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WATER QUALITY ASSESSMENT IN DIFFERENT AREAS OF KHULNA CITY IN BANGLADESH

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ABSTRACT

Water is very essential for plants and animals. So, it's necessary to have access high-quality water. Khulna city in Bangladesh is facing scarcity of clean water as high saline water is a major problem in this region. So, this study aims at assessing water quality from different areas of Khulna. Water quality analysis 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. Certain parameters of collected water samples were observed including temperature, p^H, turbidity, electrical conductivity, TDS, DO, BOD and Arsenic. The experimental data was compared with WHO and Bangladeshi standard values. The observed experimental data represented deviation from the standard value. So, proper water treatment should be carried out to ensure safe water and reduce contamination for ensuring better life.

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 (Bibi et al., 2011). 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 (Karamouz et al., 2006) 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 (Singh, 2007). 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, lack of growth in the infrastructure required for water supply, water shortage has increasingly worsened in this region (Chowdhury, 2013; Hafizur et al.,2017). Not only that, the unavailability of safe drinking water is a challenge in Khulna as high salinity level in water is found here. Thinking the water crisis several steps was taken in 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 m3). The capacity increased to 3.25 Crore liters (32500 m3) as the Department of Public Health Engineering (DPHE) of GOB Fund implemented a further development program in 1997. 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, 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 (Chowdhury, 2013). But at present the sources of water in Khulna is limited and 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 (Pal et al., 2018). 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 (Chowdhury et al., 2012). These parameters are p^H, turbidity, hardness, odor, conductivity, arsenic, TDS, BOD, and DO (WHO, 2011). 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. 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 (Kundu, 2017).
Several studies have been done on water quality at. 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—p^H, total dissolved solids, dissolved oxygen, BOD, electrical conductivity, and temperature difference—were taken into account. 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 (Chowdhury et al., 2012). 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. This study came to the conclusion that 71.43% of Khulna City's drinking water sources are hazardous and unusable (Sultana et al., 2006). Jabed et al. 2013 investigated the water quality of Bhairab river. During the summer and wet seasons, they evaluated sixteen significant physico-chemical parameters. Compared to the wet season, the overall pollutant load was much higher in the summer. They claimed that the river had essentially turned into a moving garbage dump (Hashan and Moniruzzaman). 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). The recent study focused on analyzing water quality of Khulna city. This study will help in identifying safe water for drinking and possible recommendation treatments as well as necessary steps for ensuring safe water in Khulna.

METHODOLOGY

EXPERIMENTAL SETUP

The experimental setup describes the methodology used for the entire study, including the collecting of water samples, analysis of the samples, fieldwork, laboratory studies to determine physio-chemical and biological parameters, calculating methods, and groundwater assessment. The research area's physiographic position and geological makeup are also included. In many Bangladeshi metropolitan areas, access to clean water is a significant difficulty. In Khulna, the Bhairab River's bank is home to Bangladesh's third-largest city, River Rupsha. Khulna experiences severe water shortages as a result of irrational urbanization along with a rise in groundwater and surface water salinity. To address the developing an integrated water supply system in a sustainable way is important to solving the issue (Kundu, 2017).
The experimental setup was performed in three steps.

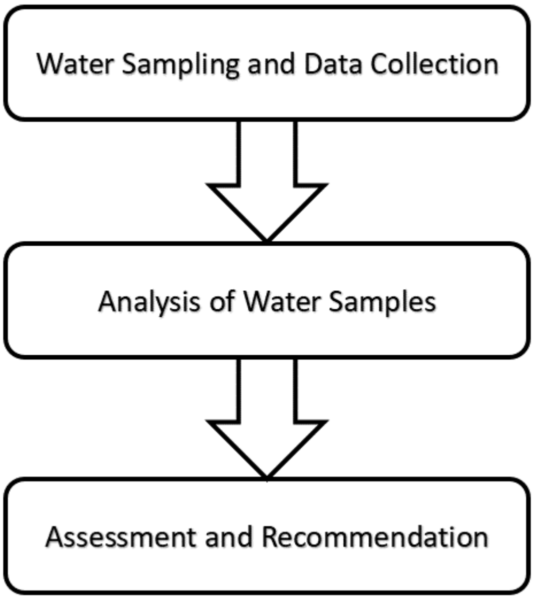

Figure1. Experimental setup of the study

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SAMPLE COLLECTION

In all regions of our country, ground water is one of the reliable water sources for human consumption. Groundwater also plays a significant part in the effort to achieve environmental sustainability because it is important to mankind. As a result, the quality of water in slums or disadvantaged areas may be altered by several moderating objects from the surrounding environment. In a slum area where the locals rely mostly on this source of water, it is vital to examine and identify the quality and features of the ground water. And Khulna's people depend also on Rupsha river's water and KWASA. According to accessibility and population living these areas, four points were selected. These are Kuet main gate, Mujgunni residential area, Sonadanga residential area and Bhairab river water.

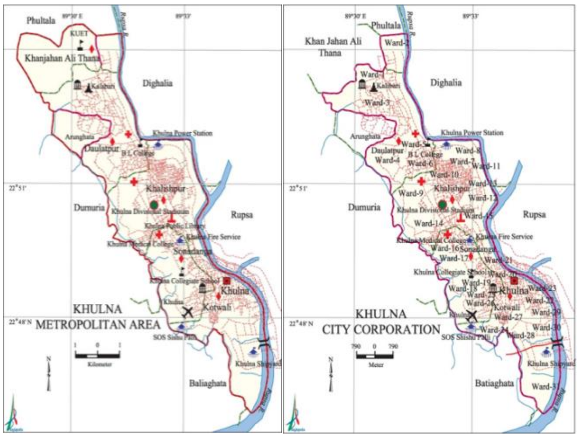

Figure 2. Map of the sample collection sites (Source: google earth)

Sample collection points were represented in table 1.

Table 1. Sample collection points

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

CHARACTERIZATION

P^H, turbidity, hardness, temperature, odor, conductivity, arsenic, TDS, BOD, and DO were tested in laboratory. p^H was measured using a standard p^H meter and turbidity was also measured using a standard turbid meter. To measure temperature of water 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.

Table 2. Parameters determined in this study

Physical	Temperature EC TDS P^H^ Turbidity
Chemical	DO BOD Arsenic

RESULTS AND DISCUSSION

TEMPERATURE

Temperature is an important water quality parameter. When evaluating the quality of the water, temperature is an essential factor. Temperature has its own impacts in addition to having an impact on a number of other factors and having an impact on the chemical and physical characteristics of water. Only KMG showed the temperature within Bangladesh's standard range. Other three samples exceed the standard temperature range. It happened because of the coastal region and similar type of results were found in some of the previous studies.

Table 3. Temperatures of the 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

ELECTRICAL CONDUCTIVITY

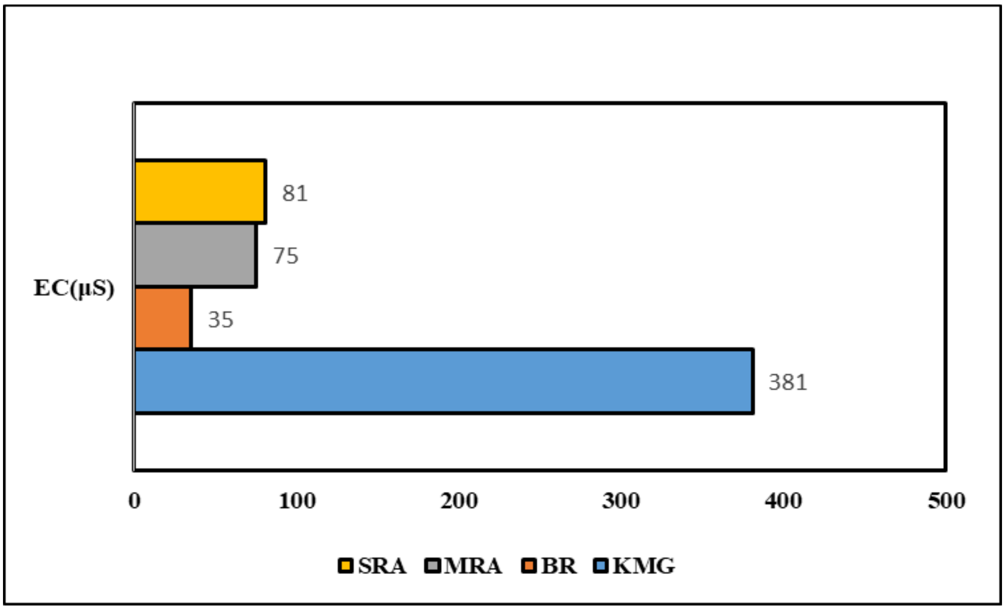

Figure 3. Electrical conductivity of different samples

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Figure 3 represents the electrical conductivity of the samples. The electrical conductivity is the ability of water to transfer electrical current (Tchobanoglus et al., 2003). The concentration of conductive ions affects the conductivity (True et al., 2004). Electrical conductivity of KUET main gate water is higher which indicate that it consists more metallic substances than other three samples. This samples' EC is not within the standard limit.

TOTAL DISSOLVED SOLIDS

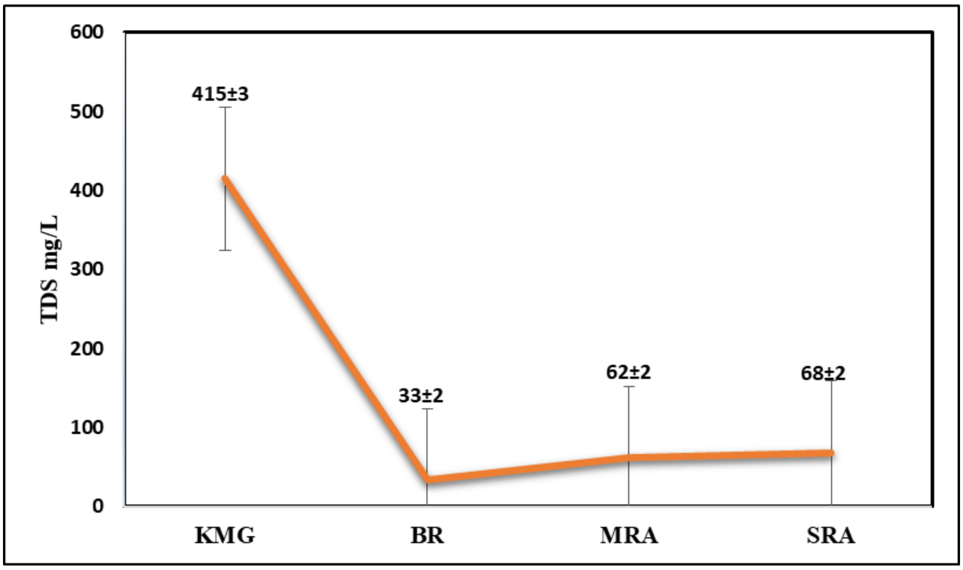

Figure 4. Total Dissolved Solids of different samples

Figure 4 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 (Spellman, 2008). TDS test result 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.

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P^H OF THE SAMPLES

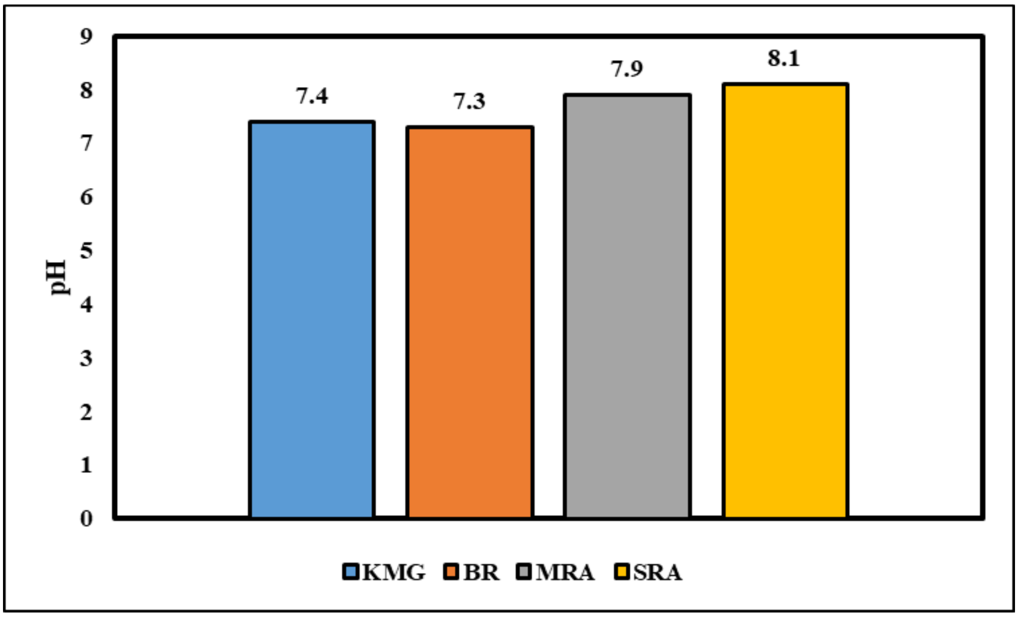

Figure 5. **P^H** of different samples

Figure 4 displays the p^H of different samples. p^H is an arbitrary number that represents how strong an acidic or basic solution is (Gholizadeh et al., 2016). p^H levels that are too high or too low can be harmful to the use of water. A high level of p^H in water is an indication of the presence of pollutants and unwanted chemicals (Hammer, 1986). The pH of the samples was within the standard limit. Here the p^H of the Sonadanga residential area is slightly alkaline as the p^H is 8.1. The p^H of other samples was in the neutral range.

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DISSOLVED OXYGEN TEST

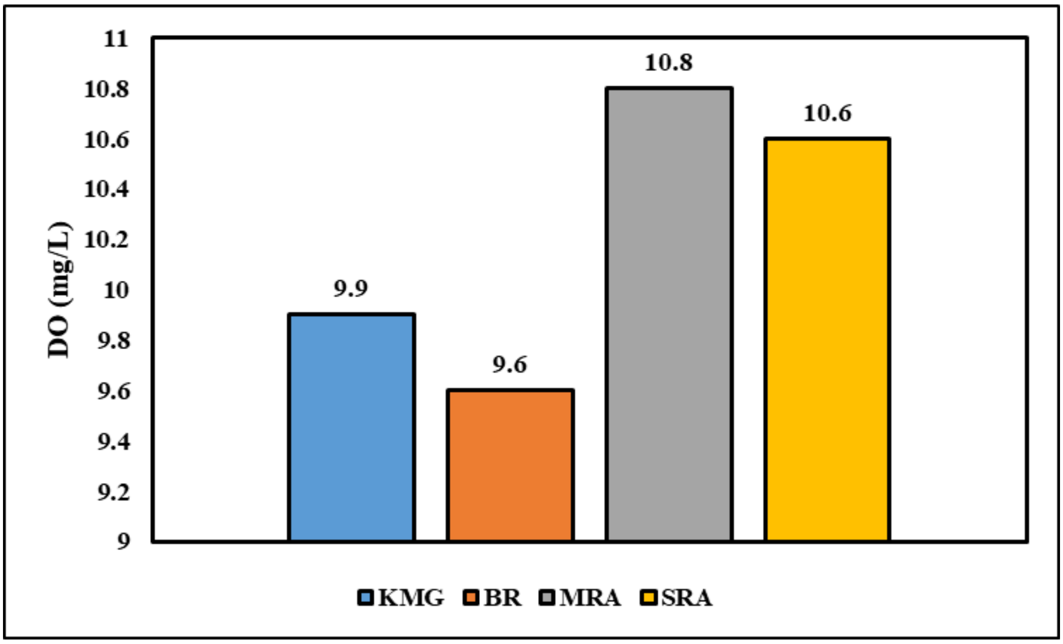

Figure 6. Dissolved Oxygen of different samples

Figure 6 represents the DO level of different samples. The better water quality depends on the dissolved oxygen test (DeZuane, 1997). 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 use 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 better quality of the water and water from those sources are rich with oxygen content.

TURBIDITY TEST

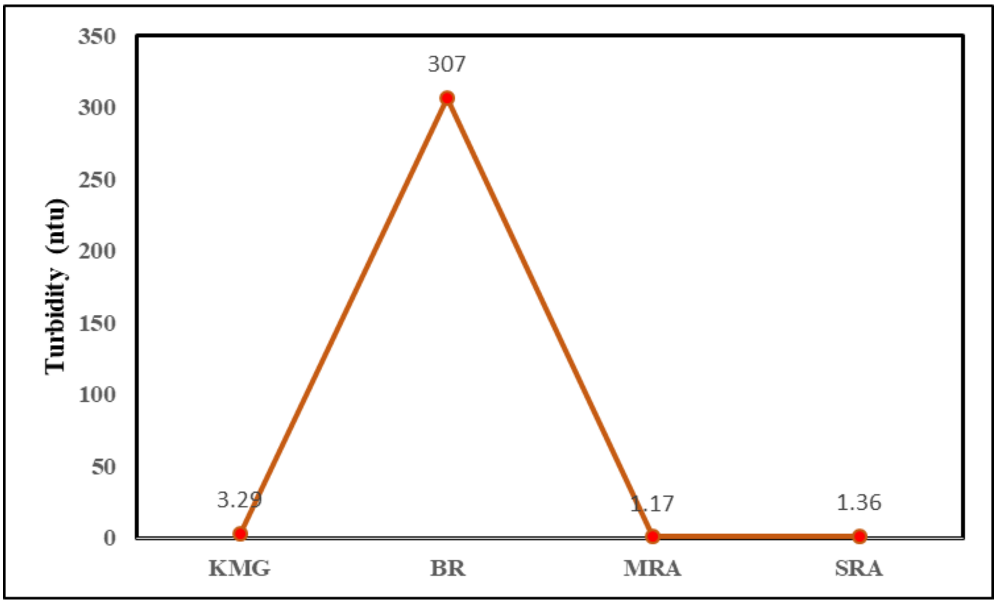

Figure 7. Turbidity of different samples

Figure 7 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 (Beutler et al., 2005). 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 (Gauthier et al 2003; Rana, 2009). 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.

BIOCHEMICAL OXYGEN DEMAND

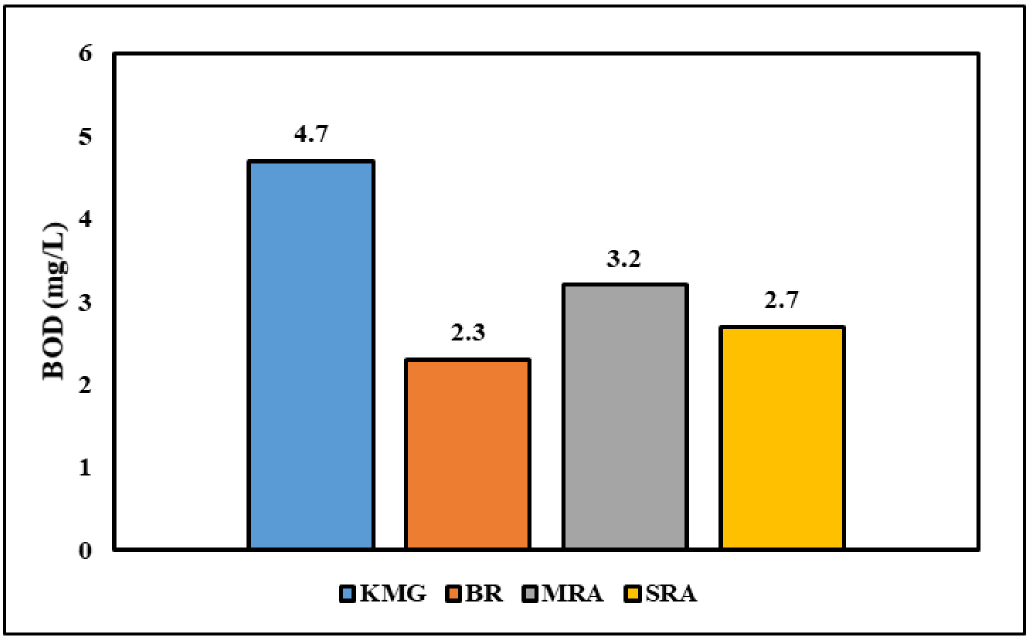

Figure 8. BOD of the samples

Figure 8 shows the Biochemical Oxygen Demand (BOD) of the samples. The biochemical oxygen demand (BOD) measures the amount of oxygen that bacteria will consume while consuming organic materials in aerobic settings (Gholizadeh et al., 2016; kamal et al., 2007). 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 2.3-4.7 ppm. So, it could be considered that the water of the four places was clean.

ARSENIC TEST

One of the most significant groundwater contaminants is arsenic (As). It puts people's health at serious danger (Rahman et al., 2021). A natural deposit in the earth, as well as industrial and agricultural practices, allow arsenic to infiltrate drinking water systems. It is restricted at 0.05 mg/l to safeguard consumers serviced by public water systems from the long-term consequences (Fahmida et al., 2013). However, the arsenic for all the four samples was found zero, which indicates the water samples are safe for drinking and other household purposes.

Table 3: Arsenic of the samples

Samples	Experimental value (ppm)	BD Standard (ppm)	WHO Standard (ppm)
1	0	0.05	0.01
2	0	0.05	0.01
3	0	0.05	0.01
4	0	0.05	0.01

CONCLUSION

The city of Khulna currently uses exclusively groundwater from KWASA tube wells, hand pumps, and private pumps; no surface water is used. The rate of saline intrusion is steadily rising as a result of extensive groundwater extraction. It is noticed that current KWASA production tube wells, hand pumps of the Mujgunni and Sonadanga area have groundwater quality that is within acceptable ranges. The surface water of Bhairab river is unfit for industrial uses as it has high DO value. As the total population in Khulna city is increasing, the demand for drinking water is also increasing. So, it is recommended to use groundwater and surface water together to meet future water demands. Additionally, a new surface water delivery system with a treatment facility should be looked into as an alternative. Additional research is needed to determine the source of surface water that surrounds Khulna City because the Bhairab River's water quality is unsuitable for industrial use. To reduce salinity in water, distillation, filtration, de-ionization method can be applied. This can be helpful for drinking purpose. Water supplies should be properly sanitized, managed, monitored, and maintained regularly. Proper water treatment can also help reducing the contamination. To decrease river water contamination from nearby pollution, the Department of Environment should enforce the appropriate laws. Laws governing pollution control must apply to both new and existing industries. Thus, we could ensure clean and safe water to reduce environmental burden as well as provide safe and drinkable water for all.

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