



Exploring the Health Benefits of Foxnuts (Makhana) in Food

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Euryale ferox Salisb, also known as "makhana," or "foxnuts" is an aquatic crop belonging to the Nymphaeaceae family. It is predominantly traded in countries across South and East Asia, such as India, China, Nepal, Bangladesh, Japan, Russia, and Korea. In India, its cultivation is primarily limited to select states, including Bihar, Assam, Manipur, West Odisha, Tripura, and Bengal. This crop holds cultural and economic significance in the regions where it's cultivated. In addition to being a staple in local cuisines, makhana has medicinal properties and is used in traditional medicine systems like Ayurveda. The expansion of its cultivation beyond its native regions could potentially open up new avenues for its commercialization and utilization, benefiting both local economies and global markets interested in this unique aquatic crop (Rathod *et al.*, 2023). Makhana (*Euryale ferox* Salisb) stands out as a significant aquatic nut crop cultivated in India. Renowned for its elevated levels of protein and carbohydrates, it holds a prominent position among agricultural products in the region (The edible part of the *Euryale ferox* plant, known as makhana seeds, is small and round with a covering that varies in colour from black to brown due to processing. These seeds are highly nutritious, containing essential minerals, proteins, and carbohydrates. They comprise approximately 12.8% of nutrients, with 76.9% being water, 9.7% protein, and 0.1% fat. Additionally, they contain trace amounts of calcium (0.02%), phosphorus (0.9%), and iron (0.004%), contributing to their overall mineral content. Popped makhana seeds are a valuable food source known for their nourishing properties (Singh *et al.*, 2020).

Nutritional Importance of foxnuts (makhana) in food

The commercial value of makhana seeds primarily lies in their popped form. These starchy white puffs are marketed as a premium dry fruit product, celebrated for their wholesomeness and delightful taste. Makhana seeds possess a calorific value of 362 Kcal/100g in their raw state, which decreases to 328 Kcal/100g once popped. Despite this, due to the high ratio of leucine to isoleucine amino acids in the seeds, their biological value is moderate, estimated at about 55. Among popped makhana, good quality, known as Rasgulla or lava, constitutes approximately 54%, while medium-quality Murra and low-grade, referred to as thurri, account for 35% and 11%, respectively (Kumari *et al.*, 2019). Also, the trace metal analysis of both whole and puffed starch revealed levels of Cu, Fe, Ca, and Mg in the seed meal and whole starch to be below 1, 100, 1000, and 2000 ppm, respectively. In contrast, purified starch exhibited 800, 80, 200, and 100 ppm concentrations for Cu, Fe, Ca, and Mg, respectively (Tehseen *et al.*, 2020).

Makhana is abundant in both macro and micronutrients, serving as a valuable source of minerals. Various studies have reported the presence of trace metals such as Cu, Na, Ca, Fe, and Mg in makhana. Additionally, the vegetative part of the plant boasts significant levels of N, P, and K. The elevated concentrations of P, Fe, and Zn are attributed to the muddy field

conditions in which makhana thrives. Furthermore, makhana is rich in vitamins, particularly vitamin A and vitamin C, with concentrations ranging from 62.23 to 63.84 IU/g and 0.18% to 0.20%, respectively (Khadatkar *et al.*, 2020). Because of its exceptional nutritional value and distinctive qualities, the significance and market worth of makhana is steadily rising. Makhana seeds are also referred to as "black diamonds" due to their esteemed status (Kumar *et al.*, 2016).

Health benefits of makhana

- Makhana holds significance as an ingredient known to bolster the spleen and kidneys. Its low sodium and high potassium content contribute to lowering blood pressure. Additionally, its minimal monounsaturated fat content helps prevent spikes in blood sugar levels (Jana and Idris, 2018).
- **Hepatoprotective activity:** The compounds found in *E. ferox*, including 1,2,3-trigalloyl glucose, gallic acid, corilagin, 1,6-digalloyl glucose, 1,2,3,6-tetragalloyl glucose, 1,2,6-trigalloyl glucose, and ethyl gallate, are known for their hepatoprotective properties. These compounds aid in reducing lipid deposits and alleviating oxidative stress, which can lead to damage to DNA, proteins, lipids, and cell membranes. This mechanism is particularly relevant in combating the progression of non-alcoholic fatty liver disease (Sumida *et al.*, 2013).
- **Antidiabetic activity:** Pentacyclic triterpenes, such as 2 β -hydroxybetulinic acid 3 β -caprylate and 2 β -hydroxybetulinic acid 3 β -oleiate, derived from *E. ferox*, exhibit hypoglycemic properties. Extracts from the plant prompt the pancreas's β -cells to release insulin, thereby contributing to the plant's antidiabetic efficacy (Ahmed *et al.*, 2015).
- **Anti-cancer activity:** Phytochemicals present in *E. ferox*, including alliin, resveratrol, and gallic acid, have been observed to trigger apoptosis in human Caucasian lung carcinoma cancer cells in a dose-dependent manner, demonstrating their anticancer properties (Nam *et al.*, 2019).
- **Antioxidant activity:** Two cerebrosides and two tocopherol polymers, known as ferocerebrosides A and B, and ferotocodimers A and E, respectively, have been extracted from *E. ferox* and display antioxidant properties. Additionally, epicatechin, a flavonoid found in the ethanolic extract of the seed shell of *E. ferox*, exhibits significant antioxidant effects, contributing to its therapeutic efficacy against various ailments (Han *et al.*, 2012; Row *et al.*, 2007).

Conclusion

Euryale ferox is widely recognized as a superfood due to its numerous health benefits. Its rich array of bioactive compounds has prompted research into its use in Ayurvedic and traditional medicine. Studies have highlighted its potential to address a range of health issues, including diabetes, cancer, heart disease, liver and kidney disorders, depression, and more. Given its nutritional profile and abundance of functional compounds, *E. ferox* is promising for both food and non-food industries.

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