

Traditional Water Purification Methods – An Analytical Overview

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ABSTRACT

There can be no state of positive health and well-being without a good quality of water. Ayurveda explains many techniques for water purification that are easy to use, economical, and can be easily applied with household resources. 70% of the human body is made of water, which plays an important role in human health. Water requires purification before consumption. With time the ways of purification have evolved drastically. Now, we have water purifiers packed with RO, UV, UF, TDS and various other technologies. Before introducing these technologies in the present era, in ancient India many traditional methods of purification practice existed. For centuries, “mankind has faced the challenges that dirty drinking water poses. Our forefathers didn't have modern technologies, and they were unaware of the chemical pollutants that make drinking water unsafe for consumption. Still, they were not short on water purification techniques and could achieve the same level of water purification as today's. This article explains an insight into the past; discuss the types of ancient water purification methods, their transformation, and the evolution of sophisticated modern innovations and some traditional water purification techniques with the advantages and limitations of each method.

Keywords: Traditional storage methods, water purification, effect of water on storage, water quality, waterborne diseases.

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INTRODUCTION

Access to clean and safe drinking water remains a significant global concern, especially in developing countries¹. Water is deemed potable when it is free from harmful chemical substances and pathogenic organisms such as viruses, bacteria, and protozoa, which are primary contributors to waterborne diseases². Despite its importance, a large portion of the global population still lacks access to purified drinking water³. Water purification, a key aspect of environmental biotechnology, involves the removal of contaminants from raw water sourced from rivers, lakes, or reservoirs⁴. This process uses physical, chemical, and biological methods to eliminate suspended particles and pathogens, ensuring water safety and potability⁵. While modern techniques are advanced, historical practices reveal that ancient communities also employed basic yet effective methods to purify water⁶.

1. TRADITIONAL WATER PURIFICATION METHODS

An overview of traditional water purification methods provides valuable context for understanding the

advancements in water treatment technologies over time. The following are several indigenous techniques that were historically practiced in India for water purification.

1.1 Filtration:

1.1.1 Purification through Wallowing Sieve⁷

This traditional method was commonly employed when water was contaminated with wind-borne impurities such as dry leaves, stalks, and coarse particles. Water was poured through a wallowing sieve to filter out these visible contaminants, particularly in rural settings. However, this technique was ineffective for treating water with high turbidity or mud content.

1.1.2. Purification through Cloth⁷

This is considered one of the oldest and most widely practiced traditional water purification methods. It typically involves using a thin white cotton cloth or discarded garments as a filtration medium. This method is effective in removing visible impurities such as plant debris, insects,

dust, or coarse mud particles from raw water. However, it is not suitable for treating highly turbid water. It was commonly used for filtering well water. In some regions of India, if the raw water is muddy and odorous, wood ash from *Shorea robusta* is mixed with the water and then filtered through cloth. Among fabrics, silk has been found to be the most effective for water filtration.

Advantages

- Simple and cost-effective
- Suitable for filtering well water
- Old, clean clothes can be reused for filtration

Disadvantages

- Only removes large and suspended particles, not microbial pathogens
- Ineffective for highly turbid water
- Cloth must be washed after each use, and any damage to the cloth affects filtration efficiency

1.1.3. Purification through Clay Vessels⁷

India has a long-standing tradition of pottery, with clay utensils historically used for cooking, storage, and various domestic purposes. Clay vessels with appropriate pore sizes have also been used for water purification, especially for filtering highly turbid water. In this method, turbid water is first collected in a large clay jar and allowed to settle. The water then slowly seeps through the porous walls of the clay vessel and is collected in a clean container placed below¹. This method not only aids in basic filtration but also naturally cools the water

1.1.4. Ceramic Filtration⁷

Ceramic filtration involves the use of clay pots that are mixed with combustible materials such as rice husks or sawdust. These pots are then fired in a kiln, during which the organic material burns away, leaving behind tiny pores that enable water filtration.

Advantages

- Simple to install, operate, and maintain
- Cost-effective method for removing turbidity and pathogens
- Provides safe storage, reducing the risk of re-contamination
- Utilizes easily available waste materials (e.g., husks, sawdust), making them suitable for rural production

Limitations

- Requires regular cleaning by gently scrubbing the surface
- Filter needs replacement every 1–2 years due to potential fine cracks
- Ineffective against chemical contaminants, heavy metals, and some pathogens
- Slow water flow makes it unsuitable for large-scale filtration

- Small suspended particles may clog the pores, necessitating regular maintenance
- Fragile construction demands careful handling

1.1.5. Household Sand Filter⁸

A Household sand filter is a simple and cost-effective method for pre-treating water, especially in rural or low-resource settings.

Construction Steps

1. Place a layer of gravel at the bottom of an earthen pot.
2. Add a layer of coarse sand above the gravel.
3. Add a layer of fine sand atop the coarse sand.
4. Position this pot over a clean container equipped with a spigot at the bottom.
5. Pour raw water into the earthen pot. The water will filter through the sand and gravel layers, collecting in the container below.

Advantages

- Easy to construct using locally available materials.
- Cost-effective solution for water pre-treatment.
- The water flow rate through a sand filter is fast, allowing filtration of more raw water⁹.
- It efficiently removes larger contaminants and some pathogens⁹.

Disadvantages

- Sand filters are unable to eradicate all pathogens and chemical contaminants⁷.
- This method is only efficient for the pre-treatment of raw water, requiring further purification to make it potable.¹⁰

1.1.6. Purification using Plant Parts

Highly turbid water with fine suspended and colloidal particles has traditionally been purified in some southern districts of Tamil Nadu, India, using the nuts of locally available plants. These nuts—particularly from *Strychnos potatorum* (clearing nut), release natural coagulant chemicals when crushed and added to water, helping impurities settle at the bottom¹¹.

After the sedimentation process, the water is typically filtered using a clean cloth¹². This method significantly reduces turbidity and improves water clarity, though it may not eliminate all pathogens¹².

1.1.7. Jempeng Stone Filter Method

Traditional water purification system called Jempeng Stone Filter Method was developed in Saringan Batu Jempeng, Bali, Indonesia, which is an irrigation canal that contains turbid water^{13,14} and is located next to a small artificial pond or bypass channel. Here Jempeng stone filter units are installed in this pond¹⁵. They are formed by a porous volcanic stone called *cadras*, and are about 60 cm in height, 50 cm in diameter and have a wall thickness of 10-12 cm.

This unit is supported on a gravel bed. The muddy water from the canal is pumped into the pond and passed through the walls of the filter unit which is porous, trapping the impurities. The filtered water is stored in the unit, and can be drawn. This technique can achieve extremely high turbidity removal and has low operating cost, as only building cost needs to be paid. Importantly, it needs little maintenance, and it's suitable for remote places where resources are scarce.

This is a very economical method, and can be used to treat water having high turbidity. It does not have a large filtration rate, however. Jempeng Stone Filter is one of the traditional techniques of water purification used in India.

1.2 Sedimentation

In ancient Egypt, Alum was used as a sedimentation agent for suspended particles. Three-Pot Water Treatment Method is one of the traditional water treatment methods that is used to reduce turbidity in rural areas. The three earthen pots are filled 1 by 1 and left to stand 3 days to allow impurities to settle out.

Methodology

The first pot is filled with raw/turbid water and left to rest for 24 hours. Water is then moved to a second pot for another 24 hours, before being moved to a third pot where it is allowed to settle for the final 24 hours. Pots are cleaned after every transfer to avoid recontamination and the last water is considered safer for use as it has lower turbidities²⁰.

Advantages

- Low-cost and locally sourced¹⁹
- Simple and requires no technical expertise²⁰
- Reduces turbidity effectively¹⁹

Limitations²⁰

- Does not eliminate all pathogens or chemicals
- Time-intensive and needs daily attention
- Requires regular pot cleaning to avoid microbial growth

2. TRADITIONAL WAYS OF WATER DISINFECTION ²¹:

2.1 Boiling and Solar Disinfection

These are among the most widely practiced traditional techniques for water disinfection, especially in rural and resource-limited settings.

2.1.1 Boiling

Boiling is a time-tested, reliable method for eliminating pathogenic microorganisms from drinking water. The process involves adding filtered water to a clean boiling pan and heating it until it reaches a rolling boil at 100 °C. Sustaining this vigorous boil for 10–15 minutes ensures the effective inactivation of bacteria, viruses, and protozoa. Once boiled, the water should be allowed to cool naturally at room temperature before it is safe for consumption.

Advantage

- Highly effective in killing all types of pathogenic microorganisms.

Disadvantages

- Requires fuel or energy, making it potentially costly depending on the fuel source.
- Prolonged boiling may lead to flat-tasting water due to loss of dissolved gases.

2.1.2 Solar Disinfection

SODIS is a simple, low-cost, and fuel-free water purification method, ideal for small quantities of low-turbidity water²². It utilizes solar radiation to inactivate pathogenic micro-organisms. The process involves filling transparent PET or glass bottles with filtered water and placing them on heat-absorbent surfaces (e.g., black metal sheets or roof tiles). These are exposed to direct sunlight for at least 6 hours, allowing UV-A rays and heat to disinfect the water.

Advantages

- Inexpensive and eco-friendly
- Effectively eliminates most pathogens
- Suitable for household-level, small-scale use

Disadvantages

- Ineffective during cloudy weather or at night
- Not suitable for large volumes of water

3. PLANT-BASED TRADITIONAL WATER PURIFICATION PRACTICES

3.1. Natural Coagulants from Plant Seeds

In various parts of the world, such as in Africa and also in Latin America, plant seeds have been traditionally utilized for purification of water; *Moringa oleifera* seeds are excellent coagulants with high levels of natural cationic proteins that help to decrease the level of turbidity and the presence of microbes in water. The preparation entails drying of the seed and grinding it to fine powder, mixing with water and adding the slurry to the water, and treating it²⁸. Coagulating properties have also been found in other plant seeds, such as *Vicia faba* (broad beans), peach (*Prunus persica*) and bean seeds, if they are used in the proper proportions.

3.2. Aquatic Plants in Wastewater Treatment

The properties of removal of nutrients and heavy metals by several aquatic plants have been utilized in wastewater treatment systems. One of the most widely studied and effective species in this regard is *Eichhornia crassipes* (water hyacinth). Absorbs and adsorbs metals like lead, copper and zinc. Similarly *Schoenoplectus tatora* (totora), endemic species of Peru and Bolivia, have been utilized in engineered wetlands for removal of nutrients and metals,³¹ and are also a well-known species in Sub-Saharan region. These systems also encourage the microbial degradation and sedimentation, which also improves the quality of

water.

Cattays (*Typha* species) are present in shallow water and can absorb nitrates, phosphates and heavy metals, such as manganese and copper. These plants have been found to support several purification processes such as biological decomposition of organic pollutants, nitrogen fixation and denitrification and the adsorption of phosphorus³⁰

3.3. Advantages and Limitations

These water purification systems that utilize plants have many benefits; they are inexpensive, eco-friendly and can be easily maintained, particularly in rural areas. In addition, the plants are hardy, drought resistant and fast growing and can be grown on an extensive basis. Constructed wetland systems also produce the harvestable biomass product, and can also be used to decrease nutrient pollution.

Seasonal plants like aquatic plants are likely to be less effective in cold weather seasons³². There is also limited seed availability or in some cases, environments, like totora wetlands, require investment and land³¹. In addition, the biomass generated in these systems may contain high levels of heavy metals and this may limit safe re-use of harvested biomass.

4. HISTORICAL EVOLUTION OF WATER TREATMENT

Water treatment goes back to the use of around 2000 BCE, and there are several ancient Sanskrit and Greek texts that talk about a variety of water treatment methods, such as boiling, filtration and straining. These early civilizations were aware of the need to treat water to render it safe for drinking purposes. The ancient Egyptians used alum as an example of chemical coagulation, to cause sediment to settle by suspending particles. The concept of filtration was expanded by Greek Physician Hippocrates when he created a Hippocratic Sleeve (cloth bag for the filtration of water for his patients). This is regarded as one of the oldest of the water purification cloth filter. The Romans also made great advances in water purification, achieving this by constructing aqueducts and by using sand filters³⁶.

5. ANCIENT METHODS OF WATER TREATMENT:

5.1. Boiling

The earliest and most common method of water purification that was used in ancient times is boiling the water. It is not a chemical treatment, but can destroy most pathogenic microorganisms. Boiling became one of the staple water treatment methods to be used by civilizations in both the East and West, particularly in times of disease outbreaks.

5.2. Filtration Using Natural Materials

Natural filtration using materials such as sand, gravel, and cloth was commonly practiced. Sand and gravel beds were used to allow water to percolate slowly, trapping larger particles and impurities³⁸. Cloth filtration, where fabric acted as a simple sieve, was another method adopted across various regions³⁵. These methods, however, were not effective against dissolved chemical contaminants, which ancient civilizations were largely unaware of.

5.3. Storage in Copper Vessels

In the ancient India the storage of water in copper vessels was prevalent and even today it is a regular practice in rural India. Copper has exhibited anti-microbial activity such as bactericidal activity against *Escherichia coli*, *Salmonella typhi* and *Vibrio cholerae* which can be used practical and effective ways of microbial control¹³⁹.

5.4. Fermentation-Based Purification

Fermentation methods were used to enhance water safety in ancient China. The beneficial microbes that were introduced in the natural fermentation process were able to outcompete the harmful microbes and thus minimised the risks of water borne diseases⁴⁰. This is an early technique of biological treatment that demonstrates a certain level of microbial awareness.

5.5. Activated Charcoal Filtration:

Activated carbon water filters were first used in 400BCE. The most important feature is its natural capacity to purify water, absorb impurities, fragrant vapours and some toxins, discovered since ancient times. The ability of the material to filter impurities, odours and some toxins from water was the most significant known property of the ancient societies. Today's home and business carbon filters for water purification are the result of this method.

6. MODERN WATER-TREATMENT METHODS

The transition from empirical, household-scale practices to engineered, high-efficiency technologies has greatly improved the microbiological and chemical safety of drinking water worldwide. The principal contemporary methods are summarised below.

6.1. Chlorination

Pressurised chlorine gas or hypochlorite solution is dosed into water, where hypochlorous acid (HOCl) and the hypochlorite ion (OCl⁻) penetrate cell walls, oxidise essential enzymes, and achieve log-scale reductions in bacteria and viruses⁴². Although highly effective and inexpensive, chlorination shows limited efficacy against certain protozoan cysts (e.g., *Cryptosporidium parvum*) and can generate regulated disinfection by-products.

6.2. Reverse Osmosis (RO)

RO employs a semi-permeable polyamide thin-film composite membrane to reject >95 % of dissolved salts, organic micropollutants, and most pathogens by applying hydraulic pressure that exceeds the solution's osmotic pressure⁴³. Modern spiral-wound modules, coupled with energy-recovery turbines, have reduced the specific energy demand of seawater RO to <3 kWh m⁻³.

6.3. Ultraviolet (UV) Disinfection

Low-pressure (254 nm) or medium-pressure (polychromatic) UV lamps deliver germicidal doses that induce pyrimidine dimer formation in microbial DNA/RNA, preventing replication⁴⁴. UV achieves >4-log

inactivation of enteric viruses and *Giardia* cysts without altering water chemistry; however, it affords no residual disinfectant and requires clear, low-turbidity influent.

6.4 Advanced Filtration Technologies

6.4.1 Ceramic microfiltration

Low cost clay/sawdust pot filters offer a bacterial reduction of 2-3 log, which means that they provide turbidity and bacterial reduction benefits for household applications in low income communities⁴⁵.

6.4.2 Pressure-driven membranes

Micro, ultra and nanofiltration membranes have absolute size rejection and they operate at less pressure than RO, and are now starting to be used with coagulation or ozonation to avoid fouling in hybrid systems⁴⁶.

6.4.3 Rapid sand filtration

This is an extension of the slow sand concept and in conventional plants, dual-media (anthracite/sand) filters are used as a polishing stage prior to disinfection to provide 1–2-log turbidity reduction⁴¹.

7. WATER FILTRATION METHODS

With the development and advancement of water purification technology, individuals have been making efforts to obtain clean and potable water. Every period has presented its own take on a practice or innovation that is unique to those methods of today.

7.1 The Egyptians (1500 B.C.)

The ancient Egyptians were first to develop a water purification system. They used the process of boiling, solar heating and heated iron in water to kill the pathogens. Many people used to filter sand and gravel to take out the dirt, which they knew was dirt. Indeed, there are instructions for such purification practices inscribed on the tombs of Amenophis II and Ramses II.

7.2 Ancient Greece (500 B.C. – 500 A.D.)

The Greeks advanced water filtration further. Hippocrates, often called the Father of Medicine, developed the *Hippocratic sleeve* — a cloth bag used to filter boiled water. This helped remove suspended particles and improve its taste⁴⁸.

7.3 1671 A.D. – Robert Bacon’s Experiment

The Greeks take the course of water filtration further. The Hippocratic sleeve, a cloth bag for filtering boiled water, was developed by Hippocrates, who is known as the Father of Medicine. This helped to clarify the water and enhance its flavor.

7.4 1700–1800s A.D. – Early Municipal Systems

Philippe de La Hire suggested the use of a sand filter, which would filter rainwater with the purified water added to the water supply, around the time of the French Academy of

Sciences, in 1703. The concept was put in practice for the first time in Paisley, Scotland (1804) with a slow sand filter for domestic water.

7.5 1854 A.D. – John Snow and Cholera

Dr. John Snow was able to demonstrate that contaminated water was responsible for the transmission of Cholera in London during the outbreak in 1854. His work is the origin of contemporary epidemiology, and the significance of clean water⁵¹.

7.6 1900s A.D. – Regulatory Milestones

In the 20th century, however, rules began to impact water quality. The Safe Drinking Water Act (SDWA) was first passed in the U.S. in 1974 and placed the responsibility of establishing and enforcing standards for safe drinking water on the Environmental Protection Agency (EPA)⁵².

8. WATER PURIFICATION IN VEDIC AND SAMHITA PERIOD

Yajurveda only mentioned water purification by passing through sunrays and kusha.⁵³ *Ayurveda* the Indian system of medicine, has also given importance to water by being included under *Pancha Mahabhoota*. As per *Ayurveda*, Oedema (*Shotha*), anemia (*Pandu*), indigestion (*Ajirna*), skin diseases (*Twak vikara*), cough (*Kasa*), rhinorrhea (*Pratishyaya*), abdominal pain (*Udar shoola*), abdominal distension (*Udar addhman*), fever (*Jwara*), anorexia (*Agni sada*), conjunctivitis (*Netra abhishyanda*), itching (*Kandu*), and boils can all result from drinking contaminated and unsafe water.^{54,55}

8.1 Sushruta Samhita

Acharya Sushruta provided a thorough analysis of the water purifying procedure in *Sutrasthana's Dravadravya vidhi adhyaya* in which six *doshas* of *jala* have been described, i.e. *sparsha*, *rupa*, *rasa*, *Gandha*, *virya*, and *vipaka*⁵⁶. In order to prevent waterborne illnesses, he had discussed disinfecting the water in addition to the purification process. *Agnikwathana*, *Suryatap-Prataptam*, *Taptaay Pind-Sikta-Lostranaam Nirvapana* are methods of purification techniques, and for make the water palatable along with to get rid of the unpleasant smell (*Sugandha*) Lotus, pandamus (*Ketaki*), Mesua ferrea (*Nagakeshar*), Michelia (*Champaka*), Stereospermum suaveolens (*Patala*), and Nymphaea alba (*Uipala*) were used to .⁵⁷ For Clearing the turbidity (*Prasadana*) *Kataka*, *Gomeda*, *Bisagranthi*, *Saivala Moola*, *Vastra*, *Mukta* and *Mani* are used.⁵⁸ *Sushruta kalpasthana dushita jala sodhana vidhi* has also mentioned i.e. The ashes obtained by incinerating plant materials such as *Dhava*, *Asvakarna*, *Asana*, *Paribhadra*, *Patala*, *Siddhaka*, *Moksaka*, *Rajadruma*, and *Somavalka* are recommended for water purification. After cooling, the ash is traditionally dispersed over natural water bodies such as lakes and reservoirs. For domestic use, a small quantity (approximately a handful) of the ash is added to stored drinking water to improve its quality.⁵⁹

8.2 Ashtanga Samghraha

According to *Ashtanga samghraha*, boiling water with ash from *Ajashringi*, *Vishala*, *Vishaghni*, *Uttamarni*, *Fannijaka*, and *Prativisha* yields *prakshepa* medications such as *Saral* and *Haridra-dwaya* to which *prakshepa dravya* such as *Elaychi*, *Uddichya*, *Manjishtha*, *Rasna*, and *Bakuchi* to be added. This medicinal water used to cleanse harmful substances.⁶⁰ To treat poisonous water, ash from *Patala*, *Paribhadra*, *Ashvakarna*, *Shmyaka*, and *Shigr* were added.⁶¹ Various *Jala pokshana yogas*, such as *bilvadi yoga* and *selvadi yoga*, have been described for detoxifying contaminated water using different herbal formulations. A *Kwatha* (decoction) should be prepared from the specific ingredients prescribed in each formulation and sprinkled over the poisoned water to achieve purification.⁶²

8.3 Nighantu period

During the *Nighantu* period, *Raj Nighantu* provides a description of *Chandrakanta Mani*, and *Dhanwantari Nighantu* discusses the use of *Kwathita Jala*. The descriptions of *Bhavprakash*⁶³, *Kaideva Nighantu*⁶⁴, and *Shaligrama Nighantu*⁶⁵ are largely consistent with that of *Sushruta Samhita*.

DISCUSSION

The use of traditional water purification techniques has been used in rural areas for centuries worldwide²³. The basic techniques employed, and often those using materials that are easily available to you, such as sand, cloth and stone, generally use the task of filtering the impurities out that you can see in the raw water. These include methods suitable for the removal of physical material (e.g. leaves, twigs, suspended material) but are not generally able to achieve microbial safety standards as required for potable water²⁵. These methods have been successfully used in past to get aesthetically pleasing water for domestic uses²⁴. But, they were not efficient at killing pathogenic microorganisms which caused health problems²³. To reverse this trend, a disinfection process such as boiling or Solar Disinfection has been shown to greatly improve the safety of water for human consumption²⁶.

The shortcomings of the old water treatment technologies sparked the development of new technologies for water treatment²⁴. The need for microbiological security was the reason of the development of modern water treatment technologies²⁵ due to inadequacies of traditional technologies for ensuring microbiological safety. Typical modern water systems will include sedimentation, filtration and disinfection processes to attain water that is of very high quality²³.

Such efficient water purification processes are more important than ever since only about 1.2% of the water on Earth is available and suitable for human consumption and population growth and climate change cause many issues²⁶. Therefore, the need of the many communities lacking a centralized system of water treatment for simple but improved household level treatment methods, particularly when traditional treatment methods are combined with simple disinfection methods.

CONCLUSION

In the Yajurveda, water is known as the elixir of life and is a source of energy and is also central in the evolution and functioning of life on earth. It is taken to be as a symbol of health, happiness, vitality as well as spiritual purity and is compared to a life-giving mother. In ancient Indian literature there are several traditional water quality measurement and monitoring techniques noted. These include things like herbal decoctions, gem purification and ritualistic sprinkling⁷. A continuity between the different cultures in terms of the necessity of potable water for public health was attempted by trying to integrate and compare the traditional Indian technique with the other ancient and classical methods such as Aegypti method of Europe, the Greek method, boiling, sedimentation and filtration. Overall, this synthesis highlights the enduring importance of water quality management and provides guidance and insights for designing cost-effective and sustainable water purification solutions based on traditional knowledge and contemporary practices.

Conflict of interest

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