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ASSESSMENT OF DRINKING WATER QUALITY IN MBSTU CAMPUS

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Abstract

The study was carried out to assess the drinking water quality of Mawlana Bhashani Science and Technology University (MBSTU) campus area and thus to provide the current status of ground water for its suitability for drinking purposes. Water samples were collected from five deep aquifer based tube wells from different parts of MBSTU campus in summer season (April-May). Three samples were collected from each station. In order to investigating the ground water quality, the water samples were analyzed for different physicochemical properties such as temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), turbidity, total hardness (TH), total alkalinity (TA) and chloride (Cl^-) concentration. The temperature, pH and EC values in analyzed water samples varied from 29.2-29.6 °C, 7.2-7.4 and 248-505 µs/cm respectively. Average value of the TDS, DO, turbidity, total hardness, total alkalinity and chloride concentration were 299 mg/l, 6.5 mg/l, 8.28 ntu, 143 mg/l and 14.4 mg/l respectively. The results were compared with the standards prescribed by World Health Organization and Environment Conservation Rules. All the parameters were found to be in the prescribed permissible limit and so it was not polluted. The water quality index (WQI) result also indicates that the water of the study area was fair and can be used for drinking or other purposes.

Keywords: Water, DO, WQI, hardness, physicochemical properties.

Introduction

Water is one of the most precious commodities of life, has numerous uses and it is impossible to exhaust all the water supplies of the world, as water is continuously recycled through the hydrological cycle (Gorde, and Jadhav, 2013). However, it is possible to degrade the quality of water to the point where it is useless, harmful or sometimes even deadly for life (Miroslav and Bashkin, 1999). Moreover, due to rapid increase of population, rapid industrialization, flow of pollution from upland to lowland, and too much use of fertilizers and pesticides in agriculture, there is a growing concern over the safety and fate of this valuable source of water (Jothivenkatachalam *et al.*, 2010). Ground water is usually defined as water which is found underground in a saturated zone of rocks, is exploited by means of tube well depending on geological

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constitution of the soil in different regions where the depth is usually varies from 50 to 500 m (Reshma and Prakasma, 2007). If water is used for drinking, it should be potable nature that means, water must be consumed in desired amount without creating adverse effect on health where nutrients, suspended matters and chemicals are responsible for such pollution (Jiban *et al*., 2009).

Bangladesh is largely dependent on groundwater (GW) source for drinking, irrigation and other purposes. About 90% of drinking water and almost 75% of irrigation water in Bangladesh are supplied from GW source (Mridha *et al*., 1996; Shahid *et al*., 2006). According to UNDP, there are three GW systems in Bangladesh: upper shallow unconfined aquifer, middle confined aquifer (also known as main aquifer) and deep confined aquifer. However, the uppermost shallow aquifer is extensively used for extraction of water for drinking and irrigation purposes almost all over the country (Shahid *et al*., 2006). At present, groundwater of Bangladesh is being contaminated widely. Heavy metals which are most harmful among these chemicals are present trace in amount can cause harmful impact on human health (Hatje *et al*., 2016). Polluted drinking water cause many diseases as diarrhea, vomitting, gastroenteritis, dysentery, kidney problems etc. (Memon *et al*., 2011). According to WHO (2006), about 80% of all the diseases in human beings are caused by water and the resulting death toll is as much as 10 million per year (Kavitha and Elangovan, 2010). The proportion of waterborne disease outbreaks are associating with the water supply systems and it has been increasing over the years (Moe and Rheingans, 2006). Once the groundwater is contaminated, its quality cannot be restored back easily and hence, water quality index (Tagy, 2013; Shivasharanappa, 2011) is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers.

Thus, it becomes an important parameter for the assessment and management of groundwater (Kumar and Kumar, 2013). The greater part of the soluble constituents in ground water comes from soluble minerals in soils and sedimentary rocks. Another common constituent is chloride ion which is derived from intruded sea water and sewage wastages. The MBSTU campus is an important educational institution at Tangail district in Bangladesh and about seven thousand students are studying here from different districts of Bangladesh. Hence the main objective of the study was to assess the drinking water quality by determining the physicochemical parameters of ground water of MBSTU campus.

Materials and Methods

Study Area

The Mawlana Bhashani Science and Technology University (MBSTU) is government financed public university at Tangail district in Bangladesh. The campus is situated at

Santosh, which is in the southwestern part of Tangail district in Bangladesh. The campus occupies almost about 57.95 acres (234515.325 m^2) of land.

Sample Collection

Drinking water samples were collected from five sampling stations in summer season (April-May). The sampling stations were New Academic Building (Station-1), Bangabandhu Sheikh Mujibur Rahman Hall (Station-2), Shahid Janani Jahanara Imam Hall (Station-3), Cafeteria (Station-4) and Shahid Ziaur Rahman Hall (Station-5). Three samples were collected from each station. Samples were collected by plastic bottles with double stoppers and those were sealed immediately to avoid exposure of air (Clesceri *et al*., 1989). Before sampling, the bottles were cleaned and washed with detergent solution and treated with 5% HNO_3 over night. The bottles were finally rinsed with deionized water and dried. The sampling containers were labeled including its spot name, identification number, date and time. All tests were completed as early as possible since the stored sample water could precipitate and that would give erroneous result.

Sample Analysis

The water samples were analyzed at the Research Laboratory of Department of Chemistry, Mawlana Bhashani Science and Technology University, Tangail, Bangladesh. The physicochemical properties of drinking water such as temperature and pH were determined by the thermometer and digital pH meter (Model: Adwa, range: -2 to 16, Hungary) respectively. Buffer solution of pH 7.0 was used to calibrate the digital pH meter. The electrical conductivity (EC) was measured by a digital conductivity meter (HANNA, HI 8633, HI 8733-HI 8734, India) and total dissolved solids (TDS) of all the samples were determined electrometrically by the digital TDS meter (Model: HANNA HI 8734, Germany). The dissolved oxygen (DO) of the water samples were determined by DO meter (Model: D 5509, Auto Cal., Taiwan). Total alkalinity was measured by titration method with 0.1 N HCl after addition 1-2 drops of methyl-orange indicator. The hardness was determined by using standard procedure (Bassett et al., 1978). The chloride ion concentration was determined by titration using Volhard's method and turbidity was measured by using a turbidity meter. Gravimetrically AgCl (mg) was estimated by filtering the precipitates which was formed during determination of chloride by Volhard's method and we followed the standard procedure (Bassett *et al*., 1978). The assessed water quality parameters were compared with WHO (2006) and Bangladesh Drinking Water Standards ECR (1997).

Water Quality Index (WQI)

Water Quality Index (WQI) (Shivasharanappa, 2011) is basically a mathematical means of calculating a single value from multiple test results and the index result represents the level of water quality in a given water source. To determine the WQI, normally the following nine water quality parameters are measured: Biochemical Oxygen Demand

(BOD), Dissolved Oxygen, pH, Temperature, Total Dissolved Solids, Turbidity. When the water is not severely polluted such as for drinking water, BOD is not essential for the determination of WQI. Hence, in this study BOD was not measured.

Hence, Water Quality Index, **WQI** = $\frac{\sum Wi \times Qi}{\sum Wi}$

Where**,**

Q_i = Quality rating for the parameter, $\sum_{i=1}^{n} w_i = 1$, W_i = weight of the ith parameter, such that, n = number of parameters. This WQI value give the quality of the water and by the Canadian Water Quality Index (CWQI) defines ranges for each: Poor (0−44), Marginal (45−64), Fair (65−79), Good (80-88), Very Good (89−94) and Excellent (95−100).

Results and Discussion

Color and odor of the water: Water usually think a colorless liquid however it possesses some level of color. All the water samples were colorless and odorless except Station-1. Water sample of Station-1 was reddish in color and was slight odor.

Temperature: Temperature is an important physical parameter for determining the quality of water. The water temperature was found 29.2-29.6 °C (Table 1) and it was acceptable to drinking according to the ECR (Table 2).

Hydrogen ion activity (pH): The pH is a term used to express the intensity of acidic or alkaline conditions. It is the expression of hydrogen ion concentration, more precisely, the hydrogen ion activity. It is an important parameter in assessing the water quality. In general, water with a pH of 7.0 is considered neutral while lower of it referred acidic and a pH greater than 7.0 known as basic. It is noticed that water with low pH is tend to be toxic and with high degree of pH it is turned into bitter taste. According to WHO and ECR standards pH of water should be 6.5 to 8.5. The analyzed pH value in water samples varied from 7.2 to 7.42 with average value of 7.3 (Table 1). Hence, in study areas the pH values were not exceeded the standard limit (Table 2) however these were falling in basic or alkaline range.

Electrical conductivity (EC): Pure water is not a good conductor of electric current rather a good insulator. Increase in ions concentration enhances the electrical conductivity of water. Generally, the amount of dissolved solids in water determines the electrical conductivity. Electrical conductivity (EC) is actually measures the ionic process of a solution that enables it to transmit current. According to WHO and ECR standard electrical conductivity value should not exceeded 1000 µs/cm. EC of the collected samples was ranged from 248 to 505 µs/cm and the average value was 377 µs/cm (Table 1). The highest value 505 µs/cm was in Station-5 and the lowest value 248 µs/cm was in Station-2 (Table 1). Since the average value (377 µs/cm) was not exceeded the WHO and

ECR standards (Table 2) so the water was good for drinking purpose on the basis of electrical conductivity.

Total dissolved solids (TDS): Water has the ability to dissolve a wide range of inorganic and some organic minerals or salts such as potassium, calcium, sodium, bicarbonates, chlorides, magnesium, sulfates etc. These minerals produced un-wanted taste and diluted color in appearance of water. There is no agreement have been developed on negative or positive effects of water that exceeds the WHO standard limit of 1000 mg/l. TDS in drinking water is originates many ways from sewage to urban industrial wastewater etc. Therefore, TDS test is considered a sign to determine the general quality of the water. The range of TDS of analyzed water samples varied between 189 to 406 mg/l as shown in Table 1. The highest (406 mg/l) and lowest (189 mg/l) TDS values were observed at Station-5 and Station-2 respectively. Hence, the range (Table 2) was acceptable and concentration of TDS is not harmful.

Table 1. Physicochemical analysis of drinking water in MBSTU campus

Parameters	Sampling Stations					Average Values
	Station-1	Station-2	Station-3	Station-4	Station-5	
Temperature (°C)	29.6	29.2	29.2	29.6	29.4	29.4
pH	7.2	7.3	7.4	7.3	7.4	7.3
EC (µs/cm)	445	248	384	302	505	377
TDS (mg/l)	362	189	294	241	406	299
DO (mg/l)	7.5	5.3	7.4	5.3	6.8	6.5
Turbidity (ntu)	8.52	7.80	8.60	7.60	8.9	8.28
Total hardness (mg/l)	200	188	184	180	172	185
Temporary hardness (mg/l)	30	42	84	100	82	68
Permanent hardness (mg/l)	170	146	100	80	90	117
Total alkalinity (mg/l)	172	91	140	118	192	143
Chloride (mg/l)	13.7	14.4	15.6	15.3	13.1	14.4
AgCl (mg/l)	160	170	174	172	152	166

Dissolved oxygen (DO): Dissolved oxygen (DO) is an important drinking water quality parameter. In the present study, the average DO concentration was found 6.46 mg/l, where highest (7.5 mg/l) was at Station-1 and lowest (5.3 mg/l) was at Station-2 and Station-4 (Table 1). According to WHO and ECR standards DO concentration should not below 5 mg/l and 6 mg/l respectively. Since the study value exceeded the minimum requirement so the water was good for drinking.

Turbidity: The average turbidity of the analyzed samples was 8.28 ntu with highest value 8.9 ntu for Station-5 and lowest 7.6 ntu for Station-4. The average value was within the standard limit prescribed by WHO and ECR (Table 2).

Total hardness (TH): Hard water is characterized with high mineral contents that are usually not harmful for humans. In ground water hardness is mainly contributed by bicarbonates, carbonates, sulphates and chlorides of calcium and magnesium. So, the principal hardness causing ions are calcium and magnesium. According to WHO and ECR standards, the acceptable limit of total hardness is 300 mg/l and 200-500 mg/l respectively. In present study area, total hardness was ranged from 172 to 200 mg/l (Table 1). These results clear, that hardness of water was according to standard values (Table 2) and it was not harmful for local inhabitants. Temporary hardness can be removed by boiling and the lowest value (30 mg/l) was detected in Station-1 and highest (100 mg/l) value was in Station-4 while the rest of other values were 42, 84 and 82 mg/l in Station-2, Station-3 and Station-5 respectively. Permanent hardness cannot be removed by heating and these values are shown in Table 1.

Total alkalinity: Alkalinity is the presence of one or more ions in water including hydroxides, carbonates and bicarbonates. It can be defined as the capacity to neutralize acid. Moderate concentration of alkalinity is desirable in most water supplies to stable the corrosive effects of acidity. However, excessive quantities may cause a number of problems. The WHO and ECR standards tell the alkalinity only in terms of total dissolved solids (TDS) of 500 mg/l. In study area, results show that alkalinity was varied from 91-192 mg/l (Table 1). Thus, these values were under the permissible limit of WHO and ECR standards (Table 2) and may not caused health related problems.

Table 2. Comparison of physicochemical parameters of drinking water of MBSTU campus with standards

Parameters	Present Study	Standards	
		WHO (2006)	ECR (1997)
Temperature (°C)	29.4	-	20-30
pH	7.3	6.5-8.5	6.5-8.5
EC (µs/cm)	377	500-1000	1000
TDS (mg/l)	299	1000	1000
DO (mg/l)	6.5	5.0	6.0
Turbidity (ntu)	8.28	5-10	10
Total hardness (mg/l)	185	300	200-500
Total alkalinity (mg/l)	143	500	500
Chloride (mg/l)	14.4	250	600
AgCl (mg/l)	166	-	-

Chloride (Cl^-): According to WHO standards, concentration of chloride should not exceed 250 mg/l but according to ECR standards, should not exceeded 600 mg/l. In study area the chloride concentration was ranged from 13.1 to 15.6 mg/l with average value of 14.4 mg/l. Thus, all the samples had lower concentration of chloride compared to standards (Table 2).

The Water Quality Index (WQI) of MBSTU drinking water is shown in Table 3 and the WQI value of MBSTU drinking water was found 71.26 and the WQI is indicating that the MBSTU water was fair.

Table 3. Data for the MBSTU Water Quality Index

Parameters	**Average value**	**Q value (Q_i)**	**Weight factor (W_i)**	**Parameter index ($W_i \times Q_i$)**
Temperature (°C)	29.4	8.82	0.10	0.88
pH	7.3	92	0.11	10.12
TDS (mg/l)	299	58	0.07	4.06
DO (mg/l)	6.5	95	0.17	16.15
Turbidity (ntu)	8.28	82	0.08	6.56
Totals			$\sum W_i = 0.53$	$\sum W_i \times Q_i = 37.77$
Water quality index (WQI):				$\frac{\sum W_i \times Q_i}{\sum W_i} = \frac{37.77}{0.53}$ = 71.26
Quality rating				Fair

Conclusion

In this study characterization of the physicochemical parameters of ground water from five tube wells at different Stations in MBSTU campus area was carried out. To assess the quality of drinking water each parameter was compared with the standard desirable limits prescribed by World Health Organization (WHO, 2006) and Environment Conservation Rules (ECR, 1997). All the measured physicochemical parameters of water of MBSTU campus were in acceptable limits prescribed by the WHO and ECR. Finally, from this research it can conclude that the drinking water sources of MBSTU are not polluted and these sources are suitable for drinking and other purposes from the point of view of levels of temperature, pH, EC, TDS, DO, turbidity, total hardness, total alkalinity and chloride concentration. The Water Quality Index also indicates that the quality of MBSTU campus water was fair for drinking. Although we could not able to measure the heavy metals (As, Pb, Cd etc.) concentration in drinking water of study area due to insufficient laboratory facility but we thought that the probability of presence of heavy metals was very poor, since there was no industry or heavy metal sources near study area. So, it is suggested to carry out further research to find out the heavy metal concentrations in drinking water of MBSTU campus.

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