RESEARCH PAPER | Biology | Volume : 3 | Issue : 4 | April 2013 | ISSN - 2249-555X

Study of Drinking Water Quality of Selected Fifteeen Areas of Ahmedabad City During Monsoon 2011

KEYWORDS: Drinking water, Ahmedabad, Statistical Analysis, GPCB Standards

M. B. Suthar
Associate Professor, Department of Biology, K. K. Shah Jarodwala Maninagar Science College, J. L .Trust Campus, Rambaug, Maninagar, Ahmedabad -380 008.

A. R. Mesariya
Associate Professor and Head, Department of Biology, K. K. Shah Jarodwala Maninagar Science College, J. L .Trust Campus, Rambaug, Maninagar, Ahmedabad -380 008.

B. K. Surpati
Student, Department of Biology, K. K. Shah Jarodwala Maninagar Science College, J. L .Trust Campus, Rambaug, Maninagar, Ahmedabad -380 008.

Z. H. Vohra
Student, Department of Biology, K. K. Shah Jarodwala Maninagar Science College, J. L .Trust Campus, Rambaug, Maninagar, Ahmedabad -380 008

ABSTRACT *Clean drinking water is essential for the survival. Unfortunately the quality of water has deteriorated because of various type of pollution. The present study is carried out for evaluating drinking water quality from Ahmedabad city by standard methods using GPCB standards from 15 areas in Monsoon 2011. The study indicates that total hardness was within highest desirable limits. The data indicates all water samples were either hard water or very hard water according to total hardness. Calcium hardness was within highest desirable limit and maximum permissible limits. Magnesium hardness was even crossing maximum permissible limits. The study also indicates that chlorinity was within highest desirable limits or maximum permissible limits. Salinity was within highest desirable limit and maximum permissible limits. EC and TDS were within highest desirable limits and even crossing maximum permissible limits. The data indicates drinking water may be used after proper treatment before distribution or use.*

INTRODUCTION :

Water is one of the most precious gifts of the nature to mankind through clean drinking water is essential for the survival of all living living organisms (Khandwala & Suthar, 2007; Suthar & Suthar, 2010). All life and peripheral activities are ceased without water. In addition to drinking and personal hygien, water is needed for agriculture, industries, electricity generation, waste management, recreation and wildlife (Patel and Patel, 2012). Improper policy is one of the most important factor that have cause several environmental pollution and ecological degradation (Goswami & Mankodi, 2012; Kundu, 2012).

Gujarat has experienced rapid urbanization with rapid economic development during last century. A recent McKinsey report on India's urbanization suggests that Gujarat will be 66% urban with 48 million urban population in 2030 AD (Suthar & Suthar, 2010; Mehta & Mehta, 2011). A large part of the State is water stressed and has severe shortage of drinking water. Hirway (2005) states that 87% urban water supply was through ground water and 3/4th of urban centres in Gujarat use ground water.

One of the key challenges of urban Gujarat is to provide drinking water as overall drinking water quality is alarming in various parts of Gujarat State. Patel & Patel (2012) surveyed 16 places of water sources and noted raised chloride content and significant variations in the physic-chemical parameters of water at Amirgadh Taluka of Banaskantha District of North Gujarat. Goswami & Mankodi (2012) reported significant seasonal variation in the fresh water of Nyari-II reservoir of Rajkot District in Saurashtra. They found high chloride with significant relationship with hardness and alkalinity in the water samples. There were higher chloride and sulphate values during summar season. Solanki et al. (2012) found pH, chloride, sulphate, electrical conductivity (EC) and total dissolved solids (TDS) well within the prescribe limit while there was need of necessary treatment of water before using it because of the presence of certain micro-organisms in the study conducted throughout the year 2009-2010 from six different locations in the Sabarmati river of Ahmedabad city. Kumar *et al.* (2011) found altered and increasing values of physic-chemical parameters in Sabarmati river and Kharicut canal at various sites during 12 months study from July 2009 to July 2010. Our previous studies (Suthar et al., 2008a-d; Suthar et al., 2010; Suthar et al., 2011; Suthar & Mesariya, 2012) showed that various areas of Ahmedabad City have poor drinking water quality. Hence, the present study was carried out as a part of continuous monitoring.

MATERIALS AND METHODS :

Ahmedabad is located on the banks of the river Sabarmati in the Northern part of Gujarat and the Western part of India. It is located at 23.03 ^{0}N 72.58 ^{0}E spanning an area of 310 Km^{2}. Ahmedabad is the centre for industrial, institutional and political activities of the Gujarat State of India (Kumar et al., 2011). The physico-chemical parameters analysed were total hardness, calcium hardness, magnesium hardness, pH, chlorinity, salinity, electrical conductivity (EC) and total dissolved solids (TDS). Total 15 samples of water were collected from municipal (13) and tube well source (2). Samples were analysed for various physico-chemical characteristics by standard methods at the college laboratory (Sunilkumar & Ravindranath, 1998). Gujarat Pollution Control Board (GPCB) drinking water standards were used (Kapila & Mehta, 2006). These standards are same as IS: 10500 of Bureau of Indian Standard for parameters studied (Shankar & Balasubramanya, 2008). Statistical analysis was done using MS-Excel 2007™ and Online Softwares for performing arithmetical mean value, maximum value (Max), minimum value (Min), median, percentage value, Pearson's correlation matrix, Student's t-test etc.

Table 1 : Method used, highest desirable limits (HDL), maximum permissible limits (MPL) and units of measurements for physico-chemical analysis of drinking water.

Sr. No.	Parameter	Method & Instrument	HDL	MPL	Unit
1	Total Hardness (TH)	EDTA titrimetric method using TH Tablets	300	600	As $CaCO_3$ mg/l

Volume : 3 | Issue : 4 | April 2013 | ISSN - 2249-555X

2	Calcium Hardness(CH)	EDTA titrimetric method using CH Tablets	75	200	As Ca mg/l
3	Magnesium Hardness (MH)	Calculated from TH and CH	30	90	As Mg mg/l
4	pH	Digital pH Meter (Systronics india Ltd. Model 335)	6.5-8.5	-	
5	Chlorinity	Argentometric Titration Method	250	1000	Mg/l
6	Salinity	Calculated from Chlorinity	450#	1800#	g/l
7	Electrical Conductivity (EC)	Conductivity Meter (Systronics India Ltd. Model 304)	0.70	2.86	mS/cm
8	Total dissolved solids (TDS)	Calculated from EC	500$	2000$	ppm

#$ Calculated values.

RESULTS AND DISCUSSION :

By the inspection, it was found that there was not having any colour, odour and taste in any sample studied.

- Total Hardness (TH) : Total hardness means the total number of calcium and magnesium cations in water. From this study we concluded that total hardness were within highest desirable limits. The ten area samples of drinking water (66.6% samples) are within the highest desirable limits (Table-2). Table 3 shows that 11 samples (73.33%) were between 150 mg/L and 300 mg/L. indicating that water samples are hard water. Remaining samples (26.67%) were even above 300 mg/L indicating that drinking water is of very hard water category.

Table : 2 Area wise physico-chemical parameters studied in Ahmedabad city during monsoon of year 2011.

Area	Source	TH	CH	MH	pH	CHL	SAL	EC	TDS
Amraiwadi	Municipal	162	80	82	7.48	63.9	115.32	0.42	294
Bapunagar	Municipal	308	100	208	7.2	79.9	144.2	0.29	203
Behrampura	Municipal	212	120	92	7.54	167.9	303.17	0.71	497
Danilimda	Municipal	312	100	212	7.63	311.9	563	1.2	840
Gita Mandir	Municipal	228	160	68	7.44	119.9	216.5	0.71	497
Ghodasar	Municipal	300	120	180	7.6	339.8	613.3	1.48	1036
Gomtipur	Municipal	182	170	65	7.71	341	221	0.69	483
Isanpur	Municipal	192	100	92	7.67	59.9	108.1	0.25	175
Jashodanagar	Tube Well	192	80	112	7.82	295	534	1.28	896
Khokhra	Municipal	177	93	84	7.42	82.5	149	0.32	228
Maninagar	Municipal	264	90	100	7.4	161	292	0.66	462
Odhav	Tube Well	196	90	106	7.44	271.9	357	1.05	438
Shah-e-alam	Municipal	260	40	220	7.96	379.8	490.8	1.61	1127
Vatva	Municipal	304	96	208	7.19	379.8	685.71	2	1400
Vejalpur	Municipal	320	100	120	7.75	567.82	1024.94	2.6	1820
GPCB Standards	No. of samples below HDL	10	01	00	00	07	09	06	09
	No. of samples between HDL and MPL	05	14	04	15	08	06	09	06
	No. of samples above MPL	00	00	11	00	00	00	00	00
	Maximum	320	170	220	7.96	567.82	1024.94	2.60	1820
	Minimum	162	40	65	7.19	59.90	108.10	0.25	175
	Median	228	100	106	7.54	271.90	303.17	0.71	497

The samples were collected and analysed in the Monsoon season of year 2011.

Units of measurements: Total hardness (as $CaCO_3$) mg/L; Calcium hardness (as Ca) mg/L; Magnesium hardness (as Mg) mg/L; Chlorinity (as Cl) mg/L; Salinity g/L; Abbreviations: TH = Total Hardness; CH = Calcium Hardness; MH = Magnesium Harndess; CHL= Chlorinity; Sal = Salinity; EC = Electrical Conductivity; TDS = Total Dissolved Solids; HDL = Highest desirable limt; MPL = Maximum permissible limit.

Table 3: Classification of ground waters based on total hardness.

Total Hardness as $CaCO_3$ (mg/L)	Water Class	Number of Samples	Percentage (%)
Less than 75	Soft water	0	0.00
Between 75 to 150	Moderately Hard water	0	0.00
Between 150 to 300	Hard water	11	73.33
Above 300	Very Hard water	04	26.67
Total			100.00

The classification is as given in Vennila et al. (2008), Units of measurements for Total hardness (as $CaCO_3$) mg/L

- Calcium Hardness (CH) : In present study, most of samples (14 samples) were having high amount of calcium hardness above the desirable limit and below maximum permissible limit. High concentration of calcium is not desirable for washing, bathing, laundering.
- Magnesium Hardness (MH) : Most of the samples (11 samples) were having high amount of magnesium hardness. High concentration of magnesium hardness reduces the utility of water for domestic use.
- pH : It is noted that pH values of all the samples were within desirable range i.e. 6.5-8.5
- Chlorinity (CHL) : The chlorinity of water samples in eight areas are between 251-1000 while other samples's chlorinity is below 250. The contribution of chlorides is may be due to minerals pollution or water pre-treatment. Human excreta particularly the urine contain chloride in amount equal to the chloride consumed with food and water.
- Salinity (SAL) : It refers to the total amount of soluble salts in water. Fresh water have salt concentrations below 0.5

Volume : 3 | Issue : 4 | April 2013 | ISSN - 2249-555X

parts per thousand (ppt). In our findings, salinity is below maximum permissible limits (6 samples) or highest desirable limits (9 samples).

- Electrical Conductivity (EC) : Electrical conductivity value of study area varied from 0.25-2.6 mS/cm. The capacity to conduct electric current depends on percentage of EC.
- Total Dissolved Solids (TDS): TDS is varied between 175-1820 ppm. Presence of excess TDS may cause gastro-intestinal irritation. It elevates the density of water and reduces the solubility of oxygen.

Table 4: Pearson's Correlation matrix calculated using MS-Excel 2007™ and p-Value Calculator™.

	TH	CH	MH	pH	CHL	SAL	EC	TDS
TH	1							
CH	-0.0976	1						
MH	0.766146***	-0.45388	1					
pH	-0.14715	-0.19216	-0.04334	1				
CHL	0.517518*	-0.0694	0.373535	0.449735	1			
SAL	0.659101**	0.659101**	0.441464	0.304711	0.911325***	1		
EC	0.601788*	-0.20929	0.439321	0.312543	0.93223***	0.973097***	1	
TDS	0.629361	-0.18977	0.452631	0.331469	0.913319***	0.967971***	0.987277***	1

Abbreviations: TH = Total Hardness; CH = Calcium Hardness; MH = Magnesium Harndess; CHL= Chlorinity; Sal = Salinity; EC = Electrical Conductivity; TDS = Total Dissolved Solids
*Correlation is significant at the 0.05 level (P<0.05),**Correlation is significant at the 0.01 level (P<0.01),***Correlation is significant at the 0.001 level (P<0.001), Two-tailed test. (http://www.danielsoper.com/statcalc3/calc.aspx?id=44)

Table 4 is related with Pearson's correlation matrix. It indicates that there is negative correlation between total hardness with calcium hardness and pH; between calcium hardness and magnesium hardness, pH, chlorinity, EC and TDS and, between magnesium hardness and pH. Other parameters have positive correlations with each other. Many parameters have significant correlation at various levels.

Table 5: Sample source-wise list of physico-chemical parameters studied

Source	No. of Samples studied	TH	CH	MH	pH	CHL	SAL	EC	TDS
Municipal	13	247.76 ± 15.255^{NS}	105.30 ± 9.314^{NS}	133.15 ± 16.409^{NS}	7.537 ± 0.061^{NS}	235.00 ± 45.997^{NS}	379.00 ± 81.990^{NS}	0.995 ± 0.212^{NS}	697.07 ± 148.67^{NS}
Tube well	02	194.00 ± 2.000^{NS}	85.00 ± 5.000^{NS}	109.00 ± 3.000^{NS}	7.630 ± 0.190^{NS}	283.45 ± 11.550^{NS}	445.50 ± 88.500^{NS}	1.165 ± 0.115^{NS}	667.00 ± 229.000^{NS}
Total	15	240.60 ± 14.293	102.60 ± 7.867	129.93 ± 14.449	7.55 ± 0.054	241.46 ± 37.538	387.86 ± 65.175	1.018 ± 0.171	693.06 ± 120.674

Values are Mean ± SEM. Student's t-test (Comparison of Municipal source with tubewell source data). ^{NS}= Non Significant

Abbreviations: TH = Total Hardness; CH = Calcium Hardness; MH = Magnesium Harndess; CHL= Chlorinity; Sal = Salinity; EC = Electrical Conductivity; TDS = Total Dissolved Solids

Table 5 indicates that there is no significant difference between sources of samples in the parameters studied.

CONCLUSION :

Summing up, it was observed that some of the samples exceeding the prescribed limit of one of other parameter studied. The present study reveals that water is not safe for drinking particular from industrial area, only it is useful for domestic purpose. So, people should be made aware of the water quality, importance on sanitation and economical water treatment methods like filtration and boiling would prove beneficial to avoid water-borne disease.

ACKNOWLEDGEMENTS :

Authors like to thank Dr. R. R. Shah, Principal, K. K. Shah Jarodwala Maninagar Science College, Ahmedabad and Management of J. L. Trust for providing opportunities and facilities for the present work. Authors are also thankful to staff of Biology Department for their encouragement. The sincere and voluntary help of FYBSc students of batch 2011-12 for the collection of water sample is highly appreciated. Authors are thankful to Mrs. Tejal M. Suthar (Associate Professor, JG College of Nursing, Ahmedabad) for valuable help in computing. We are thankful for Microsoft Office 2007™ and online softwares for easy statistical analysis facility.

The present data was presented in GUJCOST-DST Sponsored National Seminar on 'New Perspectives of Natural Sciences" (7th January, 2012) organized by NVPAS, Vallabhvidyanagar, Gujarat. India.

Volume : 3 | Issue : 4 | April 2013 | ISSN - 2249-555X

REFERENCE Goswami, A. P., & Mankodi, P. C. (2012). Hydrography of the fresh water reserviour Nyari-II of Rajkot District, Gujarat. Electronic Journal of Environmental Sciences, 5, 1-5. | Hirway, I. (2005). Ensuring Drinking Water to All : A Study in Gujarat. Paper Prepared for the 4th IWMI-TATA Annual Partner's Research Meet, 24-26 February, 2005 (As cited by Mehta, M., & Mehta, M., 2011). | http://www.danielsoper.com/statcalc3/calc.aspx?id=44 | Kapila, M., & Mehta, N. M. (2006). Evaluation of ground water quality of Amalsad village used as drinking water. International Journal of Bioscience Reporter, 4(1), 127-131. | Khandwala, R. V., & Suthar, M. B. (2007). Concept of 'APAH' in Indian Vedic literature- A Comparative study. International Journal of Bioscience Reporter, 5 (1), 1-6. | Kumar, R. N., Solanki, R., & Kumar, N. (2011). An assessment of seasonal variation and water quality index of Sabarmati River and Kharicut canal at Ahmedabad, Gujarat. Electronic Journal of Environment, Agriculture and Food Chemistry, 10 (5), 2248-2261. | Kundu, S. 2012. Assessment of surface water quality for drinking and irrigation purposes : A case study of Ghaggar river system surface waters. Bulleting of Environment, Pharmacology and Life Sciences, 1 (2), 1-6. | Mehta, M., & Mehta, D. (2011). Urban Drinking Water Security and Sustainability in Gujarat. In : R. Parthsarathy and R. H. Dholakia (Eds) : Sardar Sarovar Project on the River Narmada (Vol. 3) : Impacts So Far and Ways Forward, Chapter 25. pp. 727-743. Concept Publishing Company, New Delhi (www.pas.org.in). | Patel, J. N., & Patel, N. K. (2012). Study of physic-chemical properties of water in Amirgadh taluka of Banaskantha District of North Gujarat, India. LifeSciences Leaflets, 9, 82-90. | Shankar, B. S., & Balasubramanya, N. (2008). Evaluation of quality indices for the ground waters of an industrial area in Bangalore, India. Nature Environment and Pollution Technology, 7(4), 663-666. | Solanki, H. A., Chitnis, R. D., & and Bhavsar, H. A. (2012). Physico-chemical and bacterial analysis of Sabarmati river in Ahmedabad. LifeSciences Leaflets, 2, 70-82. | Sunilkumar, M., & Ravindranath, S. (1998). Water Studies : Methods for Monitoring Water Quality. Centre for Environment Education (CEE), Ahmedabad. | Suthar, M. B., & Mesariya, A. R. (2012). Study on drinking water quality from selected areas of Ahmedabad City, India. Lifesciences Leaflets (LSIC2011), 329-335. | Suthar, M. B., & Suthar, T. M. (2010). Status of ground water quality in urban environment in India during last two decades. Bioscience Guardian, 1(1), 1-23. | Suthar, M. B., Mesariya, A. R., & Prajapati, K. R. (2011). Physico-chemical properties of the drinking water in Ahmedabad City of Gujarat, Electronic Journal of Environmental Sciences, 4, 39-45. | Suthar, M. B., Mesariya, A. R., & Ravat, N. M. (2008a). Analysis of water quality from Ahmedabad city (Gujarat) using chemical parameters. Indian Journal of Environment and Ecoplanning, 15(1), 171-176. | Suthar, M. B., Mesariya, A. R., & Ravat, N. M. (2008b). Study on drinking water quality from some areas of Ahmedabad city of Gujarat. Electronic Journal of Environmental Sciences, 1, 23-27. | Suthar, M. B., Mesariya, A. R., Kanjariya, K. V., & Ravat, N. M. (2008c). Evaluation of drinking water quality of some areas of Ahmedabad city (Gujarat) in the year 2007. Bulletin on Environmental Science, 26(1), 51-56. | Suthar, M. B., Mesariya, A. R., Ravat, N. M., & Kalola, S. K. (2008d). The status of drinking water quality from eastern areas of Ahmedabad city, Gujarat. International Journal of Bioscience Reporter, 6(1), 55-59. | Suthar, M. B., Ravat, N. M., Mesariya, A. R., & Kanjariya, K. V. (2010). Alterations in physicochemical characteristics of drinking water collected from some areas of Ahmedabad city. Nature Environmental and Pollution Technology, 9(2), 399-408. | Vennila, G., Subramani, T., & Elango, L. (2008). GIS based groundwater quality assessment of Vattamalaikarai basin, Tamil Nadu, India. Nature Environment and Pollution Technology, 7(4), 585-592. |