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## A COMPARATIVE STUDY: QUALITY OF WATER PURIFIED WITH *TERMINALIA CHEBULA* AND *TERMINALIA BELLERICA* BASED ON THE TRADITIONAL EVIDENCE FROM SIDDHA LITERATURE

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### Keywords:

*Kadukkai*, Purification, Siddha system, *Thantrikkai*, Water

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**ABSTRACT:** Water is an essential ingredient for all living things to exist on earth. Ancient Siddha texts suggest that soaking some therapeutic plants may purify water. The current study aims to assess the water quality after being soaked with *Terminalia chebula* (*Kadukkai*) and *Terminalia bellerica* (*Thantrikkai*). Three distinct pots containing two liters of drinking water each were taken from Chembarapakkam Lake and designated as samples A, B, and C. As a control group, Sample A was left behind. In the same setting, 50g of *Terminalia chebula* is soaked for 6 hours in the sample B container, and 50g of *Terminalia bellerica* is soaked for 6 hours in the sample C container. All filtered samples were then subjected to elemental analysis, microbiological testing, and physical inspection as per the drinking water standard methodology. The water treated with *Terminalia chebula* and *Terminalia bellerica* had improved color, odor, pH, hardness, alkalinity, and conductivity within allowable bounds. Elemental analysis showed elevated calcium levels, NO<sub>2</sub> below the detection limit, and Cl, SO<sub>4</sub>, and Fe within the allowable range. Sample C has a higher magnesium content, but Sample B has a level that is acceptable. There was a decrease in the levels of fecal, total, and *Escherichia coli*. Sample C had a greater reduction than samples A and B. Thus, it can be concluded that adding *Terminalia chebula* and *Terminalia bellerica* to drinking water would undoubtedly change its characteristics.

**INTRODUCTION:** The Siddha system of medicine is one of the traditional medical systems, providing preventive, promotive, curative, and rejuvenative healthcare by adopting a scientific and holistic approach<sup>1</sup>. The ¾th region (75%) of the earth is covered by water<sup>2</sup>.

Water is a crucial natural resource, and access to safe drinking water is a fundamental human right, as recognized by international organizations like the United Nations. Both human activities and climate change significantly impact the availability and quality of water resources worldwide<sup>3</sup>.

It plays a key role in many of our body functions including bringing nutrients to the cells, getting rid of wastes, protecting joints and organs, maintaining body temperature, etc. The main sources of water are rain, surface water, and groundwater, which are used for domestic, public, industrial, and

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agricultural purposes. Unsafe drinking water and sanitation can also transmit infectious diseases such as cholera, diarrhea, dysentery, typhoid, and Guinea worm infection<sup>4</sup>. A more serious aspect of water pollution is that it is caused by human activity and industrialization. Even if the source of water supply and its treatment are of a high standard, water pollution may still occur, due to corrosion of pipelines, leaky joints, and cross-connections between water supply pipes and sewage drainage pipes.

According to the WHO/UNICEF Joint Monitoring Program 2021 update and SDG baselines, 2 billion people do not have safely managed water services at home, making them prone to various waterborne diseases that can cause illness, disability, and death<sup>5</sup>. The purification process of drinking water aims to alter turbidity, odour, color, bacterial impurities, hardness, and toxic elements. Different types of water purification methods such as distillation, filtration, chlorination, passing ultraviolet light, softening, and ozonation are available in this era. But, we require a procedure that can purify water at home to safeguard health and increase the contribution of all to the development of a nation. In ancient periods, water is purified by adding easily available plant materials like *Ocimum sanctum* leaf or seed coats of *Elettaria cardamomum* or by storing water in copper vessels. *Vetiveria zizanoides* was also used due to its pleasant smell and medicinal properties. Herbs like *Moringa oleifera* and *Zee mays* have been reported for their ability to reduce alum in drinking water through their coagulation property<sup>6</sup>. There are so many herbs used to purify the water. If simple measures to purify water is known to the population, the spreading of waterborne diseases can be reduced up to an extent. As it is mentioned in Siddha literature *Noi Illa Neri*, in ancient times, trees of *Terminalia chebula*, *Phyllanthus amarus*

and *Terminalia bellerica* were grown on the shores of rivers and lakes so that their fruits may fall into the water, purifying and sweetening the water naturally<sup>7</sup>. Hence, this study aims to scientifically evaluate and compare the drinking water quality before and after purification with *Terminalia chebula* (*Kadukkai*) and *Terminalia bellerica* (*Thantrikkai*).

## MATERIALS AND METHODS:

### Collection and Purification of Plant Materials:

*Terminalia chebula* and *Terminalia bellerica* were collected locally from a raw drug store in Aminjikkarai, Chennai, Tamil Nadu, India. The raw drugs were identified and authenticated by the Botanist, and experts in the Gunapadam Department, Govt Siddha Medical College, and used for the study. *Terminalia bellerica* and *Terminalia bellerica* were purified by removing the seeds.

**Water Collection:** Drinking water was collected from Chembarapakkam Lake in Chennai. 6 liters of water was directly collected from the lake into 3 pots with a capacity of 2 liters each. The pots are labeled as samples 1, 2, and 3. These pots with water were immediately kept under a sterilized area in Gunapadam Laboratory, GSMC Chennai at room temperature.

**Water Treatment Procedure:** Sample A container served as control water (untreated water) in the same environment. 50g of purified *Terminalia chebula* (TC) was soaked in water (sample 2) for 6 hours, and 50g of purified *Terminalia bellerica* (TB) was soaked in water (sample 3) for 6 hours and kept in the same environment. After that, all samples were filtered in 3 sterilized plastic containers separately and labelled as samples A, B, and C respectively. Then subjected to physical examination, elemental analysis, and micro-organisms examination.

**TABLE 1: WATER TREATMENT PROCEDUR**

Sample	Plant material	Quantity of plant material	Procedure	Treatment hours
Sample A	Control water	-	-	6 hours
Sample B	<i>Terminalia chebula</i> (TC)	50g	Plant material soaked in water	6 hours
Sample C	<i>Terminalia bellerica</i> (TB)	50g	Plant material soaked in water	6 hours

**Analysis Plan:** All samples were analyzed as per using the Standard protocol, Indian Standard

Drinking Water-Specification IS 10500:1991 (Reaffirmed 2009).

The estimated parameters are-

**Physical Properties:** Colour, Odour, pH Value, Total Hardness, Total Alkalinity, Conductivity @ 25 °C.

**Elements Level:** Calcium as Ca, Chlorine as Cl, Nitrate as NaO<sub>3</sub>, Iron as Fe, Sulphate as SO<sub>4</sub>, Magnesium as Mg.

**Micro-organisms:** *Escherichia coli*, Total Coliform, Total Faecal Coliform.

### Review of Literature:

***Terminalia chebula*:** *Terminalia chebula* belongs to the Combretaceae family and is widely

distributed in India, Sri Lanka, and Burma up to an altitude of 1500 (-2000) m<sup>8</sup>. It is a flowering evergreen tree and is called 'Black Myrobalan' in English. "King of Medicine" is another name for it in Tibet<sup>9</sup>.

Ancient Siddha literature quotes that *Terminalia chebula* 'cares the patients as if a mother cares for her child', and is 'superior to the nourishing mother' for its extraordinary healing power. In Siddha system of medicine, seven different varieties of Kadukkai are mentioned. They are *Visayan*, *Arogini*, *Piruthuvi*, *Amirdham*, *Sethagi*, *Sivanthi*, *Thiruviruthi* and *Abayan*<sup>10</sup>.

**TABLE 2: DIFFERENT VARIETIES OF TERMINALIA CHEBULA**

S. no.	Species name	Features	Therapeutic Indications	Place of origin
1.	Visayan	Resembles <i>Curcumis trigonus</i>	Vatha diseases	Avanthi country
2.	Arogini	Circular four lines on it	Curessannipaatham	Kanyakumari
3.	Prithivi	Softe picarp	Cures insanity and lengthens the lifespan	Sowrastra
4.	Amirtha	Fleshy	Phlegmatic disorders	Kasi
5.	Sivanthi	Goldencolor	Pilesdue to Vaayu	Grow in forest
6.	Thirivirithi	Five colors with three lines	Allkinds of sores	Grow in mountain region
7.	Abayan	Black in color	Certain kinds of diseases in the body	Pothigai hills

### General Characteristics of Kadukkai<sup>10,11</sup>:

**Colour:** Colour of the fruit varies from yellowish brown, uniform brown to light black owing to the variety and places of origin.

**Taste:** Astringent, sweet, sour, pungent, bitter.

**Potency:** Hot

**Division:** Sweet

**Indications:** Athithoolam (obesity), pun (ulcers), kamalai (jaundice), silipatham (filariasis), diseases of cheek, throat, tongue and male genitalia, Pandu (Anemia), Moothrakireecharam (Dysuria), Moolam (Hemorrhoids), Thamaraganoi (Cardiac diseases), kannnoikal (Eye diseases), Aanmaiinmai (impotency), Gunmam (Gastrointestinal conditions) Megharogam (Sexually transmitted diseases), Kuttam (Skin diseases) etc.

**Chemical Constituents:** *Terminalia chebula* is rich in tannin. Chebulic acid, chebulagic acid, gallic acid, and corilagin are the main components of tannin.

Tannin of *Terminalia chebula* are of pyrogallol (hydrolyzable) type<sup>9</sup>. Myrobalans contain astringent principles, tannin (tannic acid) 45% and a large amount of gallic acid (1.21%), chebulagic acid (5%), ellagic acid, mucilage, a brownish yellow coloring matter, chebulinic acid (12.5%) which when heated in water splits up into tannic and gallic acid. tannins, which on hydrolysis yield chebulic acid and d-galloyl glucose.

Fruit contains corilegin, beta D-glucogallin, glucose and sorbitol. In addition, polyphenolic compounds, triterpene glycosides, terchebulin (ellagi tannin), terchebin, syringic acid, punicalagin, terflavin A, flavanoids reducing sugars and starch. Terpene glycosides, arjungenin and arjun glucoside-1 have been isolated from the fruit.

**Pharmacological Actions:** Antioxidant, antimicrobial, antifungal, anticancer, antidiabetic, antiulcer, antiseptic, carminative, cardio protective, digestive, hepato protective, hemetenic, immuno modulator, styptic.



FIG. 1: *TERMINALIA CHEBULA*



FIG. 2: *TERMINALIA BELLERICA*

**Terminalia bellerica**<sup>10, 12</sup>: Thantrikkai (*Terminalia bellerica*) is also referred to as *Aksham, Akkandham, Amutham, Aaramam, Ambalaththi, Erikatpalam, Kandhakatpalam* and *Boothavasagam* in *Siddha* medicine. In English, it is known as ‘Beleric Myrobalan’. It is found growing widely throughout the Indian subcontinent Srilanka, Nepal, Southeast Asia, Bangladesh, and belongs to the family *Combretaceae*<sup>13</sup>. Growing to a height of 20 to 30 meters, it is a huge deciduous tree with a trunk that is buttressed and thick brownish gray bark that has small longitudinal fissures.

**Taste:** Astringent

**Potency:** Hot

**Division:** Sweet

**Indications:** Silanthi nanju (Spider bite), Aankurippun (Genital ulcer), Vellai (Leucorrhoea),

Kuruthiazhal noi (Hypertension), diseases due to vali (Vatha) and thee (Pitha), gives beauty and complexion to the body etc.

**Chemical Constituents:** Bellericanin, or glucoside Gallo-tannic acid, coloring agents, resins, and an oil with a yellowish green tint. Ellagic acid, Gallic Acid, Ellagic and Thiolignans, 7-hydroxy-3'4' (methylene dioxy) flavone and Anolignan B10. Also, the list consists of tannins, ellagic acid, ethyl gallate, galloyl glucose and chebulaginic acid, phenyllembin,  $\beta$ -sitosterol, mannitol, glucose, fructose and rhamnose<sup>14</sup>.

**Pharmacological Actions:** Antioxidant, antibacterial, antidiabetic, anti diarrhoeal, analgesic, immunomodulatory, antihypertensive, antisalmonella, hepatoprotective, antispasmodic and bronchodilatory activities.

**RESULTS:**

**Physical Properties:**

**TABLE 3: PHYSICAL PROPERTIES OF DRINKING WATER SAMPLES AFTER 6 HRS**

S. no.	Characteristic Test and Units	Requirement (acceptable limit)	Permissible limit in the absence of alternate source	Sample A	Sample B	Sample C
1.	Color (Hazen unit)	5	50	1.01	20.0	15.0
2.	Odour	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3.	Taste	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
4.	pH value	6.2 - 8.5	No Relaxation	7.92	7.19	7.12
5.	Total hardness as CaCO <sub>3</sub> (mg/l)	300	600	300	308	332
6.	Total alkalinity as CaCO <sub>3</sub> (mg/l)	200	2000	202	174	198
7.	Conductivity @25oc (µS/cm)	6000	80000	1122	1161	1070

**Interpretation:** Untreated control water had an agreeable taste, odor, and other physical properties

like color, pH, and conductivity were within the acceptable limit. TC and TB fruits treated with



water had an agreeable odor and unobjectionable taste. Color and total hardness values were within

the permissible limit. pH, total alkalinity and conductivity level were within the acceptable limit.

### Elements Level:

**TABLE 4: ELEMENTS LEVEL OF DRINKING WATER SAMPLES AFTER 6 HOURS**

S. no.	Parameters	Acceptable Limit Requirement	Permissible limit in the absence of alternate source	Sample A	Sample B	Sample C
1.	Cl(mg/l)	250	1000	155	149	174
2.	SO <sub>4</sub> (mg/l)	200	400	70	65	76
3.	Ca(mg/l)	75	200	72	80	78
4.	Mg(mg/l)	30	100	31	24	33
5.	Fe(mg/l)	0.3	NoRelaxation	0.37	0.27	0.24
6.	NO <sub>2</sub> (mg/l)	45	100	BDL	BDL	BDL

**Interpretation:** In untreated water, chloride, sulfate and calcium were below the acceptable limit. Magnesium and iron levels were slightly increased but present within the permissible limit.

In TC and TB treated water, chloride and iron were within the acceptable limit, and other elements were within the permissible limit.

### Microorganisms Level:

**TABLE 5: MICROORGANISM LEVEL OF DRINKING WATER SAMPLES AFTER 6 HOURS**

S. no.	Characteristic Test and Units	Requirement (acceptable limit)	Permissible Limit in the absence of alternate source	Sample A	Sample B	Sample C
1.	<i>E. coli</i> (MPN/100ml)	0	0	70	50	30
2.	Total Coli form (MPN/100ml)	0	<50	60	50	50
3.	Faecal Coli form (MPN/100ml)	0	0	20	18	20

**DISCUSSION:** Household water treatment interventions may play an important role in protecting public health where existing water sources, including those delivered *via* a piped network or other improved sources, are not treated properly or become contaminated during distribution or storage<sup>15</sup>. Thus, purification process should be emphasized from the household level<sup>6</sup>.

On physical properties examination, colour of the untreated water sample was within the acceptable limit. Water treated with TC and TB possessed increased colour, but within the permissible limit. This may be due to the compounds produced during the biodegradation of the soaked raw materials. Odour and taste of both the treated and untreated water were agreeable and unobjectionable as per Indian Standards of Drinking Water Specification. The ability of naturally occurring water to neutralize acid added to it is known as alkalinity. The total alkalinity is the acid concentration needed to achieve a certain pH. The conductivity of water indicates how well it can carry electrical current. As total dissolved

solids and electrical conductivity rise, so does the water's corrosiveness<sup>16</sup>. Here, total alkalinity and conductivity of treated water samples were within the acceptable limit.

The pH value for all water samples is in the optimum range (6.5-8.5). According to (WHO, 2006), some water samples are described as alkaline water, and the others are close to neutral. The water in a pure state has a neutral (pH=7)<sup>17</sup>. The pH value of TC and TB treated water are 7.19 and 7.12 respectively, which is near to neutral indicating purified water. Hardness expressed as mg/L CaCO<sub>3</sub> is used to classify waters from "soft" to "very hard"<sup>16</sup>. Water treated with TC and TB showed a slight increase from the acceptable limit, 308 and 332 respectively, and is within the permissible limit. Slight increase may be due to the presence of total dissolved solids.

On elemental examination of untreated water and treated water with TC and TB, presence of Calcium, Chloride, Sulphate, Magnesium, Iron, and Nitrates were assessed. Normally all water

including rain water contains chloride. The concentration of the chlorides determines the water quality because the quality of water get worse after increasing in the concentration of this anions which limit possibilities of using of natural water for different purposes (household, agriculture, industry and etc). The sulfates enter in natural water as the result of the oxidation of the substances from plant and animal origin. The increased concentration of the sulfates at one hand brings about change for the worse of some physical characteristics of water (taste, smell and etc) and on the other hand has destructive influence upon human consumption. Nitrate ( $\text{NO}_3$ ) are found in natural water as the result of the bacteriological oxidation of nitrogenous materials in soil. Nitrates ( $\text{NO}_3$ ) are one of the indicators for the degree of the pollution with organic nitrate-content substances <sup>6</sup>.

Chloride, sulfate, iron and magnesium levels were within the acceptable limit. Nitrate level of the water treated with TC and TB samples were below the detection limit indicating the absence of pollution. The treated Samples B and Chad increased calcium level than control water and within the permissible limit. Thus, it can be used as a calcium supplement for people.

Waterborne illness assay and confirmation of the causal agent's presence are laborious and time-consuming processes. Coliform organisms have been employed to ascertain the biological properties of natural waterways in place of specialized studies. Bacteria of the coliform category are rod-shaped, gram-negative, facultative, aerobic, nonspore-forming, and ferment lactose to gas. *Escherichia coli* is commonly used as an indicator organism.

This organism is present in the intestine of warm-blooded animals, including humans. Therefore, the presence of *Escherichia coli* in water samples indicates the possible presence of pathogenic organisms of human origin <sup>6</sup>. In sample C, *E. coli*, Total coli form and faecal coli form level was reduced. In Sample B, *E. coli* level was reduced, total coliform and Faecal coliform level was decreased than the control water, it may be due to the presence of agricultural fertilizers or contamination from human and animal faeces. A complete eradication of microorganisms were not

achieved. Eradication of the microorganisms from the water could be achieved by boiling the water before or after treating with TC and TB.

**CONCLUSION:** It was found that most of the physio-chemical parameters of the studied samples were within the recommended limits according to the Indian Standard Drinking water - Specification, IS 10500:2012, except for the concentration of micro-organisms like *E. coli* and Coliform. They were recorded higher than the permissible limits, while their concentration decreased in the treated water. *Siddha* medicine suggests using certain herbals to obtain pure drinking water at house level. This scientific study has revealed that soaking *Terminalia chebula* and *Terminalia bellerica* certainly alters the properties of drinking water. Since, it is a baseline study, further studies are essential to assess the requisite amount of plant material and soaking time required to attain healthy drinking water. Though this method cannot be used on a large-scale, it can surely be followed for domestic purposes.

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