Orginal Article

Microbial Contamination in Different Water Sources in Dhaka City

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ABSTRACT

Background: Water pollution is one of the significant dangers to the general well-being of Bangladesh. Drinking water sources are contaminated with coliforms. This study was done to investigate the proportion of microbial water pollution in selected areas of Dhaka city.

Methods: This was a Cross-sectional study conducted among a total of 89 water samples were collected from a variety of sources as follows: 5 samples from WASA deep tube-well, 52 from Residential water samples (26 Tap water and 26 Filter water), 6 from Rivers, and 26 from Mineral water (12 from 250ml Bottled & 14 from 20LContainer).

Results: Fecal coliform was found in 23.0% of household tape water, 3.8% of household filter water,14.3% in container water before serving, (14.3%) in container water during serving, and in all (100%) samples from rivers. All the river water (100%), 69.2% of household tape water, 42.3% of household filter water, 28.6% of 20-liter container water before serving, and 85.7% during serving were unsatisfactory (MPN> 180/100 ml of water). On the other hand, 7.7% of household tape water and 34.6% of household filter water, all bottled mineral water, and all samples from a deep tube well were of grade “excellent”.

Conclusions: All of the River water, most of the household tap water, and 20-liter container water during serving were unsatisfactory. Bacteriological assessment of all water sources for drinking should be planned and conducted on a regular basis.

Keywords: Water pollution, Faecal coliform, quality of water.

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Introduction

Safe drinking water and adequate environmental sanitation are preconditions for health and for success in the fight against poverty, hunger, and child deaths (1). According to a UNICEF report, about 800 million people in Asia and Africa are living without access to safe drinking water (2). It was estimated that nearly 1.5 billion people lack safe drinking water and that at least 5 million deaths per year can be attributed to water-borne diseases. The contaminated water or inadequate supply of safe drinking water causes various gastrointestinal diseases like diarrhea, dysentery, and water-borne diseases like cholera and typhoid (3). Poor water quality, sanitation, and hygiene account for some 1.7 million deaths a year worldwide (3.1% of all deaths and 3.7% of all DALY's), mainly through infectious diarrhoea (4). The World Health Organization (WHO) informs that every year more than 3.4 million people die as a result of water-related diseases, making it the leading cause of disease and death around the world (5). WHO has also estimated that up to 80% of all sickness and disease in the world is caused by inadequate sanitation, polluted water, or unavailability of water. Diseases related to the contamination of drinking water constitute a major burden on human health. The most common and widespread health risk associated with drinking water is microbial contamination. Up to 80% of all sicknesses and diseases in the world are caused by inadequate sanitation, polluted water, or unavailability of water (6). In general terms, the greatest

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microbial risks are associated with ingestion of water that is contaminated with human or animal feces. Wastewater discharges in fresh waters and coastal seawaters are the major source of fecal microorganisms, including pathogens (7). 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 pipelines 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 which are directly attached to dispensing machines. After dispensation, the water is provided to the consumers in small glasses (8). The organisms of diarrhea, cholera, and other waterborne diseases are not isolated from water directly. Some indicator organisms are isolated to show the fecal contamination of water. These are fecal coliforms, E. coli, Enterococci, and fecal Streptococci (9). Although a substantial amount of work has been carried out on common water-borne pathogens in Bangladesh, unfortunately, little information is available. This study was conducted to estimate the quality of water from various sources in Dhaka city.

Methods and Materials

This was a Cross-sectional study. A total of 89 water samples were collected from a variety of sources as follows: 5 samples from WASA deep tube-well, 52 from Residential water samples (26 Tap water and 26 Filter water), 6 from Rivers, and 26 from Mineral water (12 from 250ml Bottled & 14 from 20LContainer).

Water samples were collected in 200 ml capacity sterilized containers using standard water collection techniques (10). A collection of water samples by sterile glass stopper bottles were used to collect water samples. Using a clean cloth, the outlet of the tap was wiped to remove any dirt. The tap was turned on, for maximum flow for two minutes and then 200ml water was collected under medium flow, and the cap was replaced. Water samples were properly labeled with full details of the source, time, place, and date of collection (11). Collected samples were immediately stored in a chilled insulation container preferably at a temperature between 1°C and 4°C in order to prevent the overgrowth of bacteria which may result in false bacterial counts positive. These water samples were transported to the microbiology laboratory within two hours of collection.

Microbiological Analysis

Analysis of drinking water: In the laboratory, all the samples were subjected to Multiple Tube Tests for determination of the most probable number (MPN) of coliforms and fecal coliforms. The test was performed according to standard procedure (12).

Presumptive coliform count: Aseptically, one 50-volume, and five 10 ml volume water was added to bottles and tubes containing 50 ml and 10 ml each of double strength MacConkey Broth containing bromocresol purple to indicate by its color change to yellow and the formation of gas in the broth. Additionally, five 1 ml volume of water sample was added to tubes containing 5 ml of single-strength MacConkey Broth. Before incubation, all the bottles and tubes contained inverted Durham tubes and were pre-sterilized in an autoclave. After sterilization, the Durham tubes were checked to see whether they are free from air bubbles. All the bottles and tubes were incubated at 370C for 48 hours. The bottles or tubes which showed acid and gas (a bubble large enough to fill concavity at the top of the Durham tube) production were considered positive for coliforms. These acid and gas-producing cultures were considered 'presumptive positive' growths of coliforms bacilli. Cultures not showing the production of acid or gas or both at 48h are considered negative for coliforms. From the distribution of these positive bottles and tubes, the Most Probable Number (MPN) of Total Coliforms was determined by referring to the standard probability table for the estimation of Total Coliforms (12).

Confirmed test: This test was carried out by carefully streaking Eosin Methylene Blue (EMB) agar plates from each of the tubes that showed production of both acid and gas. The plates were then incubated at 37 °C for 18 to 24 hours. Dark blue colonies with a green metallic sheen on the EMB agar indicated the possible presence of Escherichia coli (13).

Completed test by MIU (Motility-Indole-Urease): According to Cappuccino and Sherman (2005) (13), the following biochemical tests were performed for the identification of bacteria. Using a sterile technique, a small amount of Coliform colonies from EMB agar was inoculated into MIU media and the tubes were then incubated for 24 hours at 370C and 440C. After incubation, the development of pink color was indicative of positive results.

The Eijkman test: Using a sterile technique, a small amount of Coliform colonies showing metallic sheen in EMB agar was picked up and inoculated into Lactose Broth media (MacConkey Broth) and MIU medium. Both the media were then incubated for 24 hours at 440C. Fecal coliform was confirmed by the production of gas and positive indole test (12).

Quality of water: The grade of the quality of drinking water was determined as per Senior (12) as mentioned in the table below.

Results

In total 89 water samples were collected from different sources of Dhaka city. Among 26 samples of residential household tap water, most, 18(69.2%), were unsatisfactory followed by 4(15.4%) of grade "suspicious", and 2(7.7%) were of grade "satisfactory". Only 2(7.7%) were of grade "excellent". Out of 26 filter water samples from residential houses, samples were predominantly 11(42.30%) of grade "unsatisfactory" followed by 9(34.6%) of grade "excellent", 4(15.4%) graded "suspicious" and 2(7.7%) were of grade “satisfactory” **(Table 2).**

Table 1 shows grades of the quality of drinking water as per senior (12)

Sl.#	Quality of supply	Coliform count /100ml	*E. coli* count	Tolerance
1.	Excellent	0	0	In all samples
2.	Satisfactory	1-3	0	Provided that coliform
3.	Intermediate	4-9	0	organisms do not occur in than 5% of samples
4.	Unsatisfactory	10 coliforms or 1 or more *E. coli* or any coliform organisms present in consecutive. samples, or the presence of any coliform organisms in more than 5% of routine samples.	In any sample	

Fourteen samples were collected from 20-litre containers used in different footpath zones of Dhaka city. Among these, 2 samples were collected from each container, one just after opening the container, but before serving and another during serving. In 7 samples before serving, 3(42.9%), were of grade "Satisfactory", 2(28.6%) were of grade "Suspicious", 2(28.6%) were of grade "Unsatisfactory” and none were of grade "Excellent". Among the 7 samples collected during serving most, 6(85.7%), were of grade "unsatisfactory", and 1(14.3%) was of grade "Satisfactory" and none was of grade "Excellent". When the grade of Container water before opening and after opening was compared and it was noted that after opening and setting on the delivery device the grade of the samples deteriorated. River water samples from 6 vital zones of Dhaka city were collected and found 100% of grade "unsatisfactory results”. From 250ml bottled water from different companies, 12 samples were collected; all were of grade "Excellent". Samples were also collected from 5 Deep tube wells of WASA from various locations and found of “Excellent” grade **(Table 2).**

Table. 2. Quality of water samples (N=89)

Types of samples	MPN	FCC	No. of samples	Quality of water
Residential tape water (n=26)	<1	0	2(7.7%)	Excellent
	1-3	0	2(7.7%)	Satisfactory
	4-10	0	4(15.4%)	Suspicious
	>10	0	12(46.2%)	Unsatisfactory
	>10	Present	06(23.0%)	Unsatisfactory
(filtered tape Water) (n=26)	<1	0	09(34.9%)	Excellent
	03	0	02(7.7%)	Satisfactory
	4-10	0	04(15.45%)	Suspicious
	>10	0	10(38.5%)	Unsatisfactory
	>10	Present	01(38.4%)	Unsatisfactory
20L container water from footpath, before serving (N=7)	0	0	0(0%)	Excellent
	01-03	0	04(57.1%)	Satisfactory
	04-10	0	01(14.3%)	Suspicious
	04-10	Present	01(14.3)	Unsatisfactory
	>10	0	01(1.3%)	Unsatisfactory
20L container water from footpath, during serving (N=7)	0	0	0(0%)	Excellent
	04-07	0	0(0%)	Satisfactory
	04-10	0	01(14.3%)	Suspicious
	>10	0	05(71.4%)	Unsatisfactory
	>10	Present	01(14.3%0	Unsatisfactory
Quality of river Water (N=06)	>180	Present	06(100%)	Unsatisfactory
250ml sealed bottles water (N=12)	0	0	12(100%)	Excellent
Deep tube well water (n=5)	<1	0	5	Excellent

Note: MPN= Most probable number FCC= Faecal coliform count

When correlation was done between the grade of tape water and filter water of the same family, it was observed that out of 26 families only in two (7.7%) families both the tape water and filter water (filtered from the same tape water) were of “excellent” grade. In 9(34.6%) families tape water was of “satisfactory”/ “suspicious” grade but filter water was “excellent”. In another (3.9%), tape water was “unsatisfactory” but filter water was “satisfactory”. In one case (3.9%), both tape and filter water were "satisfactory". In 11(42.3%) cases the filter did not work; both the tape water and filter water were of "Suspicious" / "unsatisfactory" grade. In 2(7.7%) cases, tape water was of "suspicious grade", but filter water was of "unsatisfactory" grade (Table 3).

Table 3. Comparison of Grade of tape water before filtration and after filtration

Grade of Tape water		No. of samples.
Before filtration	After filtration	
Excellent	Excellent	2(7.7%)
Satisfactory /suspicious	Excellent	9(34.6%)
Satisfactory	Satisfactory	1(3.9%)
Unsatisfactory	Satisfactory	1(3.9%)
Satisfactory /suspicious	Satisfactory /suspicious	11(42.3%)
Suspicious	Unsatisfactory	2(7.7%)
	Total	26(100%)

Discussion

Water is indispensable for life. Urbanization, overpopulation, environmental pollution, and ever-increasing demand, pose a risk to the availability of safe drinking water. The present study was done to assess the quality of drinking water in some areas of Dhaka city. In total 89 water samples were collected from different sources of different locations viz. tap water, corresponding filter water mainly from residential areas, deep tube well water, Mineral water, and river water.

Twenty-six tap water samples were collected from selected residential houses most of which, 18(69.2%), were of grade unsatisfactory followed by 4(15.4%) were of grade suspicious. Only 2 (7.7%) were of grade satisfactory and another 2(7.7%) were excellent grade. This correlates with the findings of Malathy et al (2017) (14) and Kumar et al (2013) (15). In the study of Malathy et al (2017) (14) out of 7 tap waters, 5(71.4%) were graded unsatisfactory, and only 2(28.6%) were graded satisfactory. In the study of Kumar et al (2013) (15), out of 58 tape water 40(69%) samples were of grade unsatisfactory. However, the cause of the unsatisfactory status of the water may be due to poor maintenance of the water supply system where due to leakage in the pipeline, pollutants from the surrounding area especially leaked sewerage lines, may enter the water supply lines.

In this study, out of 26 filter water (filtered tape water from sources), 11(42.3%), were of grade “unsatisfactory”, 9(34.6%) of grade “excellent”, 4(15.4%) were of grade “suspicious” and 2(7.7%) were of grade “satisfactory”. This correlates with the findings of Hamza, 2009) (16) where 47.5% (n=40) of filter water samples were unsatisfactory. Due to the lack of regular cleaning of the filters or using them for a long time with proper maintenance the filtration quality may deteriorate.

In the present study, 12 Mineral water (250ml) from 6 companies collected from the market showed an "excellent" grade. Our findings contrast with that of Malathy et al (2017) (14) where out of 11 mineral water, one (9.1%) was of grade excellent and others were of grade “unsatisfactory”.

Mineral water of 20 Liter container (N=7) was also examined in this study. Samples were taken twice, one just after opening but before setting in the dispenser for sale and another sample taken during the sale after setting in the dispenser. None of the samples before use was of grade "excellent" (0%), predominantly the samples were of grade "satisfactory" (42.9%), 14.3% were "suspicious" and 28.6% were "unsatisfactory". During the sale after setting in the dispenser, the quality of samples deteriorated more, and all the samples were "unsatisfactory" (85.7%) except one (14.3%) which was "suspicious". This finding correlates with the findings of Feeser (2016) (17) and Yamaguchi et al (2007) (18) Where a high coliform count was found in the 20L containers on dispensers due to improper cleaning during reuse.

Samples were taken from five Deep tube wells of WASA of Dhaka city, one sample from each. All the samples (100%) were "excellent". This finding correlates with that of Pravez et al (19) where all deep tube well (n=5) waters were of grade “Excellent”. This means that water of "excellent" grade was collected from deep tube wells, but their quality deteriorated during supply through the transmission system. So, it was evident that the water supply /transmission system was defective.

In the present study, 3 samples from different locations of River Turag and 3 samples from different locations of Buriganga were examined. All (100%) of the samples have MPN >180 and contained fecal coliform. All (100%) of the samples were graded as unsatisfactory. This correlates with the findings of Parveen, Ahmed, and Nasreen (2008) (20) where all 18 river water samples were unsatisfactory.

When the quality of tape water and corresponding filter water in the Residential area was compared, it was evident that after filtration quality of tape water was improved in 9(34.6%) cases and was of grade "Excellent" and in one where the grade of was "satisfactory". But in others, the quality did not improve but rather deteriorated in 2(7.7%) cases. The cause of no improvement was either improper quality of a filter or poor maintenance of the filter. This finding correlates with Sigara (2000) (21) who reported that the filtration processes themselves were observed to be not adequate in terms of removing microbial contaminants. IPI purifier when used together with chlorine disinfection eliminated all microbial contamination, however, in all other cases the treated water was still microbiologically contaminated.

Conclusions

Several sources of drinking water from Dhaka city and river water were "unsatisfactory". Bottled mineral waters of different companies and deep tube well water of WASA were of grade “excellent” in Dhaka city. For the program of supplying safe water to all, the transmission system should be improved so that no leakage occurs in the transmission pipes, and bacteriological assessment of all water sources for drinking purposes should be planned and conducted on a regular basis.

Declaration

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Ethical Statement: Not required as it is laboratory-based work.

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