# Assessment of microbiological quality of municipal supplied water within Dhaka Metropolis

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**Microbiological health risks related to water quality are persisting issues especially in the developing countries. Present study was conducted to evaluate the microbiological quality of municipal supply water of a defined region within Dhaka metropolis, Bangladesh. A total of 20 water samples were collected from 10 selected pump stations and 10 different consuming points to examine the burden of *Salmonella* spp., *Shigella* spp., *Citrobactor* spp., *Escherichia coli*, *Klebsiella* spp., *Aeromonas* spp. *and Vibrio* spp. The study also included the evaluation of impacts due to the consumption of municipal water. The results revealed that the quality of municipal supplied water was not microbiologically safe for the consumers and also demonstrated the possible commencement of various diseases including diarrhoea, typhoid, dysentery and others.**

**Key words**: Water quality; Public health; Microorganisms

Ease of access to safe water supply is one of the most important determinants of public health status (1, 2). Stipulation of the safe state of drinking water underlies the condition when it is free from pathogenic microorganisms and detrimental chemicals with a pleasant taste and clear appearance (3). Microbiologically contaminated water is widely known to be responsible for the transmission of infectious diseases resulting in severe fatality (4). It has been estimated that 80% of all diseases with approximately one third of deaths within the developing countries are caused by the consumption of microbiologically contaminated waters (5). Poor water quality, lack of sanitation and malpractice of hygiene accounts for around 1.7 million deaths a year round the globe (6). Deterioration of water treatment facilities and the municipal water distribution systems can throw up significant public health threats (7).

Over half of the people living in the large cities of developing countries as in Bangladesh live in informal settlements lacking the facility of potable water supply (8). Dhaka, one of the most densely populated cities of the world, is sectored by several municipal zones with separate establishments of water supply for the inhabitants (9). Dhaka Water Supply and Sewerage Authority (WASA) is the responsible body to supply the water needs of the Dhaka metropolis; however, the water supplied by WASA is indeed insufficient to meet the demand, and microbiological quality of the supplied water is often questionable. Instigation of enteric diseases like cholera, diarrhea, dysentery, etc. are often associated with the omnipresent tradition of microbiologically contaminated waters together with insanitary life style.

People within Dhaka city are continuously facing problem to hold the limit of their expenses for having safe drinking water as well as for the purpose of water borne disease mitigation. Based on the above rationales, current study endeavored to assess the microbiological status of the supplied water by WASA in a defined zone of the city along with a possible forecast on the water borne disease commencement.

## MATERIALS AND METHODS

**Study Area and collection of Sample.** The study area chosen for the current investigation was in the north-western part of Dhaka city with an area of 20 sq km, consisting of approximately 80 water pump stations. Ten (10) samples from pump i.e. supply points, 8 samples from households, 1 sample from hotel and 1 sample from an office (total 20 samples) were collected aseptically in pre-sterilized screw caped bottles. Bottles were marked properly and transported to the laboratory as early as possible for microbiological analysis.

**Isolation and identification of water borne microorganisms.** Conventional microbiological methods were employed. All the reagents and media were of analytical grade. Samples were serially diluted as and when necessary, and then differential and selective cultural media were used for microbial isolation and enumeration (by the spread plate method) followed by biochemical confirmation of the isolates (10). For the estimation of total viable bacteria (TVB), 100 μl of each sample was introduced onto the nutrient agar (NA) followed by incubation at 37 °C for 24 hours for the observation of total viable bacterial load (10).

An aliquot of 100 μl of each sample was spread onto the membrane fecal coliform (MFC) agar and MacConkey agar for the quantification of total fecal

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TABLE 1. Presence of heterotrophic bacteria, *E. coli*, *Klebsiella* spp. and faecal coliforms (cfu/ml) in water samples

| Sample No. | Heterotrophic plate count (cfu/ml) | Faecal coliform count (cfu/ml) | *E. coli* (cfu/ml) | *Klebsiella* spp. (cfu/ml) |
|---|---|---|---|---|
| 01 | $2.1 \times 10^8$ | $1.4 \times 10^5$ | 0 | $2 \times 10^6$ |
| 02 | TNTC | $3.2 \times 10^3$ | 0 | $1.3 \times 10^3$ |
| 03 | $1.6 \times 10^4$ | 0 | 0 | 0 |
| 04 | $1.9 \times 10^5$ | 0 | 0 | 0 |
| 05 | $1.9 \times 10^5$ | $4.2 \times 10^4$ | 0 | 0 |
| 06 | $1.4 \times 10^5$ | $4 \times 10^2$ | 0 | $1.4 \times 10^4$ |
| 07 | $5.6 \times 10^8$ | $1.8 \times 10^4$ | $2.9 \times 10^5$ | $4.8 \times 10^4$ |
| 08 | $4.2 \times 10^9$ | $1.4 \times 10^4$ | 0 | TNTC |
| 09 | $8 \times 10^8$ | 0 | $3.2 \times 10^4$ | $4.5 \times 10^5$ |
| 10 | $3.0 \times 10^9$ | $1.8 \times 10^4$ | TNTC | $1.1 \times 10^6$ |
| 11 | $3.8 \times 10^9$ | $1.2 \times 10^4$ | $6.6 \times 10^5$ | $7.5 \times 10^4$ |
| 12 | $1.2 \times 10^9$ | 0 | 0 | $5.4 \times 10^4$ |
| 13 | $8.2 \times 10^9$ | 0 | 0 | $4.0 \times 10^5$ |
| 14 | $5.2 \times 10^9$ | 0 | 0 | $8 \times 10^3$ |
| 15 | $4.8 \times 10^9$ | 0 | 0 | $2 \times 10^3$ |
| 16 | $1.6 \times 10^7$ | $4 \times 10^3$ | 0 | 0 |
| 17 | $2.8 \times 10^8$ | 0 | 0 | $9 \times 10^3$ |
| 18 | $8.8 \times 10^6$ | $3 \times 10^3$ | 0 | $2.6 \times 10^6$ |
| 19 | $2.9 \times 10^8$ | $1.5 \times 10^4$ | 0 | $3 \times 10^3$ |
| 20 | $2.3 \times 10^7$ | $2.5 \times 10^4$ | 0 | 0 |

TNTC = Too numerous to count
The odd numbered samples were from supply points and the even numbered samples were from consumer points.

coliforms (TFC), and coliforms (*Escherichia coli* and *Klebsiella* spp.), respectively. Plates were incubated for 24 hours at 44.5 °C and 37 °C for fecal coliform and coliforms, correspondingly. Ten (10) ml of sample was transferred into 90 ml of selenite cysteine broth (SCB) and alkaline peptone water (APW) for the enrichment of *Salmonella* spp*., Shigella* spp., and *vibrio-Aeromonas* spp., respectively and incubated at 37 °C for 4-6 hours. After incubation, samples were spread onto *Salmonella-Shigella* (SS) agar and thiosulfate citrate bile salt sucrose (TCBS) agar for the isolation of *Salmonella* spp. and *Shigella* spp., and *Vibrio* spp., consecutively, followed by incubation at 37 °C for 24-48 hours. Finally, all the isolates were confirmed by the prescribed biochemical tests (10).

### RESULTS AND DISCUSSION

In the present investigation, a significant objective based on the detection of the presence of water pollution indicator microorganisms including *E. coli*, *Salmonella* spp*., Shigella* spp., *Klebsiella* spp., *Vibrio* spp. *and Aeromonas* spp. All the 20 samples were found to have a huge load of pathogenic bacteria which were further biochemically identified (Tables 1, 2 & 3). The samples contained heterotrophic bacteria within a range of $1.6 \times 10^4$ to $8.2 \times 10^9$ cfu/ml (Table 1). Among 20 water samples, samples 8, 10, 12 and 14 from consumer points, and samples 11 and 13 from supply points harbored the highest load of heterotrophic bacteria (~$10^9$ cfu/ml). Samples 10 and 11 exhibited the presence of all the tested pathogenic bacteria as well except *V. cholerae*. Faecal coliforms were encountered

in 13 samples (5 from supply points and 8 from consumer points) in a range of $4 \times 10^2$ to $2.1 \times 10^5$ cfu/ml. Samples 7, 9, 10 and 11 were noticed to be contaminated with *E. coli* in an average of $10^5$ cfu/ml. Whereas, *Klebsiella* spp. were found to be present in 15 samples (8 from supply points and 7 from consumer points) ranged from $1.3 \times 10^3$ to $2.6 \times 10^6$ cfu/ml (Table 1).

After enrichment of the samples, no growth of *V. Cholerae* was observed. While, 16 samples (8 samples each from supply and consumer points) were found to be contaminated with *Aeromonas* spp. up to $10^5$ cfu/ml (Table 2). The presence of *Salmonella* spp. was detected in samples 3, 7, 9, 11 from supply points and sample 10 from consumer point. Unlikely, *Shigella* spp. were encountered in almost all samples except samples 5 and 6 up to $10^6$ cfu/ml (Table 2).

People use the municipal supplied this water source (WASA in case of Dhaka city) not only for drinking but also for other domestic usages. Unfortunately, often this water supply system gets vigorously contaminated with pathogenic microorganisms resulting in water borne disease complications (1, 4). An important aspect must be considered in this aspect that a major fraction of the city's sewage systems remains untreated which in turn cross-contaminate the ground waters and the surface waters. Thus the water supply lines and the content waters may be

TABLE 2. Presence of *Vibrio cholerae*, *Aeromonas* spp., *Salmonella* spp. *and Shigella* spp. after enrichment of water samples (cfu/ml)

| Sample No. | *Salmonella* spp. (cfu/ml) | *Shigella* spp. (cfu/ml) | *Aeromonas* spp. (cfu/ml) |
|---|---|---|---|
| 01 | 0 | $1.1 \times 10^4$ | $1.6 \times 10^5$ |
| 02 | 0 | $3 \times 10^3$ | $2 \times 10^3$ |
| 03 | $1.9 \times 10^4$ | $1.1 \times 10^6$ | $6 \times 10^2$ |
| 04 | 0 | $1 \times 10^5$ | $7.5 \times 10^5$ |
| 05 | 0 | 0 | $1.8 \times 10^5$ |
| 06 | 0 | 0 | $9.5 \times 10^4$ |
| 07 | TNTC | TNTC | 0 |
| 08 | 0 | TNTC | $2.1 \times 10^5$ |
| 09 | $1.4 \times 10^6$ | $1.3 \times 10^5$ | TNTC |
| 10 | TNTC | TNTC | $3.8 \times 10^5$ |
| 11 | $1.5 \times 10^6$ | $1.4 \times 10^5$ | $1.8 \times 10^5$ |
| 12 | 0 | $1.1 \times 10^5$ | $1.3 \times 10^5$ |
| 13 | 0 | $1.3 \times 10^5$ | $2.1 \times 10^5$ |
| 14 | 0 | $1.5 \times 10^5$ | $2 \times 10^5$ |
| 15 | 0 | $1.2 \times 10^5$ | $1.9 \times 10^6$ |
| 16 | 0 | $6.7 \times 10^4$ | $5 \times 10^4$ |
| 17 | 0 | $1.9 \times 10^5$ | $1.3 \times 10^5$ |
| 18 | 0 | $2.5 \times 10^6$ | 0 |
| 19 | 0 | $2.9 \times 10^6$ | 0 |
| 20 | 0 | $1.4 \times 10^6$ | 0 |

TNTC = Too numerous to count
The odd numbered samples were from supply points and the even numbered samples were from consumer points.
*Vibrio cholera*e was absent in all the samples.

TABLE 3. Summary of confirmative biochemical identification of the isolates

| Assumed organism | TSI Slant | TSI Butt | TSI Gas | H$_2$S production | Indole test | MR test | VP test | Citrate test | Motility | Oxidase test |
|---|---|---|---|---|---|---|---|---|---|---|
| *E. coli* | Y | Y | + | - | + | + | - | - | + | - |
| *Klebsiella* spp. | Y | Y | + | - | - | - | + | + | - | - |
| *Salmonella* spp. | R | Y | - | + | - | + | - | - | + | |
| *Shigella* spp. | R | Y | + | + | +/- | + | - | - | - | |
| *Aeromonas* spp. | R | Y | - | - | ND | ND | ND | + | ND | - |

TSI = Triple sugar iron test; MR = Methyl red; VP= Voges-Proskauer; Y = Yellow (acid); R = Red (alkaline); ND = Not done

propagated especially by the fecal coliforms. Moreover, as revealed from the presented data, existence of pathogens in the supply points is indicative of poor treatment strategies of the supplied waters. Substantial consideration should be thus given into the microbial reduction within water prior to supply across the pipelines within the distribution system.

## CONCLUSIONS

The presented data referred that the quality of municipal supplied water were not safe for the consumers and was also indicative of the possibilities to impart various enteric diseases. The situation may aggravate in near future if the authority does not pay attention and take immediate actions to restore water quality in the distribution system. Thus routine microbiological assessment of the municipal supplied water is necessary for the sake of public health management.

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