Bangladesh Journal of Veterinary and Animal Sciences, Vol. 5, January 2017

ISSN 2227-6416

Bangladesh Journal of Veterinary and Animal Sciences

Journal home page: www.cvasu.ac.bd/journal/userlist

Research Article **Short Communication**

Physicochemical and microbiological properties of some portable water samples available in Chittagong area

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ARTICLE INFO

Article history :
Submitted: 15/01/2017
Accepted: 15/04/2017

Keywords :
Potable water, total dissolved solids and coliform

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ABSTRACT

The study was carried out to assess the quality of some portable water samples available in Chittagong area. Physicochemical (P^H, TDS, hardness, bicarbonate, iron), microbiological (coliform and SPC) analysis were done to monitor the quality of some potable water. From the result of all parameters it could be concluded that all the water samples had the physicochemical parameters (P^H, TDS, hardness, iron, and bicarbonate) under normal ranges. Most of the samples except sample-1, 6 and 10 were contaminated with coliform which may cause serious health effects. Maximum samples maintained the BSTI standard of water (BDS-1240).

To cite this paper : *Alam, M. J., Akther, M. S., Begum, M. A., Matin, A. and T. Ahmed. 2017. Physicochemical and microbiological properties of some portable water samples available in Chittagong area. Bangladesh Journal of Veterinary and Animal Sciences, 5 (1): 67-72*

1. INTRODUCTION

Water is the most important resource for human. It is a crucial component of metabolic processes and serves as a solvent for many bodily solutes. As water is a universal solvent it dissolves salts, inorganic and organic compounds and gases that take part in metabolic reactions, maintain the macromolecular framework, stabilize plasma membrane, thermoregulation, transport nutrients, and maintain homeostasis and body volume/weight (Armstrong et al., 2007). Water is an indispensable commodity, which should be easily accessible, adequate in quantity, free of contamination, safe, inexpensive and readily available throughout the year in order to sustain life (WHO 1997). Water is essential to sustain life and without it life becomes impossible. It is an indispensable commodity, which should be easily accessible, adequate in quantity, free of contamination safe, affordable, and available throughout the year in order to sustain life (Al-Khatib et al., 2003). One of the world's most critical problems today is the acute shortage of clean fresh water: All-for domestic purposes, industry and agriculture-need water (Smith et al., 1985). pH is the negative logarithm of effective hydrogen ion concentration. In simple term, it refers to whether the water is acidic or alkaline. The pH scale goes from 0 to 14, with a pH of 7 is generally considered natural (not acidic or alkaline). TDS means total dissolved solids. It indicates all organic and inorganic substances in water. TDS is not associated with health effects. It is the indication of aesthetic characteristics of water. Some TDS may be harmful such as Pesticides. TDS may be in the form of anions, cations or molecules. Total hardness in water is a

measure of the concentration of the calcium and magnesium ions expressed as calcium carbonate. It is due to the carbonate, bicarbonate, sulphate, chloride of calcium and magnesium. There are two types of hardness-temporary hardness and permanent hardness. Temporary hardness is due to the presence of Bicarbonate of calcium and magnesium and can be easily removed by proper treatment such as boiling. But permanent hardness is due to the presence of chlorides and sulphates of calcium and magnesium and cannot be removed easily. The World Health Organization has estimated that up to 80% of all sickness and diseases in the world is caused by inadequate sanitation, polluted water or unavailability of water. Nearly 1.5 billion people lack safe drinking water and that at least 5 million deaths per year can be attributed to water borne disease (WHO, 2011). Health effects associated with water supplies in developing countries evaluated four bacterial indicators of tropical drinking-water quality (faecal coliforms, *Escherichia coli, Enterococci* and faecal *Streptococci*) and their relationship to the prevalence of diarrheal disease in Cebu, Philippines (Moe et al., 1991). The contaminated water or inadequate supply of safe drinking water causes various gastrointestinal diseases like diarrhoea, dysentery and water borne diseases like cholera, typhoid. It is now evident that most of the enteric diseases of human and animals are transmitted through contaminated food and water (Johnson et al. 2003). The 1% of drinking water is getting polluted with various organic and inorganic matters. The organic matters which are responsible for the contamination of water are faecal wastes of poultry and livestock farms, pesticides, herbicides, and many industrial wastes, minerals (including toxic metals such as lead, copper etc) and biological agents such as bacteria, virus, fungus, algae etc. Enterobacteriaceae in the water of river Manzanares at Cumana (Venezuela) and a high degree of enteric species of organisms was present in water (Mieres et al., 1975). The World Health Organization (WHO, 1971) and the Palestinian Standards Institution (PSI, 1997) suggest the following standards for treated drinking water: (a) Water entering the distribution system should contain no coliform organisms; (b) Water at the tap should contain no coliforms in 95% of samples taken in any one year and it should never contain more than 10 coliforms/100 ml or any *Escherichia coli*/100 ml. Bottled water has become one of the most popular drinks in Bangladesh. Nowaday it is easily available in the market. Due to lack of confidence on municipal supply water, people now prefer to drink bottled water instead of tap water, mostly when they are outside the home, and in many occasions. The results also revealed the ill performance and poor drinking water quality of the purification systems of the investigated water samples (Majumder et al., 2011). Therefore, the study was undertaken to study physicochemical and microbial analysis of potable water and also to compare "different potable water samples" collected from different regions of Chittagong metropolitan area as well as to develop concern among the people about safety issue of drinking water.

2. MATERIALS AND METHODS

The study was conducted at the quality control lab of Sanowara Drinks and Beveage Industries Limited from March, 2015 to August, 2015. The methodology is described under the following sub-headings.

2.1 Sample collection

Ten samples of potable water were collected from different locations of Chittagong. Five samples were collected from Chittagong metropolitan area and five from local areas of Chittagong.

2.2 Determination of pH

2.2.1 Calibration of pH meter

The unit of pH meter is properly installed and electrode connected. CAL flashing on the left are displayed after pressing, indicating it was in calibration mode to make an offset point calibration. The pH electrodes were rinsed in distilled water then into the buffer solution for offset calibration or the slope buffer on continuity. Main display showed the current measured value and the bottom sub-display showed 2.00 or the previous value on continuity. The value nearest to the calibration solution was selected by pressing. The preset custom standards were 2.00, 4.50, 7.00, 9.50 and 12.50. After selecting the nearest value, the exact value as the buffer solution at the current temperature being used was adjusted by pressing. Press to confirm and display will flash then revert to raw data. Now it was ready to make Slope point calibration. The steps were repeated in sequence. At least 2 calibration points (offset and slope) must be established in one session of calibration. Otherwise, erroneous reading will result. Only upon completing the entire session of calibration, we pressed to exit calibration mode and to begin measurement.

2.2.2 Measurement of pH by pH meter

Water with a pH below 7 is considered as acidic water and pH above 7 is considered as alkaline. The Environmental Protection Agency (EPA) considers pH as a secondary contaminant, with an acceptable range of 6.5 to 8.5. In this study pH of water samples was determined by using Professional Benchtop pH meter BP3001, Singapore.

2.3 Determination of TDS

TDS means total dissolved solids. It indicates all organic and inorganic substances in water. TDS are not associated with health effects. It is the indication aesthetic characteristics of water. Some TDS may be harmful such as Pesticides. TDS may be in the form of anions, cations or molecules. The acceptable range of TDS in mineral water is less than 500 ppm. TDS was determined by using TDS Meter (161002), USA.

2.4 Determination of total hardness

The acceptable range of total hardness in water is up to 320 ppm. Total hardness were determined by Hardness by calculation and EDTA titration method (Danzer et al., 2009).

2.5 Determination of bicarbonate

Bicarbonate in water was determined by titration method (Stephen et al., 1996). The acceptable range of bi-carbonate in water is less than 339 ppm.

2.6 Determination of iron

Iron forms a characteristic red color with 1,10 phenanthroline at acidic condition. The color intensity can be measured at 510nm light by using Thermo Scientific Orion AquaMate 7000 and 8000 Series spectrophotometer, USA.

2.7 Standard Plate Count (SPC) test

SPC test was conducted by microbiological pour plate method (Bartram et al., 1996)

2.8 Estimation of coliform

2.8.1 Violet red bile (VRB) agar

Violet Red Bile Agar is a selective medium used to detect and enumerate lactose-fermenting coliform microorganisms. The medium is recommended for use in the microbiological analysis of water, milk and other dairy products. The medium contains bile salts and crystal violet which serve as inhibitory agents toward some gram-positive microorganisms, especially staphylococci. Neutral red is employed as the pH indicator. Lactose-fermenting microorganisms produce pink to red colonies that are generally surrounded by a reddish zone of precipitated bile. Non-lactose-fermenting microorganisms result in colorless colonies

2.8.2 Estimation of coliform

The basic test for bacterial contamination is estimation of total coliform bacteria. Total coliform is an indicator of the sanitary condition of water. Total coliform includes the bacteria that are found in soil, water, animal and human wastes. The total coliform bacteria in water must be zero. Total coliform was determined by microbiological agar method by using violet red bile (VRB) agar (Bartram et al., 1996).

3. RESULTS AND DISCUSSION

3.1 Results from physicochemical analysis

Results for physicochemical tests for ten different water samples are shown in Table-1. The pH value for sample-7 is 8.60 that do not follow the standard range (6.5-8.5). Other samples have pH value under normal range. pH value of ten water samples compared with standard value (maximum) are shown in Figure-1. This approves that the nature of mineral water samples were slightly alkaline. The TDS content value of mineral water in the sample-9 and sample-3 (120,112 mg/L respectively) was comparatively greater than normal TDS range in mineral water. Sample-7 had lower TDS. Analysis reveals that the TDS is greater than 3-7 mg/L. It means that the water is contaminated by some suspended solids. The values are slightly higher than WHO level. TDS value of ten water samples compared with sandard value (maximum) are shown in Figure-2.

Table 1. Physicochemical analysis for ten different water samples

SL. NO.	Samples	p^H	TDS (ppm)	Hardness (ppm)	Bicarbonate (ppm)	Iron (ppm)
01.	Sample-1	7.24	21	0.9	65	0.007
02.	Sample-2	7.70	96	13	20	0.005
03.	Sample-3	7.46	112	63	15	0.009
04.	Sample-4	8.17	66	20	80	0.006
05.	Sample-5	8.09	96	30	60	0.094
06.	Sample-6	7.90	25	22	50	0.085
07.	Sample-7	8.60	07	03	14	0.004
08.	Sample-8	7.95	09	05	80	0.079
09.	Sample-9	7.81	120	33	125	0.085
10.	Sample-10	7.81	48	36	60	0.095

The variation and increase of TDS in mineral water is unsuitable for drinking. The degree of hardness value for the sample-3 was highest and lowest for the sample-1. The highest desirable limit prescribed by WHO is 320-500 mg/L for drinking purposes. However the hardness of the samples is under the prescribed limit. Bicarbonate was highest in sample-9 (125 ppm) and lowest in sample-7 (14 ppm). The WHO standard for bicarbonate in drinking water is 339 ppm. However all the water samples contain bicarbonate under normal range. Iron value of ten water samples compared with sandard value (maximum) are shown in figure-3. Iron was highest in sample-10 (0.095) and lowest in sample-7 (0.004) during analysis. However all the samples have a iron value under normal range.

Table 2. Microbiological analysis for ten different water samples

SL. NO.	Samples	SPC (cfu/gm)	Coliform (cfu/gm)
01.	Sample-1	7540	00
02.	Sample-2	7865	05
03.	Sample-3	6700	02
04.	Sample-4	6900	01
05.	Sample-5	6690	19
06.	Sample-6	7800	00
07.	Sample-7	6800	200
08.	Sample-8	6578	03
09.	Sample-9	7500	07
10.	Sample-10	7200	00

3.2 Results from microbiological analysis

Results for microbiological tests for ten different water samples are shown in Table-2. The highest SPC count was found in sample-2 (~7865) and lowest in sample-8 (~6578). The value of SPC in mineral water must be is less than 8000 cfu/gm. However all the water samples revealed the standard SPC level. Coliform count of ten water samples compared with sandard value (maximum) are shown in figure-4. There was no presence of Coliform in sample-1, 6 and 10. But the other samples were contaminated by Coliform. The samples collected from local area of Chittagong were mostly contaminated with coliform. The BSTI and WHO standard for coliform is zero. The results of this study reveal that average bacterial density in drinking water was relatively high, especially from unprotected water sources, compared with that from protected sources. The presence of *Coliform* in water suggests enteric pathogens and faecal pollution. It is also assume that in Chittagong, water layer up to 400 feet's mostly contain *Coliform and E.coli* but most of the mineral water treatment plant raised water below this point. This information is gathered by conversation with several engineers and plant employees. The sale of polluted water in containers in different parts of the country has turned into a booming business for lack of monitoring and control by the authorities concerned posing a serious health hazard to consumers.

Figure 1: pH value of ten water samples compared with standard value (maximum)

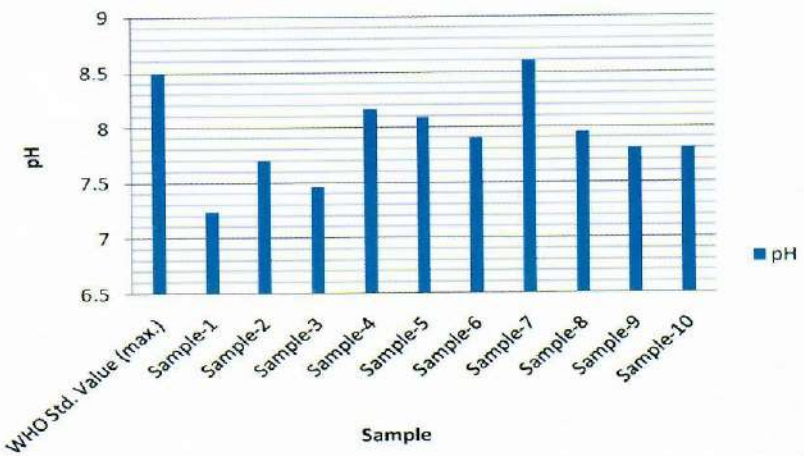


Figure 2: TDS value of ten water samples compared with standard value (maximum)

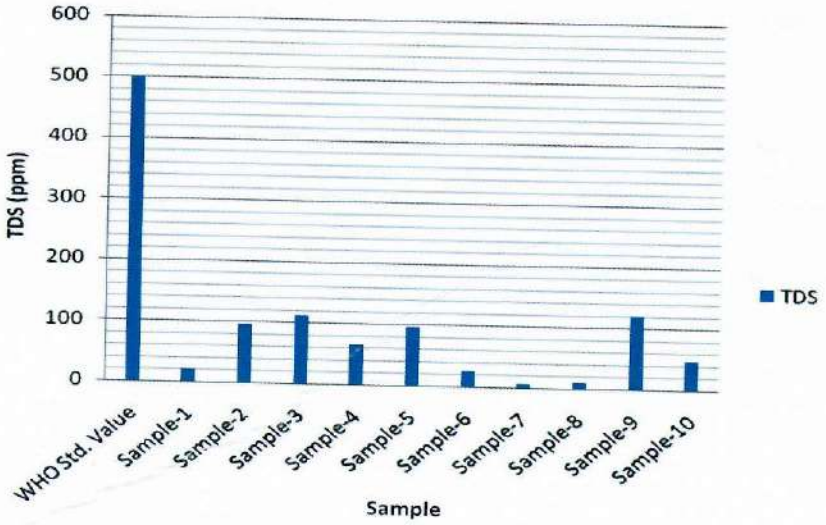
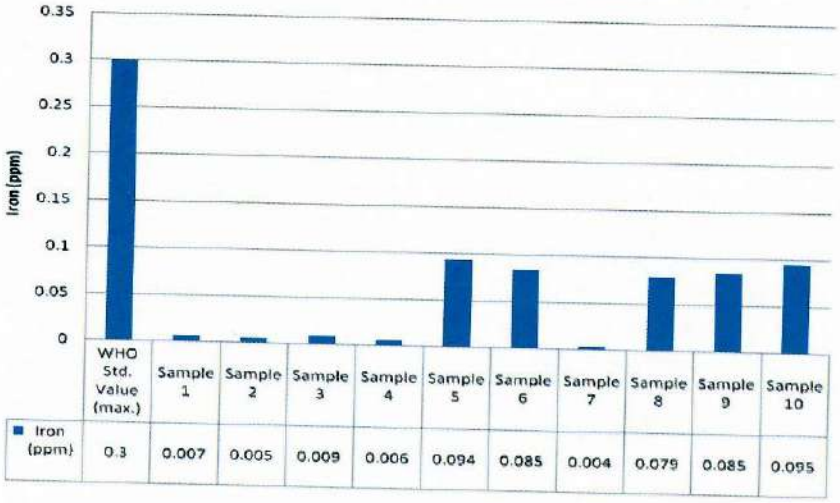
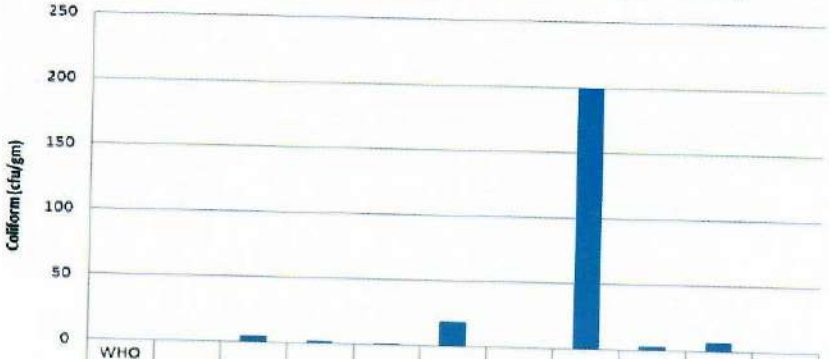


Figure 3: Iron value of ten water samples compared with standard value (maximum)



	WHO Std. Value (max.)	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
Iron (ppm)	0.3	0.007	0.005	0.009	0.006	0.094	0.085	0.004	0.079	0.085	0.095

Figure 4: Coliform count of ten water samples compared with standard value (maximum)



	WHO Std. Value (max.)	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
Coliform (cfu/gm)	0	0	5	2	1	19	0	200	3	7	0

4. CONCLUSION

Much of the ill health which affects humanity, especially in developing countries can be traced to lack of safe and whole water supply. The water intended for human consumption must be free of pathogenic and chemical agents, pleasant to taste and usable for domestic purposes since water is the most important potential source of infectious diseases. This study concludes that most of the portable water samples are contaminated with coliform which is fatal and posed major public health problems. So proper water treatment is important before consumption and the regulatory body of Government should monitor this.

5. ACKNOWLEDGEMENTS

We are thankful to Department of Food Processing and Engineering as well as Department of Applied Food Science and Nutrition, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh for the technical help during this study. We are also thankful to all the members of Quality Control Lab, Sanowara Drinks and Beverage Industries Limited, Chittagong, Bangladesh.

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