cardiovascular complications, neurogenetic disorder can be suppressed by free radicals by its oxidative stress response. Excessive from lotus seed such as hexane, butanol, ethyl acetate is known for anti-oxidative properties which are very beneficial for consumers as lotus seed are very much available in the market (Kim & Shin, 2012). Lotus seed oil extraction also contains anti-oxidative components like lupeol, eicosane, viridiforal which regulate the hydroxyl (OH) and O₂ free radicals in the dose-regulating manner (Bangar et al, 2022).

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Table 3: Summary of studies based on ethno medical activities of lotus seed:

<i>Seed Part</i>	<i>Compounds</i>	<i>Ethno medicinal Activity</i>	<i>Type of Study</i>	<i>Result</i>	<i>Reference</i>
<i>Seed embryo</i>	Alkaloid	Anti-Alzheimer	Animal	Helps to prevent Alzheimer	Arooj et al, 2021
<i>Seed extract</i>	Antioxidant	Anti-Parkinson	Animal	Control symptoms of Parkinson disease	Pal, Dey, 2013
<i>White & Red seed</i>	Phenolic	Analgesic activity	Animal	Relieve from pain in body	Pal, Dey, 2013
<i>Seed extract</i>	-	Anti-aging	Animal	Skin protection from aging	Arooj et al, 2021
<i>Dried & frozen seed</i>	Phenolic	Anti-obesity	Animal	Reduce adipogenesis	Arooj et al, 2021
<i>Seed extract</i>	Betulinic acid	Immunomodulatory	Animal	Helps to modify the response of immune system	Arooj et al, 2021
<i>Seed embryo</i>	Alkaloid	Serum Insulin	Animal	Decrease fasting blood insulin	Acharya et al, 2014
<i>Seed embryo</i>	Alkaloid	Anti-depressant	Animal	Helps to aid anxiety, depression, insomnia	Arooj et al, 2021

2. Alkaloids and Flavonoids:

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The lotus seed embryo mainly contains alkaloid compounds identified as leinsinine, nelumboferine, higenamine, norisoliensinine, isoliensinine, neferine which have different pharmacological properties like anti-pulmonary edema, anti-HIV and anti-arrhythmia (Migzhi Zhu et al, 2016). Dauricine and neferine help to prevent the currents of cardiac cells in K⁺, Ca²⁺ and Na⁺ trans membrane (Pal and Dey, 2013). Nelumbinisemen contains component that can help to decrease the feature of acne, pores, elasticity, wrinkles, blemishes etc. Studies further revealed lotus seed accompanied with green tea when consumed has a synergistic anti-aging action. Therefore, as a herbal and edible plant, it

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by-products can be used as an anti-aging merchandise in near future (Paudel & Panth, 2015). 186
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3. Conclusion 188

The investigation and studies on lotus seed have shown wide number of beneficial 189
properties for human health and lifestyle. Being enriched in components such as antioxi- 190
dant, flavonoids, alkaloids and various other favorable bio-active properties makes it a 191
horticultural, therapeutic and functional super food which is low in cost and easily avail- 192
able in the market. 193

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