Progressive Agriculture 32 (2): 84-95, 2021 https://doi.org/10.3329/pa.v32i2.58393

Progressive Agriculture

Journal homepage: http://www.banglajol.info/index.php/PA

Physico-chemical and microbiological assessment of drinking water of the selected restaurants in Mymensingh district of Bangladesh

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Article info

Article history:

Received: 23 July 2021

Revised: 15 September 2021

Accepted: 15 December 2021

Published: 31 December 2021

Keywords:

Heavy metal contamination, HPC, MPN, Drinking water

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ISSN: 1017 – 8139

eISSN: 2310 - 2950

OPEN ACCESS

Abstract

Water is essential for living organisms for their survival. Access of adequate and safe water is a basic need of human beings. In adequacy and unsafe water supply may cause various health problems. This study was designed with a view to assessing physicochemical properties of drinking water collected from different restaurants at Mymensingh *sadar*. In this case, electrical conductivity (EC), total dissolved solids (TDS), pH, dissolved oxygen (DO), biological oxygen demand (BOD), arsenic (As), iron (Fe) and lead (Pb) were measured. Furthermore, Microbiological assessments of drinking water samples were carried out. For achieving the microbiological assessment, methods of heterotrophic plate count (HPC) and total coliform count (TCC) were applied. The mean value of EC, TDS, pH, DO, BOD, As, Fe, Pb were 682.38 µS cm^{-1}, 201ppm, 7.11, 4.98 mg/L, 1.72 mg/L, 0.005 ppm, 0.181 ppm and 0.000 ppm, respectively. According to the standard of drinking water the EC, TDS, pH, DO, BOD, As, Fe, Pb toxicity were not detected in all samples. All of above mentioned parameters were present in water within permissible limits. In most cases the concentrations of Pb and in some cases the concentrations of Fe were considered as toxicants due to the higher concentrations noted. The highest heterotrophic plate count was found in water of *Ganginapar* sample (1.2×10^7 CFU/ml) and the highest total coliform count was noted in *C. K. Ghosh* road sample (13 coliforms/100 ml). Therefore, the examined water quality parameters indicate that water quality of the restaurants at Mymensingh *sadar* is suitable for drinking. Although some of the samples identified as the presence of fecal coliforms that indicates contamination of feces with water. One sample among the studied drinking water samples was contaminated with fecal coliform which is very harmful for health and this water is not suitable for drinking. It may be concluded that hygienic and quality water need to supply for human drinking purposes.

Introduction

Water is very important component of the environment. Without water life on earth would not exist. It is difficult to imagine clean and sanitary environment without water. Various health problems may occur due to inadequacy and poor quality of supplied water. Infant mortality rate is high due to unsafe water supply (Ahmed and Rahman 2000). Water has the unique property of dissolving and carrying in suspension a huge variety of chemicals and hence water can easily become contaminated. About one third of the drinking water requirement of the world is obtained from surface sources like rivers, dams, lakes and canals (Jonnalagada and Mhere 2001). But some of the reports noted that water of river and

How to Cite

Islam MA, Ema IJ, Usha KF, Kabir SML (2021). Physico-chemical and microbiological assessment of drinking water of the selected restaurants in Mymensingh district of Bangladesh. *Progressive Agriculture*, 32 (2): 84–95. **https://doi.org/10.3329/pa.v32i2.58393**

canals as well as biomass burning were contaminated with different heavy metals like Pb, Cr, Cd, Ni and Zn etc. (Rahman *et al.* 2016; Uddin *et al.* 2016; Islam *et al*. 2017; Miah *et al.*, 2019).

The importance of high quality drinking water is vastly understated. Therefore, an unadulterated source of pure drinking water and learning how to optimize hydration is one of the most fundamentally important things one can do for their health. Since tap water all too often contains a variety of unhealthy contaminants, including microorganisms, heavy metals, chlorine, fluoride, and other impurities it is recommended that this water be filtered to remove these harmful impurities. The rapid growth of population and urbanization in developing countries like Bangladesh has an enormous impact on the natural environment. As a result, pollution sources increase with the development of cities and cause contamination of air, water, and soil.

The polluted water is the culprit in all water borne diseases and epidemics. Water sources were polluted by domestic wastage in rural areas where as industrial wastes discharged into natural water sources in urban areas (Uddin *et al.* 2016; Rahman *et al.* 2016). We need water every day for various domestic, irrigation and drinking purposes. Economy of our country is agro based economy. Most of the people who live in villages get their jobs in agriculture field due to irrigation facilities in that sector. But due to industrial and agriculture revolution water which is collected in the various water resources highly polluted in various ways. So it was not suitable and safe for domestic, irrigation as well as drinking purposes. Water is basis all kind of life. Due to wrong consideration, the percolated ground water considered to be suitable, safe for the drinking and irrigation purpose owing to natural geological filtration process. Few studies have found that the ground water to be contaminated (Uddin *et al*. 2016, Rahman *et al.* 2016; Islam *et al.* 2017).

Water is polluted due to various phenomena. Drinking water supply should be completely free from pathogenic microorganisms, element in concentration that causes health impacts. Access to the safe water supply water is one of the most important determinants of health and socioeconomic development. Water pollution by different chemicals and toxic metals is a worldwide issue. All countries have been affected, though the area and severity of pollution vary enormously. In Western Europe, 1400000 sites were affected by different chemicals agents and heavy metals (McGrath *et al*. 2001), of which, over 300000 were contaminated, and the estimated total number in Europe could be much larger, as pollution problems increasingly occurred in Central and Eastern European countries (Gade 2000). Water pollution is also severe in India, Pakistan and Bangladesh, where small industrial units are pouring their untreated effluents in the surface drains, which spread over near agricultural fields. In recent time, the environment has become hostile, posing threat to health and welfare due to release of pollutants from industries and urban sewage (Ntengwe 2006; Islam *et al.* 2017; Rahman *et al.*, 2016). The surface water is also affected with different heavy metals like Cu, Zn, Cd, Hg, Fe and Pb (Serghini *et al.* 2003).

There are many restaurants available in Mymensingh city of Bangladesh. Maximum Restaurants use supply water from deep tube-wells. The supply water directly uses from deep tube-well are generally pure. But when the supply water from deep tube-well stored long time in an unhygienic or unclean tank, it becomes impure and contaminate with different pathogen (fungus, bacteria etc) and metallic substances. As the tanks are not cleaned and sometimes not use for long time in a routine way, the bottom layer of water in tank remain unused. On the other hand, some of the tanks have no cover and some became old. So, a considerable amount of fungus and bacteria grow on the side wall and stagnant water of the tanks. Also old metallic tank and supply pipe release some metallic substances in the water of the tank. After a few months with uncleaned and uncovered condition the color of water in tank changes and becomes toxic.

In Bangladesh, a large number of people living in major cities and suburbs eat their meals in various roadside restaurants. In recent times, the microbiological safety of drinking water has become a burning issue and public awareness is gradually increasing regarding waterborne diseases. Several incidents of contamination of municipal water supply from various extraneous sources and poor maintenance of pipe line causing leakage of the water pipes forced the consumers to seek safer options regarding potable water. Although costly, bottled water from different companies has become an option. However, a popular, low cost alternative is the drinking water provided in large closed containers by various companies.

For the above reason the following parameter like EC, TDS, pH, DO, BOD, As, Pb, Fe and microbial test such as HPC (heterotropic plate count) and MPN (most probable number) were measured to determine drinking water quality. Safety and quality of drinking water is always an important public health concern. Contamination of potable water has been frequently found associated with transmission of diseases causing serious illness and mortality throughout the world. Although poor sanitation and food sources are integral to enteric pathogen exposure, drinking water is a major source of microbial pathogens in developing regions. So we should increase public awareness about drinking water and if possible to increase awareness among government, nongovernmental institutes and different NGOs though the present study. The objectives of the study were to investigate water quality of the restaurants of study sites, to determine the trace elements (As, Pb, Fe) status in drinking water samples and finally to assess microbial status of drinking water.

Materials and Methods

***Collection of Water* Samples:** Twenty-six samples which were categorized into five locations, collected from the different restaurants of Mymensingh *sadar* with the help of a plastic pot. The water samples were collected in 100 ml plastic bottles. These bottles were cleaned with dilute hydrochloric acid (1:1) and then washed with tap water followed by distilled water. Before sampling bottles were rinsed 3 to 4 times with water to be sampled. After collecting the bottles containing samples were sealed immediately to avoid exposure to air. After collection, all samples were filtered with Whatman no. 1 filter paper to remove unwanted solid and suspended materials before analysis. Then the water quality parameters such as electrical conductivity (EC), total dissolved solid (TDS), pH and DO were detected by respective digital meters. Then the water transferred into another 100 ml bottle which contained 10 ml nitric acid solution to protect water samples from any fungal and other pathogenic attack. After collection water samples were carried to the Laboratory of Soil Science Division of BINA for trace element analysis. Also another set of water samples were carried to the Laboratory of Department of Microbiology and Hygiene of Bangladesh Agricultural University, Mymensingh for microbiological assessment. After bringing to the laboratory bottles were kept in a clean, cool and dry place.

***Analytical results of physicochemical* parameters:** The following parameters were measured from the water samples- Electrical conductivity (EC), Total dissolved solids (TDS), Hydrogen ion concentration (pH), Dissolved oxygen (DO), Biological oxygen demand (BOD).

Electrical conductivity (EC): The electrical conductivity (EC) of the samples was measured electrometrically by the Digital EC meter. First the electrode of the EC meter was washed out by distilled water. Then 50 ml of sample was taken in a clean beaker and immersed the electrode and waited for at least 10 seconds.

Total Dissolved Solids (TDS)*:* Total dissolved solids (TDS) were determined by evaporating measured aliquot of filtered water samples to dryness and weighing the solids residue using TDS meter according to the method outlined by APHA (1995). At first the electrode of TDS meter was washed out by distilled water. Then 50 ml of sample was taken in a clean 100 ml beaker and immersed the electrode and waited for at least 10 seconds. Then TDS reading was collected from the meter.

pH: The hydrogen ion concentration (pH) is an important parameter for assessing water quality. The pH scale is represented as ranging from 0-14; with pH 7 at 25ºC. The hydrogen ion concentration (pH) value of the water samples were determined electrometrically by pH meter. At first pH meter was calibrated by distilled water and buffer solution of pH 7.0. Then 50 ml of sample was taken in a clean 100 ml beaker and immersed the electrode of pH meter and waited for at least 30 seconds. Then pH reading was recorded from the pH meter to the note book.

Dissolved Oxygen (DO): DO of the samples were determined electrometrically by the digital DO meter. At first the electrode of DO meter was washed out by distilled water. Then 50 ml of sample was taken in a clean 100 ml beaker and immersed the electrode and waited for at least 10 seconds. Then DO reading was collected from the meter.

Biological Oxygen Demand (BOD): The BOD bottles fixed with water samples were included at room temperature for five days and analyzed by the same method of DO. The value of DO obtained was considered as the initial value of DO. To determine BOD, the final value was subtracted from the initial value of DO.

Determination of trace elements: The water samples transferred into another 100 ml bottle which contained 10 ml nitric acid solution to protect water samples from any fungal and other pathogenic attack. As, Fe and Pb were determined with the help of atomic absorption spectrophotometer (AAS, PG 990, England) at the central laboratory "BINA", Lab of Soil Science Division of Bangladesh Agricultural University, Mymensingh following the method of Clesceri *et al.* (1989). Mono element hollow cathode lamp was employed for the determination of each heavy metal of interest. At first, the AAS was calibrated followed by the manufacturer's recommendation. The filtered water sample was run directly for the determination of trace elements in acidified water samples. A standard line was prepared by plotting the absorbance reading on Y-axis versus the concentration of each standard solution of metal on X-axis. Then, the concentration of metal was calculated in the water samples of interest by plotting the AAS reading on the standard line.

***Microbial investigation in water* samples**: Heterotrophic plate count (HPC) and Most Probable Number (MPN), microbial contamination tests were performed as described-

Heterotrophic Plate Count (HPC): For the determination of heterotrophic plate count, 100 micro liter of a tenfold serial dilution of collected water was transferred and spread onto a plate count agar media using micro pipette for each dilution. The diluted samples were spread as quickly as possible on the surface of plate with a sterile glass spreader. One sterile glass spreader was used for each plate. The plates were then incubated at 37ºC for 24-48 hours. Following incubation, plates exhibiting 30-300 colonies were counted. The heterotrophic plate count was calculated according to ISO (1995). The result of total bacterial count was expressed as the number of organism or colony forming units per milliliter (CFU/ml) of water samples.

Most Probable Number (MPN): The Most Probable Number (MPN) test for water examination for the presence of coliforms was performed according to the procedures described by Prescott *et al.* (2002). An estimate of the number of coliforms (Most Probable Number) was done in the presumptive test. In this procedure, 15 lactose broth tubes were inoculated with the water samples. Five tubes received 10 ml of water, 5 tubes received 1ml of water, 5 tubes received 0.1ml of water. A count of the number of tubes showing gas production was then made, and the figures were compared to a table developed by American Public Health Association. The number was the most probable number (MPN) of coliforms per 100 ml of the water sample.

Determination of microbial contamination: After collection, water samples were transferred to the laboratory of the Department of Microbiology and Hygiene, BAU, Mymensingh and inoculated into different bacteriological media such as, nutrient agar, EMB agar, S-S agar, MacConkey's agar, MSA for detection of microbial contamination using cultural technique. After cultivation bacteria were identified using staining and biochemical tests.

***Data collection, processing and* analysis**: The data relevant to different analysis and measurements were collected properly. All the ends of data collection, data were compiled, tabulated and analyzed. Statistical analyses of the data generated out of the chemical analysis of water quality were done following the standard procedure as described by Gomez and Gomez (1984). The collected data were tabulated and coded. Microsoft Office Excel 2007 software was used for data analysis and presentation. Finally, the all the types of analyzed data were integrated and presented as maps, tables, and graphs and putted in the report.

Results and Discussion

Electrical conductivity (EC): The average value of EC was 682.38 µS cm^{-1}. EC values of different water samples ranged from 665 to 712 µS cm^{-1}. Out of 26 samples, 14 samples showed lower EC value than mean value and the rests are showed higher EC value than that of mean value. Lower EC (665 µS cm^{-1}) was noted at *Shampan* Restaurant and the highest was 712 µS cm^{-1}, recorded at Hotel *Pinu* (Table 1). Standard acceptable value of EC for drinking water was 1.5 mS cm^{-1} (EQS 2004). According to WHO standards EC value should not exceeded 400 µS cm^{-1}. In study areas, the average value of EC was 682.38 µS cm^{-1}. These results clearly indicate that water in study areas was considerably ionized and has the higher level of ionic concentration activity due to excessive dissolve solids. Thus, it is a fine conductor of electric current. The water is soft, had a low electrical conductivity when water is 20-329 mS cm^{-1} (Alagbe 2002). Depth of the water table had a moderate negative geostatistical correlation with electrical conductivity (Losinno et al. 2002). In the study, EC values of the drinking waters was less than maximum acceptable limit which was indicating well for drinking purposes. Pure water is not a good conductor of electric current rather a good insulator. Increase in ions concentration enhances the electrical conductivity of water. Generally, the amount of dissolved solids in water determines the electrical conductivity.

Total Dissolved Solids (TDS): The TDS values of different water samples ranged from 180 to 220 ppm and their standard deviation was ±9.97. The average value of TDS was 201 ppm. Out of 26 samples, 15 samples showed lower concentration than mean value and the rest 11 samples showed higher concentration than that of mean value. Lower TDS 180 ppm was found at *Hotel Akota* and *Hotel Rifat* and the highest was 220 ppm was recorded at Press Club Restaurant and *Sharinda* Restaurant (Table 1). Standard acceptable value of TDS for drinking water was 500 ppm (ABD, 2004). Since the TDS values were lower than acceptable value which indicated better for drinking. Similar result was supported by Rahman *et al.* (2004); Rahman *et al.* (2016); Islam *et al.* (2017) and Uddin *et al.* (2016).

Water has the ability to dissolved wide range of inorganic and some organic minerals or salts such as potassium, calcium, sodium, bicarbonates, chlorides, magnesium, sulfates etc. These minerals produced un-wanted taste and diluted color in appearance of water. There is no agreement have been developed on negative or positive effects of water that exceeds the WHO standard limit of 1,000 ppm. Total dissolved solids (TDS) in drinking water is originates many ways from sewage to urban industrial wastewater etc. Therefore, TDS test is considered a sign to determine the general quality of the water. In this study, the TDS range was 180 to 220 ppm. Hence, these ranges were acceptable and the concentration of TDS is not harmful.

Hydrogen ion concentration (pH): The pH values of 26 water samples collected from restaurants at Mymensingh *sadar* ranged from 6.8 to 7.3, which indicated slightly acidic to slightly alkaline. The mean value was 7.11 and their standard deviation was ±0.15. Out of 26 samples, only one sample showed lower concentration than mean value and the rest 25 samples showed higher concentration than that of mean value. Lower pH 6.8 was found at Hotel *Akota* and the highest was 7.3 was recorded at *Bhai Bhai Hotel*, *Modina Hotel*, *Manik Hotel*, *Faruk Hotel* and *Ma-Lokhkhi Hotel* (Table 1).

Table 1. Physicochemical parameters of different drinking water samples of study sites.

Location	Sample No.	Sample collection sites	EC µS cm^{-1}	TDS (ppm)	p^{H}	DO mg/L	BOD mg/L
BAU Campus	01	Bhai Bhai Hotel	676	201	7.3	5.2	1.8
	02	ModinaHotel	684	202	7.3	5.1	1.8
	03	Milon Hotel	687	201	7.2	5.2	1.7
	04	Bismilla Hotel	680	203	7.2	5.2	1.8
	05	Shiuli Hotel	700	207	7.1	4.9	2.3
	06	Mama Hotel	698	210	7.1	4.8	2.1
	07	Manik Hotel	682	200	7.3	5.0	1.7
	08	Faruk Hotel	678	200	7.3	5.1	1.7
C. K. Ghosh Road Area	09	Pressclub Restaurant	675	220	7.0	4.9	1.7
	10	Dhanshiri Restaurant	668	200	7.2	5.0	1.5
	11	Sharinda Restaurant	679	220	7.1	4.9	1.6
	12	Shampan Restaurant	665	210	7.2	4.9	1.7
	13	NirobBiriyani House	668	210	7.0	4.8	1.5
Ganginapar Area	14	Hotel Al- Hafiz	670	200	7.2	5.5	1.7
	15	Hotel PakMuslim	672	200	7.2	5.4	1.7
	16	Ma-moni Hotel	660	190	6.9	5.4	1.5
	17	Hotel Akota	672	180	6.8	5.5	1.6
	18	Joyguru MistiVhandar	668	200	7.0	5.3	1.5
	19	Ma-Lokhkhi hotel	683	190	7.3	4.9	1.7
	20	Hotel Alamin	688	200	7.1	4.9	1.6
Charpara Area	21	Hotel Rifat	693	180	7.2	5.1	1.4
	22	Hotel Riaz	686	190	7.1	4.9	1.6
	23	Musa Restora	690	195	7.0	4.9	1.6
Kachari Area	24	Hotel Salim	705	210	6.9	4.2	1.9
	25	Hotel Pinu	712	200	6.9	4.5	2.0
	26	Hotel Shathi	703	190	7.0	4.1	2.1
Range			665-712	180-220	6.8-7.3	4.1-5.5	1.4-2.3
Mean			682.38	201	7.11	4.98	1.72
Standard deviation (SD)			±13.46	±9.97	±0.15	±0.35	±0.22

EC= Electrical conductivity; TDS= Total Dissolved Solids; BOD= Biological Oxygen Demand; DO=Dissolved Oxygen.

The highest desirable and maximum permissible limit of pH for drinking water is 6.0 to 8.5 (EQS, 2004). So, in this study the pH values were not exceed the standard limit however, these were falling in basic or alkaline range. On the basis of pH value all the tested water samples were suitable for drinking according to Bangladesh Standard (pH -6.5 to 8.5) (Rahman *et al.* 2016; Islam *et al.*, 2017 and Uddin *et al.* 2016). The ranges of pH tube well 7.21 to 8.02. Out of 50 samples 90% pH values were higher than 7.0 i.e. most of the water were alkaline in nature (Basher 2005). In present study, range of pH was 6.8 to 7.3. So, the water of the restaurants was alkaline and safe for drinking.

The average value of DO of studied samples was 4.9 mg/l. DO values of different water samples ranged from 4.1 to 5.5 mg/l and their standard deviation was 0.34. Out of 26 samples, only one sample showed lower concentration than mean value and the rest 25 samples showed higher concentration. Lower DO (4.1 mg/l) was found at Hotel *Shathi* and the highest was 5.5 mg/l was recorded at Hotel *Al- Hafiz* and Hotel *Akota* (Table 1). The acceptable range of DO for domestic water supplies is from 4.0 to 6.0 mg/l by USPH standard and 3.0 mg/l according to ISI standard (Devai *et al.* 2005). According to the environmental quality standard (EQS, 2004), the following requirements for DO are prescribed: 6.0 mg/l for drinking, 4.0 to 5.0 mg/l for recreation, 4.0 to 6.0 mg/l for fish and livestock and 5.0 mg/l for industrial application (Rahman *et al.* 2012).

Shaji *et al*. (2009) examined the water quality of four open wells representing four localities around the Kerala Minerals and Metals Ltd industrial area, Chavara, Quilon district, India. The study was conducted to assess the suitability of the well waters for domestic purposes. The wells water exhibited low dissolved oxygen (2.63 to 3.13 mg/L). The dissolved oxygen was much lower than the desirable limit in all the well waters. Hence all the four well waters were found unsuitable for domestic purposes. But at Mymensingh *sadar*, different restaurant's water samples were examined and the DO range was 4.1 to 5.5 which exhibited the desirable limit. So the water was safe for drinking.

Biological oxygen demand (BOD): The average value of BOD was 1.72 mg/l. BOD values of different water samples ranged from 1.4 to 2.3 mg/l and their standard deviation was 0.22. Out of 26 samples, 1 sample showed lower concentration than mean value and the rest 25 samples showed higher concentration than that of mean value. Lower BOD 1.4 mg/l was found at Hotel *Rifat* and the highest was 2.3 mg/l was recorded at *Shiuli* Hotel (Table 1). Biological oxygen demand (BOD) is a measure of the oxygen used by microorganisms to decompose the organic wastes. When BOD level is high, DO level decrease because the oxygen available in the water is being consumed by the bacteria (Sawyer *et al*. 2003). Standard BOD value 0.2 mg/l for drinking water and value less than 3 mg/l for inland surface water (Zahid *et al*. 2004).

Arsenic: The As content from studied locations which are shown in Table 2. As was recorded from 0.000-0.0156 ppm with its mean and standard deviation were 0.005 ppm and ±0.005 respectively. The highest As value (0.156 ppm) was recorded at *Musa Restora* and the lowest was recorded at Press club Restaurant, *Dhanshiri* Restaurant and *Shampan* Restaurant. According to the (USEPA 1975) the recommended arsenic content in drinking water is 0.01 ppm. So all the water samples found free from dangerous As contamination, i.e. suitable for health and animal consumption. The speciation of As in ground water is of critical importance because organic and inorganic compounds differ largely in their toxicity (Leonard 1991). So all the water samples were free from As contamination and safe for drinking purpose. The concentration of As in wells water increased 0.007 ±0.005 ppm with the depth of wells and the depth range was 2-10 meter and 0.251±0.077 ppm with the depth range 316-400 meter (Wang *et al*. 2003).

Iron: Fe was recorded from 0.002- 0.427 ppm with its mean and standard deviation were 0.181 ppm and ±0.164. The highest Fe value 0.427 ppm was recorded at *Hotel Pinu* and the lowest was recorded at *Shampan* Restaurant. The recommended concentration of Fe for drinking water was 0.30 ppm (USEPA 1995). In this study the average value of Fe was 0.181 ppm (Table 2) which was low from the recommended concentration so all the water samples might be safely recommended for drinking and other domestic purposes.

Lead: International Standards of Pb in drinking water for acceptable limit was 0.05 ppm and maximum allowable limit was 0.1 ppm (WHO and UNICEF 2000). But in this study Pb detection was not possible in water samples of different restaurant due to absence of this metal.

Table 2. Trace element contents with mean and ranges of water samples of different restaurants of study sites.

Location	Sample no.	Sampling sites	As (ppm)	Fe (ppm)
BAU Campus	01	Bhai Bhai Hotel	0.009	0.182
	02	Milon Hotel	0.008	0.123
	03	Manik Hotel	0.003	0.220
C.K.Ghosh Road Area	04	Pressclub Restaurant	0.000	0.003
	05	Dhanshiri Restaurant	0.000	0.007
	06	Shampan Restaurant	0.000	0.002
Ganginapar Area	07	Hotel Al- Hafiz	0.0125	0.343
	08	Ma-moni Hotel	0.0056	0.315
	09	Hotel Akota	0.007	0.321
Charpara Area	10	Hotel Rifat	0.0054	0.015
	11	Hotel Riaz	0.0123	0.023
	12	Musa Restora	0.0156	0.013
Kachari Area	13	Hotel Salim	0.000	0.418
	14	Hotel Pinu	0.000	0.427
	15	Hotel Shathi	0.000	0.302
Range			0.000- 0.0156	0.002- 0.427
Mean			0.005	0.181
Standard Deviation (SD)			±0.005	±0.164

As=Arsenic; Fe=Iron.

Heterotrophic Plate Count (HPC): Heterotrophic Plate Count of drinking water samples of Mymensingh *sadar* is presented in Table 3. The geometric mean of HPC of drinking water samples of study sites was 3.05×10^{6} CFU/ml. The Heterotrophic Plate Count of drinking water samples of Mymensingh sadar having sample sites *Jobber more*, *Shash more*, *Charpara*, *Kachari*, *Ganginapar* and *C. K. Ghosh* road were 3.2×10^{5} CFU/ml, 2.8×10^{6} CFU/ml, TFTC, TFTC, 1.2×10^{7} CFU/ml and 3.2×10^{6} CFU/ml, respectively. The highest Heterotrophic Plate Count was found in water of *Ganginapar* and the value was 1.2×10^{7} CFU/ml and the lowest count was in Jobber more and the value was 3.2×10^{5} CFU/ml. According to the WHO and UNICEF (2000), drinking water quality specifications worldwide recommend HPC limits from 100 to 500 CFU/ml in water. In this study HPC was high in case all types of water samples and high HPC measurements might be due to availability of favorable conditions for the bacterial growth in water system. In another study, about 1.1 $\times10^{7}$ CFU/ml reported in a drinking water sample (Liguori *et al.* 2010). Azeredeo et al. (2001) also reported about 360 CFU/ml in drinking water in their study sites. The present study also revealed that water from different restaurants was contaminated with bacteria (Figure 1).

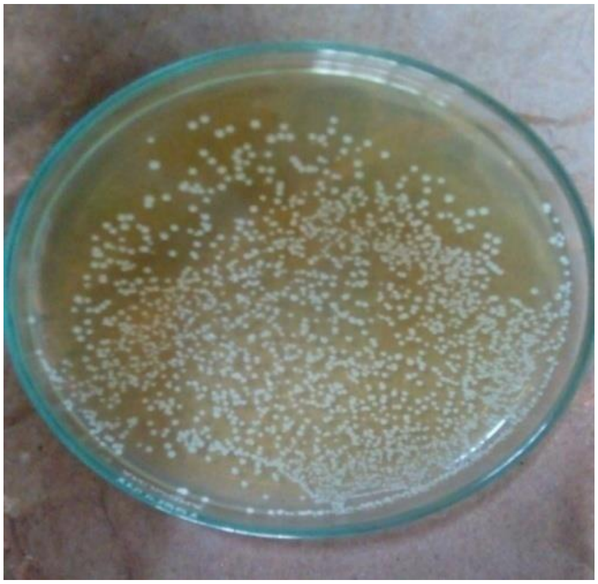

Figure 1. Total viable count of bacteria isolated from drinking water on plate count agar media.

Total Coliform Count (TCC): The Total coliform count of drinking water of Mymensingh *sadar* is presented in Table 3. The lowest coliforms were found in sampling sites *Charpara* and *Kachari* was 2 coliforms/100 ml water. The highest number of coliforms was found in restaurants of *C. K. Ghosh* road and that concentration was 13 coliforms/100 ml water. The TCC of drinking water sampling sites Jobber more, Shash more, Charpara, Kachari, Ganginapar and C. K. Ghosh road were 8 coliforms/100ml, 12 coliforms/100ml, 2 coliforms/100ml, 2 coliforms/100ml, 12 coliforms/100ml and 13 coliforms/100ml water respectively. Campos *et al*. (2002) analyzed the microbiological quality of water samples collected from selected houses and could not detect coliforms. On the other hand, Vollaard *et al*. (2005) reported that one third of the households were significantly associated with water contaminated with >100 fecal coliforms/100 ml. In this study, fecal coliform also found in water samples of restaurants. Azeredeo *et al.* (2001) also reported that drinking water contained more than 120 fecal coliforms/100 ml. In another study, about 98 fecal coliforms reported in each 100 ml drinking water sample (Liguori *et al.* 2010). So, if only one fecal coliform is present in the water that water will not suitable for drinking and is very harmful for health.

Table 3. Average and mean values of HPC and MPN of drinking water samples of different study sites.

Collection sites	Mean value			
	HPC (CFU/ml)	**HPC (CFU/ml)**	**TCC (Coliforms/100 ml)**	**Fecal Coliforms**
Jobber more	3.2×10^5 CFU/ml	3.05×10^6	8 coliforms/100ml	-ve
Shash more	2.8×10^6 CFU/ml		12 coliforms/100ml	+ve
Charpara	TFTC		2 coliforms/100ml	-ve
Kachari	TFTC		2 coliforms/100ml	-ve
Ganginapar	1.2×10^7 CFU/ml		12 coliforms/100ml	-ve
C. K. Ghosh road	3.2×10^6 CFU/ml		13 coliforms/100ml	-ve

HPC= *Heterotrophic Plate Count*; TCC=*Total Coliform Count*

Acknowledgement

The research work is partially supported by Bangladesh Agricultural University Research System (BAURES) grant program (FY 2017-2019).

Conclusion

In present study EC, TDS, pH, DO, BOD, trace elements (As, Fe, Pb) were measured from different water samples of different restaurants of study sites. To explore the microbial status- heterotropic plate count and most probable number were also examined. This study helps in selection the right options to manage water sources and also helps to find out the drinking water quality of restaurants. It is important to know that one water sample was contaminated with fecal coliform out of total samples. So, that restaurant's water is not safe for drinking purpose. It may have concluded that the consciousness to the concerned authority in developing the present situation of the drinking water system of the restaurants. The most of the analysis of physicochemical parameters, heavy metals and HPC and MPN were noted within the standard levels. From these findings it can be concluded that, water of most of the restaurants of study area are safe for drinking but it needs further observations because gradual increase of waste around Mymensingh municipalities can degrade the quality of water.

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