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Water Quality Assessment of Teligati Region, Khulna

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ABSTRACT
Over the years, the decrease in drinking water quality has become a matter of concern for living organisms. This paper shows the physical and chemical characteristics of five different drinking water supplies for the residents of the Teligati region, Khulna. Both treated water supply and natural water supplies were taken into consideration for the research. This research aims to properly understand the Drinking Water Quality Index (WQI) that is being compromised for various geographical and artificially created problems. Using proper experiments conducted in the Environmental Lab of KUET, this study was conducted to determine the specific values of Bio-Chemical Oxygen Demand (BOD), Dissolved Oxygen (DO), pH, Total Hardness (TH), Electrical Conductivity (EC), Chloride concentration, Turbidity, Color, Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) of five different samples taken for five major drinking water supplies of Teligati, KUET. All the data collected were compared with different parameters set by WHO and the deviations were observed. From the experimental data, the drinking water supply from BSMRH Hall, a fairly deep tube well (290 feet) situated close to the area, and the water supplied in the outside restaurants met the parameters set by WHO, and the other two only just made the boundary of the parameter. The non-treated drinking water supply from Bangabandhu Sheikh Mujibur Rahman Hall (BSMRH) of KUET and the Shallow tube well situated in the study area were also very close to the allowed range set by World Health Organization (WHO). The BSMRH hall drinking water supply was treated for drinking and the other four supplies were natural. This study confirms the fluctuation of the Drinking water quality index but it rarely surpasses the Water Quality Index (WQI). The treatment method needs minor adjustments and more modern techniques need to be applied. The shallow tube wells need to go out. Further bacteriological and spectrophotometric ion detection methods should be conducted in further studies for the detection of heavy metals like Arsenic, Mercury, and Lead, and also Total Coliform Count.

Keywords: Water Quality Index, Shallow Tube well, treated water, coliform

1. Introduction

The United Nations General Assembly declared safe and affordable drinking water for human utilization to be a human right in July 2016[1]. Many regions of the world already have limited supplies of fresh water. It will become substantially more restrictive in the following century as a result of population explosion, modernization, and climate variability[2]. Water quality degradation has become increasingly important as a result of the hydrological cycle being significantly altered by anthropogenic activity and climate change. a critical global concern for the long-term welfare of humans. Drinking water quality degrades as a result of cross connections and leakage introducing chemical substances into the water supply system [3]. According to the World Health Organization (WHO), home waste is responsible for over 80% of water pollution in developing nations. Additionally, poor management of water systems can result in significant issues with water availability and quality[4]. Over the past 10 years, several instances of groundwater contamination have intensified the general public's concerns about the quality of drinking water [5]. Sewage waste can leak and compromise water supply systems. Therefore, poor maintenance is another cause of water contamination. Human health is directly impacted by drinking water quality. These impacts demonstrate the level of contamination throughout the drinking water supply system, which includes freshwater, treatment facilities, and consumer distribution networks[6].

The community may be in danger of disease outbreaks and other negative health effects if water sources are not effectively treated and distributed safely. Unfortunately, drinking water sources are contaminated in many nations around the world, which hurts both the population's health and economic standing. Though the quality of drinking water is a crucial parameter for water treatment, data assessment is significant for recognizing and classifying issues with water quality. Proper assessment converts collected data on water quality indexes into valuable information. For determining the quality of the water, monitored data is crucial. Following it with corrective action, monitored data can also confirm water contamination. To identify the presence of any controlled contaminants, Water distribution systems must monitor their water sources microbiologically, chemically, physically, and radiologically. The quantities of pollutants found are used to assess if a Maximum Contaminant Level (MCL) has been breached and to determine whether further treatment is necessary. If a pollutant is found in the water, the public may need to be notified, and if the MCL has been violated, the communication must include details on the health impacts and the necessity for a backup water supply[7].

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There are several techniques for assessing the safety of the water. For this, the Water Quality Index (WQI) is a reasonably reliable measure. WQI is a method of methodically providing management and the general public with information on water quality by compressing enormous amounts of data into simple terms (such as good, and terrible). Various indices are used by researchers. The purpose of an index is to make complex statistics on water quality understandable and applicable to the general audience.[8]

According to the authors' knowledge, no research has been conducted to evaluate the drinking water quality in the Teligati region, where Khulna University of Engineering and Technology (KUET) is located. This study aims to evaluate the drinking water quality on the KUET Campus and compare it to WQI. The study also aimed to establish whether additional water purification techniques are required for the area's safe drinking water supply. The samples' monitored parameters were also determined using conventional analytical techniques. To assess both the drinking water quality and the data's mathematical processing, the WHO drinking Water Quality Index was employed.

2. Experimental Instruments:

All reagents and solutions were synthesized with chemicals of analytical grade. All tests employed de-ionized and twice-distilled water. Each piece of equipment was calibrated before each analysis by the manufacturer's instructions. A pH meter with a combination electrode and turbidimeter was used to test pH. Using a conductometer, electrical conductivity was measured. Spectrophotometric measurements were performed using a spectrophotometer. Color and dissolved oxygen were measured with digital meters. The BOD was measured in a span of five days. The hardness and chloride concentration were measured using titration and the total suspended solids were determined with the help of digital balance and oven.

2.1. Study area:

The research was conducted in the Teligati region in Khulna where Khulna University of Engineering and Technology is situated. Teligati is a suburb in Khulna Division. Teligati is situated nearby the southeast of Rajapur. This is a rural area with 51.98 km^2 and a population of 13,871.

Latitude 22.89594° or 22° 53' 45" north
Longitude 89.49082° or 89° 29' 27" east

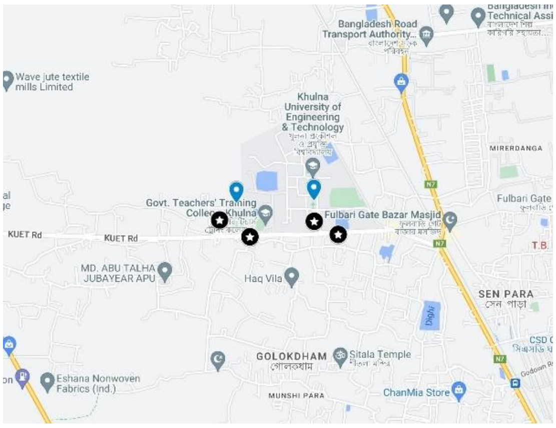

Figure 01: A map of the study area

2.2. Collection of Samples:

Five samples were taken from five major drinking water supplies in this area. BSMRH treated drinking water supply, BSMRH normal water supply, shallow tube well in Khanabari, deep tube well in Teachers Training Centre, and drinking water supply from KUET pocket gate restaurants. The treated water supply from BSMRH is chlorinated. The shallow tube well has a boring of 120 feet under the surface whereas the deep tube well has 290 feet of boring under surface. For evaluating the physiochemical properties of the drinking water, five samples were collected in 250 ml bottles. Before the collection, the bottles were rinsed properly with distilled water. The temperatures were taken as the samples were being collected. Then the samples were kept in a freezer till all the experiments were done.

3. Methodology

3.1. Determination of pH: The pH of the water samples was determined using a pH meter. It was standardized with a buffer solution of pH range between 4 and 9.

3.2. Determination of Electrical conductivity: This was done using a conductivity meter. The probe was dipped into the container of the samples until a stable reading was obtained and recorded.

3.3. Determination of Total Hardness: Titrating a sample solution with a 0.01 N ethylene diamine tetra acetic acid (EDTA) solution while utilizing the Eriochrome black T indicator, until the color changed from purple to pure blue, was used to determine the total hardness. A 250 ml conical flask was correctly filled with an estimated 20 ml of water sample before being mixed with Eriochrome black T and 2 ml of buffer solution. To dissolve the indicator, it was added and thoroughly mixed. Once the mixture's color changed from purple to pure blue, it was titrated with 0.01 N, EDTA solution.

$$\text{Total Hardness} = \frac{A \times B \times 1000}{\text{Sample}}$$

A= The difference between EDTA in the burette
B= 0.92 (Standard $CaCO_3$)

Determination of Bio-Chemical Oxygen Demand: By using the five-day dilution procedure, BOD_5 was calculated.

Determination of Dissolved Oxygen: Using a digital dissolved oxygen meter, this was achieved by dipping the probe into samples and waiting for the reading to stabilize.

Determination of Turbidity and Color: The color and turbidity of the samples were evaluated with the help of digital meters. The color was determined using a spectrophotometer and the turbidity was measured using a turbidity meter in the NTU unit.

Determination of total dissolved solids (TDS), Total Suspended solids (TSS), and Total solids (TS): This was measured using the Gravimetric Method. A portion of water was filtered out and 10 ml of the filtrate was measured into a pre-weighed evaporating dish. Filtrate water samples were dried in an oven at a temperature of 103 to 105 °C for 21 2

h. The dish was transferred into a desiccator. Then it was again weighed.

4. Results and Discussion

Sample 1: BSMRH-treated drinking water supply

Sample 2: BSMRH normal water supply

Sample 3: Shallow tube well in Khanabari

Sample 4: Deep tube well in Teachers Training Center

Sample 5: Drinking water supply from KUET pocket gate restaurants

Table 01: Experimental data for pH, EC, TH, TDS, Chloride Concentration, and TSS.

Samples	Parameter					
	pH	EC (µS/cm)	TH (ppm)	Cl (ppm)	TDS (ppm)	TSS (ppm)
01	7.9	89	370.80	120	580	10
02	7.8	292	780.33	1030	2140	30
03	7.6	375	920.50	1420	2660	70
04	8.5	84	315.54	480	520	10
05	8.0	59	220.62	180	360	07

4.1. Physicochemical Characteristics: Table 1,2,3 lists the obtained analytical results of the physicochemical parameters of five major drinking water supplies of Teligati region, Khulna.

4.2. Temperature: The thermometer provided temperatures ranging from 17-23^0 C for five different water supplies. Sample 2 recorded maximum temperature as it was stored on a tank situated on the rooftop. Through biological mechanisms, water quality may be impacted by the temperature of the water. The reported temperature range, however, is standard and poses no danger to the water's quality.

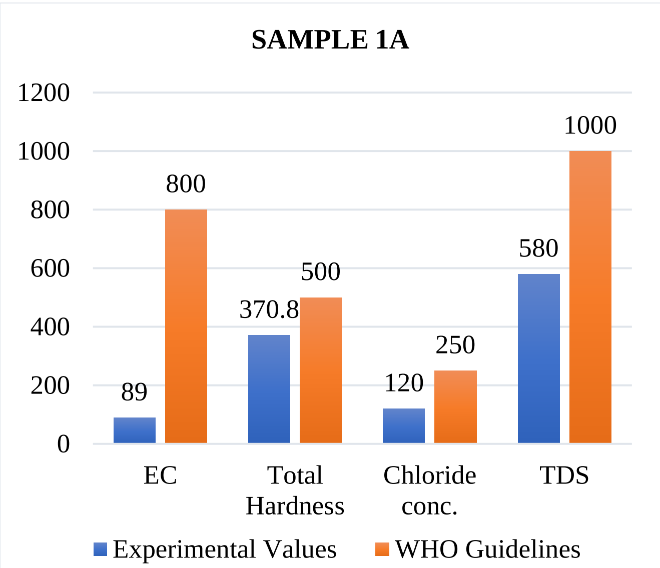

Figure 02: Comparison of EC, TH, Cl^- and TDS of sample 01 between Experimental Values and WHO Guidelines

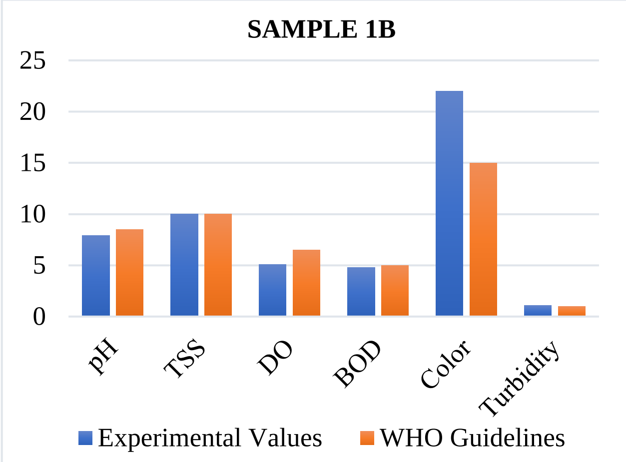

Figure 03: Comparison of pH, TSS, DO, BOD, Color, and Turbidity of sample 01 between Experimental Values and WHO Guidelines

4.3 pH: The pH of five samples ranged from 7.6- 8.5. All of the samples met WHO guidelines of pH 6.5-8.5. Though the deep tube well in TTC is very close to the boundary value and needs to be addressed.

4.4 Total Dissolved Solids and Total Suspended Solids: WHO limits TDS below 1000 ppm for safe drinking water. The TSS should be lower than 10 ppm. Sample 2 and 3 fails both these parameters. The amount of organic and inorganic solids in samples 2 and 3 is beyond the safe drinking limit.

Table 02: Experimental data for DO, BOD, Color, Turbidity

Samples	Parameters				
	DO (ppm)	BOD (ppm)	Color (PtCo)	Turbidity (NTU)	Temperature (^{0} C)
01	5.1	4.8	22	1.09	21
02	9.9	11.3	08	1.93	23
03	11	13.2	14	1.03	17
04	1.9	4.4	11	0.74	18
05	1.2	4.1	28	1.92	21

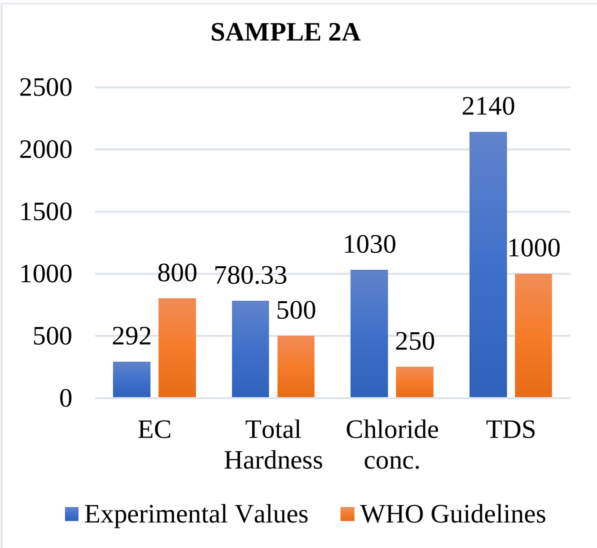

Figure 04: Comparison of EC, TH, Cl^- and TDS of sample 02 between Experimental Values and WHO Guidelines

Table 03: Table for the depth of five different water sources.

Sample	Depth of water source (m)
01	210
02	80
03	70
04	290
05	320

4.5 Electrical Conductivity: The electrical conductivity was found to be lowest for sample 5 and it had its peak for sample 3. Samples 2 and 3 met the range set by WHO of 200-800 µS/cm but other samples fell well below par. Because there are so many dissolved inorganic materials in the ionized state in groundwater, it tends to have a high electric conductivity.[9] The low EC found in samples 1,4 and 5 mean they contain little dissolved salts. This may be a result of improper treatment methods.

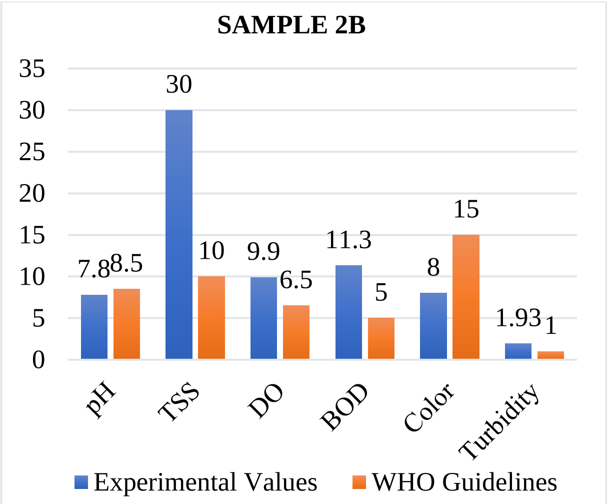

Figure 05: Comparison of pH, TSS, DO, BOD, Color, and Turbidity of sample 02 between Experimental Values and WHO Guidelines

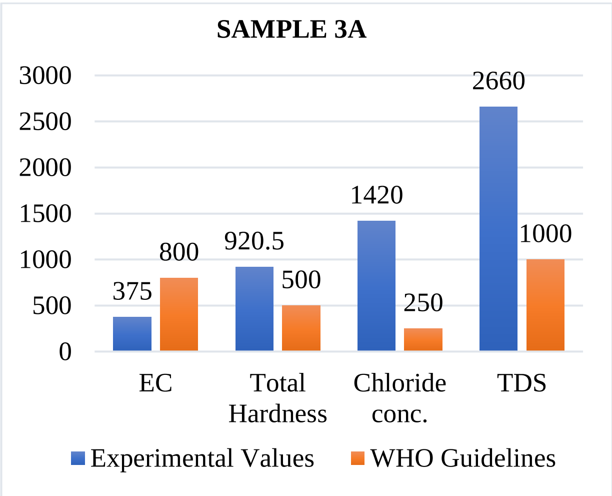

Figure 06: Comparison of EC, TH, Cl^- and TDS of sample 03 between Experimental Values and WHO Guidelines.

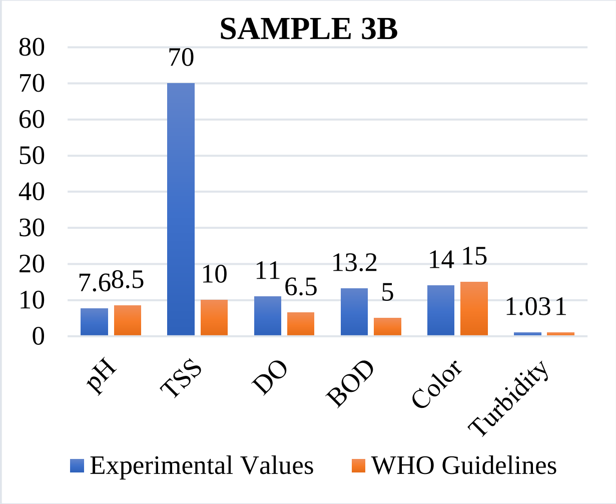

Figure 07: Comparison of pH, TSS, DO, BOD, Color, and Turbidity of sample 03 between Experimental Values and WHO Guidelines

4.6 Total Hardness: The WHO permissible limit for total hardness is not more than 500 ppm. Samples 2 and 3 from our study failed to meet the limit. This can cause a huge quantity of magnesium and calcium ions in the natural water supplies of shallow tube wells and the normal water supply of BSMRH.

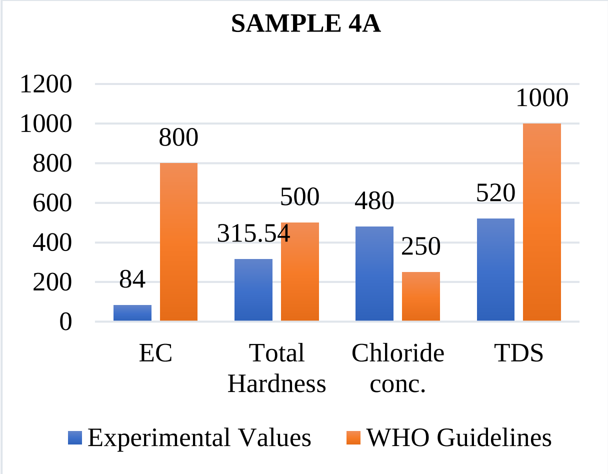

Figure 08: Comparison of EC, TH, Cl^- and TDS of sample 04 between Experimental Values and WHO Guidelines

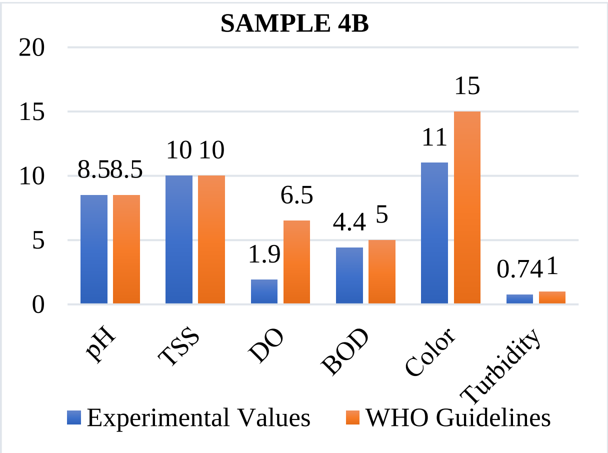

Figure 09: Comparison of pH, TSS, DO, BOD, Color, and Turbidity of sample 04 between Experimental Values and WHO Guidelines

4.7 Chloride Concentration: The five samples have chloride concentrations from 120 to 1420 ppm. Only sample 1 and 5 is by WHO limit of below 250 ppm. The Teligati region is infamous for the massive amount of salt in water; this study confirms it. BSMRH-treated water supply and water supplied in the pocket gate restaurants can be safe for usage and other supplies need proper treatment.

4.8 Dissolved Oxygen: Samples 2 and 3 fail this parameter too. Values of 9.9 ppm and 11 ppm go over WHO permissible values of 6.5 ppm.

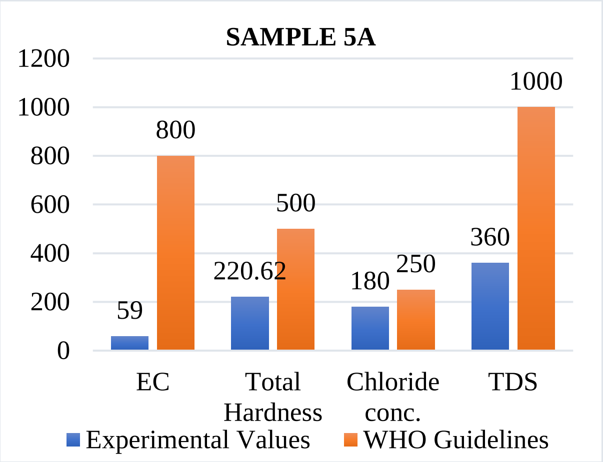

Figure 10: Comparison of EC, TH, Cl^- and TDS of sample 05 between Experimental Values and WHO Guidelines

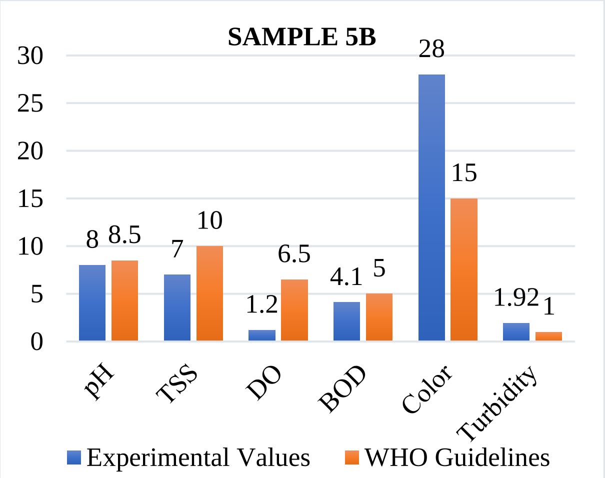

Figure 11: Comparison of pH, TSS, DO, BOD, Color, and Turbidity of sample 05 between Experimental Values and WHO Guidelines

4.9 BOD: A water supply with a BOD of 3-5 is considered moderately clean. According to our study, samples 1,3, and 5 are well within the limit.

4.10 Turbidity: The turbidity of drinking water should be below 1 NTU all the time. Out of all our samples, only sample 4 meet this criterion with sample 1 and 3 coming pretty close to the boundary.

5. Conclusion and Future Recommendation

In this study, the 5 major drinking water sources in the Teligati region of Khulna were evaluated in comparison to WHO regulations. The water quality in the area was analyzed using eleven physio-chemical parameters. Based on test outcomes, the drinking water of BSMRH, deep tube wells, and water supply in pocket gate restaurants mainly satisfied the WHO standard value for water quality. The two additional samples BSMRH normal water supply and shallow tube well barely met the limit of the water quality evaluation parameter. Physical and chemical characteristics were taken into account for completing this study. The Teligati region's drinking water would have been better evaluated using bacterial parameters like total coliform bacteria, coliform bacteria with fecal origin, aerobic mesophile bacteria, streptococci with fecal origin, sulfite reduction clostridium, proteus species, pseudomonas aeruginosa, thermos filament coliform bacteria, escherichia coli, and clostridium perfringens, The identification of heavy metals can help evaluate drinking water more accurately. Water typically contains five different forms of heavy metals, including copper, manganese, lead, chromium, and arsenic. Some heavy metals, such as arsenic, chromium, and lead, are harmful; others, like heavy metals, are necessary for metabolic activity. After analyzing all the factors. It is suggested that the city authority takes into account using samples 1, 4, and 5 from the Teligati region as potential drinking water resources. Sample 2,3 which failed to meet most parameters set by WHO should put forth a more advanced purification process. Raising public knowledge of proper water usage and safety regulations that guard against physical, chemical, and biological contamination is necessary for enhanced health safety.

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