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STUDIES ON THE GROUND WATER QUALITY OF KALOL CITY, GUJARAT, INDIA

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ABSTRACT

The present study deals with the ground water quality of Kalol, an industrial town of north Gujarat. The ground water quality was assessed by examining various physico-chemical and bacteriological characteristics. The borewell water samples were collected from north, south, east, west and central zone of Kalol during summer, winter and monsoon seasons. The physico-chemical and bacteriological parameters like temperature, pH, turbidity, EC, dissolved oxygen, free CO_2, total hardness, Ca and Mg hardness, TDS, total alkalinity, chloride, sulphate, nitrite, total iron, fluoride and MPN of coliforms have been analysed. Total alkalinity, TDS, Ca-hardness, sulphate, total iron, fluoride, and MPN count of coliforms were above the permissible limit prescribed by IS: 10500, 1991. All the water samples, collected from Kalol town, were rated as unacceptable for their taste on the basis of their total hardness values. The borewell samples collected from south, east and central cones exhibited MPN count above the desirable limit of 10 coliforms/100 mL. The ground water of Kalol town must be subjected to proper disinfection and defluoridation and well as to the treatment for controlling total dissolved solids and total hardness.

INTRODUCTION

The availability of water supply, adequate in terms of both quantity and quality, is essential to human existence. Groundwater and surface water resources as well as harvesting of rainwater are essential for sustained productivity. Groundwater is an invaluable commodity available in very limited quantity to man and other living beings. Most of Indian towns and cities do not have access to safe drinking water (Srinivas et al. 2000). Groundwater is a replenishable resource and is considered to be less polluted as compared to other inland water resources.

Groundwater is often preferred for drinking and cooking purposes with an assumption that it is pure and safer than surface waters. Therefore, above 70 percent of Indian population uses groundwater. The protection and management of groundwater quality has emerged as a great public concern in India. The quality of groundwater gets affected due to introduction of pollutants into it causing physical, chemical and biological changes. Rapid growth of urban areas has affected groundwater quality due to overexploitation of resources, improper waste disposal, lack of sanitation, lack of water source protection, faulty well construction and land disposal of urban solid wastes. 40 percent or more of the outbreaks of waterborne diseases were attributed to groundwater consumption (Narain Raj & Sharma 1995).

For effective maintenance of water quality through appropriate control measures, one needs continues monitoring of water quality. The quality of water is now the concern of scientists in all countries of the world. Gandhinagar district of north Gujarat region covers total area of 2163.48 sq. km. It includes 290 villages and 4 talukas with total population of 13,34,731. The average rain fall is around 26 cm. Gandhinagar is the main center of this district. It is capital of Gujarat state. Kalol is located 20 km from Gandhinagar. It is an industrial town with GIDC located at outskirts of the town

and at Chhatral village. A fertiliser factory, IFFCO, is located on Kalol-Ahmedabad highway. The total population of Kalol town is about 1,95,688.

In the present study, a detailed investigation was carried out to understand the quality of ground water of Kalol town taking physical, chemical and bacteriological parameters into consideration.

MATERIALS AND METHODS

Borewell water samples were collected in clean polythene carboy of 2 litres capacity. The water samples were collected from north, south, east, west and central zone during summer, monsoon and winter. The water samples were transported to the laboratory within 6 hours and pH, temperature, EC and dissolved oxygen were measured immediately. The water samples were stored in refrigerator to avoid any microbiological decomposition. The physico-chemical and bacteriological parameters were estimated in laboratory following the standard methods (APHA 1998, Maiti 2001).

RESULTS AND DISCUSSION

The data regarding physico-chemical and bacteriological analyses of drinking water samples, collected during the three seasons, from borewells are given in Table 1. The characteristics were examined in light of the IS: 10500 (BIS 1991) standards prescribed by BIS for potability of water. The BIS standard values are represented in Table 2.

All the drinking water samples were clear colourless and have unobjectionable odour. Temperature ranged from 30.0 to 34.0°C throughout the year. pH values ranged from 7.73 to 8.40 mg/L. Although comparatively higher pH values were observed during winter, the values never exceeded the desirable limit of pH 8.5. The DO values ranged from 2.02 to 5.85 mg/L. There is no standard for dissolved oxygen. Generally DO values of freshwater at one atmospheric pressure reaches 8 and 7 mg/L at the temperature of 25°C and 35°C respectively (Maiti 2001). It means that the DO values of groundwater of Kalol town were comparatively low. The hydroxide and carbonate ions were absent in all the water samples. Therefore, bicarbonate and free CO_2 were the major factors contributing to the total alkalinity. The total alkalinity values ranged from 404 to 646 mg/L and were within the permissible limit of 600 mg/L except for the bore well samples from north zone. In case of north zone, the water samples collected during summer, monsoon and winter showed total alkalinity values exceeding the permissible limit of 600 mg/L.

Generally, in groundwater the free CO_2 values range from 30 to 50 mg/L. In the present study, the free CO_2 values ranged from 18 to 380 mg/L. The high free CO_2 values were generally observed during summer months. This can be attributed to increased microbial activity and respiration rate during the summer. On the basis of TDS values all the samples collected from Kalol town were rated as unacceptable for their taste. TDS values ranged from 1320 to 3560 mg/L and even exceeded the permissible limit of 2000 mg/L usually in case of north, west and central zones.

On the basis of total hardness, the borewell samples, collected from Kalol town, were rated as hard (150 to 300 mg/L) and very hard (> 300 mg/L). The total hardness values ranged from 100 to 400 mg/L but never exceeded the permissible limit of 600 mg/L. Mg-hardness values ranged from 2.87 to 73.81 mg/L and were within the permissible limit of 100 mg/L. Ca-hardness values fluctuated between 86.10 and 231.00 mg/L and exceeded the permissible limit of 200 mg/L particularly in case of borewell water samples from south, west and central zones. The sulphate values ranged from 150 to > 400 mg/L. The sulphate values exceeded the permissible limit of 400 mg/L in case of most of the zones except east zone. Water with about 400 mg/L sulphate has a bitter taste and those with

Table1: Physico-chemical and bacteriological analyses of drinking water samples collected during different seasons from borewells situated in different zones of Kalol city, Gujarat.

		North			South			East		
No.	Parameters	Summer	Monsoon	Winter	Summer	Monsoon	Winter	Summer	Winter	Monsoon
1	Colour	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2	Odour	UO	UO	UO	UO	UO	UO	UO	UO	UO
3	Temperature	31.00	34.00	31.00	33.50	34.00	30.60	33.00	34.00	30.00
4	Turbidity	0.010	0	0	0.010	0	0.005	0.005	0	0.005
5	pH	7.73	7.73	8.00	7.76	8.20	8.25	8.10	8.40	8.20
6	DO	2.52	2.82	2.02	3.13	4.04	3.73	3.03	4.24	3.03
7	Free CO_2	80.00	60.00	96.00	380.00	40.00	34.00	160.00	26.00	32.00
8	TDS	2000	2840	3560	1520	1840	1800	1360	1320	1920
9	Total/HCO_3 Alk.	640.00	646.00	660.00	474.00	456.00	440.00	480.00	516.00	540.00
10	Total CO_2	767.10	753.54	804.57	888.88	529.56	506.38	675.32	579.97	611.74
11	Total hardness	340.00	240.00	280.00	460.00	220.00	360.00	208.00	220.00	280.00
12	Calcium	67.28	42.05	63.07	63.07	50.46	82.41	66.43	34.48	50.46
13	Ca-hardness	168.00	105.00	157.50	157.50	126.00	205.80	165.90	86.10	126.00
14	Mg-hardness	41.96	32.94	29.89	73.81	22.93	37.62	10.27	32.67	37.57
15	Chloride	639.74	624.75	623.75	574.77	419.83	424.83	349.86	347.86	364.85
16	Sulphate	>400	400	>400	>400	>400	>400	150	150	350
17	Nitrite	0.02	0.02	0.01	0.04	0.02	0.01	0.23	0.06	0.12
18	Total Iron	2.60	2.00	2.20	3.20	2.70	2.60	3.20	3.20	4.40
19	Fluoride	1.50	1.60	1.00	0.65	1.20	0.20	0.85	1.50	0.57
20	Coliforms MPN	0	0	0	49	0	0	33	8	0
21	IMViC tests	Nil	Nil	Nil	*E.a.*	Nil	Nil	*E.a.*	*E.a.*	Nil

		West			Central			Average
No.	Parameters	Summer	Monsoon	Winter	Summer	Monsoon	Winter	
1	Colour	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2	Odour	UO	UO	UO	UO	UO	UO	UO
3	Temperature	33.50	34.00	30.80	31.00	31.00	30.20	30.00-34.00
4	Turbidity	0.010	0	0.002	0	0	0.002	0-0.002
5	pH	7.83	8.00	8.05	7.84	8.25	8.00	7.73-8.40
6	DO	2.52	4.54	3.03	5.85	4.54	2.02	2.02-5.85
7	Free CO_2	100.00	40.00	38.00	18.00	38.00	28.00	18.00-380.00
8	TDS	1680	1880	2120	1800	1640	3200	1320-3560
9	Total/HCO_3 Alk.	470.00	464.00	456.00	404.00	434.00	480.00	404.00-646.00
10	Total CO_2	604.59	538.15	527.56	451.73	503.94	543.32	451.73-888.88
11	Total hardness	468.00	320.00	320.00	396.00	100.00	364.00	100.00-468.00
12	Calcium	92.51	55.50	75.69	89.15	35.32	50.46	34.48-92.51
13	Ca-hardness	231.00	138.60	189.00	222.60	88.20	126.00	86.10-231.00
14	Mg-hardness	57.82	44.26	31.96	42.31	2.87	58.07	2.87-73.81
15	Chloride	569.77	549.78	514.79	466.31	427.32	424.83	347.86-639.74
16	Sulphate	>400	>400	>400	>400	350	>400	150->400
17	Nitrite	0.03	0.02	0.01	0.03	0.005	0.02	0.005-0.23
18	Total Iron	2.60	2.70	2.20	0.70	2.30	2.00	0.70-4.40
19	Fluoride	0.90	1.40	0.20	0.30	1.40	0.20	0.20-1.60
20	Coliforms MPN	0	0	0	240	0	0	0-240
21	IMViC tests	Nil	Nil	Nil	*E.a.*	Nil	Nil	Nil-*E.a.*

Note: UO = Unobjectionable, Units: Except Temerature (°C), pH (units), Turbidity (O.D. at 420nm), MPN of Coliforms per 100 mL, rest of the values are in mg/L, Alkalinity = phenolphthalein alkalinity, hydroxide alkalinity and carbonate/CO_3^- ion values were zero, therefore Total alkalinity = Bicarbonate alkalinity, *E.a.* = *Ent. aerogenes*.

Table 2: Drinking water standards of IS: 10500, 1991.

No.	Parameters	Requirement Desirable limit)	Permissible limit in the absence of alternate source
1	Colour	5 HU	25 HU
2	Odour	UO	UO
3	Temperature	-	-
4	pH	6.5 to 8.5	No relaxation
5	Turbidity	5	10
6	EC	-	-
7	DO	-	-
8	Free CO_2	-	-
9	Total hardness As $CaCO_3$	300	600
10	Total solids	500	2000
11	Total alkalinity	200	600
12	Chloride	250	1000
13	Sulphate	200	400
14	Calcium as Ca	75	200
15	Magnesium	30	100
16	Nitrite	-	*
17	Total iron	0.3	1.0
18	Fluoride	1.0	1.5
19	MPN of coliforms	Free from Coliforms	10 or < 10 Coliforms

Note: - = No standards; UO =Unobjectionable; * = Standard for nitrite is 3.0 mg/L (WHO 1994); Units: Except Colour (Hazen Unit), Temperature (°C), pH (Units), Turbidity (NTU), EC (mhos/cm), MPN (coliforms per 100 mL of water) rest of values are in mg/L.

1000 mg/L or more, may cause intestinal disorders (WHO 1996). Total iron values ranged from 0.070 to 4.40 mg/L and exceeded the permissible limit of 1.0 mg/L. The high total iron values impart bitter astringent taste to water (Maiti 2001). The fluoride values ranged from 0.20 to 1.60 mg/L, the fluoride values exceeded the desirable limit of 1.0 mg/L, particularly during monsoon. The fluoride values, slightly higher than permissible limit of 1.5 mg/L, were observed for drinking water samples collected from north zone. Coliforms were absent in borewell samples collected from north and west zones but were present in the samples collected from south, east and central zones. MPN count exceeded the desirable limit of 10 coliforms/100 mL for these zones. Therefore, the borewell water sample from these zones were bacteriologically unsafe for drinking purpose. However, *E.coli* were not detected in these samples. It is recommended that water from Kalol town should be subjected to disinfection and defluoridation as well as to treatment for controlling TDS and total hardness by water softener and reverse osmosis.

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