



E-ISSN: 2278-4136  
P-ISSN: 2349-8234  
[www.phytojournal.com](http://www.phytojournal.com)  
JPP 2024; 13(3): 46-50  
Received: 13-02-2024  
Accepted: 18-03-2024

**Dr. Vanita Kanase**

Department of Pharmacology,  
Oriental College of Pharmacy,  
Sanpada, Navi Mumbai,  
Maharashtra, India

**Aman Gupta**

Department of Pharmacology,  
Oriental College of Pharmacy,  
Sanpada, Navi Mumbai,  
Maharashtra, India

**Komal Patil**

Department of Pharmacology,  
Oriental College of Pharmacy,  
Sanpada, Navi Mumbai,  
Maharashtra, India

**Ashniya Bandarkar**

Department of Pharmacology,  
Oriental College of Pharmacy,  
Sanpada, Navi Mumbai,  
Maharashtra, India

**Dr. Mohib Khan**

Department of Pharmacology,  
Oriental College of Pharmacy,  
Sanpada, Navi Mumbai,  
Maharashtra, India

**Corresponding Author:****Dr. Vanita Kanase**

Department of Pharmacology,  
Oriental College of Pharmacy,  
Sanpada, Navi Mumbai,  
Maharashtra, India

## Water chestnut (*Trapa natans* L.): Nutritional, phytochemical and pharmacological aspects (An Overview)

**Dr. Vanita Kanase, Aman Gupta, Komal Patil, Ashniya Bandarkar and Dr. Mohib Khan**

DOI: <https://doi.org/10.22271/phyto.2024.v13.i3a.14946>

**Abstract**

*Trapa natans* L. commonly known as Water Chestnut, is a member of the *Trapaceae* family and has gained recognition as a nutritional powerhouse and a potential source of bioactive compounds with diverse psychopharmacological properties. This review aims to summarize the current information and understanding of the phytopharmacology of Water Chestnut and its bioactive constituents, with a focus on its potential health benefits and therapeutic applications. Water chestnut is rich in various bioactive compounds, including glucosinolates, carotenoids, vitamins, minerals, and phenolic compounds. These bioactive constituents have demonstrated a wide range of pharmacological properties, including antioxidant, anti-inflammatory, anti-ulcer, hepatoprotective, and anti-diabetic effects. The fruits of Water Chestnut plant contains Phenolic compounds such as Gallic acid, Caffeic acid, ellagic acid, ferulic acid and flavonoids such as Pinobanksin, quercetin, naringenin, etc all this have anti-depressant effect. Furthermore, the high antioxidant capacity of Water Chestnut, attributed to its carotenoid and phenolic content, plays a crucial role in protecting against oxidative stress and associated diseases. The anti-inflammatory properties of this aquatic plant can be beneficial in the management of various inflammatory conditions, such as arthritis and inflammatory bowel diseases. *Trapa natans* potential in managing cardiovascular diseases, diabetes, and obesity has also been investigated, primarily due to its ability to modulate lipid metabolism and improve insulin sensitivity. Additionally, its mineral content, including calcium, magnesium, and potassium, contributes to its role in bone health and blood pressure regulation. In conclusion, *Trapa natans* L. or Water Chestnut, is a remarkable source of bioactive compounds with a wide array of phytopharmacological properties. Its diverse health benefits, including antioxidant, anti-inflammatory, and anti-ulcer effects, making it a valuable dietary addition for promoting overall health and preventing chronic diseases. Future research should focus on elucidating the mechanisms of action of Water Chestnut bioactive constituents and exploring its full therapeutic potential in clinical settings.

**Keywords:** Phytochemical, pharmacological, therapeutic potential, clinical settings

**Introduction**

*Trapa natans* L., a member belonging to the family *Trapaceae*, Order-Myrtales, Sub-family Rosidae, Class Magnoliopsida, Subclass Rosida, and Division Magnoliophyta, is also known as the "water chestnut" in English, "singhara" in Hindi, and "karimbolam" in Malyalam. Although being a plant with a high pharmacological and nutritional value, reason because it is just available only for two to three months out of the entire year, it has not received prominence and awareness of food processors. *Trapa natans* L. Plant is harvested on 603,076 acres of land globally, with 2,327,495 tonnes produced overall. The fruits of *Trapa natans* are sweet, diuretic, cooling, astringent, and tonic [1]. Plant *Trapa natans* is an annual aquatic plant that floats on the surface of water has two types of leaves: finely divided immersed leaves that look like feathers and are carried towards the length of stem of the plant, and undivided floating leaves that are being carried in a rosette on the surface of the water. The floating leaves are rhomboidal shape, fan-shape, toothed beside edges, 2-6 cm in the diameter, longer than wide, denticulate, serrate, and incised along the entire base, apex acute, crimson, and thickly villous below. Although usual lengths tend to be in the six to eight feet in range, the plant's cord-like stems can grow up to 16 foot long and are buoyant and spongy. The multiple branched roots of the stems of the Water Chestnut serve as anchors for them to the water body's bed [2]. Flower are milky colour and have four petals with a length of approx. 8mm. It is located at the middle of the rosette and begins to flower in the monsoon month of august [3].

The sweetened, soft, and enjoyable taste, of cooked water chestnut, is one of the favourite carbohydrate desserts in Asian countries. When the fruits are dried, it is grinded into flour known as singhada ke atta, which is utilised in multiple religious rites and can be eaten as a Phalahar diet during the hindu fasting days, an Indian hindu festival known as "Navratri" [4].



Fig 1: Fruit of Water Chestnut plant



Fig 2: Whole plant of Water Chestnut

#### Habitat

Water Chestnut is an annual aquatic submerged plant found to be in tropical, subtropical and temperate regions of the globe. Their natural range consists parts of southern Europe, Africa and Asia. Water Chestnut has been cultivated in Europe since Neolithic times and has been commonly used as food by ancient Europeans. The aquatic plant has become naturalized in parts of the United States of America since it was first introduced in North America. It is found in moving rivers, lakes, swamps, ponds, and is widely grown in Asian countries. It has nutrient-rich water with a pH of 6.7-8.2 and a calcium carbonate alkalinity of 12-128 mg/l [5]. For cultivating, Plant *Trapa natans* requires bright sun, sluggish, high nutrient-rich, fresh water and substrates. Seeds are stored during winter season in a jar of water in a cool place, but frost-free environment. It has been observed that seeds quickly lose their vitality and quality, if they are allowed to become dry [6]. Plant *Trapa natans* L. is native to country

India. The fruit is also known as "Paniphal." Water Chestnut grows abundantly in the lakes of union territory Kashmir, India. The plant *Trapa natans* is commercially grown in tropical parts of the globe such as Pakistan, Sri Lanka, Ceylon, Africa, and Indonesia. The plant is also cultivated abundant in southeast Asia, and the Southern parts of China and in the eutrophic waters of Japan, Italy, and tropical United States of America [7].

Table 1: Show Taxonomy Classification of *Trapa natans* L [8]

Kingdom	Plantae
Phylum	Magnoliopsida
Class	Magnoliopsida
Order	Myrtales
Family	Trapaceae
Genus	<i>Trapa</i>
Species	<i>T. natans</i>
Subspecies	<i>T. natans</i>

Table 2: Show Vernacular names of *Trapa natans* in India [9]

English	Singhara nut, Water chestnut
Hindi	Sinhaada, Singhara
Telugu	Kubyakam
Malyalam	Karimpolam
Tamil	Pannimonthan
Sanskrit	Jalakantaka, Jalaphala
Kannada	Mullu kombu balli
Marathi	Shingada

#### Cultivation and Collection

*Trapa natans* seeds are implanted in May/June month in a perennial pond. This plant Water Chestnut make use of all the available organic matter for their natural growth. Stock of 800 (50 g) common carp fingerlings is maintained in month September-October. *Trapa natans* fruits get ripen in winter season and are harvested from November to January month [10]. Plant *Trapa natans* is restricted to only fresh water, because it has been observed that its seeds fails to germinate when the sodium chloride concentrations exceed 0.1%. The plant Water Chestnut is also intolerant to  $\text{Ca}(\text{HCO}_3)_2$  and  $\text{Mg}(\text{HCO}_3)_2$  [11].

#### Nutritional composition of Water Chestnut

Water chestnut is an extremely nutritious aquatic crop that has been fail to observe by food processors due to its annual seasonal availability of only 2-3 months per year. Water chestnuts are gluten and cholesterol free, and possess cooling and detoxifying effects and are used form curing jaundice [12, 13]. On the basis of the studies done previously, the nutrient composition of Water Chestnut fruit have shown the presence of crude fibers, ash, moisture, total amount of soluble sugar, lipid, reducing sugar, non-reducing sugar and starch substance. Both variety of green and red water chestnut consists of total phenolic compounds, water soluble protein, Vitamin-C, and beta-carotene. Mineral contents were present to be potassium, iron, phosphorus, zinc, copper, sulphur and manganese. Both varieties of Water Chestnut were commonly found to have tryptophan, free amino acids, leucine, alanine, free glutamic acid, and tyrosine. In contrast, green and red varieties were found to contain glutamine, proline, asparagines arginine and cysteine. Hence, the recent research indicates the nutrient composition of green and red varieties of water chestnut as well as it concludes that water chestnut is highly nutritious to humans and animals [14]. The kernels of Water Chestnut fruit are reported to contain proteins, fats,

fibers, carbohydrates, mineral elements such as iron, copper, iodine, phosphorus, calcium, magnesium, potassium and vitamin like vitamin A, riboflavin, thiamine and nicotinic acid. The study has also provide information of the presence of phosphorylase, tannins and  $\beta$ -amylase in the kernels <sup>[15]</sup>. Nutrient composition of plant *Trapa natans* moisture 62.5, total ash 1.04, total crude fiber 2.13%, total soluble sugar 0.92%, reducing sugar 0.33%, non-reducing sugar 0.58%, starch 8.7%, fat 0.84%. Therefore, the present study indicates light on the nutrient contents of the two variety of water chestnut plant and concludes that water chestnut may play an important role in human nutrition <sup>[16]</sup>.

### Phytochemical Constituents

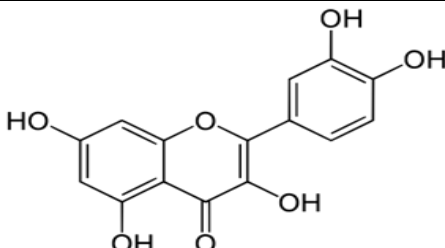
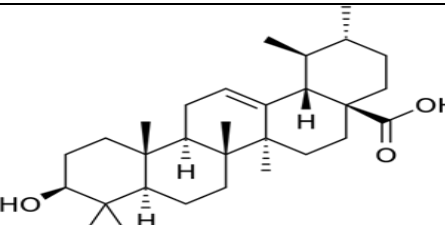
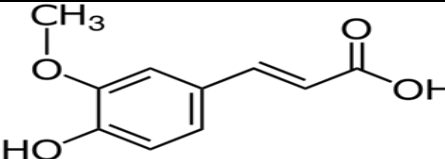
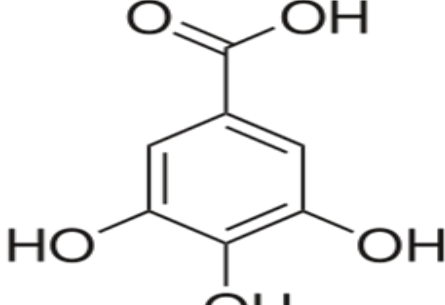
Plant Water Chestnut contains a good quantity of non-nutritional antioxidants, such as flavonoids, flavone and total phenolic contents. Flavonoids are present in plant tissues, such as vegetables, fruits, nuts, leaves and seeds, in a high concentrations. Flavonoids act as a natural anti-oxidants. Phytoconstituent screening of seed extract of plant *Trapa natans* fruits revealed the presence of carbohydrates, saponins, phytosterols, fixed oils and fat while the pericarp

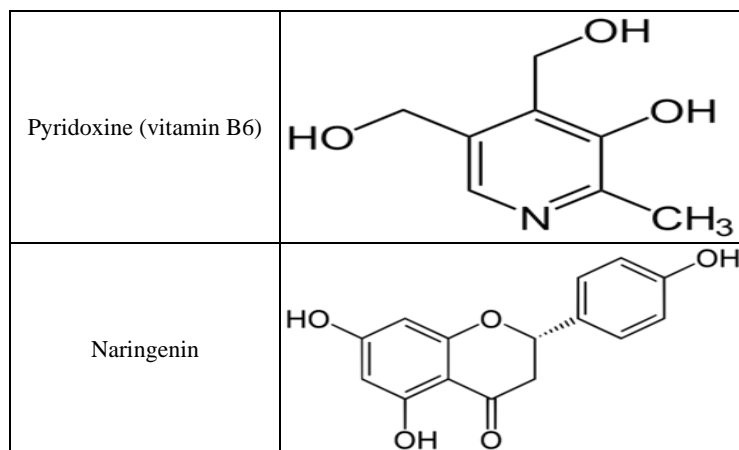
extract of the fruit of *Trapa natans* showed the presence of tannins, flavonoids and glycosides <sup>[17, 18]</sup> Study report indicates that total of ten phenolic substances known to be present in *Trapa natans* leaf extract, with three phenolic acids such as gallic acid, ellagic acid, and ferulic acid, as well as flavonoid such as quercetin 3-O-galactoside (hyperoside), being more abundant than the other compounds <sup>[19]</sup>. The most important phytochemical in the aqueous fruit extract of plant Water Chestnut. are phenolics, which have gain more attention towards scientists because of their strong anti-free radical property. Due to its great polyphenol content, there is a solid evidence that the aqueous extract of plant *Trapa natans* L. fruit has important in vitro anti-oxidant activity against free radicals <sup>[20]</sup>. Plant *Trapa natans* also contains organic constituents such as carbohydrates and various vitamins like Vitamin B-complex which includes thiamine, riboflavin, pantothenic acid, pyridoxine, nicotinic, vitamin-C, vitamin-A, D-amylase, amylase, and high amount of phosphorylase <sup>[21]</sup>. Plant Water Chestnut also contains phytochemical such Cycloeucaenol, ursolic acid, and  $2\beta,3\alpha,23$ -trihydroxyurs-12-en-28-oic acid <sup>[22]</sup>.

**Table 3:** Show Phenolic compounds, flavonoid and flavonoid glycoside present in water chestnut

Phenolic acids and their derivatives	Flavonoids	Flavonoid Glycoside
Galic acid	Quercetin	Quercetin 3-O-galactoside
Protocatechuic acid	Pinobanksin	Naringenin-7-O-hexoside
Ellagic acid	Rhamnetin	Rutin
Caffeic acid	Naringenin	Kaempferol-3-O-glucoside
p-Coumaric acid hexoside		Quercetin 3-O-rhamnoside

Source: <sup>[23]</sup>

Name of Phytochemical	Chemical Structure
Quercetin	
Triterpenoids (Ursolic acid)	
Ferulic acid	
Gallic acid	



## Pharmacological Activity

### A. Antimicrobial activity

The alcoholic extract of this plant *Trapa natans* at the concentration of 200 µg/disc showed a more strong antimicrobial activity against Gram positive bacteria (*Bacillus cereus*, *B. subtilis*, *B. megaterium*, *Staphylococcus* and *Staphylococcus aureus* β-haemolyticus) and Gram negative bacteria (*Escherichia coli*, *Klebsiella*, *Shigella dysenteriae*, *Pseudomonas aeruginosa*, *Shigella flexneri*, *Shigella sonnei*, *Shigella boydii*, *Salmonella typhi* A and *Salmonella typhi* B-56) bacteria than the activity shown by ethyl acetate, chloroform and petroleum ether extracts. The most significant cytotoxic effect in the brine shrimp lethality assay was observed for the chloroform extract [24].

### B. Analgesic activity

The ethanolic extract of the plant *Trapa natans L.* roots has shown a strong and proven analgesic activity on tested animals. Analgesic activity of the methanolic extract of the plant Water Chestnut root at a dose of 200 mg/kg and 400 mg/kg was evaluated by tail flick method and tail immersion method against the standard drug Pentazocine at a dose of 30 mg/kg. The obtained result suggest a significant analgesic effect which was observed by centrally acting drug [25, 26].

### C. Antiinflammatory activity

Fruits of Water Chestnut, commonly known as Shingoda, were reported to be potential anti-inflammatory agent in the literature survey. Anti-inflammatory activity has been performed by using Carrageenan induced hind paw edema model. The aqueous extract of the fruit pericarp have shown significant anti-inflammatory effect by decreasing paw volume on the 3rd and the 5th hour, while the aqueous extract of seed showed significant antiinflammatory effect by decreasing the paw volume at the 5th hour only [27].

### D. Antioxidant activity

Plant *Trapa natans L.* fruits had shown potential *in vitro* antioxidant activity. The activity of hydroalcoholic extract of *Trapa natans* was studied on fluorescence product and various biochemical parameters like peroxidation catalase activity and glutathione peroxidase activity in the brain of female Albino mice. Ageing was accelerated by the dose treatment of 0.5 ml of 5% D-glucose for 15 days. This resulted in the increased fluorescence product has shown an increase in lipid peroxidase and decrease the antioxidant enzyme like glutathione peroxides and catalase in cerebral cortex. After treatment with hydroalcoholic extract of *Trapa natans* (500 mg/kg) there was decrease in fluorescence product in cerebral cortex. Moreover, *Trapa natans* inhibited

increase lipid peroxidation and restores glutathione peroxidase and catalase activity in cerebral cortex as compare to ageing accelerated control group. Thus the hydroalcoholic extract was found to be effective as an antioxidative agent which could reverse D-galactose induced ageing changes resulting due to oxidative damage [28].

### E. Antidiabetic activity

Antidiabetic activity of plant *Trapa natans* fruit peels of methanolic extract was studied in Wistar rats. The study concluded that alcoholic extract of *Trapa natans* dose dependently increased oral glucose tolerance in normal rats and in Streptozotocin induced diabetic rats by decreasing and thereby controlling the increased the fasting blood sugar level [29].

### F. Antiulcer activity

The antiulcer activity of plant *Trapa natans* fruits was carried out on Wistar rats. The studies were conducted by using aspirin plus pyloric ligation method. The final result was concluded and final result showed the antiulcer activity due to the rise in total carbohydrate content and also the modified condition and state of mucosal barrier lining of the stomach [30].

### G. Immunomodulatory activity

The immunomodulatory activity of plant *Trapa natans* was evaluated in rats contrary to sheep red blood cells as antigen. The macrophage phagocytosis assay was evaluated in mice by carbon clearance method. A Delayed hypersensitivity reaction showed a gradual increase by augmenting the mean foot pad thickness at an interval of 48hrs. The Immunomodulatory study on mice has been concluded that the aqueous extract of Water Chestnut could stimulate the humoral and cellular response in animals [31].

### H. Hepatoprotective activity

Plant *Trapa natans* ethanolic root extract and its derived fractions also have shown a considerable protective impact against hepatotoxicity and lipid peroxidation, according to the study reports. The presence of phytochemical such as ferulic acid and caffeic acid in *Trapa natans* extract could explain the activity because both elements are antioxidative [32].

## Conclusion

Plant *Trapa natans L.* also known as Water Chestnut is a remarkable nutritional powerhouse and a source of bioactive compounds with diverse phytopharmacological properties. This review has highlighted its rich content of bioactive constituents, including glucosinolates, carotenoids, vitamins,

minerals, and phenolic compounds, which collectively contribute to its exceptional therapeutic potential. The bioactive compounds present in Water Chestnut demonstrated a wide range of pharmacological properties, including antioxidant, anti-inflammatory, immunomodulatory, hepatoprotective, anti-ulcer and anti-diabetic effects. Overall, plant *Trapa natans* had diverse health benefits make it a valuable dietary addition for promoting overall health and preventing chronic diseases. Further research should focus on elucidating the mechanisms of action of its bioactive constituents and exploring its full therapeutic potential in clinical settings. As consumer interest in healthy foods continues to grow, Water Chestnut has various commercial applications underscore its potential in the food, supplement, and cosmetic industries, further highlighting its importance in the field of phytopharmacology.

## Reference

- Patel AS, Patel NC, Shah MH, Shah VN. Evaluation of anti-inflammatory activity of fruits of *Trapa natans* L. Linn. IJPSRD. 2011;03:97-102. DOI: 10.1007/978-94-007-5653-3\_11.
- Ota NP, Ulrich NP. An overview of herbal products and secondary metabolites used for management of type two diabetes. Front Pharmacol. 2017;8:436. DOI: 10.3389/fphar.2017.00436.
- Agrahari AK, Khaliqzama M, Panda SK. Evaluation of analgesic activity of methanolic extract of *Trapa natans* L. *Bispinosa roxb.* Roots. IJPCR journal. 2010;01:8-11. DOI: [https://doi.org/10.1016/S2221-1691\(12\)60421-3](https://doi.org/10.1016/S2221-1691(12)60421-3).
- Chandana M, Mazumder R, Chakraborty GS. A review on potential of plants under *Trapa* species. International Journal of Research in Pharmacy and Chemistry. 2013;3(2):502-508.
- Boopathi T, Gopalsatheeskumar K, Parthiban S, Sangeetha G, ThangaKokila M, Manimaran T. Evaluation of antimicrobial activity of *Tecoma stans* and *Muntingia calabura*. 2007;6:617-627. DOI: 10.29161/PT.v6.i1.2017.38.
- Wu MY, Wu J. In-vitro Investigations on Ultrasonic of Water Chestnut. J Aquat Plant Management. 2007;45:76-83.
- Karmakar UK, Rahman KS, Biswas NN, *et al.* Antidiarrheal, analgesic and antioxidant activities of *Trapa bispinosa* Roxb. fruits. Research Journal of Pharmacy and Technology. 2011;4(2):111-115.
- Ghani A, Haq SS, Masoodi FA, Broadway AA, Gani A. Physico-chemical, Morphological and pasting properties of starches extracted from water chestnuts (*Trapa natans*) from three lakes of Kashmir, India. Brazilian Archives of Biology and Technology. 2010;53(3):731-740.
- Sharma PV. Classical uses of Medicinal Plants. Chaukhambha Visvabharati, Varanasi-1, First Edition; c1996, 377.
- Singh G, Singh S, Jindal N, *et al.* Environment friendly antibacterial activity of water chestnut fruits. Journal of Biodiversity and Environmental Sciences. 2011;1(1):26-34.
- Winne WT. Water chestnut: A foreign menace. Bulletin to the Schools. 1950;36(7):230-234.
- Jana BR, Bhatt BP, Singh IS, Idris M. A study on commercial cultivation and storage of water chestnut (*Trapa natans* L.) under wetland ecosystem of North Bihar, India. Journal of Applied and Natural Science. 2019;11(2):528-533.
- Vishwakarma N, Shukla R, Sharma A, Singh DK, Sharma P. Water chestnut processing: An entrepreneurial opportunity for livelihood security; c2022.
- Pandey G. Dravyaguna Vijnana. Choukambha Krishnadas Academy, Varanasi, 2004;3:531.
- Sushruta. Sushruta Samhita, Chikitsa Sthana. With Nibandhasangraha commentary by Shri Dalhanacharya; edited by Yadavji Trikamji Acharya; 6th ed., Varanasi, Chaukhamba Orientalia. 1997;17/6:757.
- Faruk MO, Amin MZ, Sana NK, Shaha RK, Biswas KK. Biochemical analysis of two varieties of water chestnuts (*Trapa* sp.). Pakistan Journal of Biological Sciences. 2012;15(21):1019-1026.
- Guo JT, Lee HL, Chiang SH, Lin FI, Chang CY. Antioxidant properties of the extracts from different parts of broccoli in Taiwan. J Food Drug Anal. 2001;9:96-101.
- Havsteen B. Flavonoids, a class of natural products of high pharmacological potency. Biochem Pharm. 1983;32:1141-1148.
- Aleksic I, Ristivojevic P, Pavic A, Radojević I, Čomić LR, Vasiljevic B, Senerovic L. Anti-quorum sensing activity, toxicity in zebrafish (*Danio rerio*) embryos and phytochemical characterization of *Trapa natans* leaf extracts. J Ethnopharmacol. 2018;222:148-158. DOI: <https://doi.org/10.1016/j.jep.2018.05.005>.
- Mazumdar BC. Water chestnut the aquatic fruit. The Trilogy of Wild Crops. 1985;37:42-44.
- Khare CP. Indian Medicinal Plants: An Illustrated Dictionary. Springer, Berlin, Germany; c2007.