

Makhana As a Traditional Medicine and Modern Food: A Review

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Abstract— Makhana (*Euryale ferox*) has long been revered in traditional medicine for its therapeutic properties, addressing ailments related to digestion, respiration and reproduction, while also serving as an immunostimulant. In modern times, its exceptional nutritional composition rich in protein, essential amino acids, antioxidants and minerals have positioned it as a versatile superfood with benefits such as antidiabetic, cardioprotective and anti-aging effects. Predominantly cultivated in Bihar, India, with improved varieties like Swarna Vaidehi and Sabour Makhana-1 enhancing yield and pest resistance, makhana has gained prominence in functional and gluten-free food industries. The present review explores makhana's dual role as a traditional medicine and modern health food, highlighting its nutritional profile, therapeutic potential, industrial applications and future prospects in bridging ancient remedies with contemporary dietary trends.

Index Terms— Makhana, *Euryale ferox*, traditional medicine, superfood, nutritional composition, antioxidants, essential amino acids, therapeutic properties, antidiabetic, cardioprotective, hepatoprotective, anti-aging, gluten-free, functional foods, industrial applications, Bihar cultivation, Swarna Vaidehi, Sabour Makhana-1, market growth, pharmaceutical applications, health benefits. (key words)

Introduction:

Makhana, also known as foxnut or gorgon nut, is the seed of an aquatic plant belonging to the Nymphaeaceae family. Its cultivation had started approximately 3,000 years in India and China, as noted by Jha *et al.* (1991). This plant thrives in stagnant water bodies such as ponds, lakes and lowland depressions. For many years, makhana cultivation relied on local varieties. Recognizing its commercial significance, the ICAR Research Complex for the Eastern Region in Patna, Bihar, developed the first improved variety, named Swarna Vaidehi (Kumar *et al.*, 2016). Another high-yielding variety, Sabour Makhana-1 (Kumari *et al.*, 2016), was also developed by ICAR. These improved varieties offer higher yield potential and resistance to common pests and diseases.

Importance:

Makhana is often revered as the “food of god” in India and used in a religious offering or “prasada.” Approximately 80% of country’s makhana produce comes from Bihar, particularly the districts of Darbhanga, Madhubani, Purnia and Katihar. Traditionally, the cultivation of makhana in these regions has been carried

out by the Mallah community. Despite its popularity, makhana is cultivated on around 13,000–15,000 hectares of land across India. Each makhana plant typically produces 8–9 leaves and bright purple flowers that eventually develop into fruit. The ponds used for makhana cultivation generally accommodate about 10,000 plants per hectare, yielding an average of 1.8–2.0 tons per hectare using traditional methods (Jana *et al.*, 2019).

Current Production Scenario:

In India, makhana is cultivated over an area of approximately 15,000 hectares, yielding around 120,000 metric tons of seeds annually. After processing, this results in about 40,000 metric tons of popped makhana. The global makhana market was valued at \$7.8 billion in 2023 and is expected to grow at a compound annual growth rate (CAGR) 9.7% by 2032 (IMARC, 2023).

Growth Makhana Industry:

Makhana is becoming increasingly popular in India and globally due to its rich nutritional profile, offering numerous health benefits, like low in calories, high in protein and rich in antioxidants. Its versatility as a snack, compatibility with plant-based diets and alignment with global trends for superfoods and gluten-free products have significantly boosted its appeal. The chemical composition of makhana is summarized in Tables 1 and 2, while Tables 3 and 4 provide an essential amino acid (EAA) profile and a comparison of its biological values, offering a comprehensive understanding [Devi *et al.*, 2020, Kapoor *et al.*, 2022, Jha *et al.*, 1991 & Sodi & Kumar 2019].

Table 1. Chemical composition of makhana:

Nutrients (dry matter)	Raw
Moisture Content (%)	10.80 to 11.82
Protein (%)	9.15 ± 0.10
Fat (%)	0.46 ± 0.04
Total Mineral	0.45 ± 0.03
Total dietary fibre (%)	2.55 ± 0.04
Carbohydrates (%)	87.52 ± 0.15

Energy (Kcal/100g)	362
Essential amino acid index	93.63

[Devi *et al.*, 2020 & Kapoor *et al.*, 2022]**Table 2. Minerals composition of makhana**

Minerals (mg/100 g, dry matter basis)	Raw
Calcium	14.50
Sodium	2.92
Potassium	50.25
Magnesium	13.83
Phosphorus	132.53
Iron	5.73
Manganese	1.30
Molybdenum	0.03
Zinc	1.50
Copper	0.71

(Devi *et al.*, 2020)

Table 3. Essential amino acid profile of makhana

Amino acid (mg/100 g of protein)	Raw
Lysine	2.46
Histidine	300.99
Isoleucine	14.74
Leucine	49.15
Methionine	15.97
Phenylalanine	31.95
Threonine	121.63
Valine	17.2

(Devi *et al.*, 2020)**Table 4. Comparative value of essential amino acid index (EAAI) and biological value (BV) of foods**

Foods	EAAI	BV
Fried makhana	89.97	55
Raw Makhana	93.63	-

Rice	82.88	68
Wheat	65.18	62.6
Bengal gram	81.55	68
Soyabean	85.59	50.7
Cow's Milk	88.8	84.5
Fish	89.2	59.7
Mutton	87.24	74

[Jha *et al.*, 1991 & Sodi & Kumar 2019]

Essential Amino Acid Index (EAAI) and Biological Value (BV) are crucial for evaluating protein quality in foods, significantly affecting human health. EAAI reflects the balance of essential amino acids, vital for growth, repair and overall health, while BV measures how efficiently the body uses the consumed protein for tissue maintenance. The data shows that raw makhana excels with the highest EAAI (93.63), surpassing staple foods like rice and wheat, as well as protein-rich sources like soybean and fish, indicating its high nutritional value. Although fried makhana also maintains a strong EAAI (89.97) and its moderate BV (55), lower than cow's milk and mutton, emphasizes that protein quality depends not only on amino acid content but also on how effectively the body utilizes it [Jha *et al.*, 1991 & Sodi & Kumar 2019].

Traditional Medicinal use

Makhana holds significant medicinal value in both Indian and Chinese traditional medicine. It is used to treat a variety of ailments, including digestive, respiratory, excretory, reproductive and circulatory disorders. It is also effective for conditions such as beriberi, polyuria, diarrhea, spermatorrhea and joint pains. In Chinese medicine, makhana is included in medicinal liquors with antirheumatoid properties, made from seed extract, Chinese liquor and yeast. Due to its immunostimulant effects, it is recommended for pregnant women to boost immunity. Additionally, makhana contains anti-aging amino acids like arginine, cystine, glutamine and methionine, enhancing its therapeutic benefits. These properties make makhana a valuable source of antioxidants and a potential ingredient in the pharmaceutical industry (Kapoor *et al.*, 2022).

Health benefits of makhana

Makhana shows various pharmacological actions, such as antidiabetic, antimelanogenic, antihyperlipidemic, hepatoprotective, immunomodulatory and anticytotoxic actions. It also provides therapeutic benefits for the respiratory, circulatory, digestive, renal, and reproductive systems, supporting fertility in both men and women. Rich in dietary fiber, makhana is known to aid in treating constipation and can help regulate blood pressure, blood sugar levels, heart disease, and anemia. Traditionally, it has been used to manage diabetic nephropathy, enuresis, chronic diarrhea, and liver dysfunction. Additionally, its kernel powder is a key ingredient in Ayurvedic medicine, used to strengthen the spleen and kidneys. Both raw and popped seeds are abundant in amino acids (such as arginine, glutamine, and histidine), trace minerals (including chromium and selenium), and flavonoids (like quercetin and kaempferol), all of which contribute to immune support. Makhana is gluten-free and rich in folate, making it beneficial for fetal development during early pregnancy and for women in the postpartum period (Kapoor *et al.*, 2022).

Processing of popped makhana

The processing of makhana involves several steps to transform raw seeds into popped nuts that are widely consumed as snacks or used in other products. Traditional processing steps of popped makhana is showed in figure 1. (Singh *et al.*, 2017)

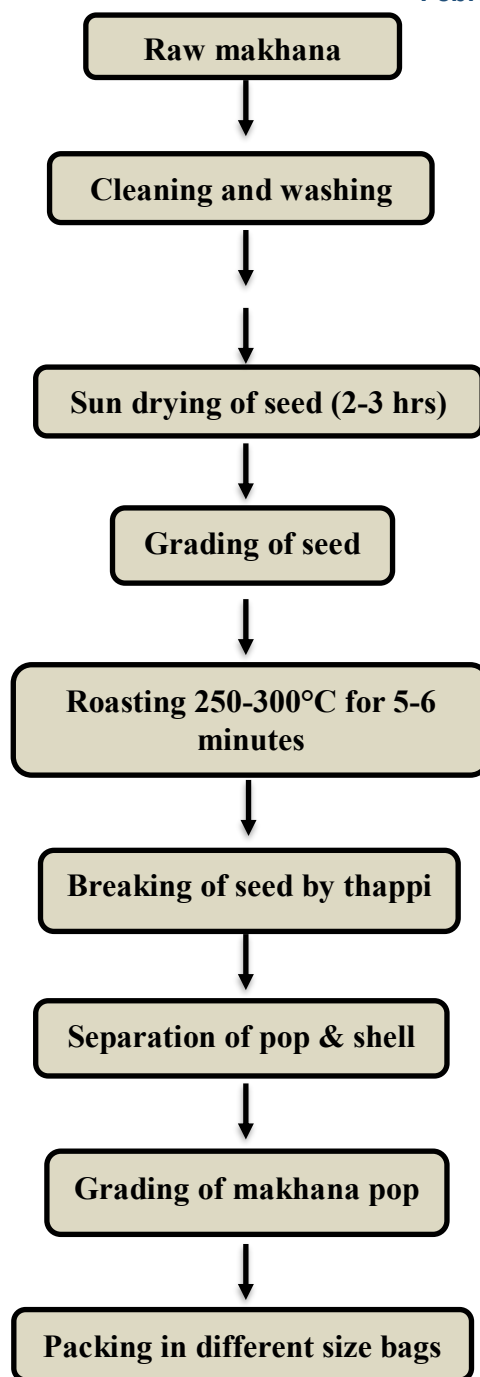


Fig 1 [Flow chart of popped makhana]

Different scientists have worked on the use of makhana as a healthy food and its medicinal and therapeutic uses. They have revealed its role as a nutrient-dense snack, rich in protein, essential amino acids and antioxidants, with significant health benefits, including antidiabetic, cardioprotective and anticancer properties. Makhana's functional applications in gluten-free foods, resistant starch and pharmaceutical use emphasize its versatility and growing importance. These are summarized below:

Sr no	Authors	Treatment/Study	Findings
1	Mittal <i>et al.</i> , 2020	They examined the nutritional, medicinal and industrial value	- They found that it has highest essential amino acid index (93.63%) among protein-rich foods. - It is rich in bioactive compounds with antioxidant, antidiabetic, hepatoprotective, cardioprotective and anti-aging properties. - It is used in Industrial applications as an adsorbent and in drug delivery systems.
2	Biswas <i>et al.</i> , 2020	They explored enzyme-mediated resistant starch production and its effects on digestibility and functional properties	- They found that RS (resistant starch) content increased to 14.88% and amylose content to 12.33%, improving crystallinity (11.32%) - Reduced digestible starch by 13.01%, aiding blood sugar control. - Lower oil absorption improved flavour retention and texture. - Enhanced thermal stability supports therapeutic food applications.
3	Vikram & Mishra 2021	They assessed the role of makhana as a nutraceutical for COVID-19 management.	- They found that it contains flavonoids, glycosyl sterols and tocopherol polymers with therapeutic effects. - It manages oxidative stress, metabolic dysregulation and cardiovascular damage, Cardioprotective, antidiabetic, hepatoprotective and immunomodulatory effects boost recovery. - Additionally, they found that recommended dose: 10–20 grams daily, usable in diets or via nasogastric tubes in critical care.
4	Devi & Deka 2021	They examined the physicochemical properties and applications of Euryale	- They found that EFKS has an A-type diffraction pattern, polyhedral granules and high pasting temperature for baking processes.

		ferox kernel starch EFKS.	- Low swelling power due to high amylose content, with solubility increasing at higher temperatures. - They also found that bread formulations with up to 20% EFKS showed good sensory attributes - Analytical techniques confirmed EFKS's properties, comparable to commercial starches like rice.
5	Liaquat <i>et al.</i> , 2022	They assessed the nutritional and health benefits of roasted fox nuts (<i>Euryale ferox L.</i>).	- They found that roasting decreases moisture (12.07% to 4.17%) and increases phenolic, flavonoid, protein and mineral content. - Protein content rises by 28%, with an EAAI of 89%, surpassing almonds and peanuts. - Key minerals like potassium, magnesium, and calcium are significantly enhanced. - High antioxidant activity (79.13% DPPH) and low GI (37.05%) make them suitable for metabolic health and as a nutrient-rich snack.
6	Kapoor <i>et al.</i> , 2022	They examined the nutritional, pharmaceutical and economic importance of foxnut.	- They reported that makhana is high in carbohydrates (61%), protein (15.6%), vitamins (C, E) and minerals (magnesium, potassium, iron). - It's amino acid index (89–93%) emphasizes its high-quality protein profile. - It Shows anticancer, cardioprotective and antidiabetic properties in experimental models. - Strong antioxidant activity boosts ferric and cupric ion reducing capacities, offering extensive health benefits.
7	Rathod <i>et al.</i> , 2023	They explored the nutritional, therapeutic and market potential of makhana.	- They reported that it is nutritionally superior to dry fruits like walnuts and cashews, with high protein, carbohydrate, essential amino acids and vitamins A and C. - It has antioxidant properties from kaempferol, combating oxidative stress and inflammation and provides anti-aging and antidiabetic benefits through amino acids like arginine and methionine.

			- It also has a long-standing use in Ayurvedic and Chinese medicine for kidney and spleen disorders. - Additional they highlight export potential, limited production and opportunities for value-added product development.
8	Vishwakarma <i>et al.</i> , 2024	They developed and optimized gluten-free pasta using semi-popped makhana (SPM) flour (47.1%), water chestnut (WCN) flour (23.50%) and potato flour (PF) (28.69%) with carrot juice.	-They found that pasta having Protein (10.29%), iron (6.90–10.87 mg/100 g), calcium (33.46–41.62 mg/100 g) and enhanced antioxidant properties (28.36% DPPH inhibition, 716.83 mg GAE/100 g TPC). - It has good sensory acceptability (7.41) and six-month shelf stability and higher nutritional value compared to semolina pasta

Future Prospect

Makhana offers immense potential for developing innovative products like fortified foods and functional snacks, advancing eco-friendly cultivation methods and exploring pharmaceutical applications for chronic diseases. Efforts to expand global markets and enhance genetic varieties will further boost its economic and nutritional value.

Conclusion:

Makhana, a nutrient-dense aquatic seed, has gained prominence as a superfood due to its remarkable nutritional profile, therapeutic properties and industrial applications. Rich in protein, essential amino acids, antioxidants and trace minerals, makhana offers multiple health benefits, including antidiabetic, cardioprotective, hepatoprotective and anti-inflammatory effects. Its versatility has enabled its incorporation into various products like gluten-free foods, resistant starch formulations and value-added snacks. Furthermore, makhana exhibits promising potential in pharmaceutical applications and traditional medicine. Enhanced cultivars, such as Swarna Vaidehi and Sabour Makhana-1, have improved yield and pest resistance, supporting its expanding global market.

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