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Research Article

ASSESMENT OF GROUNDWATER QUALITY OF KOKRAJHAR TOWN OF ASSAM IN TERMS OF SOME PHYSICO-CHEMICAL PARAMETERS

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ABSTRACT

Industrial, municipal, household and agricultural wastes as well as various man made activities decides the quality of potable drinking water. The quality of water is thus anticipated to change from place to place and time to time. Any change in equilibrium system of water quality parameters makes water viperous for drinking and other domestic, agricultural and other uses. The present investigation is undertaken to assess the quality of water in terms of some physico-chemical parameters of the collected water samples from twenty different sites of Kokrajhar Town, Assam, India and to justify whether it is up to snuff for drinking purpose or not by comparing with the standard desirable limit prescribed by different agencies. A systematic calculation was made to determine the Pearson's correlation coefficient 'r' amongst the different parameters and the significant values of the observed correlation coefficient between the parameters were also worked out. The experiment revealed that the water samples collected from various sites of Kokrajhar Town were safe for drinking, bathing as well as other domestic uses, however, water quality should be tested time to time and check the seasonal variations.

INTRODUCTION

"No Water No life" is a common saying. Life emanated in water and it is prerequisite for all forms of life inclusive of the simplest plant and micro organism to the complex living system such as human body (Adhena et al.)[1]. Water is an inimitable chemical and is strenuous system that contains living as well as non living, organic, inorganic substances. The quality of groundwater rely on some diversified chemical constituents and their concentrations (Gupta *et al*., 2009) [2] which are mostly dissolve in water from soil particles, sediments and rocks when water flows through the hill streams and the surface (Werkneh *et al*., 2015) [3]. Industrial, municipal and agricultural wastes as well as various man made activities also decides the fate of drinking water. It is for these reasons that the quality of water is anticipated to change from place to place and time to time. Any change in equilibrium system of water quality parameters makes water viperous for drinking and other domestic, agricultural and other uses. It is therefore imminent that the quality of drinking water should be monitored periodically (Ushie *et al*., 2008) [4]. In this work, drinking water quality in terms of some the physico-chemical parameters was studied at Kokrajhar Town, Assam, India. The main aim of this study was to analyze the different physco-chemical parameters of water samples collected from twenty different sites of Kokrajhar Town and to justify whether it is up to snuff for drinking purpose or not. The major water quality parameters considered for examination in this study are pH, temperature, Electrical conductivity (EC), Total Dissolved solids (TDS), Dissolved Oxygen (DO), Alkalinity, Ca-Hardness (CH), Total hardness (TH), Phosphate, Iron, Chloride, Fluoride and Arsenic.

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Sampling area

Kokrajhar is located at 26.4°N
90.27°E It has an average elevation of 38 metres (124 feet). According to 2011 India census, Kokrajhar had a population of about 34,136. The climate of the region is sub-tropical in nature with warm and humid summer and followed by cool and dry winter. Average temperature in summer is 27.64 - 31.67 ^{0}C and average winter 19.34-23.66^{0}C.

Sampling and Preservation

We have collected Drinking Water samples from twenty randomly selected area of Kokrajhar Town from different sources such as Borewells, Tubewells and Wells available in a particular site in the month of March, 2016. Samples were collected in 500 mL polyethylene bottles. The bottles were previous washed and soaked overnight with 5% HNO_3 solution (Rao *et al*., 2004) [5] and then rinsed several times with the samples at the time of sampling to avoid any type of contamination during sampling. The temperature of each samples were determined on the spot by Thermometer.

Samples were then brought to laboratory and the pH and Electrical conductivity were measured and kept at 4°C for further analysis.

MATERIALS AND METHODS

The pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Dissolved Oxygen (DO) were determined by Digital Water Testing Kit Model, No 161 (Electronics India). Alkalinity, Ca-Hardness, Total hardness, Phosphate, Iron, Chloride, Fluoride and Arsenic were measured by some ISO 9001: 2008 Certified Water Testing Kits and manual available therein.

All chemical were of analytical grade. Double distilled water were used to prepare all required solutions. The instruments were caliberated prior to use.

Measurement of alkalinity

25ml of water sample was taken in the test bottle (No-1) and 5 drops of Total Alkalinity Reagent-2 (TA-2) was added and mixed until an orange yellow colour develops. Total Alkalinity Reagent-1(TA-1) was then added dropwwase and shaked well after each drop until the colour changes from orange yellow to orange red. The no. of drops of TA-1 required for colour change was noted

Total Alkalinity = Number of drops × 5 (p.p.m. interms of $CaCO_3$)

Measurement of Calcium Hardness

25ml of water sample was taken in the test bottle (No-1). 10 drops of Calcium hardness reagent-2(CH-2) was added and mixed followed by 10 drops of Calcium Hardness reagent-3(CH-3). Few specs of Calcium Hardness-1(CH-1) was added and mixed until a dwastinct pink colour develops. For Hard / Soft water, Calcium Hardness reagent-4(CH-4) was added. Shake well after each drop untilmthe colour changes from pink to purple. The no. of drops of CH-4 required for colour change was counted.
Calcium Hardness = Number of drops × 5 (p.p.m. interms of $CaCO_3$)

Measurement of Total Hardness

25ml of water sample was taken in the test bottle (No-1). 10 drops of Total Hardness reagent-2(TH-2) was added and mixed. Few specs of Total Hardness reagent-1(TH-1) was added and mixed until a dwastinct pink colour develops. For Hard water, Total Hardness reagent-3(TH-3), shaked well after each drop until the colour changes from pink to blue. The no. of drops of TH-3 required for colour change was counted. For Soft water, Total Hardness reagent-4(TH-4) and was shaked well after each drop until the colour changes from pink to blue. The no. of drops of TH-4 required for colour change was counted.

Total Hardness = Number of drops × 2 (p.p.m. interms of $CaCO_3$)

Measurement of Iron

5ml of water sample was taken in the test tube. 5 drops of Iron reagent-1 (Fe-1) and 1 drop of Iron reagent-2 (Fe-2) was added. The solution was mixed and 5 drops of Iron reagent-3 (Fe-3) was added. The contents was mixed and waited for 2-3 minutes for colour to develop. The colour that form was compared with Iron Colour Chart and the Iron Value was recoreded.

Measurement of chloride

20 drops of water sample was taken in a clean and dry test tube and 1 drop of $NaOH/H_2SO_4$ was added to bring the pH of the solution to 7-10. 2 drops of Potassium Chromate solution indicator was added to it. Now standard *0.0282N* $AgNO_3$ solution was added by a pipette till the colour of the solution becomes permanent red.

Calculation:-
Volume of $AgNO_3$ solution= V_1
Volume of water=V_2
Strength of $AgNO_3$ solution,N_1 = 0.02282N
Amount of Chloride in water = $V_1 \times N_1 \times 35.45 \times 1000/ V_2$

Measurement of Fluoride

Seven test tubes are taken and numbered them from 1 to 7. Now by a pipette 20, 19, 18, 17, 16, 15 and 14 drops of distilled water was taken in each test tubes respectively. Now 0, 1, 2, 3, 4, 5 and 6 drops of standard NaF solution was added in each test tubes. The pipette was washed with sample water and 20 drops of sample water was taken in another test tube. In each test tube 1 drop of Sodium Arsenide solution was added. Now 1 drop of Acid Zirconium Alizarin solution was added in all test tubes. The test tubes are shaken and waited for some time to get a colour. The colour of the solution containing sample water was compared with the colour of the solution in the seven test tubes. By comparison with colour the amount of fluoride present in the water sample was determined from the standard known amount of Fluoride solution.

Measurement of Arsenic

50ml of water sample was taken in the wide mouthed bottle. 1gm of Arsenic Reagent-1 (As-1) was added and 10gm of Arsenic Reagent-2(As-2) followed by 10ml of Arsenic Reagent-3(As-3). The glass tube was filled with Mercuric chloride paper and Lead acetate wool was placed in position. The apparatus was kept in a water bath at a temperature of 60°C for about 40 minutes. The Mercuric Chloride paper was taken carefully from the apparatus and stain produced was compared with the Arsenic colour chart immediately and the Arsenic value was recorded.

RESULT AND DISCUSSION

The result of the analysis is shown in Table-1.

Temperature: Temperature is an important factor that instigate various parameters such as EC, alkalinity etc. The maximum temperature 28^0C was recorded at Main Bazar while minimum 20^0C was recorder at Chandatolla. The higher value of temperature in few sampling stations may indicate arrival of early summer in this region.

pH: pH is the negative logarithm of hydrogen ion concentration which is the measure of acidic or basic character of water. The pH of groundwater is controlled by carbonate equilibrium involving CO_2, carbonic acid, bicarbonate and carbonate anions. The variation of pH in different sampling sites (figure-2) shows pH value in agreement with the guideline limits.

Table 1 Physicochemical parameters at different sampling sites

S. No	Area	Source	Temp. ^{0}C	pH	Conductivity (µS/cm) At 25^{0}C	TDS (ppm)	DO (mg/l)	Alkalinity (ppm)	Hardness (ppm)	Ca-Hardness (ppm)	Fe (ppm)	Cl (ppm)	F (ppm)	As (ppm)
S-1	W.No-10	Well	23	7.0	147.5	80.1	11.2	50	44	40	0.18	99.26	ND	ND
S-2	Jampai Barnai	Tube Well	26	7.2	345	148.3	7	65	54	50	0.18	148.8	ND	ND
S-3	Hatimata	Well	24	7.0	165.2	96.7	9.4	65	44	40	0.27	99.26	ND	ND
S-4	Santi Nagar	Tube Well	26	7.4	180.5	107.2	8.2	45	46	45	0.18	99.26	ND	ND
S-5	Bhatarmari	Tube Well	26	7.5	130.5	71.8	5.5	85	56	35	0.18	148.8	ND	ND
S-6	Narabari	Tube Well	25	6.8	322.4	138.2	7.4	90	82	75	0.18	99.26	ND	ND
S-7	Titaguri	Tube Well	22	7.0	341.8	147.2	10.2	130	106	95	0.18	198.5	ND	ND
S-8	Main Bazar	Tube Well	28	6.6	374	180	12.5	150	102	85	0.27	99.26	ND	ND
S-9	Chandatolla	Tube Well	20	6.6	376	180.9	8.5	100	76	12	0.18	148.8	ND	ND
S-10	Bhabanipur	Tube Well	25	7.0	276	56.7	10.5	35	44	15	0.18	148.8	ND	ND
S-11	Santi Nagar	Bore Well	21	6.8	298	159.7	10.2	75	62	35	0.27	149.95	ND	ND
S-12	Jail Colony	Bore Well	21	7.0	176.6	103.9	12	60	54	40	0.18	149.95	ND	ND
S-13	Bank Colony	Bore Well	23	6.8	157.2	90.5	9	100	46	35	0.18	99.96	ND	ND
S-14	Gaurang Nagar	Bore Well	20	6.8	159.8	91.3	7.8	125	50	40	0.18	99.96	ND	ND
S-15	Bhatarmari	Bore Well	21	7.0	174.4	103.5	7.5	135	68	45	0.18	99.96	ND	ND
S-16	Suvaspally	Bore Well	20	7.2	186.6	109.5	9.2	110	54	45	0.27	149.95	ND	ND
S-17	Bagansali	Tube Well	21	7.0	94.6	56.9	6.2	65	30	50	0.18	199.93	ND	ND
S-18	Tengapara	Tube Well	20	7.6	166.2	98.7	5.5	65	50	40	0.18	149.95	ND	ND
S-19	Kodomtola	Tube Well	20	6.8	135.8	79.5	11.6	55	40	25	0.27	149.95	ND	ND
S-20	Sudempuri	Well	20	7.5	248	143.5	6.7	110	84	75	0.18	149.95	ND	ND

ND= Not Detected

Table 2 Pearson's correlation for various groundwater variable parameters

		pH	Cond.	TDS	DO	Alkalinity	Hardness	Ca-H	Fe	Cl	Temp.
pH	Pearson Corr.	1	-0.36286	-0.32787	-0.59257	-0.28037	-0.20225	0.06372	-0.306	2.16E-01	0.00278
	Sig.		0.11585	0.15818	0.0059	0.23118	0.39248	0.78955	0.18949	0.36024	0.9907
Cond.	Pearson Corr.		1	0.9614	0.22026	0.3337	0.75131	0.35645	0.05977	0.07316	0.29903
	Sig.			1.57E-11	0.35074	0.15047	1.34E-04	0.12292	0.80234	0.7592	0.20028
TDS	Pearson Corr.			1	0.2432	0.38131	0.75572	0.31455	0.15619	0.01831	0.18685
	Sig.				3.02E-01	0.09715	1.16E-04	1.77E-01	0.51081	0.93893	0.43023
DO	Pearson Corr.				1	-0.02519	0.14896	0.00149	0.49366	-0.14281	0.09814
	Sig.					0.91605	0.53079	9.95E-01	0.02696	0.54808	0.68062
Alkalinity	Pearson Corr.					1	0.7211	0.55046	0.09441	-0.12192	-0.09758
	Sig.						3.34E-04	0.0119	0.69216	0.60861	0.68234
Hardness	Pearson Corr.						1	0.71446	0.02303	0.03972	0.15207
	Sig.							4.01E-04	0.92322	0.86795	0.52214
Ca-Hardness	Pearson Corr.							1	-0.00276	0.06023	0.24298
	Sig.								9.91E-01	0.80087	0.30195
Fe	Pearson Corr.								1	-0.08677	-3.33E-16
	Sig.									0.71606	1
Cl	Pearson Corr.									1	-0.36119
	Sig.										0.11767
Temp.	Pearson Corr.										1
	Sig.										

Electrical Conductivity (EC): EC is the ability of water to conduct electrical current. In water, EC is caused by the presence of various ionic species. EC also depends on the concentration and degree of ionization of the various solid substances involved (Navneet *et al.*, 2010) [6]. Conventionally the EC is reported in µS/cm at 25^{0}C as the ionization of the solutes depend on temperature. The EC is highly correlated with the TDS which measures the total dissolved minerals. The EC value ranged from 94 - 376 µS/cm at 25^{0}C as shown in figure-3. The result of EC were within the guideline limits.

Total Dissolved Solids (TDS): The TDS measures the total amount of dissolved minerals. Water with very high TDS value is a measure of highly mineralized water. According o (Sasikaran *et al.*) [7]. TDS of potable water should not cross 1000mg/L. Water having high value of TDS is harmful for people suffering from kidney and heart disease. The TDS value ranged from 71.8 – 148.3 mg/L as shown in figure-4. It is evident that none of the samples crossed the permissible limit of TDS.

Dissolved Oxygen: Adequate amount of dissolved oxygen is necessary for good water quality. The DO limit was 5.5 to 12.5 mg/L. Water with DO level below 5.0mg/L is harmful for aquatic life (Adakole, 2000) [8]. Higher level of DO makes drinking water taste better. However in excessive amount it can cause corrosion in water pipes.

Alkalanity: Alkalinity in groundwater arises due to the presence of carbonates and bicarbonates whose salts gets hydrolyzed in solution and produces hydroxyl ions (Yadav *et al*, 2013) [9]. It is one of the best measures of sensitivity of groundwater to acid inputs. According to (USEPA guidelines)[10], higher level of alkalinity can cause embrittlement of boiler steel and boiled rice turns yellowish. All the samples of the present study have alkalinity below the permissible limits.

Total Hardness: Hardness of groundwater is actually a qualitative parameter. It arises due to the mixing of some salts specially bicarbonates, carbonates and sulphates of Calcium and Magnesium with rainwater that flows through the earth's surface and enters groundwater. Total hardness is measured in terms of Ca and Mg dipositive ions (De, A.K., 2006) [11].

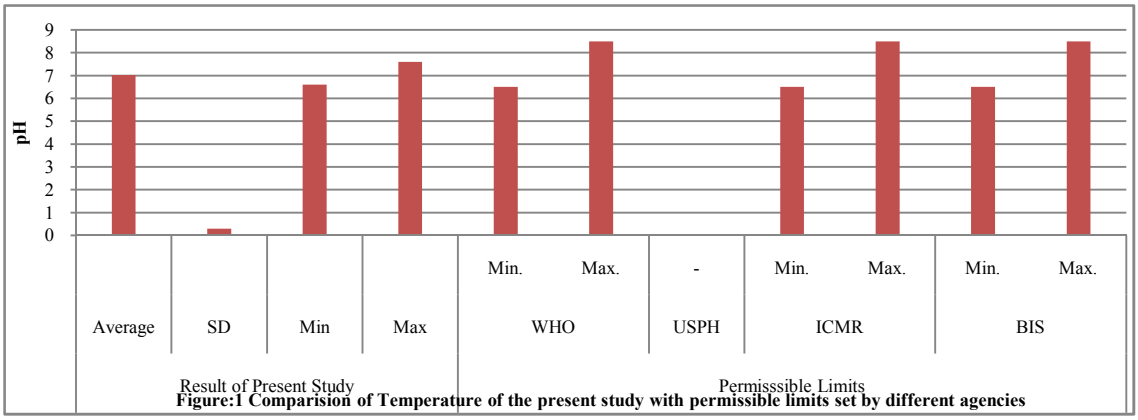

Figure:1 Comparision of Temperature of the present study with permissible limits set by different agencies

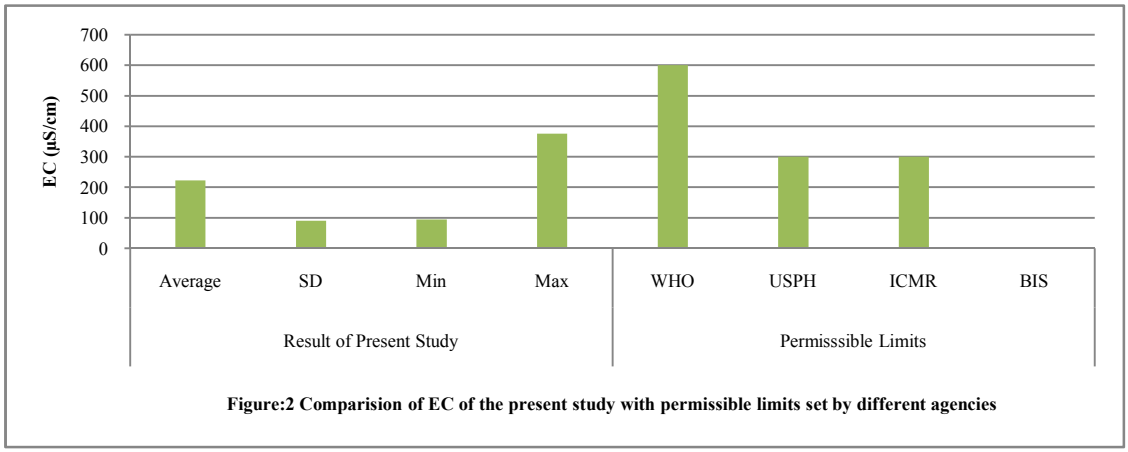

Figure:2 Comparision of EC of the present study with permissible limits set by different agencies

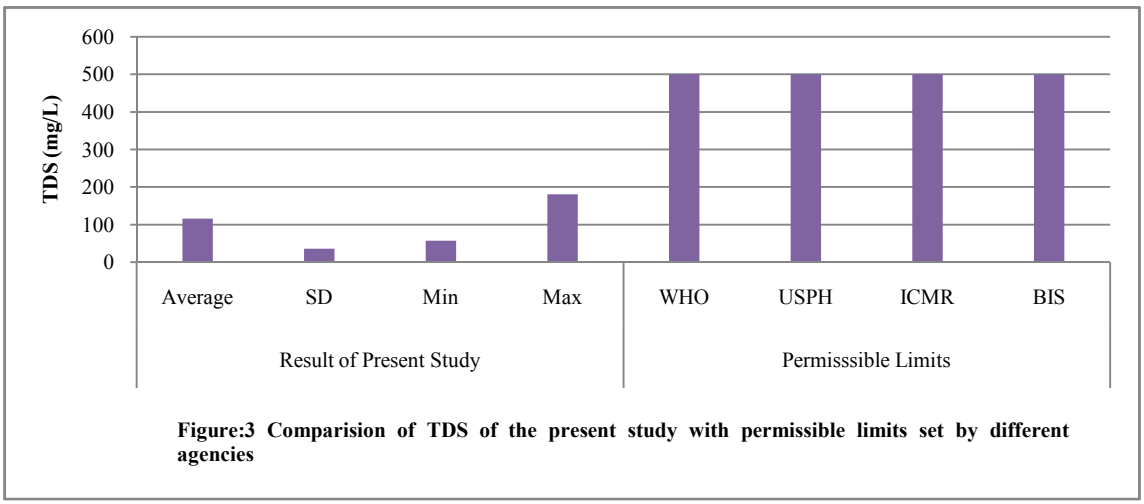

Figure:3 Comparision of TDS of the present study with permissible limits set by different agencies

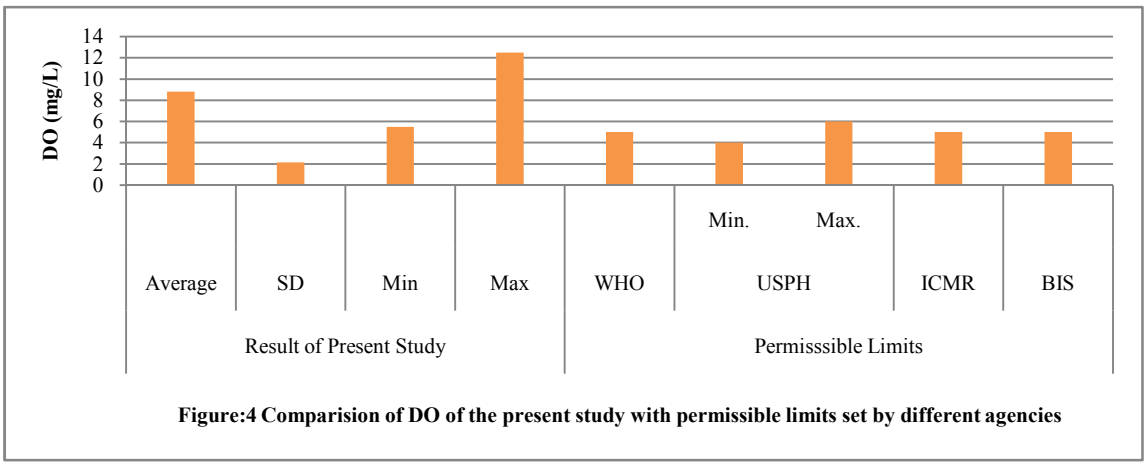

Figure:4 Comparision of DO of the present study with permissible limits set by different agencies

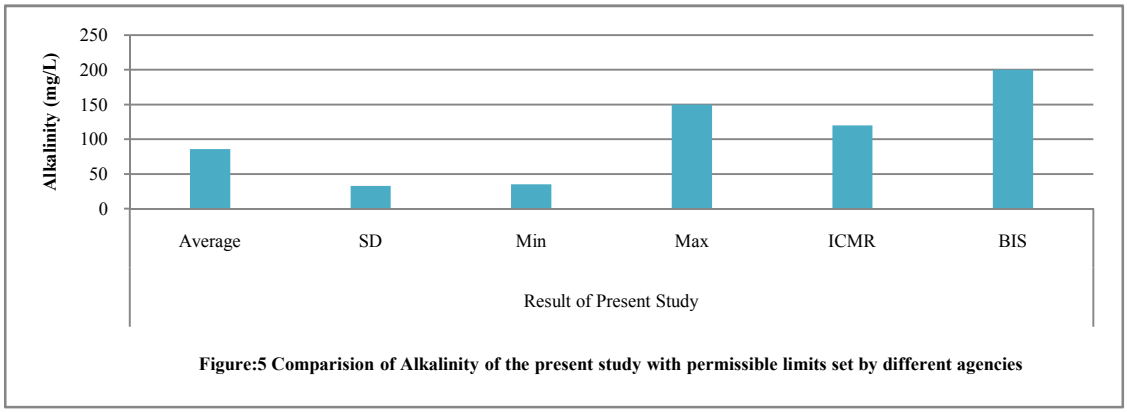

Figure:5 Comparision of Alkalinity of the present study with permissible limits set by different agencies

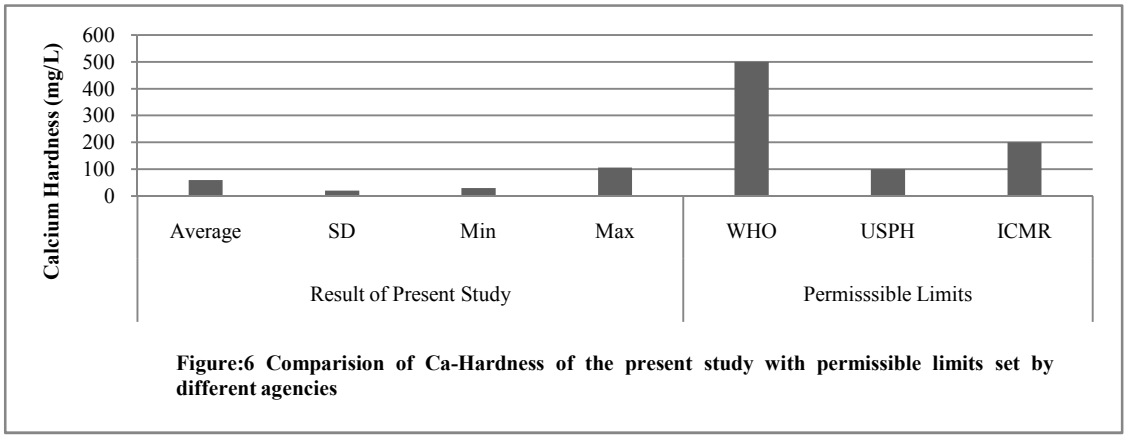

Figure:6 Comparision of Ca-Hardness of the present study with permissible limits set by different agencies

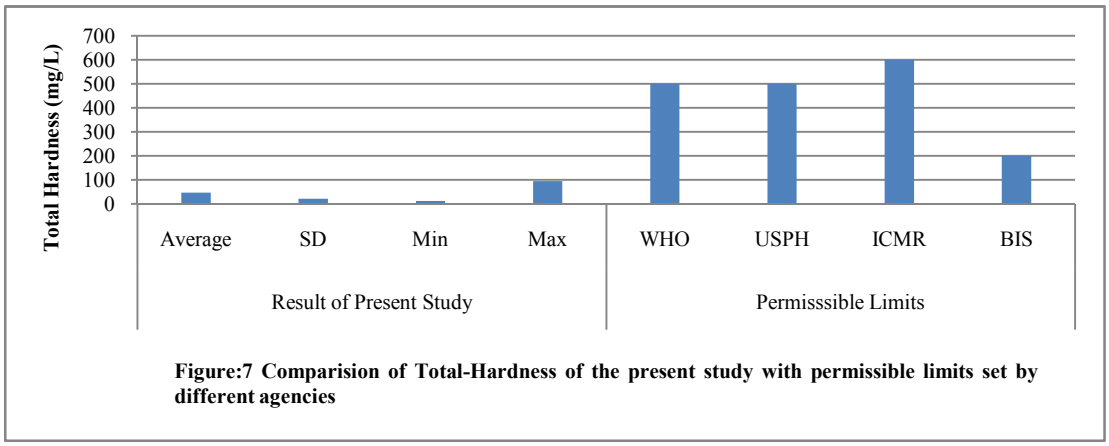

Figure:7 Comparision of Total-Hardness of the present study with permissible limits set by different agencies

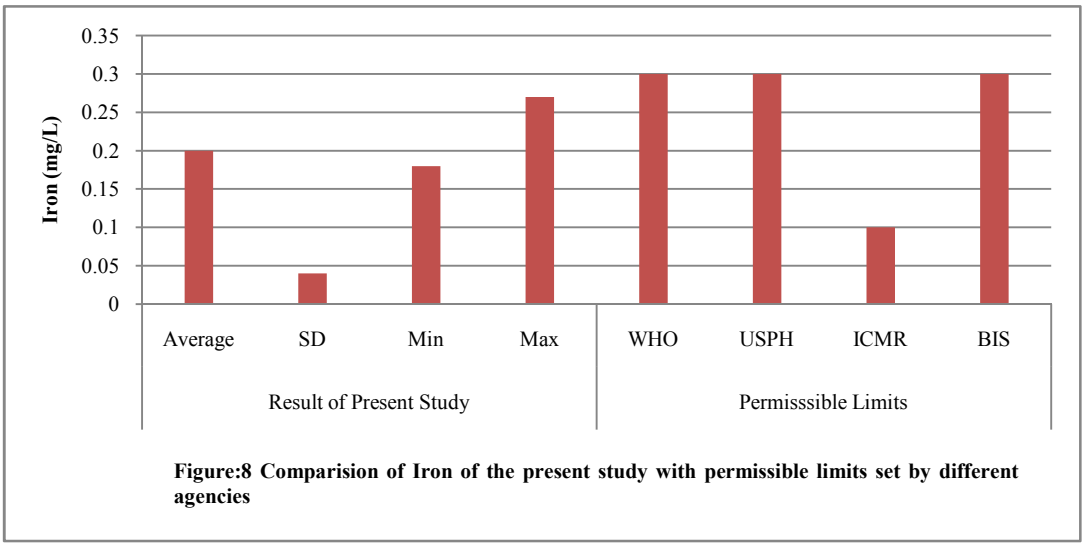

Figure:8 Comparision of Iron of the present study with permissible limits set by different agencies

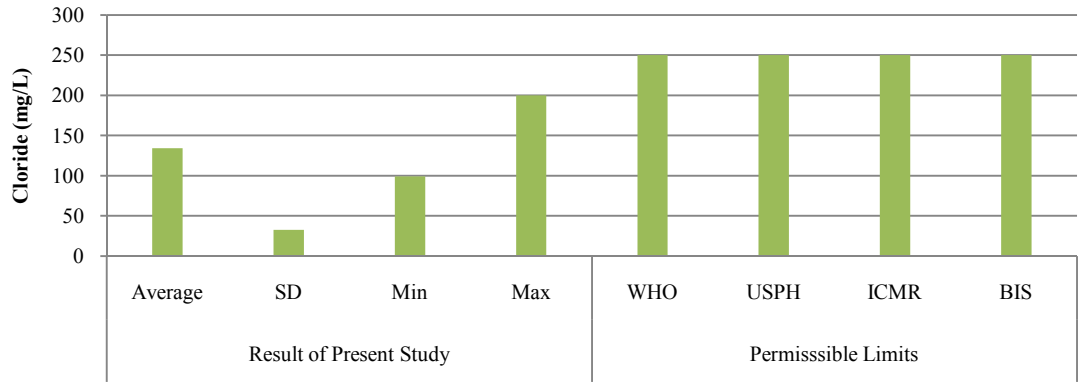

Figure:9 Comparision of Chloride of the present study with permissible limits set by different agencies

Hard water is responsible for poor lathering with soap, deterioration of the quality of clothes, scale forming (USEPA guidelines). The permissible range of hardness is 300 to 600 mg/L. Water having hardness above 64 mg/l is considered as hard water (Moyle *et al*, 1956) [12]. It is evident from the results in table-1 that the total hardness well below the permissible limit and water of only 30% sampling area can be considerd as slightly hard.

Ca-Hardness: Calcium hardness is measured in terms of the amount of carbonates, bicarbonates, and sulphates of Calcium. Minimum Ca-hardness was 12 mg/L and maximum obtained was obtained was 95 mg/L. According to (Sastry et a., 1998) [13] hard water plays a role in heart disease. The permissible limit of hardness in terms of Ca is 200-500 mg/L. The Ca-hardness level in all sampling stations were well within the permissible limit and can be considered as soft in terms of Ca-hardness..

Iron: Iron is easily available in all sources of water. Iron is essential mineral to all living bodies at a minimum level. Iron is mainly required to produce haemoglobin (Mader, 1993) [14]. But, if the concentration of iron is higher than the permissible limits then it imparts a bad odour to water and can cause hemochromatosis in human being, increases turbidity of water, corrodes water pipes and machines. In Assam, four districts viz. Barpeta, Darrang, Kamrup and Sonitpur, iron is found in the range 1 to 10 mg/L. The amount of iron present in all the sampling stations were within the permissible limit.

Chloride: Chlorides in water causes salted taste in water. It is only a qualitative parameter of groundwater. Chlorides generated from industrial wastes contaminates groundwater (R.Shyamala *et al*., 2008) [15] . The maximum permissible limit for chlorides is set to be about 250 mg/L by different agencies. Our study revealed that the level of chloride in all the sampling stations were below the maximum permissible limit.

Fluorides: An optimum level of fluorides in groundwater is essential for calcification of teeth enamel and bones. However if present in excessive amount (<1.5mg/L) in water, it causes skeletal and dental fluorosis, dysfunction in liver, kidney and other organs (McDonagh *et al*., 2000)[16] . It may also reduces milk production in lactating mothers and responsible for loss of apetite. We have not detected fluorides in the water samples in all the sampling stations of our study area.

Arsenic: Excessive amount of Arsenic in drinking water can cause liver and cardiovascular diseases. Intake of drinking water having excessive Inorganic Arsenic for a longer period of time may cause cancer in urinary bladder, kidney, skin and lungs (Hopenhayn, 2006) [17]. In Assam 20 out of 34 districts are affected by groundwater Arsenic poisoning . Many villages of Karbi Anglong, Nagaon, Kamrup and Sonitpur district of Assam are prone to Arsenic contamination in groundwater. Our study reveals that Arsenic was not detected in all the samplesof our study area.

Statistical analysis

The Pearson's correlation for various groundwater variable parameters are shown in table-2 From the data analysis, it is evident that distribution of TDS and TH is significantly (r>0.5) correlated with EC in most of the sampling stations. Positive correlation was found in 37 pairs (≈ 82%) and negative correlation was found in 8 pairs (≈ 18%) of parameters.

CONCLUSION

From the above experimentation it was revealed that all the selected physicochemical parameters of the entire water sample of the present study is well within permissible limits. The water samples collected from various sites of Kokrajhar Town were safe for drinking, bathing as well as other domestic uses. However, water quality should be tested time to time and check the seasonal variations and proper care should be taken for the maintenance of the water quality of the studied sampling sites.

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