



# Assessment of Phytochemical and Nutritional Composition of *Trapa natans* L. and Physicochemical Characteristics of Associated Water Bodies in Deni Village, Maharashtra

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## ABSTRACT

*Trapa natans* L. (water chestnut) is an important aquatic plant recognised for its nutritional and medicinal significance. The present study aims to evaluate the phytochemical constituents and nutritional composition of different plant parts (leaves, roots, and fruits) of *Trapa natans* using ethanolic extracts, along with an assessment of the physicochemical characteristics of natural and artificial water bodies utilised for its cultivation. Preliminary phytochemical screening revealed the presence of various bioactive compounds, including alkaloids, flavonoids, tannins, saponins, and phenolic compounds, which are known to contribute to its therapeutic potential. Nutritional analysis demonstrated that the fruits are rich in carbohydrates, proteins, and essential minerals, highlighting their value as a nutritious dietary source. The physicochemical analysis of water samples included parameters such as pH, temperature, dissolved oxygen (DO), total dissolved solids (TDS), and nutrient concentrations (nitrates and phosphates). Comparative evaluation indicated that natural water bodies maintain more stable ecological conditions, whereas artificial water bodies require proper monitoring and management to sustain optimal growth conditions. Overall, this integrated study emphasises the importance of both biochemical composition and environmental parameters in the sustainable cultivation and utilisation of *Trapa natans*.

**Keywords:** Phytochemistry, Physicochemical characteristics, Nutritional Composition, *Trapa natans*.

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## Introduction

Nutraceuticals, a term derived from the words “nutrition” and “pharmaceutical,” refer to foods or food products that provide health and medical benefits, including the prevention and treatment of diseases. The role of local plant-based foods in reducing health risks has long been recognized as part of traditional knowledge systems. Edible plants have historically occupied a significant place in the socio-cultural, spiritual, and healthcare practices of rural and tribal communities in India. India possesses one of the oldest, richest, and most diverse traditions of utilising plant-based resources in traditional systems of medicine.

In rural India, a large proportion of the population depends on wild edible plants to supplement their nutritional requirements. In recent times, there has been an increasing incorporation of non-conventional food plants into daily diets, not only for their nutritional value but also for their therapeutic potential in treating various ailments [1,2,3]. Aquatic plants, in particular, have significant economic and environmental importance depending on their natural characteristics. Some species are consumed as food, while others possess medicinal properties or serve as rich sources of essential minerals and vitamins.

Many aquatic plants are rich in carbohydrates and proteins, making them suitable for both human consumption and animal feed [4]. Additionally, leaf protein extracted from aquatic weeds has been explored as a potential source of nutrition for both food and feed applications [5,6].

Aquatic macrophytes play a vital role in maintaining ecological balance and serve as valuable sources of nutrients and bioactive compounds. *Trapa natans* L. (family: Lythraceae), commonly known as water chestnut, is a floating aquatic plant widely distributed in freshwater ecosystems across Asia, Europe, and Africa [7]. In India, it is extensively cultivated in ponds, lakes, and slow-moving water bodies due to its high nutritional value and economic importance [8]. It is commercially grown in various regions for its edible seasonal fruits. Morphologically, the plant has a submerged stem that can reach 12–15 feet in length and is anchored in the mud by fine roots. It exhibits 2 types of leaves: finely divided submerged leaves and rosette-like floating leaves. The plant produces four-petaled white flowers during early summer, which are insect-pollinated. The fruit is a hard nut with four barbed spines.

Traditionally, *Trapa natans* has been used for various medicinal purposes in India. It is considered nutritive, appetizer, astringent, diuretic, aphrodisiac, cooling, and tonic. It is also used in the treatment of lumbago, sore throat, bilious disorders, bronchitis, fatigue, and inflammation. The fruits are used in the preparation of liniments for treating rheumatism, sores, and sunburn. The stem juice is traditionally used for eye disorders [7,9,10]. The dried kernels of the fruits are also recommended for conditions such as abortion, dysuria, polyuria, and oedema. The fruits of *Trapa natans* are rich in carbohydrates, proteins, minerals, and vitamins, making them an important dietary component for both rural and urban populations. Previous studies have reported that water chestnut fruits contain significant amounts of starch, calcium, phosphorus, and iron, contributing to their nutritional value [11]. In addition to their nutritional benefits, *Trapa natans* contains various bioactive phytochemicals such as flavonoids, tannins, alkaloids, phenolics, and saponins, which exhibit antioxidant, antimicrobial, and anti-inflammatory properties [12].

Phytochemical screening is essential for identifying biologically active compounds that can be utilised in pharmaceutical and nutraceutical applications. Ethanolic extraction is widely preferred due to its efficiency in extracting a broad spectrum of phytoconstituents. Furthermore, understanding the distribution of these compounds in different plant parts (leaves, roots, and fruits) is important for their effective utilization.

The growth and productivity of *Trapa natans* are significantly influenced by the physicochemical characteristics of the water bodies in which it is cultivated. Parameters such as pH, temperature, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), and nutrient levels (nitrates and phosphates) play a crucial role in plant metabolism and yield [12]. Natural water bodies generally maintain ecological balance, whereas artificial water bodies often require careful monitoring and management to ensure optimal growth conditions. Despite its considerable nutritional, medicinal, and ecological importance, there is limited integrated research combining the phytochemical, nutritional, and environmental aspects of *Trapa natans*. Therefore, the present study aims to provide a comprehensive evaluation of the phytochemical and nutritional properties of *Trapa natans*, along with a comparative analysis of the physicochemical parameters of natural and artificial water bodies used for its cultivation.

## Material and Methods

*Trapa natans* L. selected for the study, it is an annual free-floating herb; root fibrous long deeply rooted in the soil of water bodies having 2 to 3 feet water. Stem 10 to 15 feet long, spongy. leaves 3 – 6 cm, 2 types one is finely divided feather like submerged, alternate and floating leaves grow in rosette pattern at the surface of water; shape rhomboid, triangular, deltoid or broadly ovate with serrate margin, apex acute, petiole red in colour, swollen at the base of lamina, spongy and pubescent. Flower white with short stalk and spiny beak, Petals 4, Polypetalous, Sepals 4 gamosepalous; Stamens 4, Ovary 2-chambered. Fruit Nut, obovoid, triangular having 2- pointed spines at opposite side, size 1-3 cm, single-seeded (Photo plate 1).

## Importance of *Trapa natans* L.

Water chestnut not only served as a staple food for humans but also appears to have served as animal feed.

It is also considered an important food crop of the world, particularly in Asian countries, including India, and because of its nutritional potential, it became a significant dietary component, with the flour of the dried kernel also being used for baking [13,14,15]. In addition to serving as a food source and as a means of phytoremediation, *Trapa* has been used in ancient European, Chinese, and Indian medicinal practices, and knowledge of traditional medicine has provided the foundation for investigating the health benefits of *T. natans* in modern times [16,17,18,19,20]. Because of several medicinal properties, such as antioxidant, antimicrobial, antiviral, analgesic, and anti-inflammatory activities, the plant species is of medicinal importance [18]. The water caltrop has also been attributed religious and cultural significance, and the fruits have, for instance, been used to manufacture rosaries in Europe or as prayer offerings during rituals in the Chinese Chou dynasty [21,22,23,17,18]. The macrophyte has also been used for ornamental purposes, for instance, as a decorative aquatic plant in ponds [24].

## Gathering of Samples

From certain natural and manmade water bodies, fresh samples of *Trapa natans* L. (leaves, roots, and fruits) were gathered. For physicochemical examination, water samples were also taken from the same locations and placed in sterile, clean bottles.

## Plant Extract Preparation

After being cleaned and shade-dried, the gathered plant materials were ground into a fine powder. Soxhlet extraction was used to create 70% ethanolic extracts. A rotary evaporator was used to concentrate the extracts, which were then stored for additional examination.

## Analysis of Phytochemicals

Standard qualitative techniques were used to perform preliminary phytochemical screening. Preliminary qualitative phytochemical analysis of ethanolic extracts was carried out using standard protocols [25] to detect the presence of phytochemicals in plant extract.

## Alkaloids test (Mayer's and Dragendorff's test)

Three to five drops of Wagner's reagent (1.27g of iodine and 2g of potassium iodide in 100ml of water) were added to a portion of the extract, and the presence of alkaloids was indicated by the production of a reddish brown precipitate (or coloration).

## Alkaline reagent test for flavonoids

2mL of a 2% NaOH solution were combined with crude extract. The presence of flavonoids was revealed by the formation of a bright yellow color that went colorless when a few drops of diluted acid were added.

## Ferric chloride test for tannins

10% alcoholic ferric chloride solution was added to 2 mL of extract. Tannins are present when a blue or greenish-colored solution forms.

## Saponin test (Foam test)

Water was combined with the test solution. Frost should form after 15 minutes of shaking and observation. This suggests that saponins are present.

### Test for Phenolic Substances

2mL of ferric chloride solution were added to a small amount of extract, and it was agitated for a few minutes. The presence of phenolic chemicals is indicated by the test's pale brown hue.

### Test for Terpenoids

2mL of each extract were combined with one milliliter of chloroform and a few drops of strong sulfuric acid. Terpenoids were promptly detected by the production of a reddish brown precipitate.

### Benedict's test for carbohydrates

After adding a few drops of Benedict's reagent (an alkaline solution containing cupric citrate complex) to the test solution, it was heated in a water bath and checked for the production of a reddish brown precipitate, which would indicate the presence of carbohydrates.

### Test for Oxalate

A few drops of ethanoic acid glacial were added to a 3 ml portion of the extracts. Oxalates are indicated by a greenish-black colouring.

### Protein Test (Biuret Test)

2 drops of 1% copper sulphate solution and 10% sodium hydroxide solution were added to the test solution, and the development of a violet or pink hue was monitored.

### Glycoside Test (Keller Killiani Test)

A few drops of glacial acetic acid and ferric chloride solution were added to the test solution, which was then combined. After adding concentrated sulfuric acid, 2 layers were seen to form. A positive test for glycosides would show a lower reddish brown layer and an upper acetic acid layer that turns bluish green.

## 4. Analysis of Nutrition

Standard methods were used to determine the nutritional composition of *Trapa natans* L. Anthrone method for carbohydrates, Lowry method for proteins, and Soxhlet extraction, oven drying for moisture content, muffle furnace for ash content, and standard titration or Atomic Absorption Spectroscopy (AAS) for minerals.

## 5. Physicochemical Analysis of Water

Water samples were analyzed following standard protocols (APHA methods) for the following parameters: pH (pH meter), Temperature (Thermometer), Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Total Hardness, Nitrates and Phosphates.



Flowering of *Trapa natans* L.



Twig of *Trapa natans* L.



Singada crop at study site



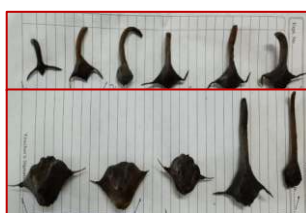
Harvesting of Crop



After Harvesting of Singada



Singada fruit for analysis at Laboratory



Singada fruit size at diff. stage



*Trapa natans* L. at study site College

Photo Plate 1: Showing habit, habitat and collection of *Trapa natans* L. at study site

## Result and Discussion

### Phytochemical Screening

The preliminary phytochemical screening of the 70% ethanolic extracts of different parts (fruit, leaves, and root) of *Trapa natans* revealed the presence of a wide range of bioactive constituents. Carbohydrates were detected in all three plant parts, as confirmed by positive results in both Molisch's and Benedict's tests. Proteins were also present uniformly across fruit, leaves, and root, indicated by a positive Ninhydrin test. Glycosides showed variation among plant parts, being absent in the fruit but present in both leaves and root as evidenced by the Heller-Killani test. Flavonoids, tannins, saponins, alkaloids, and terpenoids were consistently present in all examined parts, suggesting a rich phytochemical profile. Lactones were not detected in any of the extracts. Phenolic compounds were absent in the fruit but present in leaves and root, as indicated by the Ferric chloride test. Oxalate content showed differential distribution, being present in fruit and leaves but absent in the root [26].

Overall, the results indicate that leaves and roots possess a comparatively broader range of phytoconstituents than the fruit, particularly with respect to glycosides and phenolic compounds. The widespread presence of flavonoids, tannins, alkaloids, and terpenoids across all parts highlights the potential pharmacological significance of *Trapa natans* [27,28].

### Physicochemical Analysis of Water

The physicochemical analysis of the three water samples revealed relatively consistent characteristics with minor variations among parameters. All samples were found to be colourless and odourless, indicating the absence of visible impurities and offensive smell. The pH values ranged from 7.2 to 7.4, suggesting that the water is neutral to slightly alkaline in nature.

Electrical conductivity values varied between 601  $\mu\text{S}$  and 695  $\mu\text{S}$ , reflecting moderate ionic content in the samples. Turbidity in all samples was recorded as less than 2 NTU, indicating clear water with low suspended particulate matter. Total dissolved solids (TDS) ranged from 395 mg/L to 461 mg/L, showing moderate mineral content.

Total alkalinity values were observed between 240 mg/L and 276 mg/L as  $\text{CaCO}_3$ , with zero phenolphthalein (P) alkalinity and complete methyl orange (MO) alkalinity, indicating the presence of bicarbonates as the primary contributors. Total hardness ranged from 203 mg/L to 243 mg/L as  $\text{CaCO}_3$ , classifying the water as moderately hard. Calcium hardness was higher (200–229 mg/L) compared to magnesium hardness (16–47 mg/L), indicating calcium as the dominant contributor to hardness. Correspondingly, calcium ion concentration ranged from 80 mg/L to 112 mg/L, while magnesium ion concentration was relatively low (4–5 mg/L). Chloride concentration ranged from 77 mg/L to 89 mg/L, remaining within acceptable limits. Sulphates were either absent or present in negligible amounts (0–0.5 mg/L). Total iron content ranged from 0.6 mg/L to 0.8 mg/L, indicating slight iron presence in the samples. Silica content was consistent across all samples at 2 mg/L. Importantly, oil and grease were not detected in any of the samples, suggesting the absence of organic pollution from industrial or domestic sources (Table 2).

Overall, the results indicate that the water samples possess acceptable physicochemical quality with moderate hardness and mineral content, making them suitable for general use, though slight variations in iron and hardness levels may require attention for specific applications.

**Table 1: Preliminary phytochemical analysis of ethanolic extract of *Trapa natans* from different parts**

Sr. No.	Phytoconstituents tested	Test	70% Ethanolic extract		
			Fruit	Leaves	Root
1.	Carbohydrate	Molisch's test	+	+	+
		Benedict test	+	+	+
2.	Proteins	Ninhydrin test	+	+	+
		Heller-Killani Test	-	+	+
3.	Glycosides	Alkaline reagent	+	+	+
		Legal Test	-	-	-
4.	Flavonoid	Lead Acetate Test	+	+	+
		Foam Test	+	+	+
5.	Lactones	Ferric Chloride test	-	+	+
		Mayer's test	+	+	+
6.	Tannins	Salkowski test	+	+	+
		Oxalate	+	+	-

**Table 2: Physicochemical Analysis of Water sample**

Sr. No.	Parameters	Unit	Sample 1	Sample 2	Sample 3
1.	Colour	Hazen	Colourless	Colourless	Colourless
2.	Odour	UO	Absent	Absent	Absent
3.	pH		7.2	7.4	7.2
4.	Conductivity	$\mu\text{S}$	601	695	627
5.	Turbidity	NTU	<2	<2	<2
6.	Total dissolved solids	mg/L	395	461	433
7.	Total alkalinity as $\text{CaCO}_3$	mg/L	240	273	276
8.	P alkalinity as $\text{CaCO}_3$	mg/L	0	0	0
9.	MO alkalinity as $\text{CaCO}_3$	mg/L	240	273	276
10.	Total Hardness as $\text{CaCO}_3$	mg/L	216	243	203
11.	Ca Hardness as $\text{CaCO}_3$	mg/L	200	229	226
12.	Mg Hardness as $\text{CaCO}_3$	mg/L	16	47	31
13.	Ca <sup>++</sup>	mg/L	80	112	93
14.	Mg <sup>++</sup>	mg/L	4	5	4
15.	Chloride as $\text{Cl}^-$	mg/L	77	89	89
16.	Sulphates as $\text{SO}_4^{2-}$	mg/L	Nil	0.5	Nil
17.	Total Iron as Fe	mg/L	0.6	0.8	0.6
18.	Silica as $\text{SiO}_2$	mg/L	2	2	2
19.	Oil & Grease	mg/L	Nil	Nil	Nil

**Table 3: Physicochemical Analysis of Water sample from cultivated (College) tank**

Sr No	Parameters	Unit	Acceptable Limits IS 10500: 2012	Permissible Limits IS 10500 : 2012	Value Date :21/07/25	Value Date :16/10/25
1.	Colour	Hazen	5	15	Colourless	Colourless
2.	Odour	UO	Agreeable	Agreeable	Absent	Absent
3.	pH		6.5-8.5	No relaxation	7.3	7.1
4.	Conductivity	$\mu\text{S}$	--	--	755	783
5.	Turbidity	NTU	1	5	<2	<2
6.	Total dissolved solids	mg/L	500	2000	397	421
7.	Total alkalinity as $\text{CaCO}_3$	mg/L	200	600	263	279
8.	P alkalinity as $\text{CaCO}_3$	mg/L	--	--	0	0
9.	MO alkalinity as $\text{CaCO}_3$	mg/L	--	--	263	279
10.	DO	mg/L			4.3	3.9
11.	Total Hardness as $\text{CaCO}_3$	mg/L	200	600	224	239
12.	Ca Hardness as $\text{CaCO}_3$	mg/L	--	--	209	213
13.	Mg Hardness as $\text{CaCO}_3$	mg/L	--	--	15	26
14.	Ca <sup>++</sup>	mg/L	75	200	53	67
15.	Mg <sup>++</sup>	mg/L	30	100	3	3
16.	Chloride as $\text{Cl}^-$	mg/L	250	1000	65	79

## Nutritional Analysis

The nutritional analysis of four samples of *Trapa natans* (water chestnut/singada) collected from Kuhu, Veltur, Bhivapur, and Umred revealed notable variation in macronutrient composition and calorific value (per 100 g dry weight). Total carbohydrate content was found to be the major constituent in all samples, ranging from 57.143 g/100 g (Veltur) to 62.857 g/100 g (Bhivapur). The samples from Kuhu (62.014 g/100 g) and Umred (60.00 g/100 g) also showed comparably high carbohydrate levels, indicating that water chestnut is a rich source of carbohydrates across all studied locations. Protein content was relatively low in all samples, varying narrowly between 0.057 g/100 g (Veltur) and 0.063 g/100 g (Bhivapur). Similarly, fat content was found to be minimal, with values ranging from 0.022 g/100 g (Umred) to 0.13 g/100 g (Veltur), confirming that the samples are low in lipid content. The total calorific value showed some variation among the samples, with the highest energy content recorded in Bhivapur (252.30 kcal/100 g), followed by Kuhu (248.651 kcal/100 g), Umred (240.442 kcal/100 g), and the lowest in Veltur (229.97 kcal/100 g). The calorific differences correspond closely with variations in carbohydrate content, suggesting that carbohydrates are the primary contributors to energy value in the samples (Table 4).

Overall, the results indicate that *Trapa natans* samples from all four locations are carbohydrate-rich, low in fat, and contain minimal protein, with Bhivapur samples showing comparatively higher nutritional value in terms of carbohydrate and calorific content[29].

Table 4: Nutritional analysis of *Trapa atans*

Sample Name	Sample Particulars/Details	Sample Collected by	Approx. Qt. Received
Water Chestnut (Singada)	4 Samples	Party itself	250 gm

Test Enquired: Total Carbohydrates, Protein, Fat, Total Calories measured in 100 gm dry weight Veltur (2)

S.N.	Test Parameter	Kuhi (1)	Veltur (2)	Bhivapur (3)	Umred (4)
1	Total Carbohydrates	62.014	57.143	62.857	60.00
2	Total Protein	0.062	0.057	0.063	0.06
3	Total Fat	0.044	0.13	0.071	0.022
4	Total Calories	248.651	229.97	252.30	240.442

## Conclusion

The present study on *Trapa natans* (water chestnut/singada), along with the physicochemical analysis of associated water samples, provides a comprehensive understanding of its nutritional value, phytochemical composition, and environmental conditions. The preliminary phytochemical screening revealed that *Trapa natans* is rich in bioactive constituents such as flavonoids, tannins, saponins, alkaloids, and terpenoids across fruit, leaves, and roots. The presence of these compounds indicates significant pharmacological potential, including antioxidant, antimicrobial, and therapeutic properties. Leaves and roots exhibited comparatively higher phytochemical diversity than fruits, suggesting their greater medicinal importance. Nutritional analysis of samples collected from different locations (Kuhi, Veltur, Bhivapur, and Umred) demonstrated that *Trapa natans* is predominantly a carbohydrate-rich food source with low fat and minimal protein content. The high calorific value observed, particularly in Bhivapur and Kuhi samples, confirms its role as an energy-rich dietary component. These findings support its traditional use as a staple and functional food. The physicochemical analysis of water samples indicated that the aquatic environment supporting the growth of *Trapa natans* is generally suitable and moderately mineralised. Parameters such as neutral to slightly alkaline pH, low turbidity, moderate total dissolved solids, and absence of oil and grease reflect good water quality. However, moderate hardness and the presence of iron suggest minor variations that may influence plant composition and require monitoring.

In conclusion, *Trapa natans* emerges as a nutritionally valuable and phytochemically rich aquatic plant with considerable potential for use in food, nutraceutical, and pharmaceutical applications. The study also highlights the importance of water quality in influencing its growth and composition. Further research focusing on quantitative phytochemical analysis and bioactivity studies is recommended to explore its full therapeutic potential.

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