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Evaluation of Microbial and Physiochemical Properties of Three Selected Lakes Water in Dhaka City, Bangladesh

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Abstract: The present study was carried out to determine the water quality of three most important Lakes in Dhaka city of Bangladesh in terms of physicochemical and microbiological properties. The study reported highest number of microorganisms in Gulshan Lake followed by Banani and Uttara Lake. The average MPN/100 ml water in Gulshan Lake were 452.8 which were higher than that of the Banani Lake (260.8) followed by Uttara Lake (43.33). Among physiochemical parameters, the lowest Dissolved Oxygen (DO) was recorded from Gulshan Lake which was approximately 5 lower than the recommended value of the Department of Environment (DoE). However, the DO value in Uttara Lake ranged from 3.50 to 7.50 mg/l with the average value of 5.00 mg/l which was very closure to the DoE standard. The average Biological Oxygen Demand (BOD_5) value was ranged from 180 to 329 mg/l in Gulshan Lake, 96 to 270 mg/l in Banani Lake, whereas in Uttara lake the average BOD_5 value was found 111.56 mg/l. The average Chemical Oxygen Demand (COD) value was found 200 mg/l in Gulshan Lake which was significantly correlated with BOD_5 (0.825^{**}). Both BOD_5 and COD value of water in Gulshan Lake exceeded the permissible limit of DoE standard. The COD value of the water samples in Banani Lake was ranged from 42.55 to 200.00 mg/l and showed a significant correlation with BOD_5 (0.652^{**}) which was also much higher than the DoE standard. In case of Uttara Lake the COD value ranged from 42.55 to 127.65 mg/l which had significant correlation with BOD_5 (0.847^{**}) and similarly higher than DoE standard. However, the EC and TDS values were within safe limit according to DoE standard in all three lakes water. The study concluded that the water in all three lakes water was highly polluted in terms of microbiological and physicochemical properties. Therefore preventive and safety policy is an immediate demand for health and well-being of the people and environment of Dhaka, the capital city of Bangladesh.
Keywords: Water quality, microbiological, physicochemical properties, lakes, Dhaka.

INTRODUCTION

Safe water is termed as 'Life'. On the other hand polluted water is most reported cause for death of life. Therefore, water quality has attracted as an extensive research area especially for the transmission of various microorganisms, including pathogenic bacteria, viruses, parasites and chemical pollutants. Water and sanitation condition is mostly poor in developing countries including Bangladesh. Insufficient treatment of domestic sewage is one of the major reasons for the degradation of water environment. The effects of water pollution are not only devastating to people but also to animals, fish, and birds. Polluted water is not suitable for drinking, recreation, agriculture, and industries. It diminishes the aesthetic quality of lakes, pond, and rivers. More seriously, contaminated water destroys aquatic life and reduces its reproductive ability. Eventually, it is a hazard to human health. To meet up with the demand of this huge population the groundwater level is decreasing in alarming rate [1].

An estimated 80% of all diseases are water-related and on an average, as much as one-tenth of each person's productive time is sacrificed to water-related diseases [2]. About 20 to 30% of mortality in Bangladesh occurs due to water-borne diseases, *e.g.*, diarrhoea, dysentery, gastroenteritis. Therefore, supplying safe water is very important to cut down the incidence of water-borne diseases. Though Bangladesh

is a water rich country, the ground water level in the capital city, Dhaka is decreasing day by day. Therefore, the importance of lakes, reservoirs and surface water sources are getting extra attraction. Dhaka is mostly surrounded by three lakes *i.e.,* Gulshan Lake, Banani Lake and Uttara Lake. Water Supply and Sewerage Authority (WASA) is the responsible body to supply water to Dhaka city. But WASA can only produce 1900 million liters of water per day against Dhaka city's daily demand of 2200 million liters. About 87% of total water supply by Dhaka WASA comes from deep tube wells, and rest of the supply comes from surface water treatment [3].

Gulshan-Baridhara-Banani Lake was declared an Ecologically Critical Area (ECA) in 2001. The area in and around Gulshan, Banani and Uttara have always been Dhaka's most exclusive residential area mainly because of the pristine lake that used to encircle these neighborhoods. But the curse of encroachment has led to the disappearance of large portions of the lake. That is also being threatened by land-grabbing and rampant pollution, killing the aquatic life in the lake and endangering its ecological balance. The bad news does not end here. Large-scale encroachments have also led to the lowering of the ground level of surrounding land and have adversely affected ground water. With so much at stake, saving the Gulshan-Banani-Uttara lakes should be the most crucial task for the government and the residents of this area [4].

To reduce the pressure on groundwater, the dependence on surface water is inevitable for WASA. Moreover, this polluted river water may contaminate the aquatic environment and adjacent soils of the city. Thus, it can produce irreversible consequences. Gulshan, Banani and Uttara are the important artificial lakes of Dhaka which are situated in aristocratic area of Dhaka but at the same time slum people are frequently using this lake water for bathing and cooking causing pollution of the water body. Pollution also may be caused by parking lots, gardens, driveways, sidewalks, lawns, roads, agricultural works and fish farming in the lake resulting deterioration of water quality. In addition, wide variety of inorganic and organic compounds and microorganisms often play a major role in determining the extent of this pollution. The physicochemical features and bacterial flora of Dhanmondi Lake were investigated earlier [5, 6].

Outbreaks of water-borne diseases continue to occur in both developed and developing countries leading to loss of life and economic burdens for individuals and communities. In today's industrial societies, requirements for water much of which is derived from lakes include its use for dilution and removal of municipal and industrial wastes, for cooling purposes, for irrigation, for power generation, and for local recreation and aesthetic displays. Obviously, these requirements vary considerably among regions, climates, and countries. Rivers, ponds, lakes are waterways of strategic importance across the world, providing main water resources for domestic, industrial, and agricultural purposes [7].

The present study was undertaken to enumerate total microbial load and physicochemical properties to find out an overall pollution data of Gulshan, Banani and Uttara lakes. Therefore, the evaluation of pollution index and Ecological risk factor can be performed.

MATERIALS AND METHODS

Location of the study area

Gulshan, Banani and Uttara Lakes have been selected as the case study for this research. In case of Gulshan lake, Collection of samples started at the point of 90º41'87"E; 23º78'07"N and ended at the point of 90º42'21"E; 23º79'13"N; in case of Banani Lake, Collection of samples were started at the point of 90º41'15"E; 23º78'09"N to 90º41'02"E; 23º78'14"N and in case of Uttara Lake, Collection of samples were started at the point of 90º23'53"E; 23º52'43"N and ended at the point of 90º23'58"E; 23º51'92"N. Total number of samples collected during each sampling time was 25. Location was confirmed using Geographical Positioning System (GPS).

Water sample collection

The high-density 500 ml PVC bottles were used for sample collection and preservation. Each bottle was cleaned thoroughly by rinsing with dilute HNO_3 followed by washing with distilled water [8]. Two 500 ml bottle samples were collected from each sampling point. One was preserved with toluene for regular water analysis and other was preserves with acid for the heavy metal analysis. Another 500 ml air-tight water samples for each sampling points were also collected in sterilized bottle for microbial analysis and kept in icebox to maintain 4ºC (inhabit microbial multiplication).

Sample preparation

Water samples were kept in the air tight bottles and labeled properly for identification. The water samples were brought to the Soil, Agronomy and Environment Laboratory, Biological Research Division, Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhanmondi, Dhaka and preserved in refrigerator until analysis.

Analysis of physiological properties

pH - Water pH was determined by glass electrode using pH meter (*Model:* Jenway instrument, pH meter 3305).

Electrical conductivity (EC)

The EC of irrigation water samples was directly determined in the field by EC meter (*Model:* HANNA HI-8633) in μS/cm.

Total dissolved solid (TDS)

A rapid determination of total dissolved solids (TDS) of water samples was determined in the field by TDS meter (*Model:* Mettler-Toledo Ag, CH-8603) or made simply by multiplying the measured electrical conductivity (EC) values (in μS/cm) by 0.64 [9].

Dissolved oxygen (DO)

Dissolved oxygen of water samples was determined in the field by DO meter (*Model:* Mettler-Toledo Ag, CH-8603)

COD Titration Methodology

The Ferrous Ammonium Sulfate standardized with potassium dichromate:

Preparation of 0.125 N Ferrous Ammonium Sulfate solutions as 100 ml:

M. Wt: 392.14 gm = (392.14 X 0.125 X 100)/1000 = 4.90 gm in 100 ml distilled water.

Preparation of 0.25 N Potassium dichromate solutions as 100 ml:

M. Wt: 294.18 gm where equivalent wt as 294.18/6 = 49.03

= (49.03 X 0.25 X 100)/1000 = 1.22 gm in 100 ml distilled water.

0.125 N Ferrous Ammonium Sulfate in burette & 2 ml 0.25 N Potassium dichromate + 3 ml Sulfuric Acid (98%) in a empty vial + 8-10 drops Ferroin Indicator in to vial.

Then the titration carried on.

Titration of Blank & Sample Digested COD Vial:

A. 2 ml distilled water taken into Blank vial.
B. 2 ml sample water taken into Sample vial.
C. 2 hours digestion in COD Reactor.
D. 10-15 min cooling in to air.
E. 8-10 drops Ferroin Indicator put into both vials. (It becomes blue green or greenish blue.
F. Titrated against Ferrous Ammonium Sulfate. (Sharply color change greenish blue to orange brown). The ml used in color change for both vials (blank & sample) noted.

Calculation

COD in mg/L = (Blank – Sample) X 2000/C X M

Blank =Blank titration reading (ml)

Sample =Titration reading (ml) 2000 mg/l max chlorine concentration in COD Vials.

C= ml used in titration of standard solution

M=1 for HR COD vial.

Biochemical Oxygen Demand (BOD_5)

This is also a water quality parameter for organic matter in water, which is empirical in nature. It is measured by the quantity of oxygen utilized by suitable microorganisms during a fix-clay period. The optimum value for good water quality is 6 mgL-1 of BOD. Higher values indicate water pollution. Biochemical Oxygen Demand of water and effluents samples was determined by BOD sensor with 5 days incubation at 20ºC incubation.

Microbiological study of the collected Water samples

The examination of coliform organisms and microbiological studies were followed as per the methods given by [10-13]. The MPN was estimated by determining the number of tubes in each group that showed gas following the incubation period following the method of [10].

The Most Probable Number (MPN) is a statistical estimation of the density of microorganisms, assumed to corresponding to a poison distribution in the volumes inoculated. The accumulated gases in the presumptive tubes enable to determine the number of organisms present in the sample by means of a Most Probable Number test (MPN). The MPN was estimated by determining the number of tubes in each group that show gas following the incubation period.

The formula is as follows:

MPN/100-ml = number of positive tube x 100

V ml sample in negative tubes x ml sample in all tubes

Set up was done in a series consisting of three groups, a total of six tubes per series, in a test tube rack; for each tube, table the water source and volume of sample inoculated as illustrated. Then the water sample was mixed by shaking thoroughly. The bottles were then flamed and using 10 ml sterile pipette, 10 ml aliquots of water samples to the two tubes labeled LB2X-10 ml, containing double strength Lactose Fermentation Broth (LB2X), was transferred. Again using a 1 ml sterile pipette, 1 ml aliquots of water sample to the two tubes LB1X-1 ml, containing 10 ml single strength Lactose Fermentation Broth (LB1X) was transferred into the flamed bottle. Like above, using a 0.1 ml sterile pipette, 0.1 ml aliquots of water sample to the two tubes labeled LB1X-0.1 ml, containing 10 ml single strength Lactose Fermentation Broth (LB1X) was transferred into the flamed bottle. It had been taken a control for each sample. All tubes are then incubated for 48 hours at 37 ^{0}C.

For each sample	2 tubes of LB2X-10 ml 2 tubes of LB1X-10 ml 2 tubes of LB1X-0.1 ml

Data Analysis

The primary data were analyzed for descriptive statistics (Minimum Conc., Maximum Conc., Mean

Conc. & Std. Deviation (±)) by using SPSS (Statistical Package for Social Sciences). Further the statistical correlation analysis such as Pearson Correlation coefficient with (2 Tailed).

RESULTS AND DISCUSSION

Physiochemical properties of the Lake water samples - The concentration ranges of the physiochemical properties with the average value of the water from Gulshan, Banani and Uttara Lake are shown in Table 1, 2, 3, 4, 5 and 6. The levels of pollution of these lakes were determined by comparing the observed values of the various parameters with the water standards value recommended by DoE, Bangladesh [14].

Water pH influences the other properties of water body, activity of organisms, and potency of toxic substances present in the aquatic environment. Excessive pH is harmful for aquatic life like fish, microorganisms and aquatic plants [15].

Table-1: pH value of three lake water with DoE standard.

Name of The Lake	Minimum	Maximum	Mean	Standard deviation	DoE Standard
Gulshan Lake water	6.86	7.95	7.52	±0.25	6.5-8.5
Banani Lake	6.67	7.67	7.08	±0.22	
Uttara Lake	7.23	8.37	7.43	±0.21	

The pH of the water samples Gulshan Lake was varied from 6.86 to 7.95. The average pH value was found 7.52 (Table-1), which within the permissible limit of DoE standard. In Banani Lake the average pH value was found 7.08. The pH value in Banani Lake ranged from 6.67 to 7.67 (Table-1), which also lay within the permissible limit of DoE standard. In case of Uttara Lake the average pH value was 7.43. The pH value in Uttara Lake ranged from 7.23 to 8.37 (Table 1), which also place within the acceptable limit of DoE standard.

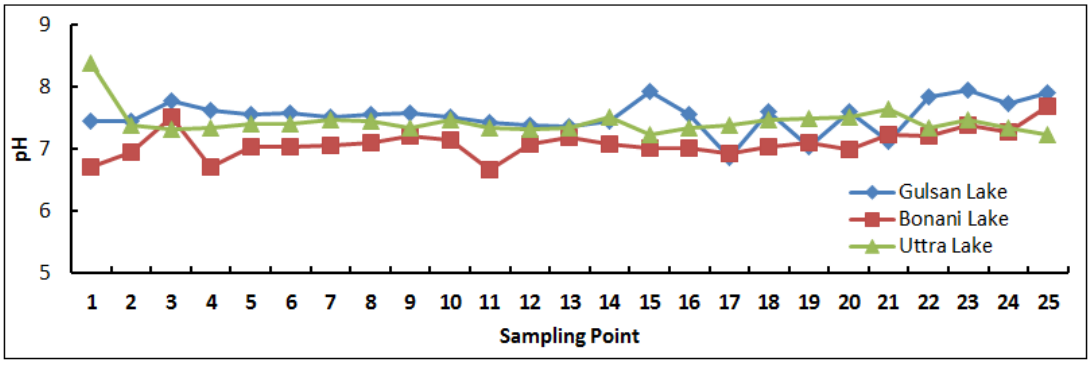

Fig-1: p^H value of three lake water at different sampling points.

The electrical conductivity (EC) is usually used for indicating the total concentration of the ionized constituents of water. The EC is an indirect measure of the ions or the charge carrying species in the effluents under the measurement conditions [16].

Table-2: EC value of three Lake Water with DoE standard.

Name of The Lake	Minimum	Maximum	Mean	Standard deviation	DoE Standard
Gulshan Lake Water	373.00	924.00	428.24	±107.86	1000 (µS/cm)
Banani Lake Water	476.00	656.00	519.24	±45.41	
Uttara Lake Water	485.00	604.00	503.08	±31.00	

The average value of electrical conductivity of the water in Gulshan Lake was found 428.24 µS/cm, which within the allowable limit of DoE standard. The EC concentration of water in Gulshan Lake was varied from 373.00 µS/cm to 924 µS/cm, (Table-2). In case of Banani Lake, the EC concentration was varied from 476.00 µS/cm to 656.00 µS/cm.

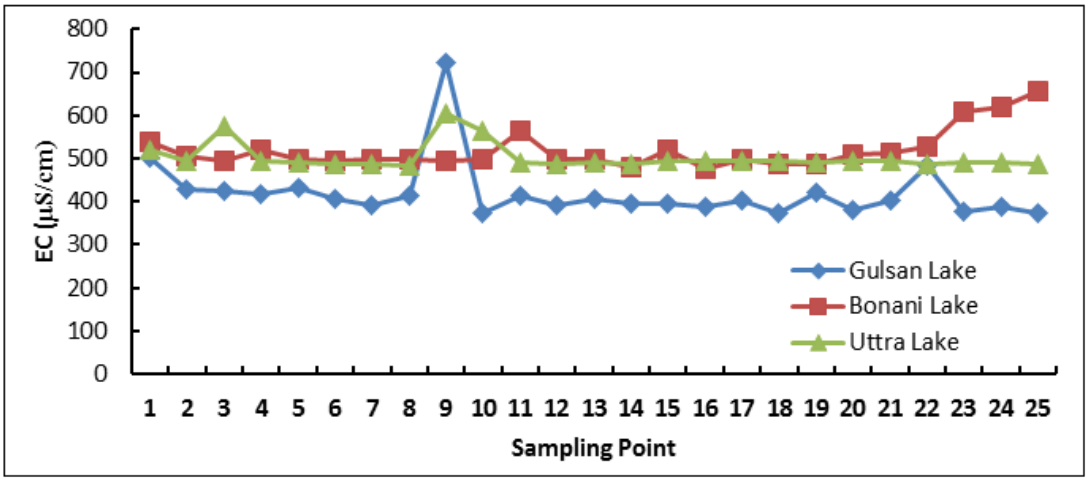

Fig-2: EC value of three lake water at different sampling points.

The average concentration of EC was found 519.24 µS/cm, (Table-2), which also lay within the acceptable limit of DoE standard. The EC concentration of water in Uttara Lake was varied from 485.00 µS/cm to 604 µS/cm, (Table 2). The usual concentration of EC was found 503 µS/cm, (Table-2), which lay within the satisfactory limit of DoE standard too. EC is significantly correlated with TDS in Gulshan, Banani and Uttara Lake (0.859**, 0.988** and 0.588**) respectively (Table 7, 8 and 9).

Dissolved oxygen (DO) in water is essential for aquatic life. Deficiencies of DO in water give rise to odoriferous products of anaerobic decomposition [17]. Oxygen is essential to all forms of aquatic life including those organisms responsible for the self-purification processes in natural waters. Like terrestrial animals, fish and other aquatic organisms need oxygen to live. The presence of oxygen in water is a positive sign of a healthy body of water but the absence of oxygen is a signal of severe pollution [16].

Table-3: DO value of three lake water with DoE standard.

Name of The Lake	Minimum	Maximum	Mean	Standard deviation	DoE Standard
Gulshan Lake Water	0.10	3.20	1.34	±0.80	6 (mg/L)
Banani Lake Water	1.00	5.70	3.09	±1.21	
Uttara Lake Water	3.50	7.50	5.00	±1.09	

The DO of the water sample in Gulshan Lake was varied from 0.10 mg/L to 3.20 mg/L with the average value of 1.34 mg/L (Table-3) which is approximately 5 times lower than the standard value recommended by DoE. Do of water in Gulshan Lake exhibited significant correlation with BOD (-.418*) (Table-7).

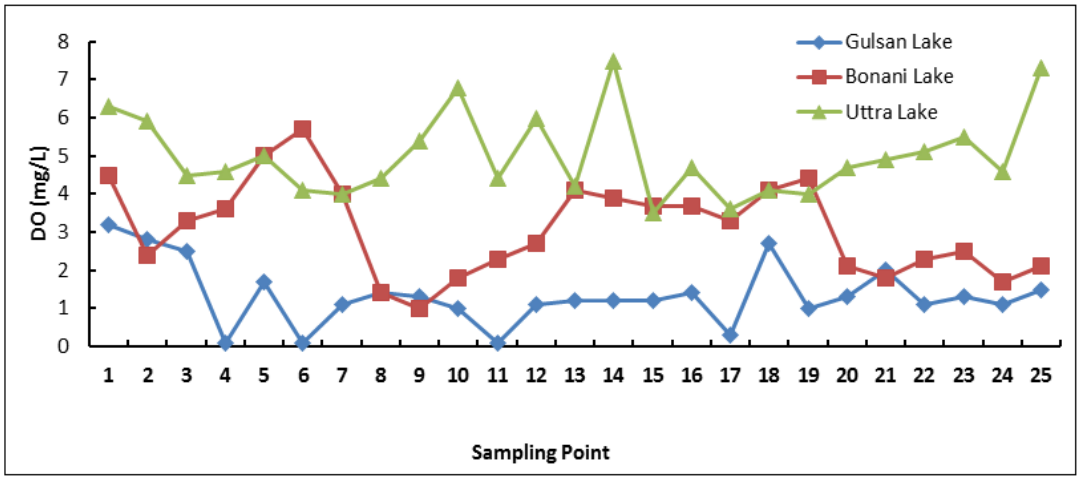

Fig-3: DO value of three lake water at different sampling points

The DO of water in Banani Lake was varied from 1.00 mg/L to 5.70 mg/L with the average value of 3.09 mg/L (Table 3) which is 2 times lower than the standard value suggested by DoE. Do of water in Banani Lake demonstrated significant correlation with TDS, COD and BOD (-0.399*, -0.533** and -0.608**) (Table 8). DO of water in Uttara Lake ranged from 3.50 mg/L to 7.50 mg/L with the average value of 5.00 mg/L (Table-3) which is slightly lower than that of the DoE standard. Do of water in Uttara lake has significant correlation with BOD (-0.414*) and it showed a negative trend (Table-9).

At a contact pressure of 1 atm, 100% saturated water at 4°C and 24°C contains 13.11 mg/L and 8.42 mg/L of DO respectively. DO decreases with the increase of temperature [18]. DO is the measure of free oxygen in dissolved state, which is a factor of Atmospheric pressure, temperature and salinity. The equilibrium concentration of dissolved oxygen (DO) in water in contact with air is a function of temperature and pressure, and to a lesser degree, of the concentration of other solutes. The higher forms of aquatic life require oxygen for survival. The DO concentration may be depleted by processes that consume dissolved, suspended, or precipitated organic matter, and values above equilibrium can be produced in systems containing actively photosynthesizing biota. Oxygen is supplied to groundwater through recharge and by movement of air through unsaturated material above the water table. This oxygen reacts with oxidizable material encountered along the flow path of the water.

The total dissolved solid (TDS) would be considered as one of the major criteria for judging water quality for irrigation, drinking and other usage [19]. TDS in water mainly consist of ammonia, nitrite, nitrate, phosphate, alkalis, some acids, sulphates, metallic ions etc. The high TDS value is not desirable because a high content of dissolved solids elevates the density of water, influences osmoregulation of fresh water organisms, reduces solubility of gases (like oxygen) and utility of water for drinking, irrigational and industrial purposes [16].

Table-4: TDS value of three lake water with DoE standard.

Name of The Lake	Minimum	Maximum	Mean	Standard deviation	DoE Standard
Gulshan Lake Water	182.25	243.00	198.03	±12.91	500 (mg/L)
Bonani Lake Water	237.00	328.00	259.44	±22.79	
Uttara Lake Water	242.00	292.00	250.72	±13.35	

The TDS value of the water sample in Gulshan Lake lie between 182.25 mg/L to 243.00 mg/L and average value was found 198.03 mg/L (Table-4). It is found that the water sample in Gulshan Lake contain TDS concentration approximately 5 times lower than the Doe standard. TDS of water in Gulshan lake exhibited significant correlation with EC (.859**), (Table-7).

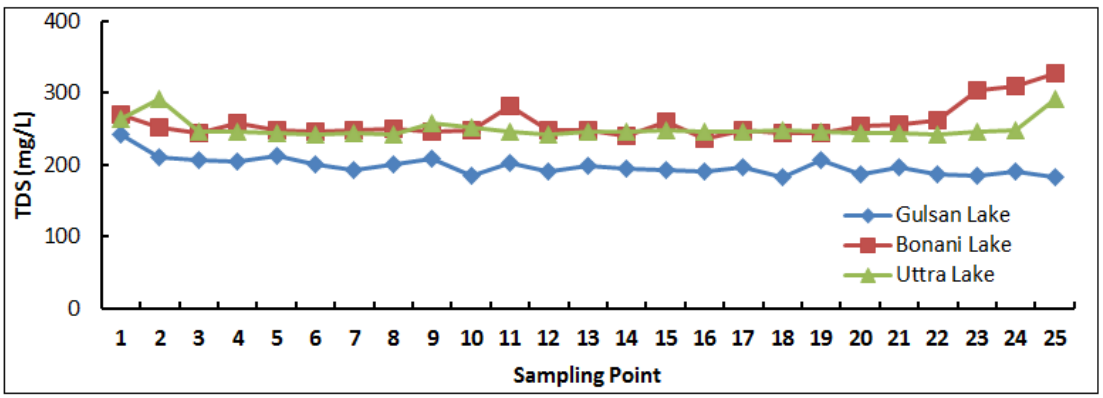

Fig-4: TDS value of three lake water at different sampling points

In Banani Lake the average TDS value was found 259.44 mg/L. The TDS value was varied from 237.00 mg/L to 328.00 mg/L (Table 4). It is found that the water samples in Banani Lake contain TDS concentration more or less 3 times lowers than the standard TDS value recommended by DoE. TDS in Banani Lake showed significant correlation with DO (-.399*) (Table-8).

In case of Uttara Lake, TDS value ranged from 242.00 mg/L to 292.00 mg/L with the average value of 250.72 mg/L (Table-4). It has significant correlation with EC (.588**) (Table 9). Chemical oxygen demand (COD) is defined as the amount of a specified oxidant that reacts with the sample under controlled conditions which is one of the most important parameter for assessing the quantity of chemically oxidizing matter in water [16]. Chemical oxygen demand (COD) measures

the oxygen required for the oxidation of mainly organic matter by a strong chemical oxidant [120].

Table-5: COD value of three lake water with DoE standard.

Name of The Lake	Minimum	Maximum	Mean	Standard deviation	DoE Standard
Gulshan Lake Water	130.00	284.00	200.80	±46.44	4 (mg/L)
Banani Lake Water	42.55	220.00	105.59	±43.44	
Uttara Lake Water	42.55	127.65	86.99	±20.52	

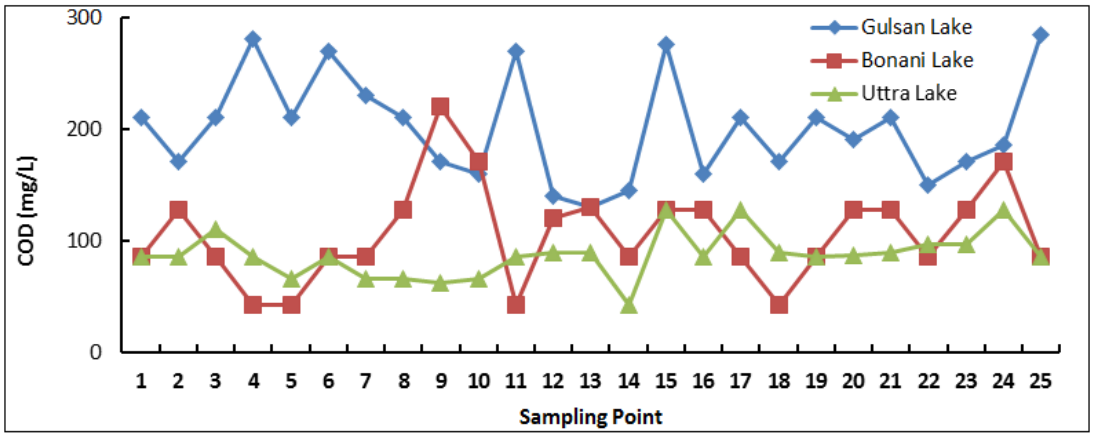

Fig-5: COD value of three lake water at different sampling points

The COD values of the water in Gulshan Lake varied from 130.00 mg/L to 284.00 mg/L. The average COD value was found 200.80 mg/L in the sampling locale, (Table 5), which showed significant correlation with BOD (0.825**), (Table 7). It is found that the COD concentration of water in Gulshan Lake exceed the permissible limit of Doe standard. The COD value of the water samples in Banani Lake was varied from 42.55 mg/L to 200.00 mg/L and the average value was found 105.59 mg/L, (Table-5), which is higher than the Doe standard. The COD in Banani Lake showed significant correlation with DO and BOD (-0.533**, 0.652**) (Table 8). In case of Uttara Lake the COD value ranged from 42.55 mg/L to 127.65 mg/L with the average value of 86.99 mg/l (Table 5) which has significant correlation BOD (0.847**) (Table-9).

Biological Oxygen Demand (BOD_5) is an index of the biodegradable organics present. Biochemical oxygen demanding wastes consumes the dissolved oxygen from water. Excessive BOD is harmful to aquatic animals like fish and microorganisms. It also causes bad taste to the drinking water [16].

Table-6: BOD_5 value of three lake water with DoE standard.

Name of The Lake	Minimum	Maximum	Mean	Standard deviation	DoE Standard
Gulshan Lake Water	180.00	329.00	255.76	±45.45	0.2 (mg/L)
Banani Lake Water	96.00	270.00	162.48	±42.19	
Uttara Lake Water	66.60	170.00	111.56	±27.12	

The average BOD_5 value was found 6.13 mg/L and it was varied from 180.00 mg/L to 329.00 mg/L in Gulshan Lake, (Table-6) which is higher than the Doe standard, It has significant correlation with DO and COD (-.418*, .825**), Table 7. The BOD values of the water in Bonani lake ranged from 96.00 mg/L to 270.00 mg/L and the middling value was found 162.48 mg/L, Table-6, which exhibit significant correlation with DO and COD (-.608**, .652**), Table 8. It is found that the water samples in Bonani Lake contain BOD concentration which exceeds the water standard of DoE.

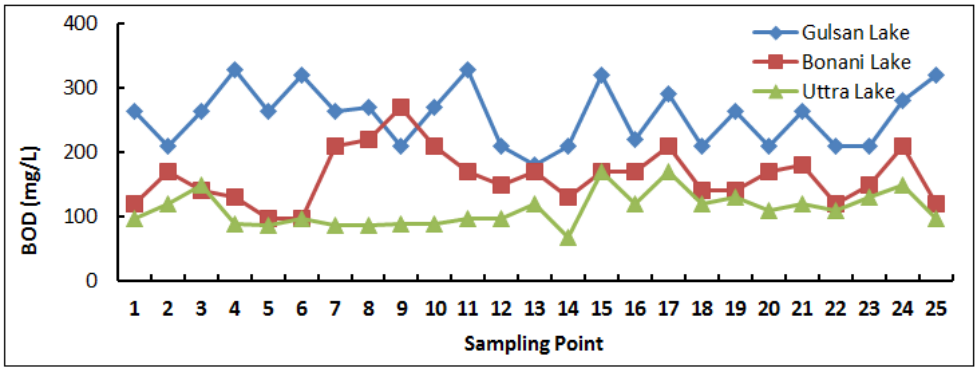

Fig-6: BOD value of three lake water at different sampling points

Table-7: Multiple correlation coefficients (r) among different physiochemical parameters of Gulshan Lake water

Parameter	pH	EC	DO	TDS	COD	BOD
pH	–	-.164	.370(*)	.100	-0.417(**)	-0.417(**)
EC		–	-.241	.152	.285	0.285
DO			–	.244	-0.883(**)	-0.883(**)
TDS				–	-.202	-0.202
COD					–	1.000(**)
BOD						–

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Where as in Uttara lake the average BOD value was found 111.56 mg/L and ranged from 66.60 mg/L to 170.00 mg/L (Table 6) which exhibit significant correlation with DO and COD too (-.414*, .847**) (Table-9).

Table-8: Multiple correlation coefficients (r) among different physiochemical parameters of Banani Lake water.

Parameter	pH	EC	DO	TDS	COD	BOD
pH	–	-.238	.370(*)	.100	-0.417(**)	-0.417(**)
EC		–	-.241	.152	.285	0.285
DO			–	.244	-0.883(**)	-0.883(**)
TDS				–	-.202	-0.202
COD					–	1.000(**)
BOD						–

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table-9: Multiple correlation coefficients (r) among different physiochemical parameters of Uttara Lake water.

Parameter	pH	EC	DO	TDS	COD	BOD
pH	–	-.238	.370(*)	.100	-0.417(**)	-0.417(**)
EC		–	-.241	.152	.285	0.285
DO			–	.244	-0.883(**)	-0.883(**)
TDS				–	-.202	-0.202
COD					–	1.000(**)
BOD						–

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

CONCLUSION

The number of microorganisms in water from average MPN/100 ml water it was observed all these three lakes showed high microbial pollution. Among total number of microorganisms per 100 ml water Gulshan Lake was showed the highest value than that of Banani and Uttara Lake.

Among physiochemical analysis of these three lake's water, it was observed that, DO of water sample in Gulshan and Banani Lake was approximately 5 times and 2 times lower than the DoE recommended value. DO of water in Uttara Lake was slightly lower than DoE standard. With increased sedimentation and organic waste

build-up, the level of dissolved oxygen (DO) decreases which highly affects water quality. With low DO, the ecosystem is greatly affected.

The average BOD_5 and COD value of Gulshan, Banani and Uttara lakes were very high and values were several times higher than DoE standard. This may be due to high amount of organic wastes discharged into these lakes. These organic wastes reduce dissolved oxygen during decomposition by heterotrophic microorganism and increase BOD_5 and COD value. High amount of microbial population in lake water also found from MPN study. Among three lakes, Gulshan showed the highest BOD_5 and COD value. From EC and TDS analysis it was shown that, most of these values were within safe limit according to DoE recommended value.

Conflict of Interest

The author (s) declared no potential conflicts of the interest with respect to the research, authorship and/or publication of this article.

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