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A review on: *Euryale ferox* (Fox nut)

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Abstract
Euryale ferox is an aquatic plant that belongs to the *Nymphaeaceae* family. It is native to Eastern and Southern Asia. It is also called as Makhana, Fox nut, Prickly water lily and Gorgon nut. The nutritional studies carried out to determine the constituents of *Euryale ferox* state that it consists of carbohydrates, proteins, moisture, minerals, fat, phosphorous, calcium and iron in addition to a lesser amount of ascorbic acid, phenol and sugar. The production of *Euryale ferox* is done in various states of India such as Bihar, West Bengal, Assam, Manipur, Tripura, Madhya Pradesh, Rajasthan, Eastern Odisha and Eastern Uttar Pradesh. In India, the 90% cultivation of this crop is done by Bihar. According to National Research Centre for Makhana, Darbhanga, there is 15,000 ha of fox nut cultivation in India. It is used as a nutraceutical/functional food. Makhana flour is used to prepare Makhana Chapatti, Makhana Kalakand, Makhana Barfi and Makhana Cabbage Pakora.

Keywords: *Euryale ferox*, *Nymphaeaceae*, constituents, makhana, fox nut, gorgon nut

Introduction
Euryale ferox is an aquatic plant that belongs to the *Nymphaeaceae* family. It is native to Eastern and Southern Asia [1]. It is also called as Makhana, Fox nut, Prickly water lily and Gorgon nut [3]. In various languages, it has different names: Padambijabh-Sanskrit, Makhana-Gujarati, Mallunipdananu-Telgu, Makane-Marathi, Jaivar-Punjabi and Tagarai-Tamil [2].

Composition
The nutritional studies carried out to determine the constituents of *Euryale ferox* state that it consists of carbohydrates, proteins, moisture, minerals, fat, phosphorous, calcium and iron in addition to a lesser amount of ascorbic acid, phenol and sugar. These constituents are present in different amounts in which carbohydrates are in maximum quantity [5, 6]. The amount of main constituents of *Euryale ferox* are mentioned in Table 1.

Table 1: Main Constituents of *Euryale ferox*

Constituents	Amount (%)
Carbohydrates	76.9
Proteins	9.7
Moisture	12.8
Minerals	0.5
Fat	0.1
Phosphorous	0.9
Calcium	0.02
Iron	0.004

Cultivation
Euryale ferox is broadly distributed in tropical and subtropical regions in humid to subhumid environments and is basically developed starch - protein source [4, 9, 11, 12]. It is generally grown in shallow, sustained water bodies, such as ponds, lakes, depressions, marshes and ditches, up to 4-6 feet deep. The standard range for the growth & development is a temperature of 20-35 ℃ and a relative humidity of 50-90% [5]. The production of *Euryale ferox* is done in various states of India such as Bihar, West Bengal, Assam, Manipur, Tripura, Madhya Pradesh, Rajasthan, Eastern Odisha and Eastern Uttar Pradesh [3]. In India, the 90% cultivation of this crop is done by Bihar. The maximum amount of production in Bihar is gained from Madhubani, Darbhanga, Sitamarhi, Saharsa, Katihar, Purnia, Supaul, Kishanganj and Araria districts. According to National Research Centre for Makhana, Darbhanga, there is 15,000 ha of fox nut cultivation in India [5]. In the world, North Bihar secures the first position in the fox nut cultivation [4].

Ayurvedic Importance

The seeds of *Euryale ferox* are used in the formulation of ayurvedic preparations [11]. One of the ayurvedic preparations is Paushtik Churana. Fox nut calms Vata and Pitta doshas. However, it may increase Kapha dosha. It empowers the body and reduces chronic fatigue. It nourishes the uterus, testicles, heart and ovaries. In addition, its Pitta relieving properties also reduce the burning sensation associated with all ailments. For normal adult the recommended dose of its powder is 10-20 grams per day [2]. The ayurvedic properties of this crop is mentioned in Table 2.

Table 2: Ayurvedic Properties of Euryale ferox

Rasa (Taste)	Madhura
Guna (Quality)	Guru, Snigh or Sneha
Virya (Energy)	Sheeta
Vipaka (Post Digestive Effect)	Madhura
Dosha Karma	Pacifies Vata & Pitta Doshas
Organ Effect	Heart, Testes, Uterus, Ovaries
Dhatu (Tissue) Effect	Rasa, Shukra, Mamsa

Therapeutic Importance

Makhana kernel stops diarrhoea and strengthens the kidneys. It is the main component of the Chinese medicinal formula "Chien-Shih", "Su-Shin" (a necessary tonic for the growth of children). It is an excellent immune system stimulant. It also regulates blood pressure. It also relieves lower back pain and knees pain. It is used in the treatment of early aging & infertility [10]. This crop has antioxidant properties [7]. It is used to regulate blood glucose levels [8, 20]. It stimulates humoral immunity [6, 14]. It is a nutritious option to control weight. It has anti-inflammatory and anti-diabetic properties [5].

Nutritional Value

Its dietary fibres keep the alimentary canal in proper shape. It consists of magnesium and potassium which assist in blood pressure regulation [5]. It is used as a nutraceutical/functional food [8].

Use in Indian food/dishes

In the making of vegetable dishes & curries the fried fox nut seeds are used [6, 16]. Its fruit is used in the paste form and in the salad also [6, 15]. Fox nut powder is used to prepare gluten-free biscuits for the people who avoid gluten in their diet for health purposes [6, 17]. Protein and mineral-rich Pua is prepared by fox nut powder [6, 18]. Bread's texture is enhanced and strengthened using puffed makhana [6, 19]. It is used to prepare healthy food preparations for children [6, 13]. Makhana flour is used to prepare Makhana Chapatti, Makhana Kalakand, Makhana Barfi and Makhana Cabbage Pakora [9]. Puffed Fox nut seeds are shown in Figure 1.

Fig 1: Puffed Fox nut seeds

Conclusion

In the entire world, India especially Bihar is leading in the cultivation of *Euryale ferox* (Makhana, Fox nut, Prickly water lily). In Bihar most of the people are dependent on the production of this crop for their livelihood. This plant is being used since the Ayurvedic times as it possesses various ayurvedic properties. It also possesses anti-diabetic, antioxidant, anti-inflammatory properties and is used to treat some heart and blood related problems. In Indian society, it is used to prepare various dishes such as Makhana Chapatti, Makhana Kalakand, Makhana Barfi, Makhana Pakora, Curries and many more food items.

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