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FOXNUT (MAKHANA): A SUPERFOOD WITH ECONOMIC AND HEALTH IMPLICATIONS

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ABSTRACT

The aquatic plant Euryale ferox's seeds, known as foxnuts, have drawn attention recently because of its distinctive nutritional makeup, therapeutic benefits, and commercial importance. The goal of this review article is to give a thorough overview of foxnuts, including information on their nutritional value, health advantages, traditional usage, and economic significance. A great supply of proteins, dietary fibre, minerals, and antioxidants may be found in foxnuts. They are highly regarded in particular for their low-fat content and distinctive starch composition, which makes them an advantageous nutritional option for anyone looking for low-calorie, nutrient-dense meals. They may have health-promoting qualities, such as antioxidant, anti-inflammatory, and anti-cancer benefits, due to the presence of bioactive substances such saponins and flavonoids. Foxnuts have a long history of usage in traditional medical systems like Ayurveda and Traditional Chinese Medicine (TCM), in addition to their nutritional benefits. These seeds are said to provide a number of health advantages, from increasing kidney health and boosting vitality to easing digestive problems and controlling blood sugar levels. The processes behind these health claims are beginning to be understood thanks to recent scientific studies. Additionally, foxnut commerce and cultivation have a considerable economic impact, particularly in areas where the plant is native. The study sheds light on foxnuts' economic significance for regional economies and international trade networks by investigating their cultivation methods, worldwide production patterns, and market dynamics. A promising natural resource with exceptional nutritional, therapeutic, and commercial potential is foxnuts.

Keywords: Foxnut; Makhana; Antioxidant; Phytochemical; Therapeutic Effect; Anti-diabetic, Economic, Global Markets

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INTRODUCTION

Aquatic nut crop Euryale ferox Salisb., also known as foxnut, gorgon nut, or prickly water lily, belongs to the Nymphaeaceae family of water lilies, however it is also referred to as Euryalaceae (Bana *et al*., 2015). It is a member of the Nymphaeaceae family and is also referred to as "Makhana" or "Phool Makhana" in the local languages of the Indian Subcontinent. Other common names for it include "fox nut," "gorgon nut," and "prickly water lily." (Goren-Inbar et al. 2014). Because of their black exterior seed coat, Makhana seeds have earned the nicknames "Black Diamonds" and "Black Gems of Wetlands" by certain experts (Sundaram et al. 2014). Dry fruits are sold as a cash crop known as pop makhana, sometimes known as Makhanalawa. (Kumar et al., 2016). The major attraction of the *Euryale ferox* plant is its delicious seeds, which are transformed into white puffed nuts. Based on their high Essential Amino Acid Index (EAAI) of 89–93%, these nuts are considered a great dietary item in the dry fruit category. (Kumar et al. 2011). One hectare of pond area has 10,000 foxnut plants, each of which produces roughly 100 seeds. Around 1.8 to 2.0 t of raw Makhana seed are produced per hectare of pond area (Khatatkar et al., 2015). White, delicious, starchy seeds are produced by the plant. Foxnut is cholesterol-free and provides large levels of vital amino acids whether it is raw or fried. Several studies found that foxnut has physical and hygroscopic characteristics that make it perfect for use in newborn formula. (Bana *et al*., 2015).

Low GI meals are shown to increase insulin sensitivity, fasting triglyceride levels, healthy body weight maintenance, and a significant reduction in health risk factors. (Livesey et al. 2008). Because they have a low GI, fox nuts completely meet the requirements for various non-communicable diseases. These nuts' low GI is due to their complex carbohydrate content, which also makes them a fantastic snack for people with non-communicable diseases. The Canadian Diabetes Association has provided suggestions for low glycemic index foods as part of their nutrition treatment for diabetes patients. (Lawson *et al*. 2005).

In addition to their nutritional benefits, fox nuts have a wide range of therapeutic characteristics that have been described in classical Chinese and Indian medical texts. In addition to its content in macro- and micronutrients, fox nuts also have special therapeutic qualities due to its phenolic compounds and antioxidant characteristics (Lee et al. 2002). After spices and fruits, nuts have the third-highest concentration of phytochemicals (Chang et al. 2016). The antioxidant activity and total nutritional value of food products are significantly influenced by phenolic and flavonoid components. Numerous research have backed their function in treating human ailments (Lin et al. 2016). When compared to those of other nutrients, the phenolic compounds' antioxidant capabilities are quite powerful. (Shahidi & Naczk 2003). Nuts are undoubtedly a handy and delicious snack, and eating one serving a day helps avoid chronic illnesses including high blood pressure, cancer, type II diabetes, cardiovascular problems, and neurological diseases (Chang et al. 2016). Fox nuts contain a high concentration of macro- (Ca, P, K, Na, and Mg) and micro- (Fe and Zn) minerals in addition to a bioactive-rich profile (Kumar et al. 2016).

TAXONOMY OF FOXNUT

The word "foxnut" can apply to a variety of plant species, although it is most frequently connected to the water lily Euryale ferox. The taxonomy of Euryale ferox is shown below:

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Kingdom	:	Plantae
Phylum	:	Angiosperms (flowering plants)
Class	:	Eudicots
Order	:	Nymphaeales
Family	:	Nymphaeaceae (water lily family)
Genus	:	Euryale
Species	:	Euryale ferox

Common names for Euryale ferox include foxnut, fox nut, gorgon nut, makhana, and lotus seed. In regions of Asia, especially in India and China, this plant's seeds are frequently employed in a variety of gourmet dishes and traditional medicines. They are prized for their dietary benefits and therapeutic qualities.

GEOGRAPHICAL INDICATION

The Kashmir valley, which stretches from the Northern to Eastern Himalayan mountains, Manipur, Bihar, Assam, Orissa, and West Bengal are all home to Euryale ferox Salisb. Although Assam, Orissa, West Bengal, and Bihar, which are neighbouring states, are the only places where it is currently grown (Jha et al., 1991). Tropical and subtropical climates with temperatures between 20°C and 35°C, relative humidity between 50% and 90%, and rainfall between 100 cm and 250 cm provide the best environmental conditions for growth (Mandal et al., 2010). The perineal plant Euryale ferox has roots in the ground and broad, rounded, blade-shaped leaves that allow it to float on the surface of pond water. The rhizomes are buried deep in the bottom of the pond with the aid of thick, meaty roots, while the leaf lamina and vascular bundles feature many stinging prickles. The plant produces 15-20 spongy fruits with 30–40 nuts apiece at a time. The nuts, which are enclosed in a mucilaginous covering, are released when the fruit dehisces and ripens (Goren et al., 2014).

NUTRITIONAL VALUE OF FOXNUT

Foxnut (Euryale ferox Salisb.) has a lot of carbs, protein, and minerals but little fat. Raw seeds have a calorific value of 328 kcal per 100g, whereas puffed seeds have a calorific value of 362 kcal per 100g. According to nutritional research, the edible component of the seed has a healthy quantity of sugar, phenol, and ascorbic acid along with 12.8% moisture, 9.7% protein, 0.1% fat, 76.9% carbohydrates, and 0.5% mineral contents. It also contains 1.45% iron. Its distinctive dietary quality is shown by the amino acid index, which is greater than that of staple foods (Francis et al., 2018). They also have significant amounts of magnesium, potassium, and phosphorus. Makhana also contains a few vitamins, but in smaller amounts (Vipul et al., 2021). In terms of sugar, proteins, phenol, and ascorbic acid content, foxnuts outperform other dry fruits like walnut, almond, cashew nut, or coconut (Shankar et al., 2010).

MORPHOLOGY OF FOXNUT

Foxnut's (Euryale ferox) morphology refers to the plant's physical features and structures. The main characteristics of the foxnut plant are described as follows:

- **Plant Type**: Usually found in freshwater ponds, lakes, and slow-moving rivers, foxnut is an aquatic plant.

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- **Leaves**: Large and globular, the leaves of Euryale ferox can measure up to 60 centimetres (24 inches) in diameter. They have a waxy layer that aids in water repulsion and float on the surface of the water.
- **Stems**: The plant is anchored to the bottom of the body of water by long, submerged stems.
- **Flowers**: The foxnut plant has single blossoms that appear above the water's surface. Typically, they are big, flamboyant, and fragrant. Both male and female reproductive organs are present in the flowers.
- **Fruits**: Euryale ferox produces a prickly, globular fruit that resembles a chestnut burr. The plant portion known as foxnuts, or the seeds, are found inside the fruit. Each fruit has several seeds.
- **Seeds (Foxnuts):** The plant's seeds have the most commercial value. They have a firm, dark-brown or black seed coat and are spherical and flattened. The seed coat has a characteristic look since it is frequently spiky or covered with tiny protrusions. White and starchy material makes up the seed's inside.
- **Roots**: The roots of foxnut plants are fibrous, which helps them stay anchored in the water and collect nutrients from the silt and water.
- **Habitat**: Adapted to growing in the calm, shallow waters of ponds and lakes, foxnut plants can be found there. They can frequently be seen in tropical or subtropical climates.

Due to these morphological characteristics, foxnut thrives in its watery environment and produces edible seeds that are a common ingredient in several Asian cuisines and have a number of medical benefits.

CULTIVATION OF MAKHANA

Makhana is grown either in field systems or perennial water bodies with 4-6 feet of water depth.

- **Pond System**: This is how Makhana farming has always been done. Old Makhana growing ponds do not require seed sowing since leftover seeds from one crop are used to plant seeds for the following crop. However, neither direct seed sowing nor transferring the plantlets into fresh bodies of water are acceptable ways to begin makhana cultivation. In the conventional technique, air-breathing fish are added to ponds as wild fish along with floodwater and gathered by farmers as a supplemental crop, in addition to Makhana.
- **Field system**: This is a novel method of Makhana farming that the research centre has standardised. According to the system, Makhana is grown in fields of crops at a water depth of 1 foot (Kumar et al., 2011). This technology is relatively simple to use and offers the chance to farm the same fields for cereals and other field crops each year. The Makhana seedlings are initially grown in a nursery before being transferred at the right time into the main field. The transplanting might take place anywhere from the first week of February to the third week of April, depending on the availability of the field and nursery. By using this approach, the Makhana crop may be harvested for as little as four months (Kumar et al., 2011b).
- **Constraints in Makhana cultivation**: Constraints for Makhana cultivation include lack of ownership of the pond/land, highly skilled nature of operations, lack of financial

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facility, lack of scientific understanding of cultivation, lack of improved variety, short lease time, and labor-intensive cultivation.

The majority of makhana farmers plant makhana on leased public or private ponds or land; as a result, the makhana growers recognised this as one of the major obstacles to their ability to turn makhana into a lucrative business. Because traditional methods are used for the majority of farming, "Lack of scientific knowledge of cultivation" is also seen as one of the key obstacles (Ujjwal et al., 2011).

HARVESTING OF MAKHANA

According to Kumar et al. (2011b), harvesting is the act of gathering scattered seeds from the pond's bottom or fields of shallow water. Makhana is harvested between the months of August and October by divers from the "Mallah" village early in the morning, between 6 and 11 o'clock. A diver enters the pond's deepest part, lies down, holds his breath, and uses both hands to move mud towards the bamboo pole known as "Kaara" in the area. Near the foot of the bamboo pole, a pile of mud collects, and it is later sieved through a "Ganjaa" bamboo screen produced locally (Khadatkar et al., 2015). It will take longer to harvest seeds if there are more of them on the pond bottom or in the fields (Kumar et al., 2011b). The diver uncomfortably sweeps the bottom of the pond, mud seeping into his ears, eyes, nose, and mouth. Divers get skin problems as a result of this. A better approach was developed to minimise the laboriousness of divers. The upgraded technique produces much more work while requiring significantly less labour than the traditional method (Khadatkar et al., 2015).

AYURVEDIC PROPERTIES OF FOXNUT

It is thought to have a number of Ayurvedic qualities and health advantages. The following are some of the foxnut's ayurvedic benefits:

1. **Sweet Taste (Madhura Rasa)**: In Ayurveda, foxnut is usually considered to have a sweet flavour. Foods with a sweet flavour are thought to nourish and strengthen the body. They can support the vata and pitta doshas' equilibrium.
2. **Cooling (Sheet Virya):** Foxnut is regarded as having a cooling character, which means it may help calm down excessive body heat. It is especially advantageous for people with a Pitta constitution or those who are experiencing Pitta imbalances.
3. **Bitter Taste (Tikta Rasa):** The doshas are generally balanced with foxnut, which may also have a little bitter flavour. Bitter flavours can improve digestion and aid in bodily detoxification.
4. **Astringent (Kashaya Rasa):** According to some reports, foxnut has an astringent flavour. Astringent meals can help reduce excessive bleeding and speed up the healing process.
5. **Nutritive (Brimhana):** In Ayurveda, foxnut is regarded as a nutritious food. It is thought to provide the body energy and sustenance. It may be especially helpful for people who want to put on weight or build more muscle.
6. **Rejuvenative (Rasayana)**: The herb foxnut is described as being restorative in certain classic Ayurvedic literature. Herbs that improve general health, vigour, and longevity are known as rejuvenative herbs.

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7. **Balancing Vata and Pitta Doshas**: Foxnut is frequently used to balance the Vata and Pitta doshas because of its sweet and cooling qualities. It can ease anxiety, lessen heat-related symptoms, and increase feelings of wellbeing.
8. **Aphrodisiac**: Ayurveda occasionally views foxnut as aphrodisiac. It is thought to improve sexual vitality and reproductive health.

Even though foxnut offers numerous Ayurvedic benefits, it should be noted that each person will react to it differently. Ayurvedic advice is frequently tailored to a person's constitution (Prakriti), present imbalances (Vikriti), and particular health objectives. It is recommended to speak with a healthcare provider or Ayurvedic practitioner before introducing foxnut or any other Ayurvedic treatment into your diet or wellness regimen, especially if you have any current medical ailments or concerns.

USES OF FOXNUT

Seeds and Makhana Pop are the two ways that makhana is kept. It is primarily consumed in popped form in India, whereas it is used as food or medicine in China. The foxnut or gorgon nut's swollen kernel, known as makhana, is popped. The edible starchy kernel of the nuts is removed by popping them after being pulled from water.

The popped kernel, also known as Makhana in India, is the inflated nut kernel created by this technique. There are various uses for makhana pop. It is a delicious cuisine that is eaten as namkeen, kheer, curry, and other dishes. Traditional uses for makhana pop include usage in traditional medicine and as a high-protein, low-fat, sweet snack. A variety of delectable and filling sweet meals, including Makhana kheer, vermicelli, halwa, flour, puddings, and other sweet dishes, are made using popped makhana. Rather than using arrow root, Makhana flour is utilised instead. Delicious meals like sweet meat, soups, Makhana kheer, and other culinary preparations are also made using the flour. The non-cereal meal makhana is ingested by worshippers during their fasts. Thus, it accomplishes the religious goal. Makhana is revered as a holy and heavenly meal in all religions (PMFME - Foxnut: Makhana).

BENEFITS OF FOXNUT

Foxnuts offer several potential health benefits, including:

1. **Nutrient-Rich:** Essential elements including protein, fibre, vitamins (particularly B vitamins like folate and riboflavin), and minerals (such magnesium, potassium, and phosphorus) are all present in sufficient amounts in foxnuts. They have little fat and few calories.
2. **Antioxidant Properties**: Flavonoids and polyphenols, which help fight oxidative stress and lower the risk of chronic illnesses, are found in foxnuts. Cells can be shielded from free radical damage with the aid of antioxidants.
3. **Weight Management**: Foxnuts might be a healthy snack option for people trying to control their weight because of its low calorie and fat content. By encouraging feelings of fullness, the fibre level may also help people consume less calories overall.

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4. **Blood Sugar Control**: Due to their low glycemic index, foxnuts have a negligible effect on blood sugar levels. For individuals who already have diabetes or are at risk of acquiring it, this may be helpful.
5. **Heart Health**: Foxnuts include the minerals magnesium and potassium that are crucial for heart health. They can lower the risk of cardiovascular illnesses and assist control blood pressure.
6. **Digestive Health**: Dietary fibre, which supports digestion and helps avoid constipation, is included in foxnuts in good amounts. Additionally, fibre supports a balanced gut microbiota.
7. **Low in Allergens**: Foxnuts are a great snack for anyone with gluten sensitivity or allergies because they are naturally gluten-free and devoid of common allergens.
8. **Rich in Protein:** Foxnuts are a good plant-based protein source since they have a respectable quantity of protein. Vegans and vegetarians may especially benefit from this.
9. **Amino Acid Content:** The body's proteins are composed of necessary amino acids, which are found in these seeds.
10. **Versatile Ingredient:** There are several culinary uses for foxnuts. They frequently offer a distinctive crunch and flavour to both savoury and sweet meals when roasted, fried, or otherwise prepared.

OTHER PROPERTIES OF FOXNUT

1. In order for the tea made with Euryale ferox to be rich in Eurotium cristatum, which regulates immunity, clears heat, and energises the stomach, the golden flower generation idea was chosen.
2. The lipid profile and body weight were both normalised with the Euryale seed shell extract demonstrates that it is both anti-obesity and anti-hyperlipidemic.
3. Poria cocos, Dioscorea opposite, Nelumbo nucifera, and Euryale ferox are ingredients in a skin-whitening composition whose principal activity is to suppress the development of melanin and the tyrosinase enzyme. As a result, it possesses anti-ageing properties.
4. A medical liquor that contains 5-13% yeast, 25-38% Euryale ferox seed powder, 20-35% coix seed powder, and 20-40% Chinese medicine liquor is said to have anti-rheumatoid properties.
5. Black sesame, oats, brown rice, lotus seeds, lily, Euryale ferox, and walnut kernels have been combined to create a powder that promotes relaxation and sleep (Yaopeng et al., 2018).

CURRENT STATUS OF FOXNUT

Given its high nutritional value and numerous health benefits, foxnut demand has been expanding rapidly in recent years. India's contemporary makhana is adored all around the country. However, commercial Makhana production is only authorised in a few regions of West Bengal, Assam, Manipur, and North Bihar. Through a network, it is accessible to producers, processors, neighbourhood sellers, and other dealers in all of the nation's major cities commissions, online wholesalers, wholesalers, and both clients and merchants. It is estimated that farmers in producing regions get about 55% of the local market's final retail price. However, its share rapidly decreases when it comes to makhana. Pops are offered in faraway markets because of their high price. The second most significant factor in the final

price of Puff Macana is the retail margin, which accounts for around 19% of the retail price. The export potential has not yet been utilised for exports. India exports hardly 1-2 of her at the moment proportion of the whole production. Pop Makhana is exported to foreign nations in amounts of about 100 tonnes (Singh et al., 2020).

PHARMACOLOGICAL ACTIVITIES OF EURYALE FEROX SEEDS

Activator and adsorbent activity of shell

The shell of the Euryale ferox salisb. was once used as fuel (Liu et al., 2015). Nevertheless, a later study revealed that the Euyrale ferox shell has been utilised to create activated charcoal using a chemical process including phosphoric acid, potassium hydroxide, and zinc chloride as the activating agent (Kumar et al., 2015; Kumar et al., 2016). As a bio-adsorbent for chemical dyes, environmentally friendly activated charcoal made from Euryale ferox shell is employed. As a result, it is a useful source for cleaning up wetland water bodies that have been contaminated by coloured water effluents such basic fuschin and industrial waste (Kalita et al., 2017). The methanolic extract of Euryale ferox seeds and other plant parts showed significant antibacterial activity against nine clinically isolated bacterial strains (Staphylococus aureus, Escherichia coli, Pseudomonas aureoginosa, Citrobacter freundi, Shigella flexneri, Klebsiella pneumoniae, Proteus vulgaris, Salmonella typhi and Salmonella typhimurium), thereby providing a scientific basis for its use in urinary tract infections (Parray et al., 2010).

Foxnut as an antioxidant

The most significant action of makhana is the antioxidant activity of foxnut connected to medical conditions like proteinuria inhibition or diabetic nephropathy. When evaluated with DPPH, TEAC, and CAT (Catalase) SOD (Superoxide Dismutase) activity, foxnut (Euryale ferox Salisb) extracts show enhanced rates of radical scavenging behaviour, decreasing power, and are a powerful antioxidant because it reduces lipid peroxidation. Additionally, it improves cell viability, guards against H2O2-driven apoptosis, and enhances the functionality of certain antioxidant enzymes. Foxnut is a considerable source of natural antioxidants. the ability to be employed as dietary supplements, functional foods, and medications for hyperlipidemia and diabetes. They contain the flavonoid kaempferol. According to Tehseen et al. (2000) and Rahul et al. (2002), flavonoids have anti-inflammatory properties and have an anti-free radical action.

Foxnut as anti-aging

The most potent antioxidants that can eliminate free radical intermediates, stop chain reactions, and function as a fighting agent have been shown to be amino acids. The most important amino acids present in Foxnut are leucine, isoleucine, methionine, cysteine, arginine, and glutamine. Creatine precursors, which are required for healthy skin, nails, and hair, are the amino acids arginine and methionine. Creatine, which is made from arginine and methionine, is essential for having healthy skin. Additionally, creatine has a significant role to play in the body's cell metabolism. Creatine provides the cells with energy, enabling the development of connective tissue, cells, and skin metabolism. Cysteine-derived taurine lessens the impact of diabetes on cells. Arginine restores the flexibility of the arteries and veins and produces nitric oxide within the tissue, which improves blood flow. Other amino

acids, like iso-leucine and proline, aid in the body's development and growth (Jana et al., 2018).

Foxnut as an anti-diabetic

It is a severe medical condition caused by a wide range of metabolic illnesses, which are distinguished by a mix of hereditary and environmental variables that disrupt protein, starch, and fat metabolism. Regarding the financial viability of the health care system, it has a substantial impact on the health, quality of life, and longevity of patients. It is a significant medical condition caused by a wide range of metabolic problems including improper protein, lipid, and carbohydrate metabolism, which are brought on by a confluence of genetic and environmental variables. Regarding the financial viability of the health care system, it has a substantial impact on the health, quality of life, and longevity of patients. It is a significant medical condition caused by a wide range of factors. Streptozotocin (STZ), a toxin that produces free radicals, and autoimmune infiltration's pro-inflammatory circumstances are examples of reactive oxygen species (ROS). Furthermore, people with diabetes produce more oxygen-free radicals, which may have a significant role in the majority of diabetic sequelae, including diabetic nephropathy, neuropathy, and retinopathy (Tehseen et al., 2020).

USE OF FOXNUT AS TRADITIONAL MEDICINE

Due to its possible health advantages, it has been employed in conventional medical systems including Ayurveda and traditional Chinese medicine (TCM). Here are some traditional medical uses for foxnut and possible health advantages:

1. **Astringent Properties**: Foxnut is said to have astringent qualities that can aid in easing digestive problems and lowering diarrhoea. It is used to treat diseases linked to excessive mucus and diarrhoea in Ayurveda.
2. **Kidney Health**: According to TCM, foxnut has advantages for renal health. It is frequently used to support general renal function and to strengthen the kidneys.
3. **Anti-inflammatory**: Bioactive substances found in foxnut may have anti-inflammatory effects. It could be used to reduce inflammation and associated illnesses' symptoms.
4. **Rich in Nutrients**: The foxnut is a healthy dietary source. It is a beneficial dietary additive for general health because of its high protein, fibre, vitamin, and mineral content.
5. **Weight Management**: Foxnut, which has a high fibre content and little calories, is occasionally suggested as a snack for people trying to control their weight.
6. **Antioxidant Properties**: Antioxidants included in foxnut may aid in the body's efforts to combat damaging free radicals, potentially lowering the chance of developing chronic illnesses.

Despite the fact that foxnut has been used in traditional medicine for many years, there hasn't been much scientific study on its therapeutic benefits. More research is necessary to confirm this historical usage and fully comprehend both the possible advantages and hazards of foxnut use. It is best to speak with a healthcare provider before using foxnut or any other traditional treatment for medical reasons, especially if you have underlying medical disorders or are on medication, to make sure it is secure and suitable for your individual circumstance. Additionally, as part of a comprehensive strategy for health and wellbeing, food and lifestyle decisions should be taken into account.

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SUGGESTION FOR FUTURE RESEARCH

Due to its possible health advantages and commercial significance, foxnut (Euryale ferox), also known as Gorgon nut or Makhana, has attracted research interest. Here are some ideas for foxnut research in the future:

1. **Nutritional Composition and Health Benefits**: Study on the nutritional makeup of foxnut in further depth. Examine the macronutrients, micronutrients, and bioactive substances it contains. Investigate its possible health advantages, including its function in preventing diabetes, enhancing heart health, and assisting with weight control.
2. **Phytochemicals and Antioxidant Properties**: Study more about the foxnut's phytochemicals and their antioxidant abilities. Determine the precise substances that have antioxidant properties and evaluate their possible use in food, medication, or cosmetics.
3. **Cultivation and Agronomy**: Research ways to make foxnut farming methods better. Investigate environmentally friendly agricultural methods, ideal growing environments, and genetic advancement to boost production and quality.
4. **Environmental Impact and Sustainability**: Investigate how growing and collecting foxnuts affects the environment. Analyse its sustainability and look at ways to lessen its impact on the environment.
5. **Post-Harvest Processing and Value Addition**: Create and improve post-harvest processing methods to increase the shelf life and quality of foxnuts. Look into value-added items like foxnut-based snacks, drinks, or flour.
6. **Functional Food and Nutraceutical Development**: Investigate the use of foxnuts in the creation of functional food items or nutraceuticals. Look into their possible use as dietary supplements or in the treatment of particular medical disorders.
7. **Allergenicity and Safety**: To make sure eating of foxnuts is risk-free for various populations, including those with food allergies, undertake safety evaluations and examine the allergenicity of foxnuts.
8. **Market and Economic Analysis**: Conduct market research to comprehend price patterns, export prospects, and global demand for foxnuts. Examine the advisability of foxnut production and processing economically.
9. **Culinary Applications and Recipes:** Encourage the study of foxnuts' uses in food. Create creative cooking methods and recipes to encourage their use in other cuisines.
10. **Cultural and Traditional Uses:** Examine the various cultural and historical applications of foxnuts. Record local knowledge and customs concerning the use and consumption of foxnuts.
11. **Genetic Diversity and Conservation**: Establish conservation methods to safeguard the foxnut populations' genetic resources by looking into their genetic diversity. Investigate biofortification methods to boost foxnuts' nutritional value and make them a more profitable crop for addressing nutrient deficits in some areas.
12. **Pharmacological Research:** Examine the usage of foxnuts in traditional medical systems and look at any potential therapeutic benefits they may have.
13. **Toxicology and Contaminant Analysis**: Establish safety standards for ingestion by conducting toxicological tests to detect probable pollutants or naturally occurring poisons in foxnuts.

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14. Consumer Acceptance and Preferences: Through sensory investigation and consumer surveys, determine customer preferences, perceptions, and acceptability of foxnut-based goods.

ECONOMIC AND HEALTH POTENTIAL OF A SUPERFOOD IN GLOBAL MARKETS

Makhana, is emerging as a significant player in the realms of commerce and financial management due to its nutritional and therapeutic properties. The economic importance of foxnut cultivation is particularly pronounced in regions like India and China, where it is not only a dietary staple but also a lucrative cash crop. The commercial potential of foxnuts lies in their diverse applications in the food industry, ranging from snacks to dietary supplements, which cater to the growing demand for healthy, nutrient-dense food products. Financially, the cultivation and processing of foxnuts present a viable investment opportunity for both small-scale farmers and large agribusinesses. The crop's high yield and relatively low input costs make it a profitable venture, especially in regions with suitable agro-climatic conditions. Moreover, the global trend towards healthy eating and the increasing awareness of superfoods have positioned foxnuts favorably in international markets, with exports gradually rising. The cultivation of foxnuts, while promising, also faces challenges such as the need for improved scientific knowledge and better financial facilities to support farmers. Addressing these constraints through policy interventions and investment in research can enhance productivity and market access, further bolstering the financial prospects of foxnut cultivation. Additionally, the development of value-added products, such as roasted foxnuts, foxnut flour, and foxnut-based snacks, could significantly increase market value and provide additional revenue streams. As the foxnut industry continues to evolve, there is a substantial opportunity for stakeholders to innovate and expand within this niche market, leveraging its economic and health benefits to drive sustainable growth. The integration of modern agricultural practices, financial support, and marketing strategies will be crucial in realizing the full potential of foxnuts as a commercially viable and nutritionally valuable crop.

CONCLUSION

Some crops in this vast cosmos have been overlooked due to agronomic, cultural, genetic, financial, and societal factors. More than 7,000 plant species are farmed or harvested from the forest, but only 150 crops are sold on a significant worldwide scale, according to ethno-botanical research. This analysis focuses on a plant species that will require more attention in the near future since it can significantly benefit human health in general. Because of a lack of information and study, the usage of this nourishing superfood is restricted. Because it cannot compete with important commodity crops that command significant economic interests, foxnut has not received enough attention from policymakers. This fruit is a blessing that has only been used locally and is undiscovered. Food for the next generations arriving on a planet that is already ill can be saved with timely study and investment.

REFERENCES

1. Goren-Inbar, N., Melamed, Y., Zohar, I., Akhilesh, K., & Pappu, S. (2014). Beneath still waters – Multistage aquatic exploitation of Euryale ferox (Salisb.) during the Acheulian. *Internet Archaeology*, *37*. https://doi.org/10.11141/ia.37.1.

2. Sundaram, P. K., Sarkar, B., & Mondal, S. (2014). Design and performance evaluation of pedal operated Makhana (Euryale ferox Salisb) seed grader. *Research Journal of Agricultural Sciences*, *5*(3), 428–431.

3. Kumar, Lokender, Gupta, V.K., Jha, B.K., Singh, I.S., Bhatt, B.P., Singh A.K. (2011). Status of Makhana (Euryale ferox Salisb.) *Cultivation in India,* ICAR Research Complex for Eastern Region, Patna, Research Centre for Makhana, Darbhnga, Bihar-846005, India.

4. Korrapati, D., Jeyakumar, S. M., & Katragadda, S. (2018). Development of low glycemic index foods and their glucose response in young healthy non-diabetic subjects. *Preventive Nutrition and Food Science*, *23*(3), 181–188. https://doi.org/10.3746/pnf.2018.23.3.181.

5. Livesey, G., Taylor, R., Hulshof, T., & Howlett, J. (2008). Glycemic response and health - A systematic review and meta-analysis: Relations between dietary glycemic properties and health outcomes. *The American Journal of Clinical Nutrition*, *87*(1), 258S–268S. https://doi.org/10.1093/ajcn/87.1.258s.

6. Lawson, M., Pacaud, D., Lawrence, S., Daneman, D., & Dean, H. (2005). 2003 Canadian clinical practice guidelines for the management of diabetes in children and adolescents Margaret. *Pediatrics and Child Health*, *10*(Suppl A), 5A–16A. https://doi.org/10.1016/j.cnur.2017.07.008.

7. Lee, S. E., Ju, E. M., & Kim, J. H. (2002). Antioxidant activity of extracts from Euryale ferox seed. *Experimental and Molecular Medicine*, *34*(2), 100–106. https://doi.org/10.1038/emm.2002.15.

8. Chang, S. K., Alasalvar, C., Bolling, B. W., & Shahidi, F. (2016). Nuts and their co-products: The impact of processing (roasting) on phenolics, bioavailability, and health benefits - A comprehensive review. *Journal of Functional Foods*, *26*, 88–122. https://doi.org/10.1016/j.jff.2016.06.029.

9. Lin, D., Xiao, M., Zhao, J., Li, Z., Xing, B., Li, X., … Chen, S. (2016). An overview of plant phenolic compounds and their importance in human nutrition and Management of Type 2 diabetes. *Molecules*, *21*(10), 1–19. https://doi.org/10.3390/molecules21101374.

10. Shahidi, F., & Naczk, M. (2003). *Phenolics in food and nutraceuticals*, (2nd ed.,). CRC Press. https://doi.org/10.1201/9780203508732.

11. Chang, S. K., Alasalvar, C., Bolling, B. W., & Shahidi, F. (2016). Nuts and their co-products: The impact of processing (roasting) on phenolics, bioavailability, and health benefits - A comprehensive review. *Journal of Functional Foods*, *26*, 88–122. https://doi.org/10.1016/j.jff.2016.06.029.

12. Kumar, L., Singh, A. K., & Bhatt, B. P. (2016). Nutritional status of recently developed Makhana (Gorgon Nut) variety "Swarna Vaidehi". *Journal of AgriSearch*, *3*(4). https://doi.org/10.21921/jas.v3i4.6701.

13. Bana M and Gupta RK. "Formulation, nutritional and phytochemical analysis of ready to mix infant Food using Gorgon Nut, Samak Rice and Banana powder". Journal of Pharmacognosy and Phytochemistry 4.4 (2015): 76.

14. Khatatkar A., et al. "Drudery involved in traditional way of harvesting makhana seeds (Euryle ferox salisb) from ponds". Bhartiya Krishi Anusandhan Patrika 29.1 (2014): 25-30. 4.

15. Kumar L, Singh AK, Bhatt BP. Nutritional status of recently developed Makhana (Gorgon Nut) variety "Swarna Vaidehi." Journal of AgriSearch. 2016, 3(4). https://doi.org/10.21921/jas.v3i4.6701.

16. Jha V, Kargupta AN, Dutta RN, Jha UN, Mishra RK, Saraswati KC. Utilization and Conservation of Euryale ferox Salisbury in Mithilla, (North Bihar) India. Aquatic Botany 1991;39:295-314. 6.

17. Mandal RN, Saha GS, Sarangi N. Harvest and processing of Makhana (Euryale ferox Salisb.)-an unique assemblage of traditional knowledge. Indian J. Trad. Know. 2010;9:684–688.

18. Goren-Inbar N, Melamed Y, Zohar I, Akhilesh K, Pappu S. Beneath Still Waters - Multistage Aquatic Exploitation of Euryale ferox (Salisb.) during the Acheulian. 'Human Exploitation of Aquatic Landscapes' special issue (ed. Ricardo Fernandes and John Meadows), Internet Archaeology. 2014; doi:10.11141/ ia.37.1.

19. Francis A., et al. "Major Health Benefits and Functional and Sensory Properties of Cookies Prepared from All Purpose Flour Supplemented with Fox Nut". International Journal of Research and Engineering 5.5 (2018): 441-421.

20. Shankar M., et al. "A review on gorgon nut". International Journal of Pharmaceutical and Biological Archives 1.2 (2010): 101- 107.

21. Dr. Vipul Vikram and Dr. Shweta Mishra, "A review on Euryale Ferox: Daily dietary regime for Covid -19 patients." International Journal of Applied Research 2021; SP6: 29-34. DOI: https://doi.org/10.22271/allresearch.2021.v7.i6Sa.8607.

22. Kumar Lokendra, Gupta V.K., Jha B.K., Singh I.S., Bhatt B.P., Singh A.K., 2011b, Status of Makhana (Euryale ferox Salisb.) Cultivation in India, ICAR Research Complex for Eastern Region, Patna, Research Centre for Makhana, Darbhnga, Bihar-846005, India.

23. Kumar Ujjwal, Kumar Abhay, Singh K. M., 2011, Constraints and Drudgery in Makhana Cultivation, ICAR Research Complex for Eastern Region, Patna, Bihar-800 014, India.

24. Kumar Lokendra, Gupta V. K., Singh I. S., Bhatt B. P., Kumar Devendra, 2011, Sequential Double Cropping System of Makhana (Euryale Ferox Salisb.) Cultivation In Agricultural Fields Of North Bihar, India, ICAR- Research Complex For Eastern Region, Research Centre For Makhana, Darbhanga, Bihar-846 005, India.

25. Khadatkar Abhijit, Gite L.P., Gupta V.K., 2015, An Improved System to Reduce Drudgery of Workers in Harvesting of Makhana Seeds from Ponds, Central Institute of Agricultural Engineering, Bhopal-462038, India.

26. Reading Material for Foxnut (Makhana) Under PMFME Scheme National Institute of Food Technology Entrepreneurship and Management.

27. Roopal Mittal, Shailesh Sharma, Amit Mittal "A Critical Review on Ethnobotanical and Pharmacological Aspects of Euryale Ferox Salisb". DOI: 10.5530/pj.2020.12.199. http://www.phcogj.com/v12/i6.

28. Yaopeng W, inventor; Yaopeng W, assignee. Nerve soothing and sleep assisting powder. Chinese Patent CN109527352. 2018, 16.

29. Singh DK, Kumar U, Kumar A, Singh IS. Strategies for Export Promotion of Popped Makhana in India. September, 2020, 30-33.

30. Liu H, Huang X. Introduction of the industrialization development and cultivation and processing technology of Euryale ferox salisb. J. Chang Jiang Vegetables 2015;32(16):29–30.

31. Kalita S, Pathak M, Devi G et al. Utilization of Euryale ferox Salisbury seed shell for removal of basic fuschin dye from water: equilibrium and kinetics investigation. RSC advances 2017;7:27248-27259.

32. Parray JA, Kamilli AN, Qadri R et al. Evaluation of Antibacterial Activity of Euryale ferox Salisb., A Threatened Aquatic Plant of Kashmir Himalaya. Hussaini AM (Ed). Medicinal plants of Himalayas: advances and insights, global science books, UK, 2010;80-83.

33. Kumar A, Jena HM. High surface area microporous activated carbons prepared from fox nut (Euryale ferox) shell by zinc chloride activation. Appl. Surf. Sci. 2015;356:753-761.

34. Kumar A, Jena HM. Preparation and characterization of high surface area activated carbon from fox nut (Euryale ferox) shell by chemical activation with H3 PO4 , results phys. 2016;6:651-658.

35. Zang H, Yangai L, Wu X et al. Kinetics and equilibrium studies of the adsorption of methylene blue on Euryale ferox shell-based activated carbon. Micro. Nano. Lett. 2018;13:552-557.

36. Tehseen S, Sarfraz F, Ateeq N, Ashfaq F, Yasmin I, Mehmood T. Acta Scientific Agriculture (ISSN: 2581- 365X) Foxnut (Euryale ferox Salisb.): A Health Promising Fruit. Acta Scientific Agriculture. 2020;4(12):68–72.

37. Jana BR and M Idris. "Anti-aging Amino Acids in Euryle ferox (Salisb.): A Review". Advances in Plants and Agriculture Research 8.1 (2018): 39-43.