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A Comprehensive Examination of the Nutritional Value and Health Advantages of Makhana *(Euryale Ferox)*

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Abstract: Makhana, sometimes referred to as lotus seeds or fox nuts, is a very nutritious and adaptable food that has been used in Ayurvedic treatment and traditional Asian cuisines for ages. This review examines Makhana's remarkable nutritional value and health benefits. It has 12.8% in it. It is composed of 76.9% water, 9.7% protein, 0.1% fat, 0.02% calcium, 0.9% phosphorus, and 0.5% and 0.004% other minerals. The great medicinal potential and exceptional antioxidant qualities of foxnut are attributed to a variety of antioxidant components. Foxnut is used as a folk medicine. Makhana is a noteworthy fruit because of its low glycemic index, which helps with blood sugar regulation and makes it a good option for diabetics. Its high concentration of vital minerals, including as calcium, iron, phosphorus, potassium, and magnesium, supports cardiovascular health as well as general well-being. Makhana has several health benefits and a high nutritional content, which has led to a major increase in demand in recent years. India's modern makhana is highly regarded throughout the nation.

Keywords: Antioxidant properties, Ayurvedic medicine, Asian cuisines, Glycemic index, Therapeutic potential.

I. Introduction

India is a biodiverse nation where many different plants are used as herbs, which are subsequently employed as pharmaceuticals. Immune boosters such as Syzygium aromaticum (Clove), Mentha (Pudhina), Ocimumtenuiflorum (Tulsi), and Cinnamomum verum (Dalchini) are vital to our culinary arts. and denotes a delicious condiment and seasoning. additions. As a result, these herbs are more beneficial in daily life due to their established medical benefits [1]. In order to study the drug's additional pharmacological effects, the researchers also become interested in tasks that involve eliminating the active chemical. Additionally, these plants are quite inexpensive and have no drawbacks. have negligible cost and no negative impacts. Comparably, the intriguing aquatic herb Euryale ferox, a rhizomatous watery flowering plant of the Euryale genus also known as fox nuts or lotus seeds, has been prized for millennia in many regions of Asia, especially in India and China [2]. The search for clean, nutrient-dense foods has led us to find age-old ingredients with amazing health benefits in the field of nutrition and wellness. "Makhana," an aquatic herb that has been prized in traditional Indian cuisine for millennia, is one such hidden gem. Makhana, commonly known as lotus seeds or fox nuts, is a plant that grows from the pure waters of aquatic plants in the genera Euryale and Nelumbo. These humble seeds, which are frequently seen tucked away inside the vivid lotus blossoms, have recently drawn notice from all around the world for their remarkable health-promoting qualities. The plant yields starchy, white, tasty seeds. Whether it is fried or eaten raw, foxnut is low in fat and high in essential amino acids. According to a number of studies, foxnut has hygroscopic and physical properties that make it ideal for use in infant formula [3]. It's interesting to see how makhana went from being a mainstay of Indian subcontinent cuisine to being a superfood phenomenon. Makhana, once enjoyed as a delicacy during religious ceremonies and festivals, is now a staple on the tables of people who are health-conscious all over the world. Its rebirth can be attributed to a multitude of health benefits that coincide with contemporary dietary choices, in addition to its delicate and pleasant crunch. It develops in perennial water bodies like ditches, ponds, lakes, land depressions, and swamps that have stagnant conditions [4]. This plant is acclimated to tropical and subtropical climates. The makhana farming region spans approximately 13,000 hectares. A lot of resource-poor farmers, especially in Bihar and Manipur, rely on makhana farming as a source of income. Its healthy growth and development require the following conductive range: 20 °C to 35 °C, 50% to 90% relative humidity, and 100 cm to 250 cm of annual precipitation

[5]. Upon submersion in water, foxnut seeds undergo unique biochemical changes that become apparent at different phases of seed germination. Age-related increases in protein content have been reported. Excellent rating Makhana, also called rasgulla (or lava), makes up about 54% of pops; medium-quality murra and low-grade thurri, on the other hand, make up 35 and 11% of pops, respectively [6].

It is high in vitamins, proteins, carbs, and amino acids in terms of nutrition. 70–80% of it is starch [7]. Makhana seeds are widely used and have been shown to be effective in treating a number of conditions, including splenic hypofunction, chronic diarrhea, renal illness, and severe leucorrhea. This review included information on the several patented elements, plant extracts, and extracted bioactive chemicals that are present in Euryale ferox Salisb in notable amounts. Information about their pharmacological activities was also supplied. Therefore, it is imperative to provide a thorough explanation of Euryale ferox Salisb., a plant that has the ability to both prevent and treat serious illnesses in humans when they are still in their early stages. It must therefore be compiled in a single location.

II. Nutritional Importance of Makhana

Makhana, sometimes referred to as lotus seeds or fox nuts, is a very healthful and adaptable diet. Makhana is an aquatic cash crop that is low in fat, high in carbohydrates, and high in protein. It has long been a component of Ayurvedic treatment and traditional Asian cuisines. Because makhana is thought to have anti-inflammatory qualities, it might be possible to lessen health problems associated with inflammation. It is used to treat inflammatory problems in conventional medicine [8]. Popped makhana contains 84.9% carbs, 4% moisture, 9.5% protein, and 0.5% fat. Makhana was essential to the cotton industry and had great medicinal value. Makhana promoted proper treatment of the respiratory, digestive, circulatory, and reproductive systems. The biochemical analysis of makhana seeds showed that they had a low fat content of 1.36% and a high protein content of 15.6%. According to Kumar [9], there are 362 and 328 calories in 100 g of raw and puffed makhana, respectively. The makhana's high protein and fat content makes it similar to almonds, walnuts, cashew nuts, and coconuts. Makhana reported 16 different kinds of amino acids in the kernel [10]. When it comes to protein and amino acid composition (g/16 g N), makhana has higher levels of arginine, alanine, and tyrosine than eggs. There are 362 and 328 calories in 100g of raw and puffed makhana, respectively [11].

III. Nutraceutical Properties of Makhana

A. Antioxidant Properties

The primary function of makhana is its antioxidant activity, which has been connected to disorders such as diabetic nephropathy and proteinuria inhibition. When examined utilizing DPPH, TEAC, and CAT (Catalase) SOD (Superoxide Dismutase) activity, foxnut (Euryale ferox Salisb) extracts show enhanced rates of radical scavenging behavior, decreasing power, and are a powerful antioxidant because they lower lipid peroxidation [12]. It also increases the vitality of cells, protects against apoptosis caused by H_2O_2, and boosts the performance of particular antioxidant enzymes. Natural antioxidants can be found in large amounts in foxnut. the capacity to be used as functional foods and dietary supplements, possibly curing diabetes and hyperlipidemia. The flavonoid kaempferol is present in them. Additionally, anti-inflammatory flavonoids mitigate the deleterious consequences of free radicals [13].

B. Antiaging Properties

The best antioxidants have been discovered to be amino acids, which can also function as a fighting agent, eliminate free radical intermediates, and stop chain reactions. Foxnut contains several essential amino acids, including cysteine, glutamine, leucine, isoleucine, methionine, and arginine [14]. The amino acids methionine and arginine, which are essential for strong, healthy skin, hair, and nails, are the building blocks of creatine. The maintenance of skin health requires acquired creatine, arginine, and methionine. Creatine is also required for the proper functioning of the body's cells. Because creatine gives cells energy, the skin's connective tissue, cells, and metabolism can all develop. Diabetes incidence is reduced via cellular action through the conversion of cysteine to taurine [15].

C. Anti-Diabetic Properties

Makhana, or lotus seeds, are widely utilized for a variety of health advantages in Ayurvedic and traditional medicine systems, including possible benefits for managing diabetes. Dietary fiber, such as fox nuts, can help control blood sugar levels by slowing down the absorption of carbs. Additionally, fiber encourages satiety, which can help with weight control—a crucial component of managing diabetes. Since too much salt can cause high blood pressure and cardiovascular problems, fox nuts' naturally low sodium content is advantageous for those with diabetes [16].

Table I: Nutraceutical Properties of Makhana

Sr. No.	*Nutraceutical Property*	*Potential Health Benefits*	*References*
1.	Antioxidants	May help protect cells from oxidative damage	[1]
2.	High Dietary Fiber	Supports digestive health and may aid in weight management.	[1]
3.	Low in Saturated Fat	May promote heart health.	[2]
4.	Low in Cholesterol	May help maintain healthy cholesterol levels.	[3]
5.	Rich in Protein	Provides essential amino acids for muscle repair and growth.	[4]
6.	Essential Minerals (e.g., Phosphorus, Potassium, Magnesium)	Supports bone health, nerve function, and muscle function.	[2], [5]
7.	Gluten-Free	Suitable for individuals with gluten sensitivity.	[6]
8.	Low in Sodium	Supports healthy blood pressure levels.	[11]
9.	Low Glycemic Index	Can aid in controlling blood sugar levels.	[9]
10.	Anti-Inflammatory Properties	May help reduce inflammation in the body.	[14]
11.	Amino Acids (e.g., Tryptophan)	May promote relaxation and better sleep.	[10]

IV. Medicinal Properties of Makhana

Makhana has always been appreciated for its possible therapeutic benefits in conventional medical systems like Ayurveda. In China and India, makhana was a prized medicinal herb. Numerous ailments involving the digestive, respiratory, excretory, and reproductive systems are treated with it. Makhana is abundantly available and a rich source of natural antioxidants [17]. It is relevant to the healthcare and pharmaceutical industries. Apart from these, it is also used to treat renal problems, chronic diarrhea, leucorrhea, articular pain, micturition, gonorrhea, polyuria, spermatorrhoea, and seminal loss. Makhana contains higher concentrations of anti-aging amino acids such arginine, glutamine, cystine, and methionine [18]. The antioxidant-active ingredients in makhana seeds and their combined benefits may be largely responsible for the plant's ability to treat proteinuria. Makhana contains a trace mineral called selenium, which is necessary for the synthesis of antioxidant enzymes. Cells are shielded from oxidative damage by it. The low fat and low salt content of makhana may be beneficial to heart health. According to Sharma [19]. the presence of magnesium and potassium may improve cardiovascular health and help control blood pressure.

Makhana is a significant herb used in traditional Chinese and Indian medicine. It is used to treat a wide range of diseases of the respiratory, digestive, excretory, and reproductive systems. Additionally, spermatorrhoea, micturition, gonorrhea, polyuria, and spleen issues are treated with it. Kidney-related symptoms include persistent diarrhea, severe leucorrhea, and beriberi [20]. foxnut recommends using to boost immunity for the mother who gave birth to the child. Makhana seeds are used in ayurvedic remedies to treat various disease like heart and anemia. It has very little monounsaturated fat, which keeps blood sugar from rising. Its high potassium and low sodium contents also help to lower blood pressure. In Ayurvedic medicine, makhana is regarded as a "cooling" meal and is frequently advised for people suffering from heat-related ailments including heatstroke or excessive body heat [21].

Fig. 1: Medicinal Properties of Makhana

V. Future Possibilities

Makhana stands for a bright future in a society where people are becoming more health-conscious and looking for plant-based, vegan, gluten-free, and non-GMO food options. These seeds are unique due to their exceptional nutritional value; 100 grams include only a small amount of fat and around 9.7 grams of protein, 14.5 grams of dietary fiber, and important trace elements like calcium, iron, magnesium, and potassium. Makhana stands noteworthy due to its remarkable nutritional composition [22]. Furthermore, even though makhana has a moderate flavor by itself, it can be the basis for a variety of flavors and tastes. Vacuum-sealed makhana packages with tantalizing tastes like tomato, tikka masala, piri-piri, sour cream and onions, and even chocolate can be found in grocery shops, demonstrating its

versatility in satisfying a wide variety of palates. Because of its adaptability, it presents itself as a desirable and contemporary snack option that fits in well with customers' shifting dietary requirements.

VI. Present Scenario of Makhana

Makhana has several health benefits and a high nutritional content, which has led to a major increase in demand in recent years. India's modern makhana is highly regarded throughout the nation. Despite this, only a small portion of West Bengal, Assam, Manipur, and North Bihar are permitted to produce Makhana for commercial use. But it may reach all of the country's major cities through a network, as well as producers, processors, small-town vendors, commissions, wholesalers, consumers, and retailers. Farmers in production areas are thought to get roughly 55% of the final retail price set by the local market. But when it comes to makhana, its share drops off quickly [23]. Pops are expensive, thus they are only available in overseas markets. The retail margin, which makes up about 19% of the retail price, is the second most important aspect in the ultimate price of puff makhana. Exports have not yet made use of the export potential. Currently, about 1-2 percent of India's total production is exported. About 100 tons of pop makana are shipped to other countries [24].

VII. Conclusion

This article provides an explanation of the importance of makhana. Agronomic, cultural, genetic, economic, and sociological factors have all contributed to the omission of some crops in this vast cosmos. Ethnobotanical surveys indicate that approximately 7,000 individuals. Few plant species are cultivated or removed from the forest. 150 different kinds of crops are traded extensively worldwide. This investigation focuses on a kind of plant that will require more attention soon because it significantly enhances human health overall. There is a dearth of information and study on this nutritious superfood. Because foxnut cannot compete with major commodity crops that are highly relevant economically, policymakers have not given it more consideration.

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