CARAS
© 2023, Centre for Advanced Research in Agricultural Sciences
Research Journal of Agricultural Sciences
Volume 14; Issue 03 (May-Jun 2023); pp 692–695

Open Access
ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Full Length Research Article

Physicochemical Characterization and Microbial Analysis of Commercial Drinking Water, Chennai, Tamil Nadu

Pragathi A. H*[1] and C. M. Noorjahan[2]

[1-2] P. G. and Research Department of Zoology, Justice Basheer Ahmed Sayeed College for Women (Autonomous), Teynampet, Chennai - 600 018, Tamil Nadu, India

Abstract

This research focused on the physical qualities, chemical composition and microbiological contamination of various brands of bottled water sold around Chennai city, Tamil Nadu, India. Aims and Objectives of the present investigation is to determine the physicochemical parameters such as color, odor, pH, EC, BOD, COD, chloride and fluoride of the different water samples of commercial bottled drinking water and microbial analysis were also studied for the water samples. The results of the study revealed that the parameters of the sample were within the permissible limit as prescribed by WHO guidelines. Bacteria such as *Bacillus subtilis, Klebsiella Pneumoniae* and fungal species such as *Mucor* sp and *Aspergillus* sp were identified in the water samples thereby indicating that the water is contaminated, which may cause infection and water borne diseases.

***Key words*:** Commercial bottled drinking water, Physicochemical parameters, Microbial analysis, Contamination, Infection

Water is a necessity for all living things in this world. Water has a variety of purposes for humans, animals and other living organisms. Drinking water that is clean, safe and hygienic is essential for good health. Drinking water should be potable, which means it may be consumed in any volume without causing health problems or endangering human life. The quality of water has deteriorated as a result of sloppy waste disposal, sewage, poor water management and environmental irresponsibility [1]. Water quality can differ from one source to the other depending on a variety of factors such as water sources, water purification methods and storage tanks [2]. There are no strict quality control requirements in place for bottled water used for human consumption. Usage of commercial drinking water by the public has become more frequent. Many people drink on a daily basis. They would not know that consuming commercial drinking water causes water-borne diseases. Packaged water bottles have a number of microbes that cannot be seen with the naked eye. These microbes cause serious health issues for those who consume it. Based upon the above views, the present investigation was carried out to determine Physicochemical parameters and microbial analysis of the commercial bottled drinking water.

MATERIALS AND METHODS

Collection of samples

10 different Commercial bottled drinking water samples (I, II, III, IV, V, VI, VII, VIII, IX and X) were selected for this project and collected in sterilized plastic bottles of 500 ml and 1000 ml capacity. Commercial bottled drinking water was procured from the shops in Chennai, Tamil Nadu, India. The samples were collected freshly as soon as the bottles were opened and brought to the laboratory for further analysis.

Physicochemical parameters of water sample

Physicochemical parameters of water samples such as pH, EC, BOD, COD, Chloride and Fluoride were carried out by following the Standard Methods of [3].

Isolation of microorganisms from water samples
Stock culture

1 ml of different water samples were taken and transferred into a conical flask containing 99 ml of sterile distilled water. Then it was shaken and serially diluted.

Nutrient agar medium preparation

Nutrient agar medium was prepared by dissolving 1gm of nutrient agar in 100 ml of distilled water and sterilized. After sterilization, the medium was poured into sterile petri plates and were allowed to solidify for 30 minutes.

Pour plate method

Received: 12 Feb 2023; Revised accepted: 05 May 2023; Published online: 12 May 2023

Correspondence to: C. M. Noorjahan, P. G. and Research Department of Zoology, Justice Basheer Ahmed Sayeed College for Women (Autonomous), Teynampet, Chennai - 600 018, Tamil Nadu, Tel: +91 9025482496; E-mail: cmnoorjahan@gmail.com

Citation: Pragathi AH, Noorjahan CM. 2023. Physicochemical characterization and microbial analysis of commercial drinking water, Chennai, Tamil Nadu. *Res. Jr. Agril. Sci.* 14(3): 692-695.

1 ml of serially diluted different water samples were cultured in sterile petri plates which contain nutrient agar medium following pour plate method after which they were inverted and incubated for 24 to 48 hours at 37°C. After the incubation period, bacterial colonies developed on the medium in the plates were determined by following the procedure of [4-5].

Malt extract agar medium preparation

Malt extract agar medium was prepared by dissolving 1gm of malt extract agar in 100 ml of distilled water and sterilized. After sterilization, the medium was poured into sterile petri plates and were allowed to solidify for 30 minutes.

Pour plate method

1 ml of serially diluted different water samples were cultured in sterile petri plates which contain Malt Extract Agar medium (MEA) using pour plate method and incubated at room temperature for 4-5 days. Fungal species developed on the medium were observed periodically using lactophenol cotton blue by following the Manual of [5] and identified.

Identification and characterization of microorganisms

Identification and characterization of bacteria

Microorganisms that were identified as *Bacillus* sp, *Klebsiella* sp. Dominant microorganisms were characterized and confirmed by biochemical tests such as Indole test, Methyl red test, Voges-Proskauer test, Citrate Utilization test, Triple Sugar Iron test, Urease test, Catalase test, Coagulase test, Nitrate reduction, Gelatin hydrolysis. The dominant bacteria were selected based on colony counting and tested for gram staining and biochemical tests and they were identified as *Bacillus subtilis* which is gram positive and showed positive results for Gelatin hydrolysis, Citrate test, Voges Proskauer test and Nitrate reduction test. The other dominant bacteria identified as *Klebsiella pneumoniae* is gram negative and showed positive results for Catalase test, Urease test and Triple Sugar Iron test.

RESULTS AND DISCUSSION

Physicochemical parameters of different commercial bottled drinking water

The data obtained from the above experiments were expressed as Mean, Standard deviation and One-way ANOVA. The results for the physicochemical characteristics of different water samples (Table 1) revealed that the color of water is colorless, the taste of water is little bit sweet and odorless, the pH of water is around 7.120±0.084 to 7.140±0.167, EC value ranged from 48.8 ±22.26 µmhos/cm to 79±51.52 µmhos/cm. The BOD value of water ranged from 1.48±0.228 mg/l to 1.8±0.212 mg/l. The COD value of water ranged from 2.76±0.207 mg/l to 2.9±0.255 mg/l. The chloride in water ranged between 5.88±1.171 mg/l to 5.94±2.552 mg/l. The fluoride in water has a minimum value of 0.058±0.0164 mg/l and maximum value of 0.058±0.0164 mg/l. The data obtained for One-way ANOVA revealed that BOD is Statistically significant which is $p<0.05$.

Table 1 Physicochemical parameters of different commercial bottled drinking water

Parameters	Mean ± Standard Deviation	F Value	p Value
pH	7.120 ± 0.084 7.140 ± 0.167	0.0572	0.8171
EC µmhos/cm	48.8 ± 22.26 79 ± 51.52	1.4476	0.2633
BOD mg/l	1.48 ± 0.228 1.8 ± 0.212	5.26	0.0506
COD mg/l	2.76 ± 0.207 2.9 ± 0.255	0.9071	0.3688
Chloride mg/l	5.88 ± 1.171 5.94 ± 2.552	0.0023	0.9631
Fluoride mg/l	0.058 ± 0.0164 0.058 ± 0.0164	0	1

*p<0.01 and *p<0.05

Table 2 Identification of bacteria and fungi species in commercial bottled drinking water

Bacteria	Fungi
Pseudomonas sp	*Mucor* sp
Bacillus sp	*Penicillium* sp
Klebsiella sp	*Aspergillus* sp
Salmonella sp	*Rhizopus* sp

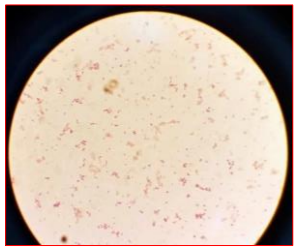

Fig 1a Gram staining for *Bacillus subtilis*

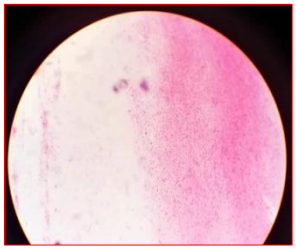

Fig 1b Gram staining for *klebsiella* pneumoniae

Identification of bacteria and fungal species in commercial bottled drinking water

Table 3 Biochemical tests for dominant bacterial species

Biochemical Tests	*Bacillus subtilis*	*Klebsiella pneumoniae*
Gram Staining	+	-
Shape	Rod	Rod
Indole Test	-	-
Methyl Red Test	-	-
Citrate Test	+	+
Triple Sugar Iron Test	-	+
Voges Proskauer Test	+	+
Urease Test	-	+
Nitrate Reduction Tesr	+	+
Gelatin Hydrolysis Test	+	-
Catalase Test	+	+

\+ Positive

\- Negative

The results of microbial analysis of different water samples (Fig 1a-b), (Table 2a-b) revealed the presence of Bacillus *subtilis* (Fig 2a) and *klebsiella Pneumoniae* (Fig 2b). Whereas fungi present in commercial drinking water were identified as *Mucor* sp and *Aspergillus* sp.

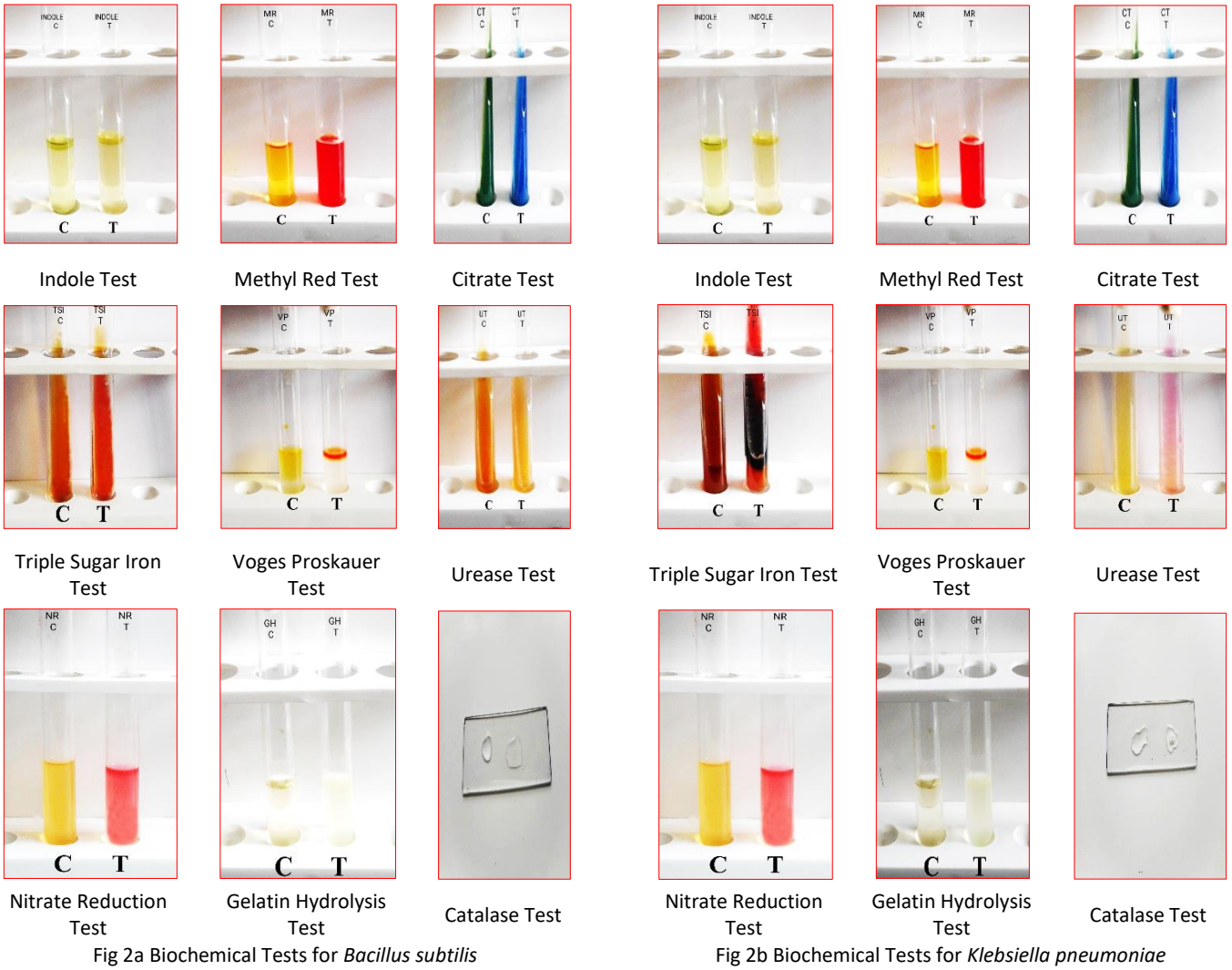

Fig 2a Biochemical Tests for *Bacillus subtilis*

Fig 2b Biochemical Tests for *Klebsiella pneumoniae*

Commercially available bottled drinking water contaminated with harmful bacteria and fungi can seriously harm people and result in cholera, typhoid fever, and other gastrointestinal illnesses. pH of water is the most important factor in determining its corrosiveness. The lower the pH value, the more corrosive the water [6]. pH is also linked to electrical conductance and total alkalinity [7]. In this study, the pH is ranged between 7.120±0.084 to 7.140±0.167 which is within the permissible limit as per [8].

Electrical conductivity is a measure of an aqueous solution's ability to carry an electric current and is affected by the presence of ions, their total concentration, mobility and temperature [9]. In this study, the EC ranged between 48.8±22.26 µmhos/cm to 79±51.52 µmhos/cm is within the permissible limit of [10] Hence it is suitable for drinking and the results of this study is supported with the work of [7].

The amount of oxygen required by bacteria to stabilize decomposable organic matter is commonly defined as Biochemical Oxygen Demand. BOD indicates the extent of pollution of the water samples [11]. Water with BOD levels <4 mg/l are deemed as clean, while those >10 mg/l are considered polluted and unsafe [12]. COD is a chemical oxidant that is used to measure the oxygen equivalent of organic matter in a sample. COD values should be less than 10 mg/l after water treatment. The BOD values of bottled drinking water in this study were between 1.48±0.228 mg/l to 1.8±0.212 mg/l which is less than 4 mg/L [8] and the COD value between 2.76±0.207 mg/l to 2.9±0.255 mg/l, which is less than 10 mg/l considered to be potable drinking water [11].

Chloride can be found in varying concentrations in all natural waters. As the mineral content increases, likewise does the chloride content [12]. High chloride content in water samples may be due to pollution from rich effluent of sewage and municipal waste, but chloride in excess imparts a salty taste to water and causes laxative effects in people who are not accustomed to high chloride levels [13]. In this study, the chloride content present in the bottled drinking water ranged between 5.88±1.171 mg/l to 5.94±2.552 mg/l which were within the permissible limit (250 mg/l) of [8]. The results of this study correlate with the work of [10].

Fluoride content in the bottled drinking water is between 0.058±0.0164 mg/l to 0.058±0.0164 mg/l which is within the permissible limit of [8] and thus the findings coincide with the work of [14]. Fluoride is required by humans as a trace element and higher concentrations of this element are toxic. A fluoride concentration of 0.6-1.0 mg/l in potable water prevents tooth decay and promotes bone development [15]. Thus, the physico-chemical parameters of the commercial drinking water are all within the permissible limit of [8].

Microbial contamination in the commercial drinking water samples were also carried out. The results of the study showed the presence of bacteria and fungi. There should be absence of bacteria and fungi in drinking water. The results of this study showed that the different water samples are contaminated with various species of bacteria and fungi. The bacterial coliforms present in commercial drinking water were identified as Gram-positive *Bacillus subtilis* and Gram negative *klebsiella pneumoniae* found to be present in all the 10 different water samples. The results of the study were supported by [16-17].

The major fungi genera found in Norwegian drinking water were *Penicillium* spp., *Absidia* spp., *Acremonium* spp.,

Aspergillus spp. and *Mucor* spp. Some of the species isolated from water samples are known to be strong allergenic skin irritants or to cause infections in immunocompromised people such as AIDs, cancer and organ transplant patients as well as people with asthma or other respiratory problems [18]. The result of this study revealed the presence of *Aspergillus* sp and *Mucor* sp were in the 10 different water samples which correlates with the work of [19-20]. Potable drinking water is a clear liquid that has no color, taste or odour. However, when infected with organisms such as fungi, these qualities are lost and the water becomes harmful to both human and animal populations [21-23].

CONCLUSION

Thus, it can be concluded from the results of the above study that water is an essential source for living things. Commercial bottled drinking water may cause harmful effects and water borne diseases. Hence it is contaminated with microbes as evidenced from results of the present study. So, this project is an awareness to the public who consume commercial bottled drinking water. People should know that bottled drinking water is not safe to drink because it contains microbes that cause health issues. So, we should stop drinking commercial bottled drinking water and take our own water bottles wherever we travel. Drinking boiled water is safe and avoid bacterial and fungal infection and water borne disease.

Acknowledgement

The author wish to thank Dr. C. M. Noorjahan M. Sc., M. Phil., Ph. D, Assistant Professor, Parents, Sheeba Ali Siddiqui. This research work was financially supported by Tamil Nadu State Council for Science and Technology (TNSCST) under the "Student Project Scheme 2021-22".

LITERATURE CITED

1. Agarkar SV. 2003. Fluoride content in drinking water of villages around Chikhli, Dist. Buldana, Maharashtra. *Asian Jr. of Chem*. 15(3/4): 1875-1876.
2. Batarseh MI. 2006. The quality of potable water types in Jordan. *Environmental Monitoring and Assessment* 117: 235-244.
3. APHA. 2017. Standard methods for the examination of water and wastewater 23rd (ed). American Public Health Association. Washington; DC. 2017.
4. Powar, Daginwala. 1995. *General Microbiology*. Himalaya Publishing House, Bombay.
5. Onions AHS, Allsopp D, Egginns HOW. 1981. *Smith's Introduction in Industrial Mycology*. 7th (Edition). Edward Arnold Publishers Ltd.
6. Hossain M, Biswas P,Islam, M, Usha, K, Marzia S. 2020. Physicochemical characterization of drinking water of selected regions in Bangladesh. *Progressive Agriculture* 31(1): 36-44.
7. Gupta DP, Sunita SJP. 2009. Physicochemical analysis of ground water of selected area of Kaithal city (Haryana) India. Researcher 1(2): 1-5.
8. WHO (World Health Organization) (2005,2012,2016). Guidelines for Drinking Water Quality. Retrieved from WHO web site.
9. Sarda P, Sadgir P. 2015. Assessment of multi parameters of water quality in surface water bodies-a review. *Int. Jr. Res. Appl. Sci. Eng. Technology* 3(8): 331-336.
10. Parashar C, Verma N, Dixit S, Shrivastava R. 2008. Multivariate analysis of drinking water quality parameters in Bhopal, India. *Environmental Monitoring and Assessment* 140(1): 119-122.
11. Kurup R, Persaud R, Caesar J, Raja V. 2010. Microbiological and physicochemical analysis of drinking water in Georgetown, Guyana. *Nature and Science* 8(8): 261-265.
12. Dubey N. 2003. A comparative status of quality of drinking water of Bhopal city filtration plants and ground water with special reference to heavy metals and organo chemicals. *Ph. D. Thesis*, Barkatullah University, Bhopal.
13. Gupta P, Vishwakarma M, Rawtani PM. 2009. Assessment of water quality parameters of Kerwa Dam for drinking Suitability. *International Journal of Theoretical and Applied Sciences* 1(2): 53-55.
14. Bindhu S, Selvamohan T. 2009. Assessment of groundwater quality- Dharmapuram Panchayat Kanyakumari District, T.N. *Indian Jr. of Env. Protection* 29(5): 439-444.
15. Kundu N, Panigrahi M, Tripathy S, Munshi S, Powel M, Hart B. 2001. Geochemical appraisal of fluoride contamination of groundwater in the Nayagarh district, Orissa. *Env. Geal*. 41: 451-460.
16. Antony RM, Renuga FB. 2012. Microbiological analysis of drinking water quality of Ananthanar channel of Kanyakumari district, Tamil Nadu, India. *Revista Ambiente and Água*. 7: 42-48.
17. Hussain T, Roohi A, Munir S, Ahmed I, Khan J, Edel-Hermann V, Anees M. 2013. Biochemical characterization and identification of bacterial strains isolated from drinking water sources of Kohat, Pakistan. *African Journal of Microbiology Research* 7(16): 1579-1590.
18. Gunhild H, Ann KK, Peter G, Sybren de Hoog G, Ida S. 2006. Diversity and significance of Mold species in Norwegian drinking water. *Appl. Environ. Microbiology* 72(12): 7586-7593.
19. Okpako EC, Osuagwu AN, Duke AE, Ntui VO. 2009. Prevalence and significance of fungi in sachet and borehole drinking water in Calabar, Nigeria. *African Journal of Microbiology Research* 3(2): 56-61.
20. Hussain T, Ishtiaq M, Hussain A, Sultana K. 2011. Study of drinking water fungi and its pathogenic effects on human beings from district Bhimber Azad Kashmir, Pakistan. *Pak. Jr. Botany* 43(5): 2581-2585.
21. Eja ME. 2002. *Water Pollution and Sanitation for Developing Countries*. Seaprint Nigeria Publishers; Calabar. pp 71.
22. Leoni E, Legnani PP, Guberti E, Masottii A. 1999. Risk of infection associated with microbiological quality of public swimming pools in Bologna, Italy. *Public Health* 113: 227-232.
23. ATSDR. 2004. Medical management guideline (MMGs) for Water (Pollution). Agency for Toxic Substance and Disease Registry (ATSDR) CDC.