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## Nutritional and pharmacological aspects of *Trapa natans*: An underutilized boon crop of West Bengal

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### Abstract

In the present era, individuals prioritize their health and seek value-added products as integral components of both their everyday meals and indulgent dining choices. *Trapa natans* L., a petite free-floating plant predominantly found in shallow water or swampy regions, is indigenous to Europe, Asia, and Africa. Commonly referred to as water chestnut or singhara in India and 'panifal' in West Bengal, this plant's seeds are enclosed in thick, dark brown hard kernels known for their delicious taste and rich composition of high protein, carbohydrates, starch, flavonoids, and essential minerals. These kernels serve various purposes, functioning as appetizers, tonics, analgesics, anti-diarrheals, anti-inflammatories, anti-bacterials, and anti-diabetics. With its excellent starch content, *Trapa natans* L. emerges as a noteworthy substitute for starches like potato, corn, and wheat. The plant holds considerable importance in the manufacturing of diverse products such as biscuits, infant milk formula, and alcohol. Furthermore, it serves as a source of gluten-free flour, offering a suitable replacement for wheat flour for individuals with celiac disease caused by gluten intolerance. The multifaceted attributes of *Trapa natans* L. underscore its significance in both dietary preferences and industrial applications.

**Keywords:** *Trapa natans*, pharmacological properties, nutritional value, by-product, underutilized crop

### Introduction

*Trapa natans*, commonly known as water chestnut or water caltrop, is an aquatic plant species native to parts of Asia and Europe (Bhatiwal *et al.* 2012) [2]. It is known for its distinctive, floating, and spiky fruits, which resemble chestnuts and are commonly found in freshwater bodies like ponds, lakes, and slow-moving rivers. It belongs to the genus *Trapa* within the family Trapaceae. There are several species of *Trapa*, but *Trapa natans* is one of the most well-known. It is an aquatic perennial plant with submerged roots and floating leaves (Fig. 1). The leaves are triangular in shape and have serrated edges, often floating on the water's surface (Chandana, 2013) [3]. The most distinctive feature of *Trapa natans* is its fruit, which is a hard, spiky nut-like structure with four sharp, barbed horns. These fruits are colloquially referred to as "water chestnuts" due to their chestnut-like appearance. It is primarily found in freshwater habitats, including ponds, lakes, marshes, and slow-moving rivers (Malviya, 2010) [4]. It prefers shallow waters with muddy or silty substrates. The plant is native to regions in Asia, including India, China, Japan, and Southeast Asian countries, as well as parts of Europe. In some areas, it is considered an invasive species, as it can rapidly spread and displace native aquatic plants.

### Historical perspectives

First discovered in North America in the 1870s, *Trapa natans* was later found to have originated in a botanic garden at Harvard University in 1877. The herb was then discovered budding in the Charles River bank in 1879. *Trapa natans* resembles an elaborately patterned European plant. The plant's huge size and presence of peeling nuts restricts its ability to spread. Northeastern states can also purchase the plant. Water chestnut was regarded as a necessary dietary item in devotion as an offering during the Chinese Zhou Dynasty. The rituals of the Zhou (2<sup>nd</sup> century BC) were said to have followed the custom of a devotee carrying a bamboo basket with dried water in it. It is well-known and grows in freshwater lakes (Kritikar and Basu, 1993) [1].

### Traditional Uses

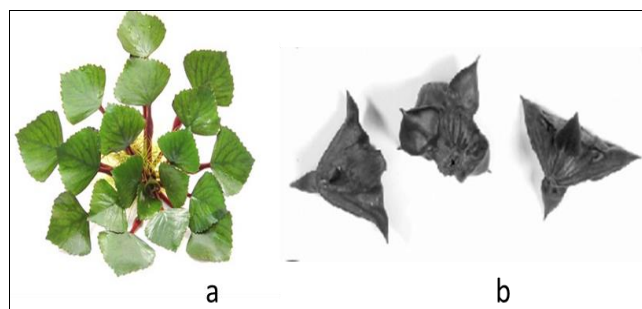
The Ayurvedic medical system recognizes Paniphala as Shrungataka (Bhatiwala *et al.* 2012) [12]. Most Ayurvedic lexicons and vocabularies mention Shrungataka in connection to its different qualities and therapeutic effects. A few of the synonyms for Shrungataka are Jalakanda (due to its aquatic properties) and Trikona kanda (because of its triangle form). The medicine is also said to preserve Sheeta veerya (cool in potency, anabolic in nature), Ruksha Guru (dry and heavy for digestion), and Madhura Kashaya rasa (due to its sweetened and astringent flavor). Additionally, it lessens the vitiated Pitta dosha, which is one of the three bio forces in charge of metabolism. Therefore, Shrungataka is effective in treating a number of conditions brought on by Pitta dosha. In order to address the etiology and signs of srungataka, pittahara might be utilized as a diuretic. Additionally, the medication can be used as a hemocoagulant, typically for postpartum hemorrhages (Ghani *et al.* 2010) [6]. One of the most important Ayurvedic treatments for fractures, ginkgo taila also strengthens bones, is said to be ginkgo. Eladi taila is administered in the event of fractures, Vrushya ghruta, and Apathyakarasvarasa are administered as aphrodisiacs, and other Ayurvedic formulations are provided in addition to the medication (Shrungataka) for Shiroroga (head illnesses). Shrungataka paste can be administered with ghee in Visarpa (Erysipelas), along with a few other pittahara dravyas (Singh *et al.* 2011) [17].

### Cultural and Culinary Uses

The fruit of *Trapa natans* is edible and has been a part of traditional diets in various Asian cultures for centuries. In culinary contexts, water chestnuts are often used in both raw and cooked forms. The crunchy texture and slightly sweet taste of water chestnuts make them a popular ingredient in salads, stir-fries, and various Asian dishes. They are also commonly used in Chinese cuisine, where they are known as "ling nut" or "ling jiao."

### Nutritional Value

Due to their culinary popularity and nutritional value, water chestnuts are cultivated in many parts of Asia, including China, Thailand, and India. Water chestnuts are low in calories and a good source of dietary fiber, making them a healthy addition to various dishes. They also contain minerals like potassium and manganese, as well as some vitamins, such as vitamin B6 and vitamin C.



**Fig 1:** a) Plant of water chestnut, b) Fruit of water chestnut

### Chemical composition of kernel of *Trapa natans*

*Trapa natans* kernels have a moisture percentage of 81.12% (wet basis), according to a chemical examination of the fruit. Fresh nuts with a high-water content are consumed at breakfast and are thought to reduce heartburn and indigestion. The fruit's overall soluble solids content was 7.2%. The amount of citric

acid in the whole acid was 0.142%. The fruit had a negligible level of fat content (0.36%), which supports its significance as a food for the diet. Chinese water chestnut also has a low crude fat level of 0.06%, according to reports. The fruit's total ash content, which was 1.33%, proved that it had a good amount of minerals.

### Pharmacology Activities

#### Anti-oxidant properties

Water chestnuts contain significant amounts of total phenol, flavonoids, and flavones. The water chestnut fruit's pericarp extract showed the presence of phenolic substances, alkaloids, flavonoids etc whereas phytochemical analysis of the fruit's seed extract showed the presence of carbohydrates, Saponins, Phytosterols, fixed oils, and fat.

#### Anti-inflammatory properties

As a response pattern to injury, inflammation induces the accumulation of cells and exudates in irritated tissues, offering protection from further harm. Researchers have studied inflammation for centuries to comprehend ways to mitigate its adverse effects on the body. Celsius identified the four primary signs of inflammation (redness, heat, pain, and swelling, or rubor, calor, dolor, and tumor) in the year 30 AD and employed leaf extracts for their treatment. Substances that aid in reducing inflammation are known as anti-inflammatory agents. In the evaluation of anti-inflammatory activity, the pericarp and seed extract of *Trapa natans* L. fruits were administered at doses of 200 mg/kg and 300 mg/kg using carageenan-induced hind paw edema. Significantly, the pericarp exhibited greater anti-inflammatory activity compared to the seed. (Aghari *et al.* 2010) [8].

#### Anti-microbial properties

Antimicrobials can be added to food in a number of ways to prevent the growth of hazardous and rotting bacteria. These can either be released gradually from the packaging or applied right once. Three main methods of incorporating antimicrobials into food systems are highlighted in this article. These methods might be essential for reducing harmful germs and increasing product shelf life. In the study conducted by Parekh and Chanda (2007) [9], the bactericidal efficacy of different *Trapa natans* L. fruit rind extracts were investigated using the agar disc diffusion method. The research revealed that the extracts exhibited varying degrees of antibacterial activity, with the strongest effects observed against gram-negative bacteria. Notably, the petroleum ether extract demonstrated the lowest antimicrobial activity, while the 1, 4-dioxane extract exhibited the highest antibacterial effectiveness among the tested extracts. This finding indicates that *Trapa natans* L. fruit rind extracts, particularly those obtained through 1, 4-dioxane extraction, have notable antibacterial properties, emphasizing their potential as antimicrobial agents, particularly against gram-negative bacteria. Such insights contribute to the understanding of the potential applications of *Trapa natans* L. in the development of antimicrobial strategies for various purposes, including food safety and preservation. (Patel *et al.* 2011) [10].

#### Gastric acid regulation

While not well-studied, it's possible that water chestnut consumption may have a mild effect on gastric acid secretion. If water chestnuts help regulate stomach acid production, they could indirectly reduce the risk of gastric ulcers, particularly those associated with excessive acid production (Karimi *et al.* 2015) [11].

**Gut microbiota modulation:** Emerging research suggests that the gut microbiota plays a role in digestive health, including ulcer development. Dietary fiber and certain compounds in water chestnuts may support a healthy gut microbiome, potentially reducing the risk of ulcers.

#### Healthy foods for expectant women

Water chestnut flour is used to make porridge for pregnant women to prevent bleeding after delivery because it increases fetal growth and helps pregnant women with hypertension. The dried seeds can be used to stop bleeding in women. It also promotes milk production from the mammary duct. Juice from water chestnuts can be used medicinally and helps to get rid of bile and phlegm humour. Additionally, it boosts libido. Water chestnuts are used to treat inflammatory diseases and blood toxins. They are energizing agents that reduce fatigue and limit bleeding from wounds. Potassium content in a cup of water chestnuts is 362.1 mg. This element is required for normal brain and muscle function. Consuming sodium affects blood pressure and water retention in the same way. Water chestnuts' strong cooling properties make them a fantastic way to beat the summer heat. They also have a variety of auxiliary and therapeutic properties. Leprosy and bronchitis are both treated with water chestnut seeds, while diarrhea and dysentery are treated with the juice. It promotes fetal growth and aids in the treatment of pregnancy-related hypertension (Patel *et al.* 2012) [12].

#### Value added product

Value-added products derived from *Trapa natans*, commonly known as water chestnut or water caltrop, can offer a range of culinary and nutritional benefits. These products are typically processed from the edible portions of the plant, which are the seeds or corms found within the spiky fruit. Here are some value-added products of *Trapa natans*.

- 1. Water Chestnut Flour:** Water chestnut flour is made by grinding dried water chestnut corms into a fine powder. It is a flexible component suitable for a range of culinary uses, such as baking, enhancing the thickness of soups and sauces, and creating gluten-free dishes. Water chestnut flour is prized for its neutral flavor and ability to add texture to dishes.
- 2. Canned or Preserved Water Chestnuts:** Canned or preserved water chestnuts are a common value-added product. The water chestnuts are peeled, sliced, and often preserved in water or a light syrup. They are convenient for use in salads, stir-fries, and other dishes, adding a crisp texture and mild, slightly sweet flavor.
- 3. Water Chestnut Snacks:** Water chestnuts can be sliced and dehydrated to create crunchy, nutritious snacks. These snacks are often seasoned or flavored to enhance their taste. They are a healthy alternative to traditional potato chips and offer a satisfying crunch.
- 4. Water Chestnut Syrup or Concentrate:** Water chestnut syrup or concentrate is made by extracting the juice or essence of water chestnuts. It can be used as a sweetener in beverages, desserts, and cocktails, providing a unique flavor profile.
- 5. Water Chestnut Chips:** Water chestnut chips are thin slices of water chestnuts that have been dried or fried to create crispy chips. These chips can be seasoned and served as a snack or used as a garnish for salads and appetizers.
- 6. Water Chestnut Paste:** Water chestnut paste is a puree made from the flesh of water chestnuts. It is used as a base

for making various desserts and sweets, especially in Asian cuisines. It can be sweetened and flavored to create fillings for dumplings, buns, and pastries.

- 7. Water Chestnut Extracts:** Extracts derived from water chestnuts may be used as flavoring agents in beverages, confectionery, and baked goods. They can impart a subtle, sweet, and nutty flavor to products.
- 8. Water Chestnut Flour-Based Noodles or Pasta:** Water chestnut flour can be used to make gluten-free noodles or pasta, catering to individuals with dietary restrictions. These products are popular among health-conscious consumers.

Value-added products of *Trapa natans* are not only appreciated for their culinary versatility but also for their nutritional benefits, including fiber and essential minerals. The processing and packaging of these products ensure their convenience and longer shelf life, making them accessible to consumers both locally and internationally.

#### Conclusion

In conclusion, *Trapa natans*, commonly known as water chestnut, holds significant historical, cultural, and culinary importance, tracing back to its discovery in North America in the 1870s. With its origins at Harvard University's botanic garden, this plant has been recognized for its traditional medicinal uses in Ayurveda, offering remedies for various ailments and contributing to dietary practices since ancient times. Its culinary versatility, nutritional value, and the development of value-added products underscore its significance in Asian cuisines and beyond. Furthermore, recent pharmacological studies highlight its potential health benefits, including anti-inflammatory, antimicrobial, and gastric regulation properties. The emergence of value-added products derived from *Trapa natans* opens up new avenues for culinary innovation and nutritional enhancement. With its rich history, diverse applications, and promising pharmacological attributes, *Trapa natans* continues to captivate interest and contribute to various facets of human well-being, bridging the past with modern innovations in food and medicine.

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