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PHYSICO-CHEMICAL CHARACTERIZATION AND MICROBIAL IDENTIFICATION OF COMMERCIAL DRINKING WATER IN CHENNAI, TAMIL NADU

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ABSTRACT

Physico-chemical and microbial properties of commercial drinking water (Sachets and bottles) in Chennai were studied. The results indicated that all physico-chemical parameters (pH, BOD, COD, chloride and fluoride) were within the permissible limits of WHO, but microbiological examination of the samples indicated contamination of drinking water posing serious problems to human health.

INTRODUCTION

Water is essential for the existence of life on this planet. Water has multitudes of utility for man and animals. Water used for drinking should be potable which means that it could be consumed in any desired amount without adverse effect on health, and that this vital fluid should be free from turbidity, colour and objectionable taste (Jayalakshmi Devi & Belagadi 2005). Today, good quality water has become a precious commodity. The quality of water is getting vastly deteriorated due to unscientific waste disposal, improper water management and carelessness towards environment. This has led to scarcity of potable water affecting the human health (Agarkar 2003).

Consumption of packed and bottled water is a normal process nowadays by all people in houses, public places, etc. (The New Indian Express, August 2001). Bottled water which is potable must be free from all pathogenic microorganisms and harmful chemicals. According to WHO, about 80% of all the diseases in human beings are caused by contaminated water (Vanish 2004). Therefore, water supplied for drinking and various other purposes must have good quality and should be free from microbial contamination, which otherwise results in large outbreaks of waterborne diseases (WHO 1996). To ascertain whether the commercial drinking water, sold in bottles and sachets, is contaminated, an attempt has been carried out to study physico-chemical parameters and identification of microbes in commercial drinking water of Chennai city.

MATERIALS AND METHODS

Drinking water samples were collected from polythene bottles and sachets in Chennai. The collecting bottles were sterilised and rinsed thrice with the sample before collection. Five different commercial water samples in the polythene bottles (BI, BII, BIII, BIV and BV), and five in polythene sachets (SI, SII, SIII, SIV and SV) were collected. The samples were collected freshly as soon as the bottle or sachet were opened.

The physico-chemical parameters of commercial drinking water samples such as colour, odour, taste and pH were determined immediately after collection of the samples. Electrical conductivity

(EC), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chloride (Cl) and fluoride (Fl) were determined following the standard methods (APHA 1989).

The biological parameters such as bacteria and fungi were determined by the procedure of Powar & Daginwala (1995) and Onions et al. (1981). One mL of different samples were cultured in a sterile petriplate which contains nutrient agar medium following pour plate method after which they were inverted and incubated for 24 to 48 hrs at 37°C. After the incubation period, colonies developed on the plates were analysed using Gram's staining method.

One mL of different samples were also cultured in a sterile petriplate which contains Malt Extract Agar medium (MEA) by pour plate method and incubated at room temperature for 4-5 days. Fungal species developed on the medium were observed periodically. The fungal colonies grown on MEA were subcultured on Potato Dextrose Agar (PDA) slants (Booth 1971). The fungi were stained with lactophenol cotton blue and identified using Manual of Onions et al. (1981).

RESULTS AND DISCUSSION

The results of the analysis of physico-chemical parameters of commercial drinking water samples are given in Tables 1 and 2. The physico-chemical parameters like colour, odour, taste and pH were well within the permissible limits (WHO 1996). Colour, odour and taste of different commercial drinking water samples showed that they were colourless, odourless and tasteless. Electrical conductivity of different samples (polythene bottles) varied from 25 µmhos/cm to 137 µmhos/cm whereas in water samples of polythene sachets, it ranged from 130 µmhos/cm to 141 µmhos/cm, which is higher than the permissible limits (50 µmhos/cm) as per WHO standards (1996). Higher the concentration of salts, especially chloride in water, higher will be the electrical conductivity. An increase or decrease in conductance of a particular water source will result in similar increase or decrease in other quality parameters (Kataria & Jain 1995).

The BOD values of drinking water samples in polythene bottles ranged between 6 mg/L and 7.4 mg/L whereas in sachets from 1.4 mg/L to 1.8 mg/L. Since BOD is a measure of biodegradable material in water, increase in the organic matter causes increase in the BOD level which makes it unsuitable for drinking purpose. COD of different water samples of polythene bottles ranged from 70 mg/L to 80 mg/L, whereas in sachets, from 78.3 mg/L to 82.5 mg/L.

Table 1: Physico-chemical characteristics of commercial drinking water.

Samples	Parameters								
	Colour	Odour	Taste	pH	EC µmhos/cm	BOD mg/L	COD mg/L	Cl mg/L	Fl mg/L
BI				6.5	25	6	80	10	0.06
BII				6.2	117	6.2	70	14	0.10
BIII				6.2	137	6.4	72	17	0.10
BIV				6.2	91	7	72.3	12	0.06
BV				7.5	120	7.4	70.5	13	0.03
SI	Colourless	Odourless	Potable	7.3	140	1.4	80	13	0.02
SII				7.3	138	1.6	82.5	12	0.01
SIII				7.2	130	1.8	81	10	0.03
SIV				7.2	141	1.7	81.5	11	0.02
SV				7.4	133	1.7	78.3	12	0.01

Chloride level of 100 mg/L in drinking water indicates a risk of corrosion in transport pipes. If the level exceeds 300 mg/L there is a risk of change in the taste of water (Jayalakshmi Devi & Belagali 2005). In this study, the chloride level of different water samples of polythene bottles varied from 10 mg/L to 17 mg/L, and in polythene sachets from 10 mg/L to 13 mg/L which are within permissible limits (200 mg/L) of WHO, and it is in accordance with the work of Guru Prasad (2005).

Fluoride causes health hazards at both the lower and higher concentrations. Lower concentration of fluoride (< 0.5 mg/L) causes dental carries, while higher concentration (beyond 1.5 mg/L) causes dental and skeletal fluorosis (Suthar et al. 2005). In this study, the fluoride level of different water samples of polythene bottles ranged from 0.03 mg/L to 0.10 mg/L, whereas in sachets from 0.01 mg/L to 0.03 mg/L, which are within permissible limits (1 mg/L) of WHO (1996). Thus, the physico-chemical parameters (pH, BOD, COD, chloride and fluoride) of the different commercial drinking waters were found to be acceptable within the permissible limits of WHO (1996).

The microbiological studies of different commercial drinking water samples (Tables 3 and 4) were also carried out, which showed the presence of bacteria and fungi. In general, the bacteria should be nil in potable drinking water, whereas in this study both bacterial and fungal species were identified in the water samples of both bottles and sachets. Bacteriological studies have highlighted both Gram positive and Gram negative bacteria in the water samples, which were identified as cocci and bacilli.

Polythene sachets showed Gram positive bacteria in all the 5 samples (BI, BII, BIII, BIV and BV) represented by cocci and bacilli. The bottles showed Gram positive in the four samples (SI, SII, SIV and SV), and one sample showed gram negative (SIII) with bacilli which is supported by the work of Kavitha & Sivapriya (2005) who have identified the presence of *Pseudomonas* sp., *Klebsiella* sp., *Bacillus* sp., *Streptococcus faecalis, Staphylococcus aureus* and *Clostridium* sp. in the different samples of commercial mineral water. The presence of *Bacillus* and *Pseudomonas* was also supported by Michel et al. (1995), Vachee et al. (1997), Tamagnini & Gonzalez (1997) and Grant (1998).

The variety of potential waterborne pathogens include various species of bacteria, viruses and protozoa. These pathogens cause waterborne diseases posing a serious threat to health, since the potential of contaminated water to transmit disease is very high. Waterborne diseases are single most

Table 2: Comparison of commercial drinking water with reference to drinking water standards.

S.No.	Characteristics	Analysis of commercial drinking water		World Health Organization (WHO 1996)
	Physico-chemical Parameters	Polythene Bottles	Polythene Sachets	Maximum Permissible Limits
1.	Colour	Colourless	Colourless	Colourless
2.	Taste and odour	Agreeable	Agreeable	Agreeable
3.	pH	6.2-7.5	7.2-7.4	6.5 - 9.2
4.	Electrical Conductivity µmhos/cm	25-137	130-141	-
5.	BOD mg/L	6-7.4	1.4-1.8	-
6.	COD mg/L	70-80	78.3-82.5	-
7.	Chloride mg/L	10-17	10-13	200
8.	Fluoride mg/L	0.03-0.10	0.01-0.03	1.0

Table 3: Bacteriological characteristics of commercial drinking water.

Medium	Samples	Parameters		
		Colour of the Colony	Shape	Gram's Reaction
	Bottles			
Nutrient Agar	BI	White	Bacilli	Positive
	BII	White	Bacilli	Positive
	Bill	Creamy white	Cocci	Positive
	BIV	White	Bacilli	Positive
	BV	White	Bacilli	Positive
	Sachets			
	SI	Creamy white	Cocci	Positive
	sn	White	Bacilli	Positive
	SIII	Creamy white	Cocci	Negative
	SIV	Creamy white	Cocci	Positive
	SV	White	Bacilli	Positive

Table 4: Identification of fungi in commercial drinking water.

Medium	Samples	Fungi
	Bottles	
Malt Extract Agar	BI	*Aspergillus* sp. and *Penicillium* sp.
	BII	*Mucor* sp. and *Aspergillus* sp.
	BIII	*Penicillium* sp.
	BIV	*Aspergillus* sp. and *Aspergillus niger*
	BV	*Aspergillus terreus*
	Sachets	
	SI	*Laziodiplodia* and *Aspergllus* sp.
	SII	*Aspergillus* sp.
	SIII	*Aspergillus* sp.
	SIV	*Rhizopus* sp. and *Aspergillus niger*
	SV	*Aspergillus* sp., *Mucor* sp. and *Aspergllus terreus*

important factor responsible for nearly 80% of human mortality in India. Children are worst affected, especially in rural areas and urban slums. Typical waterborne diseases caused by bacteria include typhoid, cholera, paratyphoid, gastroenteritis and bacterial dysentery.

Not only the bacterial species are responsible for the waterborne diseases, even the fungal species cause diseases like aspergillosis, coccidiomycosis, blastomycosis, histoplasmosis and pneumocystis etc. through the food poisoning if the contaminated water is utilized for food preparation or drinking. Hence, this study has been further extended to isolate and identify fungi from different commercial drinking water samples. The results revealed the occurrence of 7 species of fungi in different water samples which include *Aspergillus niger*, *Aspergillus* sp., *Aspergillus terreus*, *Laziodiplodia*, *Mucor* sp., *Penicillium* sp. and *Rhizopus* sp. Accidental or deliberate consumption of wild fungi or fungally contaminated food can lead to poisoning or toxicosis of the consumer because some fungi naturally contain toxic metabolites called mycotoxins. Deeper, systemic fungal infections of lung and central nervous and lymphatic systems cause much more serious diseases, for

example, aspergillosis, coccidiomycosis, blastomycosis, histoplasmosis and pneumonia are all caused by fungi (Nicklin et al. 2001).

Even though the commercial drinking water is treated and purified, the presence of microbes in sachets and bottles is shocking. The efficiency of current technique for recovering and detecting waterborne pathogens in drinking water is often very low. Many pathogens are so fastidious in their environmental and nutritional requirements that only highly specialised laboratory techniques can be used to detect them (Guerozoni et al. 1994).

It is significant to note that in this study the levels for certain physico-chemical parameters were within the permissible limits but the microbiological parameters revealed the contamination of water samples in bottles and sachets.

As the mineral water companies are increasing year by year, care should be taken to prevent contamination of the products. The increasing demand for better quality water is responsible for the increase in companies manufacturing bottled water. People opt for this kind of water for several considered reasons as safe drinking water. Secondly, it is an alternative to hard water available in certain areas. Water intended for human consumption should be not only safe but also whole some. Though the companies are claiming that their water is pure and mineralized, the results of the above study showed that they must be tested seriously for quality control (Kavitha & Siva Priya 2005).

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