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TITLE: WATER QUALITY ASSESSMENT IN DIFFERENT AREAS OF KHULNA CITY IN BANGLADESH

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Abstract

Water is very essential to avoid illness and enhance the quality of life. So, it's necessary to have access to high-quality water. Khulna city in Bangladesh is facing a scarcity of clean water; high saline water is also a problem in this region. So, the study aims at identifying contaminated water by collecting samples from different areas of Khulna. Water quality testing is carried out as part of the study to ensure that the community receives clean water and they can be aware of the quality of such water. Samples taken from different areas were tested in the laboratory. The analysis involved measuring several quality parameters including pH, turbidity, hardness, dissolved oxygen (DO), and biochemical oxygen demand (BOD). The pH levels were observed to be within the acceptable range, with the Sonadanga area showing slightly alkaline water at a pH of 8.1. However, the turbidity levels in the Bhairab River were extremely high at 307 NTU, far exceeding the Bangladeshi standard of 10 NTU, the DO levels across samples were reported between 9.6 to 10.8 mg/L, which are generally acceptable for drinking water. The BOD levels were also found to comply with safety standards, indicating that the water could potentially be suitable for drinking if proper treatment methods are applied. Overall, while some water sources show adequate quality, the prevalence of contamination and the looming water crisis highlight an urgent need for improved water management and treatment strategies in Khulna City.

Keywords: Turbidity, TDS, DO, BOD, Electrical conductivity

1. Introduction

Water is very essential for both human beings and the environment. Water is important for performing vital operations of the human body and for managing different aspects of daily life [1]. But at present, because of the increasing human population, industrialization, uses of fertilizers, and various activities of human water are being polluted. As a result, clean water is scarce [2]. Due to the scarcity of clean and good-quality water, people are suffering from various water-borne diseases and facing many problems in doing other chores [3]. Many cities in Bangladesh, including Khulna, are facing such a problem as good-quality water is not readily available here. This city is surrounded by lots of industries; even the largest sea port, Mongla, is also situated here. Due to rapid urbanization, industrialization, and lack of growth in the infrastructure required for water supply, the water shortage has increasingly worsened in this region [4]. Not only that, the unavailability of safe drinking water is a challenge in Khulna, as a high salinity level in water is found here [5]. Thinking about the water crisis, several steps were taken the previous year. In 1994, the capacity of the water supply was increased by the implementation of various development operations to 2.50 billion liters (25000 m^3). The capacity increased to 3.25 Crore liters (32500 m^3) as the Department of Public Health Engineering (DPHE) of GOB Fund implemented a further development program in 1997 [6]. The majority of production tube wells become clogged due to lack of development activities, which reduces the available water supply by 2.36 crore liters. With financial support from the World Bank and the Municipal Support Project (MSP), LGED conducted a feasibility study in 1994 to help Khulna City deal with its water crisis. In 1997, this investigation was finished. Following research, the MSP project erected 10 (ten) production tube wells with a 16 MLD capacity in 2002 [7]. But at present, the sources of water in Khulna are limited, and the availability of drinking water is very scarce. So, accessing clean water is very much necessary in Khulna to avoid infections and enhance quality of life [8]. For this purpose, monitoring water quality at regular intervals can be helpful. This can be done by observing physico-chemical and microbiological criteria utilized in water quality testing [9]. These parameters are pH, turbidity, hardness, odor, conductivity, arsenic, TDS, BOD, and DO [10]. The study aims to identify contaminated water by collecting samples from different areas of Khulna. After this, the study conducted a series of experiments involving both physical and chemical tests on water samples collected from various locations in Khulna City. These include temperature, turbidity, total dissolved solids, electrical conductivity, pH, DO, BOD. Water quality testing is carried out as part of the study to ensure that the community receives clean water and they can be aware of the quality of such water. The study will analyze surface water quality parameters of four different places of Khulna, assess the current water supply scenario in terms of availability and demand for drinking, household uses, commercial uses, etc., and propose improvement measures that can serve as a model for other cities in Bangladesh [11].

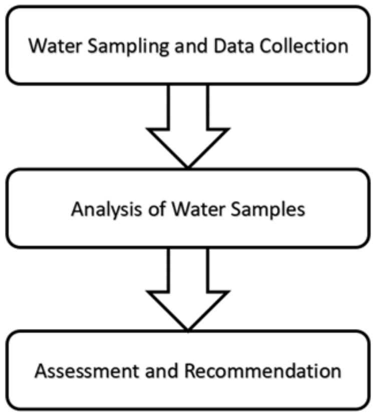
Several studies have been done on water quality. Some of these studies are included here. Rumman et al. (2011) used the weighted arithmetic approach and the National Sanitation Foundation (NSF) method to determine the water quality index (WQI) along the 128 km Faridpur– Barisal road. When calculating WQI, the six most crucial variables—pH, total dissolved solids, dissolved oxygen, BOD, electrical conductivity, and temperature difference—were taken into account. According to Chowdhury et al., 2012, the WQI value ranged between 19 and 96 according to the arithmetic mean approach, whereas the NSF method showed WQI values between 55 and 91. According to WHO and Bangladeshi criteria, the total groundwater quality of the research region was determined to be adequate for drinking. However, research on bacterial status revealed that 36.36% of pump water and 42.86% of home water in Khulna City were contaminated with fecal coliform and coliform of non-fecal origin. Jabed et al. 2013 investigated the water quality of Bhairab river. During the summer and wet seasons, they evaluated sixteen significant physicochemical parameters. Hashan and Moniruzzaman compared to the wet season, the overall pollution load was much higher in the summer. They claimed that the river had essentially turned into a moving garbage dump. Shamsuddin and Alam, 1988, looked at the significant differences in water quality between the industrial and non-industrial stretches of the Sitalakhya River. They discovered these differences in both the dry and wet seasons, which gives a clue as to the degree of pollution in the industrial section (Shamshuddin and Alam, 1998).

2. Materials

pH was measured using a standard pH meter and turbidity was also measured using a standard turbid meter. To measure temperature of water, a thermometer was used. The conductivity meter was used to determine the electrical conductivity as per the directions were given by the manufacturer's manual using standard solutions. To determine TDS 100 ml of every sample was taken and filtered. Now it was weighed again, the difference was the TDS. For the measurement of BOD, 300 ml BOD was taken and filled with sample water, then initial do was measured. After that the samples were kept in the incubator and after 5 days BOD5 was determined.

3. Methodology

3.1 Flow chart of the experiment



In this research study, sample water was collected from several points from Khulna city. After this, chemical and physical tests were carried out in the laboratory, and from the results of the tests, the overall quality of water was known. This helped to take proper steps to purify water at the required area.

3.2 Sample collection points

It is vital to examine and identify the quality and features of the groundwater, as most of the locals depend on this. Khulna's people depend mostly on Rupsha river's water and KWASA. According to accessibility and population living in these areas, four points were selected. These are shown below in Table 1 and Figure No. 1.

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Table 1. Sample collection points

Sample Station	Indication	Sample Type	Ward No.
KUET Main Gate	KMG	Submersible Water	01
Bhairab Ghat	BR	River Water	Outside
Mujgunni Residential Area	MRA	KWASA Supply	09
Sonadanga Residential Area	SRA	KWASA Supply	17

Figure No. 1: Samples collection areas

3.3 *Analysis of water samples*

The physical and chemical tests were performed on the acquired sample to determine its quality and address potential health risks in the study area. Temperature, electrical conductivity, total dissolved solids, and turbidity are considered physical test whereas pH, DO, and and BOD tests were done as chemical analyses.

4. Results and discussion

4.1 Water quality parameter analysis

To provide safe drinking water, maintain the general public's health, and avoid exposure to dangerous pollutants, water quality assessment is crucial. It aids in the detection of contaminants and pathogens in water. Because many aquatic species depend on particular conditions to exist, monitoring water quality also helps to conserve ecosystems. Water quality evaluations assist in preventing negative impacts and mitigating ecosystem damage by identifying sources of contamination, such as industrial waste and agricultural runoff. Water availability and quality are protected for future generations through sustainable management of water resources through quality evaluations.

Temperature is an important water quality parameter that affects both the physical and chemical characteristics of water. The effect of temperature is shown in the table below. Here The Bhairab River's water temperature is more than that of groundwater. This is because groundwater is found in deep aquifers, where sunshine and surface temperature swings have little effect, whereas rivers collect solar radiation throughout the day, raising the water temperature, particularly in tropical regions like Khulna's.

Table 2. Variation of temperature in samples

Sample	Experimental Value (°C)	BD Standard (°C)
KMG	29.2	20-30
BR	31.5	20-30
MRA	30.3	20-30
SRA	30.1	20-30

Figure No. 2 represents the electrical conductivity of the samples. The electrical conductivity is the ability of water to transfer electrical current [12]. The concentration of conductive ions affects the conductivity. Electrical conductivity of KUET main gate's water is higher than others, which indicates that it consists of more metallic substances than the other three samples. Again, this sample's EC is not within the standard limit.

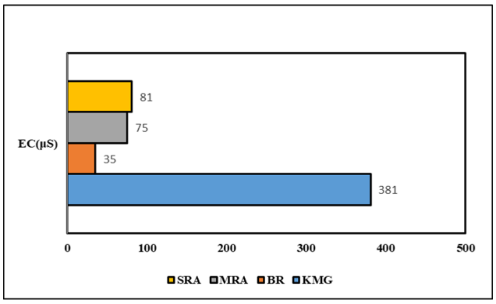

Figure No. 2. Electrical conductivity of different samples

Figure No. 3 depicts the total dissolved solids of different samples. TDS value is the amount of organic and inorganic matter in water. These metrics are valuable to the wastewater treatment plant operators [13]. TDS test results observed that KUET main gate's water had a higher TDS value than other samples. Although high TDS levels in drinking water are not harmful to health, they do give the water a salty, bitter, or brackish flavor. TDS level of 50 to 300 ppm is fair for drinking purposes. But 300-500 ppm TDS level is not good for drinking. So, 415 ppm TDS in KUET main gate's water is not suitable for drinking. As other samples range from 33 to 68 ppm, they are quite good for drinking purposes..

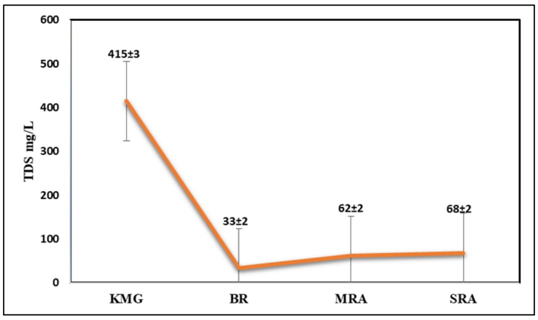

Figure No. 3. Total Dissolved Solids of different samples

Figure No. 4 displays the pH of different samples. pH is an arbitrary number that represents how strong an acidic or basic solution is. pH levels that are too high or too low can be harmful to the use of water. A high level of pH in water is an indication of the presence of pollutants and unwanted chemicals. The pH of the samples was within the standard limit. Here the pH of the Sonadanga residential area is slightly alkaline as the pH is 8.1. The pH of other samples was in the neutral range.

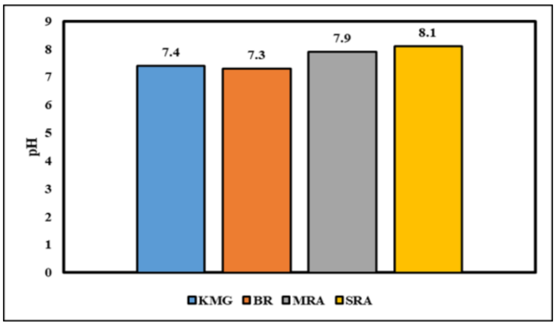

Figure No. 4. pH of different samples.

Figure No. 5 represents the DO level of different samples. The better water quality depends on the dissolved oxygen test. The DO value of the study was from 9.6 to 10.8, whereas the DO level above 6.5 to 8 mg/L indicates a healthy quality of drinking water. So, from the comparison, it can be said that the water of different four places could be used for drinking purposes. Here the samples are within the standard limit. Among them dissolved oxygen of Mujgunni residential area is higher. The higher DO level represented the better quality of the water and water from those sources were rich with oxygen content.

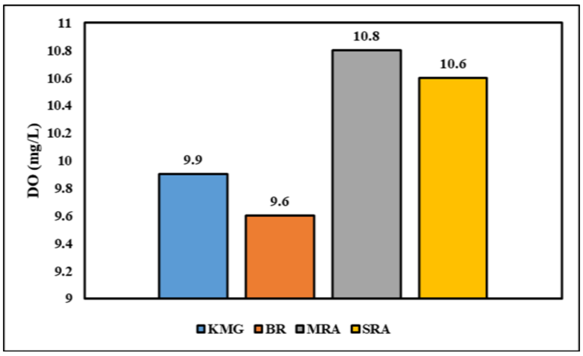

Figure No. 5. Dissolved Oxygen of different samples

Figure No. 6 represents the turbidity of different samples. Turbidity measurement is also an important parameter for determining water quality. It indicates the liquid's visual characteristics and a gauge of how clear it is. Higher turbidity lowered the water's transparency, which had a detrimental influence on the river's water quality and prevented it from being utilized for agriculture or as a source of drinking water. Turbidity level was found higher in Bhairab river water and it was 307 NTU whereas the BD standard is only 10 NTU. This means there are a lot of suspended particles in the water and light can hardly go through it. Infact, this water is not clear. So, from the test, it can be said that the quality of the sample water is not that bad. If proper treatment is applied, they can be more clear and good for drinking purposes.

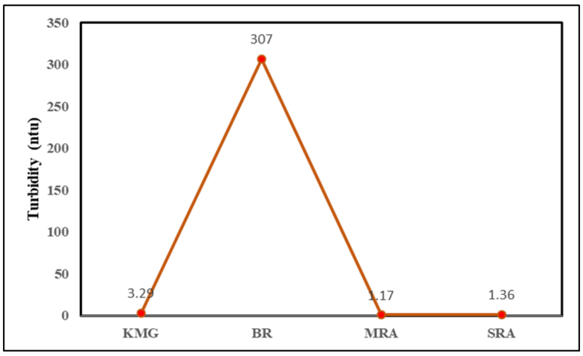

Figure 7. Turbidity of different samples

Figure No. 7 shows the biochemical oxygen demand (BOD) of the samples. The biochemical

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oxygen demand (BOD) measures the amount of oxygen that bacteria will consume while consuming organic materials in aerobic settings. Water is considered clean when the BOD level is 3-5 ppm. When the BOD level is 6-9 ppm, the water is said to be polluted as there are bacteria and organic matter to decompose the waste. In the experiment, the BOD level was found to be 2.3–4.7 ppm. So, it could be considered that the water of the four places was clean.

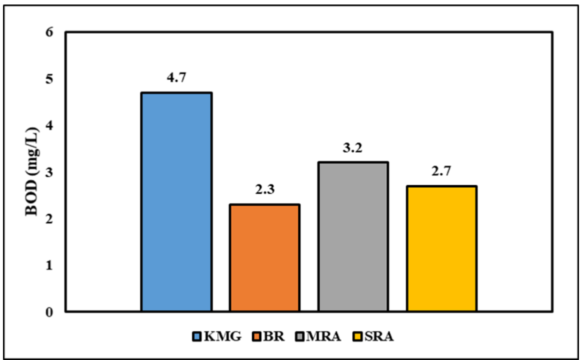

Figure No. 7. BOD of the samples

5. Conclusion

Various water quality parameters were tested. The test results indicated that the water quality in Khulna deviated from the standards set by the World Health Organization (WHO) and Bangladeshi regulations. Specific water quality parameters analyzed included pH, turbidity, hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD), total dissolved solids (TDS), and electrical conductivity. Results indicated that the turbidity level in samples from the Bhairab River was particularly high, at 307 NTU, exceeding the Bangladeshi standard of 10 NTU, indicating high levels of suspended particles and pollutants .

Khulna primarily relies on groundwater sources, such as KWASA tube wells, but the escalating rate of saline intrusion and the over-extraction of groundwater were leading to a decline in water quality. The study recommends the integration of groundwater and surface water to ensure a sustainable supply. To combat high salinity levels, suggestions include implementing treatment measures such as distillation, filtration, and deionization techniques. Regular monitoring of water quality and public awareness regarding the quality of drinking water are necessary as crucial steps to improve access to safe drinking water and to mitigate health risks associated with poor water quality.

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