Water Quality in Different Tea Estates in the Northern Part of Tezpur city

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Abstract

In the present work, water samples were collected from different points of Tea gardens in northern part of Tezpur city for water quality assessment. Analysis of the collected samples was determined using the respective calibrated analytical instruments to identify the highly correlated and interrelated water quality parameters which are required for safe human consumption and other domestic uses. Physio-chemical parameters such as pH, Salinity, Electrical Conductivity, Iron, Fluoride, Nitrate, TDS, DO, Resistivity, Total Hardness, and Turbidity of all the samples were determined. Out of the collected samples, pH of almost all of the samples found to be less than the prescribed limit (IS 10500:2012), Turbidity of almost all samples found to be more than the prescribed limit, iron concentration is recorded between 0.08 to 3.28 mg/L. No fluoride above the desirable limit is detected. Three of the water samples found to contain coliform bacteria. Nitrate is detected in low concentration. All other parameters analyzed were found to be within the limit.

Keywords: Environmental; Nitrate; Iron; pH; Turbidity; Bacteriological

Introduction

Water is one of the vital components on earth. Water has a unique property of dissolving and carrying in suspension a huge variety of chemicals and hence water can easily get contaminated. About two third of the drinking water requirement is obtained from sources like tap water, well water, hand pump etc. Water pollution caused by the use of pesticides and chemical fertilizer in agriculture and the untreated effluents coming from the industries are poisoning the water bodies everywhere [1-3]. India is currently facing critical water supply and drinking water quality problems. Water supplies in India are no longer unlimited. In many parts of the country, water supplies are threatened by contamination and future water supplies are uncertain. Although there is evidence of prevailing contamination of water resources in many areas of India but information about drinking water in north east India is very little. Available literature shows that groundwater in Assam are highly contaminated with iron [4]. High level of fluoride distribution in groundwater sources of certain districts of Assam has also been observed [5]. The elevated lead, iron, fluoride and nitrate level in drinking water near tea gardens is a new public concern in Assam because of chemical pesticides in use [6].

A critical step in assuring the quality of drinking water resources is to identify the cause of current or potential contamination problems. Testing of water quality on a regular basis is, therefore, an important part of maintaining a safe and reliable source [7]. The guideline values, along with tolerance limits prescribed by the Bureau of Indian Standard [8] are important in determining water quality. If the people continue to use contaminated water, many side effects may occur in their health. The efforts are much less than needed to mitigate the crisis. Hence immediate action must be taken by the research community and save the poor people. People of the villages in and around the tea estate areas of Sonitpur district are below poverty line, the provision of safe drinking water is one of the prior conditions for overall social development. Tezpur city is surrounded by different tea gardens. The present investigation has been carried out to study the drinking water quality with respect to fluoride, nitrate, iron and physical parameters in and around some tea gardens north of Tezpur city, Sonitpur district, Assam to help users at the national or local level to establish which chemicals in a particular setting should be given priority to developing strategies for risk. Another aspect in water quality analysis is the detection of any harmful bacteria that are health hazard to the body.

Bacteria are known to survive in water bodies like pond, shallow dug well and more commonly in surface water. Depending upon the source of water like if the drinking water source is near the drain, or near an unhygienic place the source might get contaminated. Thus to ascertain the portability of water one needs the water to be analyzed properly in order to detect the presence of any bacteria or other potential harmful microbes. The present work is intended to provide information on the water quality of different Tea Estates in and around Tezpur city by analyzing the different Physio-chemical and bacteriological parameters.

Experimental

Materials and Methods

All sample containers (amber PVC) were thoroughly washed and dried. The bottles were rinsed and filled with sample of water at the time of collection. For bacteria samples all the containers were autoclaved and sterilized before collection. The water samples for bacteria are kept in an ice box (to avoid the cross contamination) while on the way to the laboratory for analysis. Each sample was taken for physical, chemical and bacteriological analyses. Proper labelling was done during the time of sample collection.

The temperature was measured at the sampling site using thermometer. During the sample collection the entire sampling site along with the source were recorded. The sampling location map made by Google earth pro is shown in **FIG. 1.**

FIG. 1**. Map showing the collected water samples from different locations of tea estate**

Analysis of turbidity, pH, TDS, EC, salinity, Resistivity, total hardness, DO, fluoride, Iron, Nitrate done as per standard procedure used for water analysis (APHA, 2005). Salinity, TDS, Conductivity, Resistivity were measured by multipara meter (EuTech CD650). Turbidity was measured by using turbidity meter (EuTech TN100), Total hardness measured by complex metric titration using Erichrome Black–T as indicator (EDTA method). Iron was estimated by colorimetric method using UV-Vis spectrophotometer at 510nm (Analytik Jena SPECORD 205). Fluoride was measured by ion meter (Thermo scientific ORION 4 STAR) using Orion combined fluoride selective electrode. Cadmium, lead, copper were analyzed using 797 VA computrace (Metrohm) in differential pulse mode. All chemicals used are of AR grade reagents. Type 1 water with resistivity of 18MΩ (ELGA make, Model DV25) and calibrated borosil glass wares were used throughout for preparation of solutions.

The bacteriological analysis was done by pipetting out 20 ml of sample from sterilized tube in to Bacteriological tube (H2S strip method) using DRDO Water Testing Field Kit. The kit is used to determine whether coliform bacteria are present or absent in the collected water.

Results and Discussion

The collected sampling locations along with the information data are given in **TABLE 1**. The areas of sampling collection are situated in the northern and eastern part of Tezpur city. **TABLE 2** and **TABLE 3** represents the physico-chemical parameters of water quality of the collected samples. Different parameters are discussed as follows:

TABLE 1. **Sampling sites and sources of collected water from different tea gardens.**

Code No.	Water Source
A1.	Tezpur and Gogra Tea garden (Tap water)
A 2.	Durrung Tea Garden (Well water)
A 3.	Mahatma Gandhi M.E. School,Nagapathar (Hand pump)
A 4.	Nagapathar railway crossing point (Hand pump)
A 5.	Nagapathar (well water)
A 6.	Nagapathar (Hand pump)
A 7.	Thakurbari (hand pump)
A 8.	Rangapara-Balipara railway crossing point (near Nahorani Tea Estate) (hand pump)
A 9.	Hatibari bus stop (Nahorani Tea Estate) (hand pump)
A 10.	Railway Crossing Nahorani Tea Estate (hand pump)
A 11	Amaribari (well water)
A 12	Pholbari Tea Estate (Tap water)
A 13	Amaribari railway crossing (Adabari Tea Estate) (hand pump)
A 14	Khelmati, Adabari L.P. school (Tap water)
A 15	Khelmati market (well water)

TABLE 2. **Physical Parameters of the collected samples.**

S.no. (A1-A15)	pH	Conductivity (µs/cm)	TDS (mg/L)	Turbidity (NTU)	Salinity (mg/L)	Total hardness (mg/L)	DO (mg/L)	NO$_3$ (mg/L)	F$^-$ (mg/L)
1.	6.56	130.3	129.3	3.07	125.3	60	6.66	Tr	0.216
2.	6.49	204.3	202.8	10.42	195.9	75	5.47	Tr	0.029
3.	6.12	106.9	106.3	16.22	103.4	60	4.30	Tr	0.132
4.	5.97	80.24	79.74	47.20	79.21	30	5.83	20	0.091
5.	6.29	171.6	170.3	76.10	164.7	75	5.27	20	0.141
6.	5.97	104.1	103.5	188.0	101.2	60	3.71	20	0.134
7.	6.37	119.0	118.1	45.6	114.9	60	3.64	Tr	0.149
8.	6.22	77.57	77.08	125.0	76.63	45	6.09	Tr	0.095
9.	5.60	296.6	294.6	3.01	287.4	75	5.56	Tr	0.489
10.	6.23	148.8	147.4	59.0	143.3	75	4.61	Tr	0.080
11.	6.36	246.1	243.8	1.86	238.2	105	6.06	20	0.032
12.	6.24	95.59	94.89	40.5	93.68	45	5.83	Tr	0.078
13.	6.39	141.6	140.2	28.5	136.8	90	6.22	Tr	0.131
14.	6.27	206.4	205.1	4.45	199.8	90	6.49	10	0.172
15.	6.37	267.5	265.4	50.4	260.6	105	4.40	20	0.131

TABLE 3. **Selected heavy elements analysis of collected water with some.**

Sample No./Code	Fe (mg/L)	As (µg/L)	Cd (mg/L)	Cu (mg/L)	Pb (mg/L)
A1.	Tr	Tr	Tr	Tr	Tr
A2.	Tr	Tr	Tr	Tr	Tr
A3.	Tr	Tr	Tr	Tr	Tr
A4.	1.58	Tr	Tr	Tr	Tr
A5.	0.44	Tr	Tr	Tr	Tr
A6.	3.28	Tr	Tr	Tr	Tr
A7.	0.10	Tr	Tr	Tr	Tr
A8.	2.41	Tr	Tr	Tr	Tr
A9.	0.67	Tr	Tr	Tr	Tr
A10.	0.69	Tr	Tr	Tr	Tr

A11	Tr	Tr	Tr	Tr	Tr
A12	0.58	Tr	Tr	Tr	Tr
A13	0.08	Tr	Tr	Tr	Tr
A14	Tr	Tr	Tr	Tr	Tr
A15	2.49	Tr	Tr	Tr	Tr

pH

pH is one of the important parameters for water quality. pH scale below 7 is acidic, above 7 is alkaline in nature. It is the measure of the hydrogen ion concentration. All the pH recorded are acidic in nature. Except sample A1, all pH of the samples is found to be below the desirable limit.

Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) are the total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water, expressed in units of mg per unit volume of water (mg/L). The TDS of all the samples are found to be within the desirable limit.

Turbidity

Turbidity is the cloudiness or haziness of water or solution. Its unit is nephelometric turbidity units (NTU). Turbidity measured of the samples are found to be high. The turbidity ranges between 1.86-188 ntu. the high turbidity is recorded and are arranged in the highest to lowest order as A6>A8>A5>A10>A15>A7>A4>A12>A13>A3>A2>A14>A1>A9>A11 respectively.

Total Hardness

Total hardness is a measurement of the mineral content in a water sample that is irreversible by boiling. Total hardness of all the samples found to be within the prescribed limit. All other physical studies namely electrical conductance, salinity, dissolved oxygen, etc are found to be in the acceptable ranges

Nitrate

Nitrate is one of the health hazard compounds found mainly in the water bodies of the agricultural land due to chemical fertilizers. Blue baby syndrome is due to nitrate consumption from contaminated water and other sources. **TABLE. 2,** represent the analysis of nitrate in the collected samples. The Sample number A4, A5, A6, A11, A14 and A15 shows the presence of nitrate below 20 mg/L which is within the desirable limit for nitrate. This also indicates that the effect of chemical fertilizer is very much present in the water bodies of the area. Hence, regular analysis of water is essential to check the concentration of nitrate.

Iron

Another important elemental analysis of water quality is the iron. Presence of Iron beyond the prescribed limit [WHO/BIS] may lead to many health complications [9]. The maximum iron concentration of the water samples found to be 2.49mg/L. Except for sample codes A1, A2, A3, A11 and A14 all other samples found to contain iron above the prescribed limit as shown in **TABLE 3**.

Fluoride

Fluoride is another parameter worth investigating Fluoride at low concentration is beneficial to health but higher dose of fluoride is detrimental to health which may lead to dental and skeletal fluorosis [10,11] . In order to investigate the presence of fluoride due to pesticides and other additives to the gardens, we measure the fluoride concentration of the entire sample. But the results showed that there is no fluoride contamination in the water bodies of the samples under surveyed.

Correlation Study

The correlation of pH with different parameters was investigated and is shown in **FIG. 2.** It was observed that there is sharp negative correlation between pH and iron. This is expected as with increasing pH, the soluble ferrous ions slowly get converted to insoluble ferric state and the case is reversed with decreasing pH **FIG. 2(a).** The trends are found to be similar in the correlation of pH with TDS, Turbidity, salinity, electrical conductivity **FIG. 2(b) to 2(e).** In the case of total hardness there is slightly a positive correlation with pH **FIG. 2(f)** This may be due to increase in hardness of water because of iron precipitation some of the ions contributed to hardness of water increases. Since the concentration of fluoride, nitrate, Cd, Cu, As, and Pb detection level in the sampled water found to be very low, hence no correlation has been made.

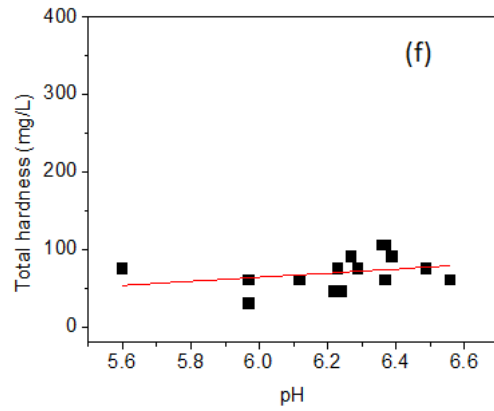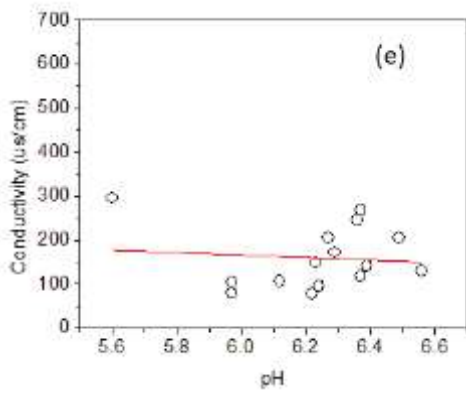FIG. 2**. Showing the correlation between pH with different parameters.**
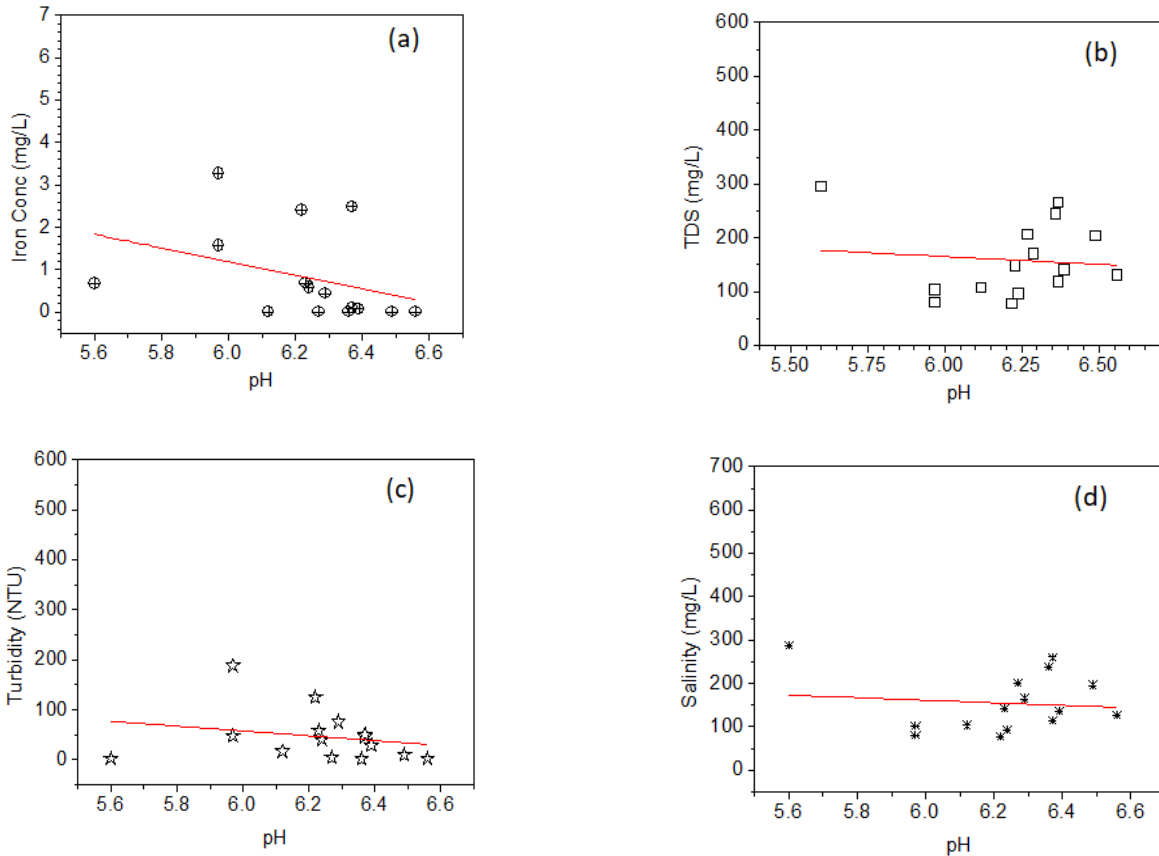
FIG 3. **(a) Water sample for coliform bacteria before incubation (Using DRDO Water Testing Kit)**
(b) Water sample after 24 hours of Incubation.

3(a)

3(b)

Bacteriological Studies

The preliminary investigation on the presence of coliform bacteria was performed using the DRDO Water Testing Kit based on H_2S paper strips. In absence of any coliform bacteria there is no change in the colour of the water samples. When coliform bacteria is present the water solution turns brackish black in colour. The incubation period of 24 hours was observed. Three of the samples were found to be contaminated with coliform bacteria. These samples are A11, A14 and A 15 respectively. The detected sample sources are well water and tap water source. **FIG. 3(a)** showed the testing results before incubation period and after incubation period at 37°C as shown in **FIG. 3(b).**

Conclusion

From the studies conducted, it reveals that the pH of almost all of the samples is acidic in nature and the values found to be less than the prescribed limit. Turbidity is another parameter found to be more than the permissible limit with the highest value being recorded from 10.42 NTU to 188 NTU. Iron concentration is recorded between 0.08 to 3.28 mg/L. Fluoride ions are not detected in the collected water. All other parameters analyzed were found to be within the prescribed limit. Negative correlation observed between pH and iron, TDS, EC, Turbidity, salinity and positive correlation of pH with total hardness. Presence of nitrate though in low concentration is alarming which needs to be monitored regularly. Three of the samples found

to be contaminated with coliform bacteria. Information was given to the concern with the advice to properly treat the water for bacterial sterilization by boiling before consumption.

Acknowledgement

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