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Fox Nut A Booster For Improving The Health Of Athletes

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Article Details

ABSTRACT

Keywords: Fox nut, athletes, superfood, Performance-enhancing, protein rich, muscle recovery, energy source.

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Fox nuts have been used in history of subcontinent as a medicinal food due to its vast health benefits. In the competitive world of sports, maintaining optimal health and performance is of utmost importance for athletes. This food has shown many health benefits such as anti-depressant, anti-aging, good for bones, anti-diabetic and good for heart related problems. The presence of phytochemicals and bioactive compounds in fox nut seeds contributes to its potential health benefits for athletes. These benefits include anti-inflammatory properties, which can help alleviate exercise-induced muscle soreness and promote faster recovery after intense training sessions or competitions. The antioxidant content in fox nut also aids in reducing oxidative stress caused by rigorous physical activity, thus minimizing cellular damage and optimizing athletic performance. It is also considered to have low glycemic index which helps it to become a helpful snack for the diabetic people. It plays a beneficial role in lowering the blood glucose levels of diabetic patients as it has a low glycemic index and are full of fibers. Some of its extracts also help in improving bone health status and help treat osteoporosis patients and due to its high protein content, they help athletes to perform better and to gain more muscle and fulfill their protein requirements. This reviewed summarized that fox nuts have been proved to be helpful for athletes and normal population, as they have many medicinal benefits and help to improve the performance to athletes.

INTRODUCTION

Fox nut (*Euryale FEROX*) also known as Phool makhana, is a nutritious and versatile crop. It is primarily grown for its edible seeds, which are consumed in various forms such as roasted, popped, and ground into flour. It is a prime cash crop from the aquatic region Euryale Ferox, which is from the family Nymphaeaceae. It is also commonly called names such as prickly water lily fox nut and in the Indian region as Phool Makhana. Due to its black outer seed coat appearance, scientists have also mentioned the seeds as Black Diamonds or Black Gems of Wetlands. The reason of its popularity is such that this plant has edible seeds which are refined into white puffed nuts which are abundant with nutrition content. According to the Essential Amino Acid Index, it counted for 89-93%, making it a top dry fruit product. This source of essential amino acids is mandatory for a diet such that they are not already synthesized in the human being (Kumar *at el.*, 2015).

Fox nut is a popular ingredient in Indian and Pakistani cuisine and is often used in sweet and savory dishes. However, what many people don't know is that fox nut is a powerful booster for athletes. It is loaded with nutrients that are essential for maintaining good health and providing the body with the necessary energy to perform at optimal levels. This review paper highlighted the therapeutic potential of fox nut for athlete performance. (Singh *at el.*, 2017).

First and foremost, fox nut is a great source of complex carbohydrates. Athletes require a lot of energy to fuel their workouts and competitions and carbohydrates are a primary source of energy for the body. Fox nut is an excellent source of complex carbohydrates are slowly digested by the body, providing a steady supply of energy over a longer period of time. fox nut emerges as a promising superfood that can enhance the health and performance of athletes. Its unique nutritional composition, including proteins, carbohydrates, dietary fibers, vitamins, and antioxidants, provides a range of benefits such as improved muscle recovery, reduced inflammation, and enhanced energy levels. Incorporating fox nut into athletes' diets may prove to be a valuable strategy for optimizing their overall well-being and maximizing their athletic potential. This makes it an ideal food for athletes who require sustained energy throughout their training sessions and competition (Liaquat *at el.*, 2022).

Fox nut is also rich in protein, which is essential for building and repairing muscle tissue. When athletes engage in intense physical activity, they place a lot of stress on their muscles, and protein is needed to repair the damage. Fox nut contains a high amount of plant-based protein, making it an excellent food for athletes who follow a vegetarian or vegan diet. (Liaquat *at el.*, 2022).

Life cycle of fox nut and production in India;

India is the largest producer of fox nuts, accounting for over 80% of the global production. The states of Bihar, Uttar Pradesh, and West Bengal are the major fox nut-producing regions in India. Fox nut cultivation in India is largely done by small and marginal farmers. The crop is grown in low-lying areas and flood-prone regions, where other crops are not suitable. Fox nut cultivation is a low-input and low-maintenance crop, making it an attractive option for small farmers (kumar *at el.* 2016).

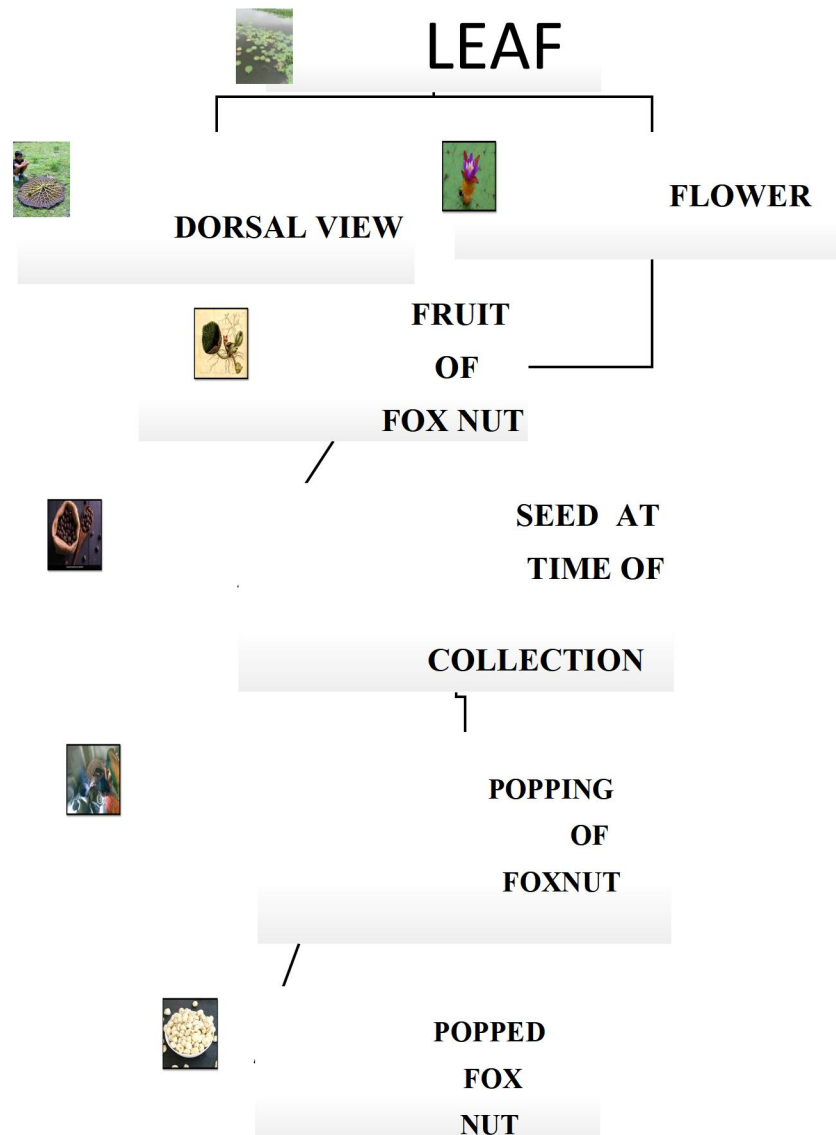
The demand for fox nuts in India has been increasing in recent years due to the growing popularity of the crop as a healthy snack. Fox nuts are rich in protein, fiber, and other essential nutrients, making them a popular choice among health-conscious consumers. The processed fox nut products like fox nut flour, popped fox nuts, and fox nut snacks have also gained popularity in India and abroad (fig: 1). The Indian government has been promoting fox nut cultivation through various schemes and initiatives to support small farmers and boost rural income. Bihar is the largest producer of fox nuts in India, accounting for over 60% of the country's production.

Fox nut cultivation in Bihar is largely concentrated in the districts of Darbhanga, Madhubani, Samastipur, and Supaul (Gupta *et al.*, 2015).

Figure 1: Life cycle of fox nut

Process of cultivation and Climate morphology:

The climate and soil conditions in Bihar are favorable for fox nut cultivation. The crop is grown in low-lying areas and flood-prone regions, where other crops are not suitable. Fox nut cultivation is a low-input and low-maintenance crop, making it an attractive option for small farmers in Bihar. About 5 lac families are involved in fox nut cultivation. 7500 to 10,000 tons of



makhana is sold each year. Fox nut cultivation is suitable for areas with a tropical climate, with temperatures ranging from 25 to 35 degrees Celsius. The crop requires a warm and humid climate with a good amount of rainfall, but it can also tolerate drought conditions to some extent. Fox nut is mainly grown in low-lying areas and flood-prone regions, where the water table is high. The crop requires a lot of water, and the water level in the soil should be

maintained at a depth of 30-50 cm during the growing season. The ideal pH range for the soil is 6.5-7.5. The crop performs best at lower altitudes, where the climate is warmer and more humid (Gupta *et al.*, 2015).

The first step in fox nut cultivation is land preparation. The land is plowed and harrowed to make it ready for planting. The soil should be well-drained and fertile to support the growth of the crop. The next step is seed selection (**fig 2**). High-quality seeds should be chosen to ensure a good yield. The seeds should be free from diseases and pests and should be of the right variety. Fox nut is planted during the monsoon season, between June and July. The seeds are sown directly in the field at a depth of about 2-3 inches. The distance between the rows should be about 3 feet, and the distance between the plants should be about 1-2 feet. Irrigation is essential for the proper growth of fox nut plants. As the crop requires regular watering, especially during the initial stages of growth. The water level in the field should be maintained at about 1-2 inches during the first few weeks of growth. Fertilizers are used to improve the soil fertility and provide the necessary nutrients to the crop. Organic fertilizers like cow dung and many other are ideal for fox nut cultivation. As weed control is essential for the proper growth of the crop. Weeds can compete with the fox nut plants for nutrients and water. The field should be weeded regularly to ensure that the crop grows properly. Fox nut plants start flowering after about 45-50 days of planting. The flowers give way to pods that contain the fox nuts. The pods are harvested when they turn brown and start to crack. The pods are then dried in the sun and the fox nuts are extracted. After harvesting the pods, the fox nuts are extracted from the pods. The fox nuts are then washed thoroughly to remove any dirt or debris. Nuts can be dried in the sun or by using a dryer. The dried fox nuts are then stored in a cool, dry place to prevent moisture buildup. Once the fox nuts are dried, they can be processed into different products like popped fox nuts, fox nut flour, and fox nut snacks. The fox nuts can be roasted, popped, or fried to create different products. After processing, the products are packaged and labeled for sale (**fig 2**). Fox nut is in high demand in the market due to its many health benefits. The fox nut products can be sold in local markets or exported to other countries. Marketing and sales strategies should be developed to ensure that the products reach the intended market (Sharma *et al.*, 2023).

Flow chart

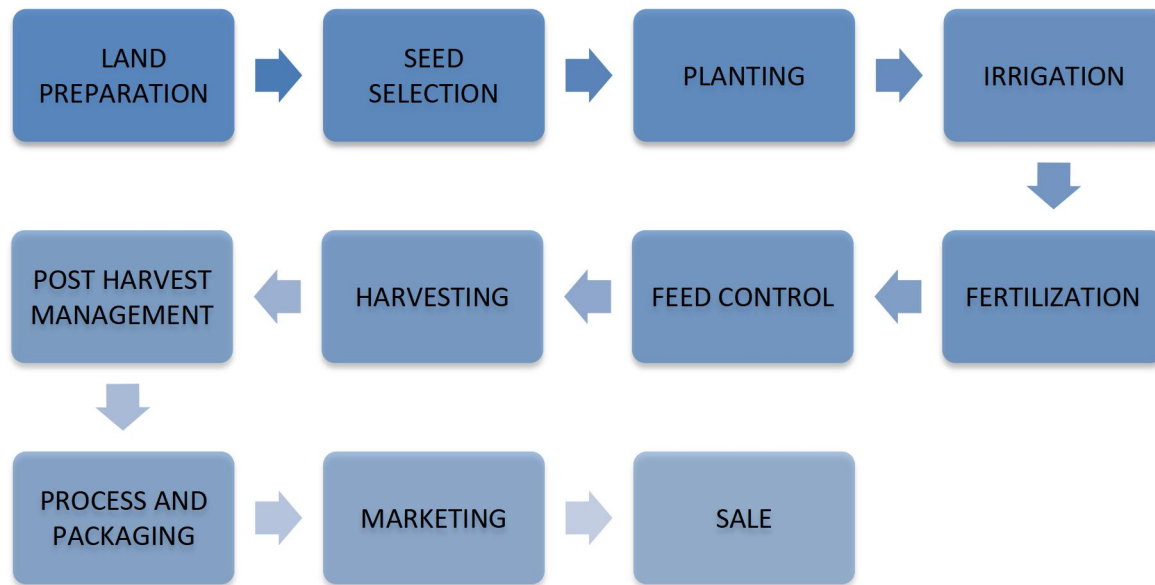


Figure 2: fox nut cultivation and processing

Importance of Optimal Health for Athletes:

In the competitive world of sports, maintaining optimal health and performance is of utmost importance for athletes. As an emerging superfood, fox nut (*Euryale ferox*) has gained significant attention due to its potential to enhance athletes' health and well-being. This reviewed explores the nutritional composition and health benefits of fox nut, along with its specific effects on athletic performance (**fig 3**). Fox nut has been considered a medicinal food which has been known for its various health benefits like muscle growth anti-aging, anti-hyperlipidemia, anti-diabetic properties (Kapoor *et al.* 2022).

Fox nuts, being a low GI food is perfect for Non-Communicable Diseases. Its low GI is due to its complex carbohydrate content, and makes them a nutritional snack for patients with NCDs. Fox nut is ranked third after some fruits and vegetables for having the most abundant phytochemicals. They are important in preventing CVD disorders, high blood pressure, cancer & type 2 diabetes. Moreover, these nuts have higher concentration of calcium, potassium, sodium, magnesium, iron and zinc making them a rich source of nutrition (Singh *et al.*, 2017).

The Significance of Muscle Repair for Athletes

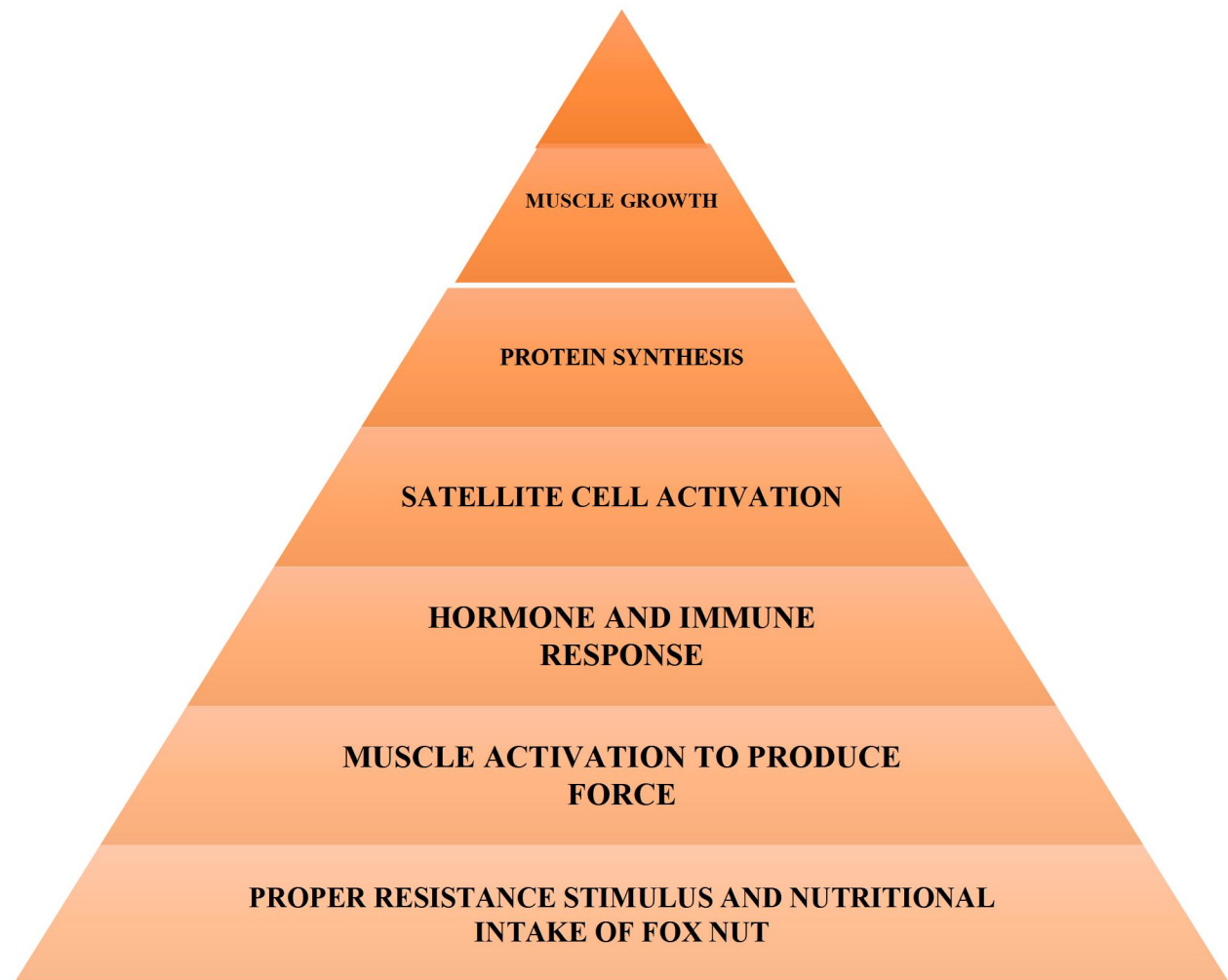


Figure 3: Hypertrophy in athletes' body

Nutritional Composition of fox nuts:

Micronutrients: Proteins and Carbohydrates for Energy

Fox nut are a good source of energy and are rich in n nutrients and several bioactive compounds that offer a wide range of health benefits. They help to treat many health problems like cardio problems, diabetes, osteoporosis, or other bone problems. Fox nuts are high in carbohydrates, and most of the carbohydrate content comes from starch. They are a good source of protein and contain all essential amino acids. These are low in fat, and the fat content is mostly unsaturated fat. They are an excellent source of dietary fiber, which can help support digestive health. Fox nut is enriched with nutrients seeds. They are enriched in protein, carbohydrates and fats. (Banger *at el*, 2022).

This food is considered as highly nutritious food based on its amino acid index. This food makes an amazing reserve for amino acid in body because our body don't produce them naturally. Fox nut is a unique aquatic plant known for its edible seeds, which are rich in essential nutrients such as proteins, carbohydrates, dietary fibers, and various minerals. Fox is included in top most nutritional food. Food because it has a good amount of nutrition value. The main benefit include that it can serves as a good protein source for vegetarians. Its saggy

& bland taste makes it unsuitable for human consumption. However, seasoning or roasting can enhance by hindering the undesirable flavor (Alasalvar *et al.*, 2020).

Effect of low glycemic index foods in athletes;

Fox nuts has numerous health benefits contain different bio-actives compounds, minerals and vitamins. It plays its major role to deal with in different diseases like diabetes, cardiovascular diseases, and diseases of liver, its recognized as a superfood with ample amount of nutraceutical benefits due to its medical and nutritional properties. It is considered as a nutraceutical nut which play an important role for food industries (Liaquat *et al.*, 2022).

Fox nuts also called makhana its one of the qualities it lowers the blood glucose level glycemic index. we can lower the blood glucose level more by combine it with guar gum and gluten. Starch retro-gradation also occur but it's a slow process like re-crystallization and more. Amylose, amyl-pectin, differently under goes retro gradation in nuts, can also be gelatinized by giving the approximate temperature of 60C, 70C and 80C with at least 15 to 20 minutes the process, proceed with drying at the temperature of seventy and eighty degree to crushed in the form pf powder ideal temperature is about 70C and if we treated the fox nut with 4 C its take one whole day (Gupta *et al.* 2021).

Micronutrients: Vitamins and Minerals Supporting Athletes' Health:

Fox nuts are a rich source of several micronutrients such as magnesium, potassium, phosphorus, iron, and zinc, these seeds are good sources of flavonoids. They contain flavonoids and polyphenols, antioxidants that help protect against oxidative stress. The seeds are also abundant in vitamins, particularly thiamine, riboflavin, and niacin, as well as antioxidants like flavonoids and phenolic compounds. These nutritional components play a crucial role in supporting athletes' overall health, boosting energy levels, and aiding in muscle recovery. Several chronic diseases like cardiovascular disorders, type 2 diabetes, cancer or high blood pressure. Fox nuts have higher concentration of micronutrients like Fe and Zn. They have also higher concentration of macronutrients like Ca, P, K, Na. As compared to other nuts, fox nut contains less fat content which makes it's a good food choice (Alasalvar *et al.*, 2020).

Besides its nutrition values, fox nut also a great range of medicinal properties. Some essential oils are present in the composition of fox nuts, which is obtained by hydrodistillation of green-yellow-colored oils. These essential oils are included butylated hydroxytoluene, palmitic acid, linoleic acid, α -tocopherol, hexanoic acid, π -tocopherol, 4-ethyl2-methoxyphenyl, 5-methyl-2-furan carbo. Butyl hydroxytoluene is also helpful due to its antioxidant properties and use in food additives and used in different things like cosmetics, pharmaceuticals, rubber, and embalming fluid as a good source of vitamins (E, C). Overall, fox nuts are a highly nutritious food that is low in calories, making them an excellent snack option for people who are looking to maintain a healthy weight while still getting all the essential nutrients their body needs. However, it's worth noting that the composition can vary depending on factors such as the region where the seeds are harvested and the processing methods used (Bhat *et al.*, 2023).

1.6 Health Benefits of fox nuts in athletes:

1.6.1 The Role of Antioxidant properties for athletes:

Fox nuts have been observed to have antioxidant properties and have shown quite remarkable effects in lowering oxidative stress in the young football athletes. Two tocopherols' polymers have been found in fox nuts and have been known to show antioxidant properties in human subjects. the presence of phytochemicals and bioactive compounds in fox nut seeds contributes to its potential health benefits for athletes. These benefits include anti-inflammatory properties,

which can help alleviate exercise-induced muscle soreness and promote faster recovery after intense training sessions or competitions. This, in turn, can lead to enhanced athletic performance (Biwas *et al*, 2016).

With increase in health consciousness among the population fox nut can be used as a healthy alternative to the all-purpose flour. Fox nut flour was used to make various flour related good and seen to have higher protein content and antioxidant properties which would be healthy for the population and a good source of high protein foods. Fox nuts is a great alternative as it has beneficial properties for spleen and kidney. Various foods like burfi were made from fox nut which were high in calories and low in sugar which is good for a healthy person. It is helpful in treatment of anemia, constipation, limbs pain specifically in athletes. It is also used to treat wounds, treating kidney problems. It is helpful in treatment of cancer because of its anticancer properties (Jana *et al*. 2019).

The antioxidant content in fox nut also aids in reducing oxidative stress caused by rigorous physical activity, thus minimizing cellular damage and optimizing athletic performance. Fox nut's rich antioxidant content plays a vital role in neutralizing free radicals, which are produced during intense exercise and can lead to cellular damage and oxidative stress. By mitigating these harmful effects, fox nut helps athletes preserve muscle integrity and supports long-term health. The extracts of fox nuts only contribute to the therapeutically effect in the subjects but no enhancements in their performance was observed (Kapoor *et al*, 2022).

Antidepressant and anti-aging properties of fox nuts:

Fox nuts have been known to show antidepressant properties. Lycoxanthin, dodecanoic acid and vitamin E, and acetate have been found in fox nuts that have shown antidepressant properties. Vitamin E has also been known to show neuroprotective properties and these properties can be linked to the athletes to reduce depression and anxiety among the athletes before a game and hence can prove to be beneficial in their mental health as well as give a boost to their performance in the sport (Kapoor *et al*, 2022).

As the population is becoming more and more aware on healthy eating behavior, they have turned to high protein foods rather than high carbohydrate containing food groups and fox nuts have been shown to contain major amino acids which leads to the high protein content of the food. Moreover, it contains the balance ratio of leucine and isoleucine methionine and cysteine which are the precursor of creatinine which is beneficial for healthy hair and skin. As creatine is a major supplement, taken by the athletes and can be considered a healthy and natural source of creatine to help boost athlete performance. Furthermore, slow down the aging factors which act as a hurdle in the career of an athlete (Kapoor *et al*, 2022).

Anti-fatigue properties of fox nuts for athletes:

An experiment was held to determine the anti-fatigue properties of fox nuts. A swimming test was conducted in mice to determine their tolerance to exercise. The extracts from fox nuts showed anti-fatigue properties in the mice, and extracts helped increase the hepatic glycogen levels in the mice able to swim for longer duration. This can also be applied to the athletes and it would have a great impact on the performance of the athlete by increasing their glycogen content and delaying fatigue and help the athlete to outperform his/her previous limits. These compounds helped in increasing the lactate dehydrogenase which clears the lactic acid accumulation during vigorous exercise and help delay fatigue in the muscles. It also helped to decrease the blood urea levels which rise during a strenuous exercise session (Kapoor *et al*, 2022).

Fox nut prevent osteoarthritis in athletes;

Osteoarthritis is a common problem being surfacing among various athletes around the world and the study on fox nuts to treat osteoarthritis. The super lubricant nano particles present in the fox nuts can help increase the performing years of an athlete and enhance his performance. In addition to its high carbohydrate and protein content, fox nut is also loaded with vitamins and minerals that are important for athletes. The high fiber content of fox nut seeds supports digestive health and can contribute to weight management, which is essential for athletes aiming to achieve and maintain their optimal body composition. The seeds' low glycemic index further makes them a suitable option for managing blood sugar levels, providing sustained energy during physical exertion. It contains magnesium, potassium, and calcium, which are essential for maintaining healthy bones and muscles. It also contains iron, which is important for delivering oxygen to the muscles during exercise. Another benefit of fox nut for athletes is its low-fat content. While fat is important for providing the body with energy, too much fat can lead to weight gain and decreased performance. Fox nut is a low-fat food that provides athletes with the energy they need without the risk of excess fat. (Kapoor *et al*, 2022)

MECHANISM OF ACTION

FOX NUT ON ATHLETES BODY



Figure 5: Mechanism of action in an athlete's body

Fig 5 represents the consumption of fox nuts as part of a diet or as a supplement. Once consumed, fox nuts are broken down in the digestive system through processes like chewing, stomach acid secretion, and enzyme action. The nutrients present in fox nuts are then absorbed through the intestinal lining into the bloodstream. The absorbed nutrients from fox nuts are transported to various cells and tissues in the body. These nutrients play essential roles in cellular processes, such as energy production, muscle function, and tissue repair. The carbohydrates present in fox nuts are converted into glucose, which is used by cells as a primary source of energy through a process called cellular respiration. This energy production enables athletes to perform physical activities and exercise. The nutrients derived from fox nuts contribute to overall metabolic processes, including protein synthesis, enzyme production, and hormone regulation. These metabolic enhancements support optimal physiological functioning in athletes. Enhanced metabolism and energy availability, athletes experience improved physical performance, including increased strength, endurance, and recovery.

DIFFERENT RECIPE OF FOX NUT FOR ATHLETES:**Foxnut Cookies**

There are many cookies available in market these days that contain nutrition value and health benefits. Fox nut cookies are also available in market that is a source of energy and a healthy snack. To make these cookies we are going to need 50g of fox nut and 60g of all-purpose flour and mix it with fox nuts and other healthy nuts (Francis *et al*, 2018).

Makhana chapatti: when mixed with a ratio of 1:1. Two products mainly raw makhana wheat flour is mixed with each other and oil is added. Chapatti is made at 150°C.

Makhana Pakora: raw powder, besan and soy oil is added together and fried.

Makhana barfi: sweet using 200 g of sugar, 1500 milk, 5 g ghee. Ingredients are mixed and boiled at 130-140°C. After cooling the products are cut into rectangular shapes and dry fruits are added.

Makhana kheer: consists of 40% makhana and milk powder up to 30- 35%. It doesn't need cooking just mixing simply with water for 30-60s is needed.

It's used in the preparation of healthy dishes like kheer, halva etc. It's basically used in milk-based products. It's used as a thickening agent for taste. These nuts are served with tea as snacks. Many diet cookies are available these days in the market that are very healthy and have many nutritional benefits too. Fox nut chocolate cookies are essential for our body (Bhatt *et al*, 2017).

Due to its rich content in carbohydrate its seed covering is used as a quoting in banarasee saree and cotton clothing. Many of workers are used for gain instant energy. It's considered as offering in Hindu temples and it's considered a very pious food item. they make biscuits (Bhatt *et al*, 2017).

CONCLUSION

In conclusion, fox nut (*Euryale ferox*) holds great promise as a beneficial dietary addition for athletes seeking to improve their health and performance. The unique nutritional composition and bioactive compounds found in fox nut seeds offer a multitude of advantages that can positively impact athletes' bodies and overall well-being. Essential nutrients, such as proteins,

carbs, vitamins, and minerals, supply athletes with the building blocks they need for muscle repair, energy replenishment, and overall body function.

However, it is essential to acknowledge that further research is needed to better understand the specific mechanisms through which fox nut exerts its beneficial effects on athletes' bodies. These nutrients help athletes push their physical limitations and reach peak performance by improving muscle recovery, reducing exercise-induced inflammation, and increasing endurance. As this intriguing superfood develops popularity in the sporting world, it has the potential to transform the way athletes approach nutrition and well-being, opening up new pathways for athletic greatness

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