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Current Status on Bacteriological Quality of Drinking Water of the Jahangirnagar University Campus, Dhaka, Bangladesh

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Abstract: *Microbiological quality of drinking water of Jahangirnagar University was studied. In the disease prone, humid, tropical region of Bangladesh, outbreaks of diarrheal diseases, often in an epidemic scale, are not unusual. Samples were collected from water tap of different academic buildings, Student dormitories, small food shops that developed in the campus, etc. The HPC (Heterotrophic Plate Count) ranged from 486 to 665 cfu/ml, from 298 to 1520 cfu/ml, and from 372 to 1002 cfu/ml for the water samples collected from the sampling sites respectively. None of the samples were found compliant with microbiological standards as recommended by the World Health Organization (WHO) in terms of total coliform counts (TCC). The ranges of TCC were 2-0.52x10^{2}cfu/100ml, 2-8.94x10^2 cfu/100ml, and 5-2.56x10^2 cfu/100ml in case of academic buildings, student dormitories, and food shops respectively. The average TCC and Fecal Coliform Count (FCC) were worst in the case of food shops and the better case was for academic buildings.*

Key words: *Bacteriological quality, drinking water, total coliform counts (TCC), Fecal Coliform Count (FCC,) The HPC (Heterotrophic Plate Count), Jahangirnagar University.*

I. Introduction

Protection of any drinks from deleterious microbial contaminants is a global issue. Each year millions of people throughout the world become ill, and thousands die, from contaminated food and drinking water (Tryland *et.al*, 2003). Gastrointestinal illnesses of different orders are the most common symptoms for the ground water and surface water systems. Among which a number of pathogenic microbes such as *E. coli*, *Salmonella*, *Shigella*, *Bacillus*, *Pseudomonus*, *Streptococcus* etc. contaminating water may cause diarrhea, enteric fever, dysentery, and other severe illness (Frobisher *et.al*., 1974).

Bangladesh is a diarrhea prone country where dysentery and cholera are also a major health concern. About 70% of world's diarrheal diseases are of food borne. Water is also considered as major route for this disease, especially in less developed countries. Apparently, clear water without taste and odour may be a potential carrier of pathogenic microorganisms and can danger health and life of human beings. Water receives microorganisms from air, soil, sewage, organic wastes, dead plants and animals etc. The majority of bacteria found in water belongs to groups: fluorescent bacteria (e.g: *Pseudomonas sp, Alginomonas sp*), chromogenic rods *(Xanthomonas sp* etc.), coliform groups *(E. coli, Aerobacter*, etc.), proteus group, non-gas forming, non-chromogenic, and non-spore forming rods, spore formers of *Bacillus* and pigmented cocci.

Testing of water drinks including beverages like bottled water and carbonated soft drinks for bacteria has received increasing attention from consumers and public regulatory bodies with purpose of mainly to identify the presence and risk of presence of bacteria dangerous to public health.

Because of the large number of possible hazards in drinking water the development of standards for drinking water requires significant resources and expertise, which many countries are unable to afford. Fortunately, guidance is available at the international level.

Comparatively the water supply in the Jahangirnagar University campus is safe. But, a number of sudden diarrheal incidences in near past reveals some sorts of faults in the supply system management. Moreover, now a day, a tendency among the students have been developed to take their food stuffs including regular lunch and dinner in small shops developed many where in the university campus which don't have their any water supply from the university's water pumps. Thus there is a probability of unhygienic practices in handling and storing waters in their limited resources which may pose a health risk particularly for the students. Therefore, the present study was undertaken to determine the bacterial quality of drinking waters in the Jahangirnagar University campus.

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II. Meterials And Methods

2.1 Sampling

Sterile glass wares were used to collect the samples from various sources according to the method mentioned by APHA (1992). Total samples analyzed were 78 in number and the sample source used were a total of 26 out of which 8 were academic departments, 8 were students' residential halls and rest 10 were food shops from various corners of the university campus. Departments were denoted as D-1, D-2, and so on up to D-8; students' residential halls were as SD-1, SD-2, and so on up to SD-8; and the food shops as FS-1, FS-2, so on up to FS-10.

Sample collector's hand was sterilized by 95% alcohol. Autoclaved conical flasks were used for collecting water sample from the tap. After autoclave the conical flasks were dried inside the Laminar Air flow System.

Dried conical flasks were air tight with cotton plug and covered with aluminum foil. Water samples were collected aseptically in sterile conical flasks. In order to collect the samples it was allowed to run tap water for 5 minutes before taking it into the flasks. Water samples were transported to the laboratory as early as possible.

2.2 Bacteriological analysis

Bacterial counts were made indirectly by viable culture method using membrane filter, pour plating and spread plating technique. Replications of all carbonated soft drinks were tested for heterotrophic plate count (HPC), total coliform count (TCC), and fecal coliform count (FCC). 0.1 ml of sample was spread on the solid surface of agar medium, or 1.0 ml sample was placed onto sterile plates which was then mixed with sterile medium poured into the plates after being cooled to about 45^{o}C, and 10-100 ml sample was passed through membrane filter (0.22 µm, Millipore) before placing on solid surface of agar plates. Appropriate dilutions were made whenever required for plating. Triplicate plates of each agar medium for all samples were carried out for enumeration of typical colonies. For total heterotrophic bacterial count (HPC), total coliform count (TCC), and fecal coliform count (FCC) the media used were Nutrient agar (Difco), MacConkey agar (Difco), and MFC agar (Hi-Media) respectively. All the plates were incubated for 24 to 72 hours at 37^{o}C except MFC agar plates which were incubated at 44^{o}C. Characteristic colonies grown on selective and differential agars were then confirmed for identification following standard morphological and biochemical tests according to Buchanan and Gibbons (1974). Among the tests carried out were gram staining, spore staining, catalase, coagulase, oxidase, IMViC, starch hydrolysis, sugar fermentation, and nitrate reduction.

III. Result And Discussion

In Bangladesh, water borne diseases are mainly related to the use of contaminated surface water. The outcome of bacteriological analysis performed on samples collected from the water tap of different academic buildings, Student dormitories, small food shops developed in the campus of Jahangirnagar University, Bangladesh appears in tables 1, 2, and 3. The HPC ranged from 486 to 665 cfu/ml, from 298 to 1520 cfu/ml, and from 372 to 1002 cfu/ml for the water samples collected from academic buildings, student dormitories, and food shops respectively. In case of academic buildings it was found that only two out of total eight were reported with HPC under the maximum permissible limit of 500 cfu/ml set by United States Environmental Protection Agency (USEPA, 2003). Other four were with heterotrophic bacterial counts slightly higher than the permissible limit of 500 cfu/ml. In case of student dormitories HPC was found 50% with under permissible limit and the rest 50% above the limit; and the 80% of food shops showed HPC counts above permissible limit. The highest HPC was found in case of student dormitory and it was 1520 cfu/ml. However, the average HPC was not that much high in any of the samples analyzed. The low HPC might be due to the incubation temperature of 37^{o} C, as it has been claimed that numbers of bacteria recovered decreases with increasing incubation temperature, from 25 ^{o}C to 35 ^{o}C (Armas and Sutherland, 1999; Reasoner, 2004; Rosenberg, 2003; Venieri *et al*, 2006). In drinking water, the usual number of HPC may vary from less than 1 cfu/ml to more than 10^4 cfu/ml and they are influenced by temperature, presence of chlorine residual and level of assimilable organic matter (LeChevallier *et al*., 1980). Shahriyar *et al.,* (1994) reported a total bacterial count of 1200-3500 cfu/100 ml in bottled water which was below the permissible limit whereas, Akond *et al*., (2006) observed high value of HPC (0.3×10^4 to 92×10^4 cfu/100ml) exceeding the set standard limit for 100 bottled samples out of 175 in Dhaka city of Bangladesh. Although presence of large number of HPC bacteria doesn't necessarily indicate a significant health risk (Allen *et al*., 2004) and a risk assessment analysis of HPC bacteria in water determined that the risk of colonization from oral ingestion of HPC bacteria was <110,000 cfu/ml for a single exposure (Rusin *et al.,* 1997). Closer counts were reported for acid-fast bacteria in carbonated and non-carbonated Italian mineral water (Caroli *et al.,* 1985). Both compliance and non-compliance HPCs in bottled water have been noticed worldwide (Warburton *et al*., 1986; Gonzalez *et al*., 1987; Khan *et al*., 1992; Tamagnini and Gonzalez, 1997; Warburton *et*

al., 1998; Armas and Sutherland, 1999; Leclerc and Moreau, 2002; Jeena *et al*., 2006; Venieri, 2006).This HPC is a useful parameter to assess the quality status of water, its distribution system and also about the origin.

As per World Health Organization (WHO) and Bangladesh Drinking Water Standard (BDWS), the count of fecal coliform (FC) and total coliform (TC) should be 0 per 100ml. According to Central Pollution Control Board, India, total coliforms organism MPN/100 ml shall be 50 or less in drinking water source. No coliform was detected from municipal tap water, supplied for drinking to the inhabitants of market area of Burdwan, India (Chatterjii *et al.,* 2007). The results of the bacteriological analysis of drinking water from Mt Darwin showed that most drinking water sources are contaminated with coliforms and pathogenic bacteria (Zvidzai *et al.,* 2007). In our present investigation, the total coliform counts ranged from 2 to 52 for academic buildings, from 2 to 894 for student dormitories and it was from 5 to 256 in case of food shops. The highest count was reported from a student dormitory (894) where outbreak of diarrhea was a recurrent phenomenon in the near past. It is an indication for either poor maintenance of the storing system or faulty supply system of that dormitory. So, the authority must pay proper attention in this regard. Otherwise students will have a greater probability to risk exposure of gastroenteritis again in future. However, on an average, the water quality in terms of TCC is more alarming in case of food shops than the student dorms and academic buildings. This is an indication of poor hygiene maintained in the shops both in handling and storing the waters. Proper management is required to maintain the water quality in food shops. In a study on quality of drinking water of Kalama region in Egypt 30% of water sample from public tap waters were contaminated with coliform bacteria (Ennayat *et al*., 1988). Another study in India showed that 41-67% of water samples from open water sources were contaminated with coliform and/ or faecal coliform bacteria (Pathak *et al.,* 1994). In an investigation for the quality of tap drinking water and spring water in the Quebec City of Canada 36 and 28% of water samples were contaminated by at least 1 coliform or indicator bacterium and /or at least 1 pathogenic bacterium (Lavesque *et al*., 1994). A study on microbial quality of bottled water in Turkey stated that coliform bacteria found in 12 of the 130 bottles of spring water (Erginkaya and Var, 1997). Research done by Moshtaghi and Boniadian (2007) revealed that *Coliform* sp. formed 14% for tap water samples and no Coliform bacteria isolated from bottled mineral water in Shahrekord (Iran). A non compliance coliform count in bottled water was reported by Reddy (2000) in India but that was only 24 MPN/100 ml water sample. Studies also showed the bottle water were free from any coliform bacteria in Argentina (Tamagini and Gonzalez, 1997) and in Ghana (Obiri-Danso *et al*., 2003). In terms of coliform count the bottled water in Canada was noticed both satisfactory and unsatisfactory as well (Warburton *et al.,* 1986). Comperatively a lower coliform count ranged from 0-19 cfu/100 ml of bottled water sold in Bangladesh was reported by Khan *et al*,. (1992). Present study revealed that 100% samples were contaminated with coliform bacteria having the minimum counts of 2 cfu/100 ml and maximum of 894 cfu/100 ml.

The 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 areas and industrial areas (Davies-Colley *et al.,* 2001). In drinking water from municipal supplies, the coliform tests can be used as an indicator of the treatment efficiency and the integrity of the distribution system. Although coliforms may not always be directly associated with the presence of faecal contamination, the presence of coliforms in drinking water suggests the potential presence of pathogenic enteric microorganisms such as *Salmonella* spp, *Shigella* spp, and *Vibrio cholerae*. Coliform bacteria are the only microbiological contamination to be regulated by law in both tap and bottled water all over the world. The presence of total and faecal coliform in bottled water samples has been reported to be due to poor hygienic practices of the producers, illiteracy and unhygienic practices of vendors (Coroler *et al*,. 1996). Over 3 million deaths per year is attributed to water-borne diarrhoeal diseases, especially among infants and young children in poor communities in Africa, Asia and South America (Anon, 1997). In the present study, the range of FCC bacteria was 0 to 2 (academic building), 0 to 44 (student dormitories) and 0 to 20 (food shops). The absence of faecal indicator bacteria in sample is attributed to good hygiene practices. In this research, food shops were also found to be contaminated with the faecal coliform compared to academic buildings and student dormitories. Shahriyar *et al*., (1994) reported a faecal coliform ranging from 0.03-30 cfu/100 ml of locally produced bottled water and 0-10 cfu/100 ml of bottled water sold in Bangladesh (Khan *et al*., 1992).

The Table 4 shows the risk group category as per the WHO guideline based on faecal coliform counts. 61.5% of the samples are in conformity group, 30.8% in low risk group and 7.7% are in intermediate risk group. None of the samples tested belonged to either high risk or very high risk group in terms of their FC counts.

Table 1: Count of heterotrophic (HPC), total coliform (TCC), and faecal coliform (FCC) bacteria in the studied water samples collected from various academic buildings.

Brand Code	Number of bacteria (cfu)/100 ml of sample		
	HPC × 10^2	TCC	FCC
D-1	592	08	0
D-2	504	05	0
D-3	496	03	0
D-4	502	52	2
D-5	552	05	0
D-6	486	02	0
D-7	506	03	0
D-8	665	10	1

Table 2: Count of heterotrophic (HPC), total coliform (TCC), and faecal coliform (FCC) bacteria in the studied water samples collected from various student dormitories.

Dormitory Code	Number of bacteria (cfu)/100 ml of sample		
	HPC × 10^2	TCC	FCC
SD-1	896	200	5
SD-2	1520	894	44
SD-3	521	05	0
SD-4	664	10	0
SD-5	465	03	0
SD-6	480	12	0
SD-7	298	02	0
SD-8	430	25	0

Table 3: Count of heterotrophic (HPC), total coliform (TCC), and faecal coliform (FCC) bacteria in the drinking water samples from various food shops in JU Campus.

Shop Code	Number of bacteria (cfu)/100 ml of sample		
	HPC × 10^2	TCC	FCC
S-1	568	100	0
S-2	372	05	0
S-3	782	150	03
S-4	1002	256	20
S-5	822	98	04
S-6	580	108	08
S-7	456	173	10
S-8	502	50	0
S-9	796	95	02
S-10	560	50	0

Table 4: Risk categorized classification of water samples supplied in the academic buildings, student dormitories and food shops in the Jahangirnagar University Campus based on WHO, 1997 guidelines.

Brand Code	Number (%) of samples source positive for a categorized risk group based on FC count (cfu/100ml)					Total
	A (blue) 0 cfu/100ml	B (Green) 1-10 cfu/100ml	C (Yellow) 10-100 cfu/100ml	D (Orange) 100-1000 cfu/100ml	E (Red) >1000 cfu/100ml	
Departments	6 (75)	2 (25)	0 (0)	0	0	8
Student Halls	6 (75)	1 (12.5)	1 (12.5)	0	0	8
Food Shops	4 (40)	5 (50)	1 (10)	0	0	10
Total	16 (61.5)	8 (30.8)	2 (7.7)	0	0	26
Risk Group	In Conformity	Low Risk	Intermediate Risk	High Risk	Very High Risk	

IV. Conclusion

The water quality in the Jahangirnagar University campus is comparatively better than the scenario exists in other areas of the country even when compared to the bottled water marketed in Bangladesh (Akond, *et al*., 2006). However, it is being hereby recommended for the proper sanitary survey, design and implementation of water and or/ sanitation projects; regular disinfections, maintenances and supervisions of water sources, and regular bacteriological assessment of all water sources for drinking should be planned and conducted. Moreover, the authority must pay attention about the regular maintenance of water tank cleaning especially in student dormitories for avoiding any unexpected incidents like emotional outbursts. Authority also must be strict in their power exercise to the shop owners to maintain the hygiene for the betterment of the community in the campus.

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