

A CRITICAL REVIEW OF AYURVEDIC & MODERN METHODS OF PURIFICATION OF DRINKING WATER

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ABSTRACT

Ayurvedic methods of purification of drinking water by means of filtration of tap water by clean & neat cotton clothes daily, Treatment of filtered water with various herbs mentioned and boiling water vigorously for 1 minute is very effective till which having excellence as cost effective, without any major complication than modern method. The safety & accessibility of drinking water are major concern throughout the world. As all sources are likely to be contaminated by toxic element like arsenic, fluoride and microbes etc. health risk may arise from consumption of such water. At least 11% of the world population is without the access to safe drinking water ^[1]. The process of purification of drinking water is aimed to alter toxic element, microbe, , etc. According to Times Of India Newspaper dated 24 January 2015 (Source- NMMC's Environmental Status Report 2013-14), the drinking water supplied to city is very high on quality. It's just 1.02% short of achieving the 100% purity mark in 2014-15. Opposite to this, a major task in front of authorities in developing and underdeveloped countries is providing drinking water to their people. In many countries like India, villages are geographically apart and inhabitants may have to walk kilometers to fetch water. On such situation, supplying clean drinking water remains a major problem.

Key words: arsenic, fluoride, microbes, turbidity

INTRODUCTION

The recognition of water is important as shown "By means of water God gives life to every living thing", (Islam: Quran 21:30). "The iota of life is created in water" (Hinduism: Atharvaveda, Asthagarideyam). "Whoever believes in me, stream of living water will pour from within him" (Christianity: John 7:38). Since 2000, United Nations Committee on economic, social and cultural

rights elaborated the necessity of drinking water and included this as a person's right to it.

Economically a country is pulled back when drinking water supply is not proper. Absence of clean water and sanitation are major risk factors for ill health.[23]

The safety & accessibility of drinking water are major concern throughout the world. As

all sources are likely to be contaminated by toxic element like arsenic, fluoride and microbes etc. health risk may arise from consumption of such water. At least 11% of the world population is without the access to safe drinking water^[1]. The process of purification of drinking water is aimed to alter toxic element, microbe, turbidity etc. According to Times Of India Newspaper dated 24 January 2015 (Source- NMMC's Environmental Status Report 2013-14), the drinking water supplied to city is very high on quality. It's just 1.02% short of achieving the 100% purity mark in 2014-15. Opposite to this, a major task in front of authorities in developing and underdeveloped countries is providing drinking water to their people. In many countries like India, villages are geographically apart and inhabitants may have to walk kilometers to fetch water. On such situation, supplying clean drinking water remains a major problem.[24]

In Ayurveda, water contamination & preventive measures for purification of drinking water is explained in detail.

Aims and Objectives

1. To evaluate, discuss & elaborate the concept of contamination of drinking water as per Ayurveda & Modern Medical Science.
2. To evaluate, discuss & elaborate various methods of purification of drinking water as per Ayurveda & Modern Medical Science.

Methodology-

Type of Study – Conceptual and Observational

This article is based on textual review & observations. Material related to drinking water was collected from Ayurvedic & Modern texts. The *Ayurvedic* Texts used in this study

were *CharakSamhita*, *SushrutSamhita*, *Ash-tangSangraha*, *Ash-tangHrudya*, *Kashyapsamhita*, *Vangsen-Samhita*, *Baishajya-Ratnavali*, *Yogaratkarak*, *Bhavaprakasha* and available commentaries of those. Various websites have also been referred to collect information on the relevant topics.

Causes of Water Contamination as per Ayurveda^[7]

Drinking water will be contaminated by decomposed dead bodies of aquatic animal (like Insect, water snake etc.), decomposed aquatic plant, unexposed to sun-moon-air, microorganism, mixed with rain water^[2, 3, 4, 5, 6]. Ayurveda has mentioned contamination of water is one of the causative factor to produce a waterborne disease like diarrhoea^[7].

Causes of Water Contamination as per Modern Science^[9]

Many classes of pathogens excreted in feces are able to initiate water contamination & waterborne infections. There are bacterial pathogens, including enteric and aquatic bacteria, enteric viruses, and enteric protozoa, which are strongly resistant in the water environment and to most disinfectants. The water is also contaminated by various toxicants & poisonous water will be slimy, possesses strong odor, frothy & has line on the surface. Frog & fishes living in such water dies due to intoxication. Men, horse, elephant who drink it, also produce intoxication.

Characteristics of Pure Drinking Water as per Modern Science

Table: 1 Microbiological Requirement in Drinking Water as per Indian Standard^[9]

Characteristic	IS 14543:2004	IS 13428 :2005
Escherichia coli (or thermo tolerant bacteria)	absent in 250	ml sample
Coli form bacteria	absent in 250	ml sample
Faecal streptococci and Staphylococcus aureus	absent in 250	ml sample
Sulphite reducing anaerobes	absent in 250	ml sample
Pseudomonas aeruginosa	absent in 250	ml sample
Aerobic Microbial Count -at 20 to 22°C in 72 h	shall not exceed 100 per ml	--NS--
Yeast and Mould	absent in 250	absent in 250
Salmonella and Shigella	absent in 250	absent in 250
Vibrio cholera and V. parahaemolyticus	absent in 250	absent in 250

Table: 2 Physical Requirements in Drinking Water as per Indian Standard ^[9]

Characteristic	IS 14543:2004	IS 13428 :2005
Color, true color units, Max	2	2
Odor	Agreeable	Agreeable
Taste	Agreeable	Agreeable
Turbidity, NTU, Max	2	2
Total dissolved solids, mg/l	500	150 TO 700
pH value	6.5 TO 8.5	6.5 TO 8.5

Table: 3 General Parameters Concerning Substances Undesirable in Excessive Amounts in Drinking Water as per Indian Standard ^[16]

Characteristic	IS 14543:2004	IS 13428 :2005
Nitrate (as NO₃), mg/l, Max	45	50
Nitrite (as NO₂), mg/l, Max	0.02	0.02
Fluoride (as F), mg/l, Max	1.0	1.0
Chloride (as Cl), mg/l, Max	200	200
Sulphate (as SO₄), mg/l, Max	200	200
Alkalinity (as HCO₃), mg/l, Max	200	75 to 400
Phenolic compounds (as C₆H₅OH), mg/l, Max	Absent	Absent
Sulphide (as H₂S), mg/l, Max	0.005	0.005

Table: 4 Parameter Concerning Toxic Substances in Drinking Water as per Indian Standard^{16]}

Characteristic	IS 14543:2004	IS 13428 :2005
Mercury (as Hg), mg/l, Max	0.001	0.001
Arsenic (as As), mg/l, Max	0.05	0.05
Cyanide (as CN), mg/l, Max	Absent	Absent
Lead (as Pb), mg/l, Max	0.01	0.01
Pesticide residues considered individually	Not more than 0.0001 mg/1	--
Total pesticide Residue	Not more than 0.0005 mg/1	--

Table: 5 Characteristics of contaminated water as per Ayurveda^[2, 3, 4 &5]

Sr.	Name of Examination	Observation
1	Examination by means of Touch	Slimy, Insect laden, disagreeable to teeth, hot or thick feeling.
2	Examination by means of Appearance	Discolored, Unsanitary & Frothy.
3	Examination by means of Taste	Distasteful, Tasteless, Sour & Salty.
4	Examination by means of Smell	Fowl or Flesh

Table: 6 Characteristics of contaminated water as per Ayurveda specially contaminated by poison^[10]

Sr.	Name of Examination	Observation
1	Examination by means of Touch	Slimy
2	Examination by means of Appearance	Frothy & like line on the surface.
4	Examination by means of Smell	Strong Odor

Diseases due to ingestion of contaminated water as per Ayurveda^[4 & 5]

Excessive thirst (Trishna), flatulence(Adhmana), abdominal disease(Udarvyadhi), fever(Jwara), cough(Kasa), loss of appetite(Kshudhamandhya), Goiter(Granthi), heaviness(Angagaurav), abdominal pain(Udarshool),

tion(Kosthabaddhata), edema(Shotha), anemia(Pandu), indigestion(Ajeerna), asthma(Shwasa) & rhinitis(Pratishaya).

Diseases due to contact of contaminated water as per Ayurveda^[4&5]

Contact of contaminated water by means of bath or any other ways causes skin disorder (Kustha), itching(Kandu) & conjunctivitis(Netrabhishyanda).

Diseases due to ingestion of water specially contaminated with poison as per Ayurveda^[2]

Vomiting (Chhardi) , Fever (Jwara) , burning(Daha) & swelling(Shotha).

The various Ayurvedic method of purification of drinking water

a. **Mechanical Purification** - This method of purification by clean & neat cotton clothes will be applied for mechanical contamination like mud^[2 & 10].

b. **Thermal purification-** This method of purification by heating on domestic fuel, sunlight or dropping heated solid in water will be applied for destroying of microorganism^[2 & 4]. The most effective means of water purification is boiling. Keeping water at a vigorous and rolling boil for 1 to 3 minutes depending on elevation will eliminate all bacteriological contaminants.

c. **Herbal purification-** This method of purification by scenting the Ayurvedic Herb like Delphinium Denudatum, Strychnous Potatorum & flower of Mesua Ferrea, Michelia Champaka & Nelumbo Nucifera etc. for destroying of unwanted favor of water^[2 & 4].

d. **Vishanashak (Anti-Toxic) Herbs for purification of water-** Anogessus Latifolia, Diptereocapus Turbinatus, Pterocarpus Marsupium, Erythrina Variegata, Stereospermum Suaveolens, Vitex Negundo, Casia Fistula, Acacia Catach should be burnt & ash should be spread on the water from reservoirs like lake & a handful of this ash should be put into the pot containing drinking water to be used when needed^[10].

e. **Container to store purified drinking water-** After purification of water, it will be store in any one of the pot belonging to Gold, Silver, Copper, Bronze or Devine stone^[2].

Traditional Methods of purification of drinking water in all over the world^[11]

Some of the traditional methods of purification of drinking water used in all over the world are-

- **Filtration through Wincrowing Sieve-** This type of filtration is used when the water sources is polluted by wild-borne impurities such as dry leaves, stalks, and coarse particles. The raw material is passed through a Wincrowing Sieve, and the impurities are filtered. This type of filter is widely used in village of the Bamako area, Mali. This method cannot be used when the raw water is highly turbid or muddy, since the sieve cannot filter fine suspended particles in raw water.

- **Filtration through cloth-** Thin white cotton clothes or a discarded garment is used as the filter medium. This filter can filter raw water containing such impurities as plant debris, insect, dust particles or coarse mud particles. Filtration of suspended particles present in water can be achieved only to very small extent. Therefore, this type of filtration is not suitable for highly turbid water. It is most suitable for filtration of well water. This practice of cloth filtration is quite common in villages in India, Mali, and southern part of Niger and probably in many other parts of the developing world. In some part of the Indian villages, if the raw water is muddy & highly odorous, then wood ash of the Sal tree (Shora Robusta) is mixed with water & then filter through the cloth.

- **Filtration through Clay vessel-** Clay vessels with a suitable pore size are sometimes used to filter highly turbid water. Turbid water is collected in a big clay jar & allowed to settle down. This trickled water is

collected in a vessel (usually in a clay pot) by placing it at the bottom of the porous clay jar. This method of water treatment is common in Egypt.

- **Clarifications & Filtration using plant Parts-** Highly turbid water with fine suspended & colloidal particles are first coalesced and settled out using the nuts of a locally available plant, in some of the southern district of Tamilnadu India, which is then filtered using cloth filters. Studies have found that the nut excrete coagulant chemicals upon soaking which does the trick. Similarly wiry roots of the rhizomes from the ‘Ramachham’ (*Vitiveria Zizanoides*) are placed in clay jar, which has tinny whole in it bottom. Raw water is poured into this jar, and then water is allowed to filter through these layers of roots. The water then trickles through the tiny holes at the bottom of the jar. The filter water is collected at the bottom of the jar. Usually this filtered water is very clear & has pleasant smell. This type of water filtration is common in southern district of Kerala & Tamilnadu India.

- **Jampeng Stone Filter Method-** This type of water filtration method is de-

veloped in SaringanbatuJempeng, Bali, Indonesia. Here, a small artificial pond or a by-pass channel is cut by the side to an irrigation canal, which carried muddy water. Jampeng Stone Filter unit are placed in the artificial ponds. The filter unit is carved out a porous material called ‘Cadas’. This unit has an average height of 60 cm, a diameter of 50cm, and a wall with thickness of 10-12cm. This type of unit can be placed on the top of a stone-supporting gravel bed. Muddy water filters through the porous wall of the filter unit and gets collected inside. This type of unit can be used as a village water treatment unit. It can treat even highly turbid water. The main feature of this unit is that the only cost involved is the investment cost. Practically there is no operational or maintenance cost such as for cleaning.

Water Treatment Methods - Overview and Historical Perspective as per WHO^[12]

- The various physical and chemical methods for water treatment at the household level or point-of-use are summarized in Tables 7 and 8, respectively.

Table: 7 Physical Methods for Water Treatment at the Household Levels^[12]

Method	Availability and Practicality	Technical Difficulty	Cost	Microbial Efficacy
Boiling or heating with fuels	Varies	Low-Moderate	Varies	High
Exposure to Sunlight	High	Low-Moderate	Varies	Moderate
UV Irradiation (lamps)	Varies	Low-Moderate	Moderate- High	High
Plain Sedimentation	High	Low	Low	Low
Filtration	Varies	Low –Moderate	Varies	Varies
Aeration	Moderate	Low	Low	Low

Table: 8 Chemical or Physical-Chemical Methods for Water Treatment at the Household Level^[12]

Method	Availability and Practicality	Technical Difficulty	Cost	Microbial Efficacy
Coagulation-Flocculation or Precipitation	Moderate	Moderate	Varies	Varies
Adsorption (charcoal, carbon, clay, etc.)	High to moderate	Low to moderate	Varies	Varies with adsorbent
Ion exchange	Low to moderate	Moderate to High	Usually High	Low or moderate
Chlorination	High to moderate	Low to moderate	Moderate	High
Ozonation	Low	High	High	High
Chlorine Dioxide	Low	Varies	High	High
Iodination (elemental, salt or resin)	Low	Moderate to High	High	High
Acid or base treatment with-citrus juice, hydroxide salts, etc.	High	Low	Varies	Varies
Silver or Copper	High	Low	Low	Low
Combined systems: chemical coagulation-flocculation, filtration, chemical disinfection	Low to Moderate	Moderate to High	High	High

DISCUSSION

Ayurveda has mentioned , *Kshudra Jantu* (Micro-organism) is one of cause for water contamination which will be found in water containing decomposed dead bodies of aquatic animal (like Insect, water snake etc.), decomposed aquatic plant, unexposed to sunlight, moonbeam & air, microorganism, mixed with rain water^[2, 4, 5 & 6].

It is interesting to note that several methods existed in ancient time for assessing and maintaining water quality as revealed by the Vedas and Texts on "Ayurveda". In Brihat-Samhita, written and compiled by Varahamihira, several methods for obtaining potable water from contaminated sources, using plants, metals and heat are described besides

the purification process of ground water has been dealt with at length. A powder mix extracted from herbs like Anjan, Bhadramushtha, Khas (vetiver), Amla (*emblicaofficinalis*, gooseberry) and Nirmali (*bhuiamla / kataka*), were in use in measured quantities for purifying water in wells. Sushruta, the famous Indian Surgeon provided a detailed practical guidance for water purification. He showed that with herbs and other natural substance muddy water could be purified, using Nirmali seeds, roots of Kamal (lotus/water lily), rhizomes of algae and three stones, Gomed (garnet) Moti (pearl) and Sphatik (quartz crystal). He suggested exposing contaminated water to the sun or

immersing a red hot iron rod or hot sand in it, for purification purpose.

Solar water purification involves purifying water for drinking and household purposes through the usage of solar energy in many different ways. Using solar energy for water treatment has become more common as it is a usually low-technology solution that works to capture the heat and energy from the sun to make water cleaner and healthier for human use and consumption. Solar water treatment is particularly beneficial for rural communities, as they do not have other forms of water purification infrastructure and more importantly, electricity to run such structures. The most positive feature about solar water purification is that there is no requirement of fuel. It's precisely due to the lack of fuel that makes solar applications relatively superior than conventional sources of energy as it does not cause pollution (global warming, acid rain, ozone depletion) or health hazards associated with pollution.

Solar radiation reduces the bacterial content of water, and may therefore offer a method for disinfection of drinking water that requires few resources and no expertise^[13]. Irradiation treatment has been proved to be a powerful tool in inactivating human pathogenic microorganisms in water, waste water and sludge, in food and medical products (Lagunas-Solar, 1995; Farooq et al., 1993)^[14]. Here point to be noted that the water from unexposed to sunlight may be contaminated & need to expose for decontamination as Ayurveda has been already mentioned.

Microphages can be used as a potential disinfectant in the natural water, which need fresh oxygen to live & can kill the various microorganism from waste water. Indeed,

Thomas et al. (2002) have already begun investigations into phage bio-control in wastewater treatment and this review has highlighted aspects of wastewater treatment where phage-induced bacterial lysis might be harnessed in order to deliver improvements in sludge dewater ability and digestibility, to control foaming and to control levels of specific bacterial pathogens^[15]. This is what the Ayurveda has been already mentioned the water from unexposed to air contaminated & need to aeration.

Improper maintenance of a modern water filter can infect, lead to dangerous levels of bacteria building and growing within the actual filter, similar to a dirty kitchen sponge. Charcoal filters are especially at risk for bacteria buildup. Filtration of drinking water daily by means of clean & neat cotton clothes is one of excellence solution due to affordable, easy to use & effective.

There is chances of recontamination of water from modern electrical system of filtration, which having electrical heating system. But decontamination of drinking water by means of heating of water before uses daily is one of best solution. Boiling & heating of water with fuel has been used to disinfect household water since ancient time. It is effective to destroying all classes of water-borne pathogen (Viruses, Bacteria, Fungi, Protozoa & Helminthes ova) & effectively applied to all waters including those high in turbidity & dissolved constituents^[16].

There a few things to be aware of regarding water purification using Chlorine. Many Chlorine tablets are considered dangerous goods and need to be handled very carefully. Direct contact with chlorine tablets or resulting dust can cause severe skin and respiratory irritation. Chlorine tablets are also highly

flammable and potentially explosive when mixed with acids or other common chemicals. The biggest complaint that is reported by those using Chlorine tablets for water purification is the taste. Halazone tablets, household bleach or calcium / sodium hypochlorite create a very strong “chlorine” taste and odor in the water. Many indigenous populations around the world refuse to use water purification tablets made from Chlorine because the resulting water is so unpalatable. The concern of course is that users from any population will not use the water purification tablet because of the resulting taste and odor, and will risk drinking unsafe water. There are some herbs described in Ayurveda that causes decontamination of water along with excellence flavor & odor, if heated with water in adequate quantity^[2 & 4]

Method of purification of drinking water like Mechanical, Thermal, Herbal which is still very effective & has being used in rural & tribal area in India.

Water heated with some Ayurvedic Herbs for drinking & dehydration has to be given & proved very effective^[17].

Plant-based coagulant sources, processes, effectiveness and relevant coagulating mechanisms for treatment of water and wastewater is studied & plant-based coagulants include Nirmali seeds (*Strychnos potatorum*), *Moringa oleifera*, Tannin and Cactus found satisfactory result^[18].

All over the world, rural communities have adopted simple & rudimentary treatment technique that mainly aim at filtering out the visible impurities from the water collected from local sources. Though these traditional methods are expedient & can remove certain type of particles in water, they do not pro-

vide necessarily of what would be considered, under the present day situation, as drinking quality. However, it can be considered that these methods provide water of quality that is acceptable to those rural communities, and in most of the cases, with a further simple step of disinfection, they would yield water free from pathogens.

Antibacterial properties of some metals and alloys in combating coliforms in contaminated water has been studied & an interesting observation was that zinc was as effective as copper in destroying the bacteria. It was also found that the more the surface area of the metals, the faster they destroyed the coliforms. Some other metal like Gold, Silver etc. have also studied & found satisfactory antimicrobial property^[19, 20 & 21].

The majority of the water purifiers under use are inadequate for decontamination of virus from drinking water. Virological standards in evaluating such devices need to be established urgently, in order to help manufacturers to improve the performance of such products and most importantly, to help consumers^[22].

CONCLUSION

Ayurvedic methods of purification of drinking water by means of filtration of tap water by clean & neat cotton clothes daily, Treatment of filtered water with various herbs mentioned and boiling water vigorously for 1 minute is very effective till which having excellence as cost effective, without any major complication than modern method.

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