Bangladesh J Microbiol, Volume 31, Number 1&2, June-December 2014, pp 69-72

Short Communication

Comparison of Microbiological and Physicochemical Quality of Tap and Dispenser Water from Different Mid-Range Restaurants of Dhaka City, Bangladesh

Nur-Alam[1], Rubayat Jamal[1], SM Sabbir Alam[2] and Mohammad Moniruzzaman[2*]

[1]Incepta Pharmaceuticals Ltd., 40 Shahid Tajuddin Ahmed Sarani Tejgaon I/A, Dhaka 1208, Bangladesh, [2]Department of Microbiology, University of Dhaka, Dhaka 1000, Bangladesh

Dhaka is the most populous city in Bangladesh and the tenth-largest metropolitan in the world with about twelve million inhabitants. Most people of Dhaka have low or middle ranged incomes and frequently use roadside mid range restaurants to take their meals and drinking water. Water quality is a significant health concern in Bangladesh and is a probable source of many water borne diseases and outbreaks. Tap water and dispenser water samples were collected from ten roadside restaurants. These samples were analyzed for pH, salinity, conductivity, TDS (total dissolved solid) for physicochemical quality analysis while total coliform, faecal coliform and total heterotrophic bacterial counts were determined for microbiological quality analysis. All the samples conformed to the WHO standards of TDS, salinity and conductivity. Except for 20% of the tap water samples, pH of all the samples was found to be satisfactory. The heterotrophic plate count was in a range of 8.0 x 10^1 cfu/ml to 9.3 x 10^5 cfu/ml from tap water sample and 6.5 x 10^1 cfu/ml to TNTC from dispenser water samples. Only 10% of the tap water samples and 30% of the dispenser water samples complied with the WHO stipulated limit of total heterotrophic count (100 cfu/ml). In terms of total coliforms, all the tap water samples and 20% of the dispenser water samples were found to be contaminated, whereas 50% of both the tap water and dispenser water samples were contaminated with faecal coliforms, indicating possible faecal contamination and presence of pathogenic bacteria. By comparing coliform/faecal coliform count on tap and dispenser water it was found that dispenser water is safer than tap water.

Keywords: Coliform, faecal coliform, Dispenser water, Tap water, Roadside restaurants

There is a profound scarcity of proper drinking water. Though two-third of the earth's surface is covered with water, only 1% is potable. Safety and quality of drinking water is always an important public health concern[1-4].

The World Health Organization (WHO) has estimated that up to 80% of all the diseases in the developing countries are caused by inadequate sanitation, polluted water or unavailability of safe water[5]. About 29-30% of mortality occurs due to waterborne diseases, *e.g.*, diarrhoea, dysentery and gastroenteritis[6]. Drinking water distribution systems can be colonized by saprophytic heterotrophic microorganisms that grow on biodegradable organic matter[7]. Water contamination can occur during storage and distribution through pipe line and other distribution system[8]. It can reach serious proportion in industrial countries[9]. Mechanical failure, human error or deterioration in the quality of the source water can lead to failure even in the best treatment systems and disinfection processes[10-11].

Dhaka is the most populated city Bangladesh with around 12 million inhabitants. Most people have low or middle ranged income. Most of the working-class people have to take their meals from the mid range restaurants of Dhaka city during office/ work hours. During the meals they have two options to choose for the drinking water – either they can take the water for free which is collected from the tap or they can have the water from dispensers in exchange of some money. The water on the dispensers is provided by various bottling companies in the city, which is publicly perceived as safer than the tap water.

Almost all sources of municipal supply in Bangladesh are from ground water. It is generally considered a very good source of drinking water but it may also be polluted, which can be traced back to four main origins: industrial, domestic, agricultural and environmental pollutions. Some studies have emphasized that appearance and growth of microbiological populations in drinking water can be associated with elevated values of some physicochemical parameters[12-15], values of analyzed microbiological parameters were correlated with values of physicochemical indicators- temperature, turbidity, pH value. For the assessment of the microbiological quality of water, most water testing procedures are based on finding the indicator

***Corresponding author:**
Mohammad Moniruzzaman, Department of Microbiology, University of Dhaka, Dhaka 1000, Bangladesh
E-mail: monir.micro@gmail.com

microorganisms whose presence indicates the presence of pathogenic microorganisms[16].

Ten important locations of Dhaka City were selected for the sampling site. Locations selection was considered on the basis of population density of Dhaka city. These are Pallabi-PA(2), Chankharpool-CH(2), Gabtoli-GA(2), Farmgate-FG(1), Gulistan-GU(1), Nilkhat-NK(1) and Kochukhat-KK(1).

Physicochemical parameters, namely TDS, salinity, conductivity (using a TDS meter) and pH (using a pH meter) were measured for each of the water samples. Two separate media - nutrient agar (NA) and mFC agar were used for microbiological analyses. Coliform organisms have long been recognized as a suitable microbial indicator of drinking-water quality, largely because they are easy to detect and enumerate in water[17-18]. After collecting the sample, two separate processes were used to analyze the microbiological status of the samples. For the total heterotrophic count, 0.1ml of serially diluted sample was spread on the plate and incubated at 37°C for 24 hours. Two sets of membrane filter methods were used for the faecal coliform and total coliform counts. Total coliforms can be defined as aerobic or facultative anaerobic, Gram-negative, non-spore forming rods that can ferment lactose with the formation of gas at 35 ± 0.5°C or 44 ± 0.5°C for 24-48 hours. All coliforms are not exclusively faecal in origin. The detection of faecal coliform organisms which can grow at high temperature (44 ± 0.5°C), in particular *E. coli*, provides definitive evidence of faecal pollution[19].

Physicochemical quality of drinking water is an important water quality parameter. By studying ten different samples from ten different middle class hotel and restaurants we found that except pH in few cases all other parameters fulfilled standard criteria. Dispenser water always met standard quality in all cases. pH varied from 6.5 to 7.75 for tap water and 6.8 to 7.2 for filter water. Conductivity varied from 302 to 800 µS/cm for tap water and 260 to 964 µS/cm for filter water. TDS varied from 151 to 407 mg/ml for tap water and 127 to 482 mg/ml for filter water. Salinity varied from 0.1 to 0.4% for tap water and 0.1 to 0.5% for filter water.

Table 1 shows the comparative data of water sample collected from two different sources of ten different sites.

In case of pH only 20% of the tap water samples were above the standard limit but all of the filtered water samples were within the limit. At the same time, conductivity (5,000-50,000 µS/cm)[5], salinity (WHO: <0.5ppm), colour, taste and odour of both the filter and the tap water were very much satisfactory[5] .

For assessing microbiological quality of drinking water three different microbial counts are considered – total heterotrophic (HPC), faecal coliform and total coliform counts (Table 2). Mostly the presence of faecal coliform or total coliform in water renders it undrinkable based on the standard limits set by WHO. The following table shows the comparative data of water sample collected from two different sources of the same collection sites.

Total heterotrophic plate count (HPC) in our supplied samples varied from restaurant to restaurant. For tap water samples supplied by WASA or own pump, HPC varies from 80-9.3 x 10^5 cfu/ml and dispenser water supplied from various companies with BSTI standard certification seal (except one) varies from 65 TNTC cfu/ml[20]. Comparing with WHO only 10 and 30% of the samples are within limit (100 cfu/ml) and only 50% and 60% are within limit set by USEPA (United States Environmental Protection Agency) (500 cfu/ml) for tap water and dispenser water, respectively.

Total coliform count per 100 ml varied from 6 to TNTC and 0 to TNTC for both tap water and dispenser water respectively. The maximum acceptable value of total coliform in drinking water is less than 1 per 100 ml and less than one for faecal coliform[21]. Range varies from 0 to TNTC and 0 to 47 cfu/100 ml for tap water and dispenser water respectively. Compared to WHO (0 cfu/100 ml) standards, only 50% samples of tap water were safe

Table 1. *Comparison of physicochemical quality of drinking water from two different sources of 10 different mid range restaurants in Dhaka City*

Serial No.	Name of the sample collection site	Conductivity µS/cm		TDSmg/ml		Salinity%		pH		Odour		Appearance	
		Tap	Dispenser	Tap	Dispenser	Tap	Dispenser	Tap	Dispenser	Tap	Dispenser	Tap	Dispenser
1	PA1	302	260	151	129	0.1	0.1	7.17	7.2	None	None	Clear	clear
2	CH1	800	783	407	393	0.4	0.4	7.44	6.8	None	None	Clear	clear
3	CH2	764	336	390	127	0.4	0.2	7.75	6.9	None	None	Clear	clear
4	GA1	302	284	151	142	0.1	0.1	6.70	7.0	None	None	Clear	clear
5	GA2	455	820	227	410	0.2	0.4	6.73	6.8	None	None	Clear	clear
6	NK	723	964	362	482	0.4	0.5	6.6	6.69	None	None	Clear	clear
7	GU	475	442	237	221	0.2	0.2	6.8	6.99	None	None	Clear	clear
8	FG	470	419	235	209	0.2	0.2	6.75	7.1	None	None	Clear	clear
9	KK	521	444	253	398	0.3	0.4	6.5	6.8	None	None	Clear	clear
10	PA2	345	324	172	162	0.2	0.2	7.45	6.9	None	None	Clear	clear

Table 2. *Comparison of microbiological count of two different sources of drinking water from 10 different mid-range restaurants in Dhaka City*

SerialNo.	Name of the sample collection site	Total heterotrophic count (cfu/ml)		Faecal coliform count (cfu/100 ml)		Total coliform count (cfu/100 ml)	
		Tap	Dispenser	Tap	Dispenser	Tap	Dispenser
1	PA1	1.05×10^2	2.3×10^3	4.7×10^1	0	TNTC	1.27×10^2
2	CH1	1.3×10^4	4.85×10^2	0	1.4×10^1	TNTC	TNTC
3	CH2	9.3×10^5	TNTC	0	6.0×10^0	TNTC	TNTC
4	GA1	8.0×10^1	1.07×10^3	0	0	1.08×10^2	1.84×10^2
5	GA2	6.1×10^2	8.5×10^1	TNTC	0	TNTC	0
6	NK	5.45×10^2	8.0×10^1	5.6×10^1	0	TNTC	0
7	GU	1.25×10^2	1.1×10^2	TNTC	1.0×10^0	TNTC	3.0×10^0
8	FG	3.3×10^2	2.8×10^3	2.03×10^2	4.7×10^1	TNTC	TNTC
9	KK	2.3×10^4	6.5×10^1	0	0	0	TNTC
10	PA2	3.95×10^2	1.75×10^2	0	$5.0\ 10^0$	TNTC	1.08×10^2

and 50% of the dispenser water samples could be regarded as safe to drink.

Our study objective was to analyze both tap and dispenser water from microbiological and physicochemical quality perspective and determine which of these two options is safer for the public health. Our findings show that if we combine the three counts – TC, FC and HPC, then not a single one of our collected tap water samples were safe for drinking, and only two samples (GA2, NK) are safe in case of dispenser water according to WHO and BSTI standard limits for drinking water safety[5]. For the tap water which are supplied by pumps owned by the restaurants, microbiological loads were less than the WASA supplied waters. Sample – KK, for which TC and FC were within limit but HPC was 2.3×10^4 cfu/ml, was supplied by Dhaka cantonment. This observation puts the water quality of WASA into questions; however more data is necessary to support this observation. Physicochemical properties of all sample sources were within limit except pH in some cases.

Presence of large number of heterotrophic bacteria doesn't necessarily indicate a significant health risk[18,22]. Incidence of large number of heterotrophic bacteria might suggest the presence of opportunistic pathogens of non-faecal origin that can cause a threat to the young, the old and the infirm[23]. It was reported that consumption of drinking water contaminated with pathogenic microbes of faecal origin is a significant risk to human health in the developing world, especially in remote rural communities.

We collected all the samples directly from the tap and dispenser machines, so cross- contamination from glass or handling by waiters can be ruled out. Since all the dispenser water supplying companies had BSTI approval logos on the bottles (except one), so reasonably they should be considered as safe. But as the result shows, the water quality is far below than the appropriate levels so proper monitoring and investigation should be needed. Further work is needed to assess the quality of drinking water at every step of purification from the microbial point of view all over Dhaka City.

Based on the presented analysis, it can be concluded that drinking water available in the mid range hotel and restaurants in Dhaka City is generally not safe for public consumption and can act as a source of water-borne diseases and outbreaks. Although dispenser water is perceived to be safer than the tap water, both have a level of contamination beyond the accepted standards. Presence of any contaminants in drinking water may pose serious public health concern. So authority should ensure to supply safe drinking water to city dwellers.

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