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Physicochemical and Bacteriological Analysis of Water Quality Under Different Environmental Condition

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ABSTRACT

The microorganisms present in water cause harmful effects in human body. The presence of bacteria and pathogenic (disease-causing) organisms can prove fatal and hence is a matter of great concern when considering the safety of drinking water. The pathogenic organisms can cause intestinal infections, dysentery, hepatitis, typhoid fever, cholera, and other illnesses. The paper discusses results of physicochemical and bacteriological analysis done on various water samples taken from different sources in Ahmedabad, Gujarat, India. The water samples collected from different regions of Ahmedabad were found to have significant impurities, considerable deterioration and remarkable variation. The samples were first collected and then stored in water storages made up of different materials like earthen material, plastic container. The study was conducted to analyse the change in basic properties of water samples over a significant period of time under varied environmental conditions made up of different materials. Various environmental conditions like under direct sun light or in room temperature which shows sunlight causes the elimination of microbes from water due to photo-degradation process. The tests were conducted and their results were studied on various physicochemical parameters such as pH, Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Dissolved Oxygen (DO).

Key Words: Water analysis, Sabarmati River, antibacterial effect, solar disinfection, Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Dissolved Oxygen (DO).

INTRODUCTION

Water plays an essential role in human life. Although statistics vary, the World Health Organisation (WHO) reports that approximately 36% of urban and 65% of rural Indian's were without access to safe drinking water (WHO, 2009). Normally water is often used for domestic purposes especially for drinking. Water is the source of all biological lives and their sustenance

too. Water for different purposes has its own requirements for the composition and purity and each body of water has to be analysed on a regular basis to confirm the suitability.

Drinking contaminated water can cause diarrhoea, cholera, dysentery, and various other diseases like Typhoid, Amoebiasis, Jaundice, Enterobacteriaceae, etc. [1, 2]. Water contamination can be caused by different types of pathogens (disease causing organisms).

The major pathogens causing water borne disease are as under:

- Bacteria (eg salmonella, shigella – causing bacillary dysentery, cholera);
- Viruses (Hepatitis A, Hepatitis E, rotavirus); and
- Other parasites including protozoa (cryptosporidium, giardia, toxoplasma) and helminths.

A key strategy for improving access to clean water is to enable rural households to purify water in their homes using an appropriate water treatment technology. One such technology is water filter i.e. a filter treated with silver coating to act as disinfectant and improve quality of water.

But the proportion of contaminants in water has increased. These contaminants in turn have ill-effects on biological life on the earth. The microbes were investigated by standard microbiological investigations.

EXPERIMENTAL SECTION

The water samples were collected from different locations of Sabarmati river in Ahmedabad. All the samples were collected in sterilized and phosphate free bottle. The procedures for the analysis followed standard methods of analysis of water and waste water. All chemicals used were of AR grade and instruments used for study were of best quality and highest accuracy [2, 3, 4, and 5].

TABLE-1: Result of Physicochemical study done on water samples of Sabarmati River taken from different places in Ahmedabad, Gurajat, India on dated 2/2/2010

Sample Collected		Parameters *				
River	Location	pH	D.O.	B.O.D.	C.O.D.	T.D.S
Sabarmati	Hansol Bridge	8.6	6.5	7.1	31	156
Sabarmati	Rly. Bridge, Ahmedabad	8.1	4.85	2.54	18.5	120
Sabarmati	Pirana Bridge	8.2	3.38	51.35	211.7	397
Sabarmati	Ellise village	8.03	3	49	203	389
Sabarmati	Vasna - Narol Bridge	7.87	0.3	67	214	408
Sabarmati	Kalol Bridge	8.37	6.7	4.1	38	200
Bottled Water		7.7	7.1	nil	nil	50
TAP Water		7.6	9.5	1.24	10	109
WHO Standard		6.5-8.5	>6.5	<2	< 50	<150

**All values except pH are in mg/liter*

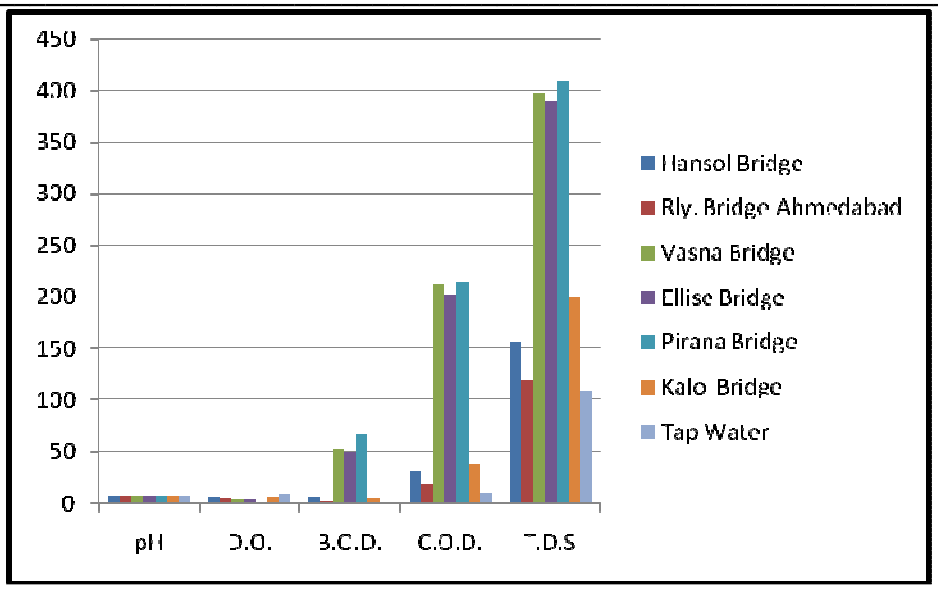

Fig. 1: Graphical analysis of results of physicochemical study

A. Physicochemical Analysis of Water Quality

The Sabarmati river basin extends over an area of 21,674 sq km. Located in Western India, the basin covers areas in the States of Rajasthan and Gujarat. It raises in the Aravalli hills. The total length of the river from the head to its outfall into the sea is 371 km. [1]. The results of Physicochemical study done on water samples of Sabarmati River taken from different places in Ahmedabad, Gujarat, India are enumerated under different tests/parameters in Table 1.

Table 1 and Fig 1 show the result of Physicochemical study against their benchmark values under WHO standards for Drinking water. The study shows that on pH scale, water quality of Sabarmati River meets the desired water quality criteria as specified by WHO except for the sample taken from Hansol Bridge where pH values slightly exceeds the benchmark WHO standard range of pH from 6.5 to 8.5. The sample taken from Vasna – Narol Bridge was found to have lowest pH value of 7.87 and hence safest for drinking purposes among all the samples taken and analyzed on pH scale.

WHO standard specifies minimum value under the Dissolved Oxygen (DO) test as 6.5 mg/l and any value above 6.5 is considered as safe for drinking. The results of water analysis showed wide range of 0.3-9.5 mg/l. The minimum value (0.3 mg/l) of DO was observed for water sample taken from Vasna Bridge whereas the maximum value (6.7 mg/l) was at Kalol Bridge among samples taken from river though tap water was found to have the highest value at 9.5 mg/l. Thus, only samples taken from Hansol Bridge and Kalol Bridge met the WHO standard.

As per WHO standard for Biological Oxygen Demand (BOD) test, the maximum value under BOD should be 2 mg/l for ensuring safety of water for drinking purposes. The tests showed wide range of values obtained under BOD test with minimum value (2.54 mg/l) observed for sample taken from Railway Bridge and maximum value (51.35 mg/l) observed for sample taken from Vasna-Narol Bridge. Thus, none of the samples met WHO standard, only sample taken from Railway Bridge came close to desired standard value specified by WHO standard.

The results under Chemical Oxygen Demand (COD) test show values ranging from 18.5 mg/l to 214 mg/l against WHO standard specifying maximum value of 50 mg/l. The sample taken from Railway Bridge was found to have minimum value of 18.5 mg/l whereas the maximum value of 214 mg/l was found in sample taken from Vasna-Narol Bridge. Thus, only samples taken from Railway Bridge, Hansol Bridge and Kalol Bridge had COD values at 18.5 mg/l, 31 mg/l and 38 mg/l meeting the WHO standard for safety of water.

WHO standard for Total Dissolved Solids (TDS) test specifies maximum value at 150 mg/l where our samples were found to have values ranging from 120 mg/l to 408 mg/l. The sample taken from Railway Bridge was found to have minimum value of 120 mg/l whereas the maximum value of 408 mg/l was found in sample taken from Vasna-Narol Bridge. Therefore, only one sample taken from Railway Bridge was found to meet WHO standard while sample taken from Hansol Bridge having TDS value at 156 mg/l came close to meet the WHO standard.

B. Impact Analysis of water quality under varying environmental conditions

The bacteriological quality of bottled water is of great interest to consumers as an alternative of Tap water and ensures greater safety for drinking purposes. The samples were exposed to sunlight has been shown to deactivate dieses-causing organisms in polluted drinking water.

TABLE-2: Physicochemical analyses of water under different conditions when stored in plastic container (in time period of February 2010 to march 2010)

Material used: Plastic		**Stored under direct Sunlight**					**Stored in Room under**				
Sample	Time	pH	DO	BOD	COD	TDS	pH	DO	BOD	COD	TDS
River water	0W	8.2	3.38	51.35	211.7	397	8.2	3.38	51.35	211.7	397
	1W	8.2	4.2	50.3	214	396	8.2	3.3	55	215	396
	2W	8.2	4.32	50	215.3	395.3	8.2	3.3	59	215	399
	3W	8.19	5	48.67	215	395	8.2	3.6	60.96	216.9	400
	4W	8.19	5.6	48.5	216	395	8.2	3.4	62	217	401
Tap water	0W	7.6	9.5	1.24	10	109	7.6	9.5	1.24	10	109
	1W	7.6	9.51	1.2	10	109	7.6	9.4	1.24	10	109
	2W	7.6	9.5	1.2	10	109	7.6	9.4	1.24	10	110
	3W	7.6	9.69	1.15	10	108.5	7.6	9.45	1.29	10	110
	4W	7.6	9.99	1.1	10	108.5	7.6	9.39	1.24	10	110
Bottled water	0W	7.7	7.1	nil	nil	50	7.7	7.1	nil	nil	50
	1W	7.7	7.1	nil	nil	50	7.7	7.1	nil	nil	50
	2W	7.7	6.8	nil	nil	50	7.7	7.1	nil	nil	50
	3W	7.7	6.79	nil	nil	50	7.7	7.1	nil	nil	50
	4W	7.7	6.75	nil	nil	50	7.7	7.1	nil	nil	50
WHO Standards for drinking water		6.5-8.5	>6.5	<2	< 50	<150	6.5-8.5	>6.5	<2	< 50	<150

The water samples were stored in earthen (ceramic) as well as plastic vessel and kept under various conditions like under direct sun light or in room. Accordingly, the samples were subjected to varying temperature. The material used in making the storage tanks due to their

different chemical composition had different effects on the water sample over a period of time when stored under varying conditions. Thus, the paper enumerates the result of study of physicochemical and microbial parameters on water quality. The analyzed data were compared with standard values recommended by WHO and are shown in Table 2 and Table 3.

Table 2 shows the result of physicochemical study against their benchmark values under WHO standards of drinking water when water is stored under different conditions in plastic container. The samples were stored under direct sunlight and also in room under normal sunlight to study how their water quality changes over time when subjected to varying conditions.

When stored in plastic vessel, study showed that the water quality of Sabarmati river meets the desired water quality criteria as specified by WHO for all the samples taken from different places in Ahmedabad.

TABLE-3: Physicochemical analyses of water under different conditions when stored in Ceramic vessel

Material used: Ceramic		**Stored under direct Sunlight**					**Stored in Room**				
Sample	Time	pH	DO	BOD	COD	TDS	pH	DO	BOD	COD	TDS
River water	0W	8.2	3.38	51.35	211.7	397	8.2	3.38	51.35	211.7	397
	1W	8.2	3.38	51.34	211.7	397	8.2	3.38	51.35	211.7	397
	2W	8.2	3.38	51	211.7	397	8.2	3.38	51.35	211.7	397
	3W	8.2	3.38	51.3	211	397	8.2	3.38	51.35	211.7	397
	4W	8.2	3.39	51.34	212	398	8.2	3.38	51.35	211.7	397
Tap water	0W	7.6	9.5	1.24	10	109	7.6	9.5	1.24	10	109
	1W	7.6	9.5	1.23	10	109	7.6	9.5	1.24	10	109
	2W	7.6	9.5	1.23	10	109	7.6	9.5	1.24	10	109
	3W	7.6	9.5	1.24	10	109	7.6	9.5	1.24	10	109
	4W	7.6	9.5	1.24	10	109	7.6	9.5	1.24	10	109
Bottled water	0W	7.7	7.1	nil	nil	50	7.7	7.1	nil	nil	50
	1W	7.7	7.1	nil	nil	50	7.7	7.1	nil	nil	50
	2W	7.7	7.1	nil	nil	50	7.7	7.1	nil	nil	50
	3W	7.7	7.1	nil	nil	50	7.7	7.1	nil	nil	50
	4W	7.7	7.1	nil	nil	50	7.7	7.1	nil	nil	50
WHO Standards for drinking water		6.5-8.5	>6.5	<2	< 50	<150	6.5-8.5	>6.5	<2	< 50	<150

The effects of solar radiation are believed to contribute to the inactivation of pathogenic organisms. The sunlight causes the elimination of microbes from water due to photo-degradation process. UV-A interferes directly with the metabolism and destroys cell structures of bacteria, reacts with dissolved oxygen in the water and produces highly reactive forms of oxygen (oxygen free radicals and hydrogen peroxides), that are believed to also damage pathogens, cumulative solar energy (including the infrared radiation component) heats the water. If the water temperature rises above 50°C, the disinfection process is three times faster. At water temperatures higher than 45°C (113°F), synergistic effects of UV radiation and temperature further enhance the disinfection efficiency. [5, 6] Human pathogens are adapted to live in the

human intestines, where they find a dark, humid environment and temperatures ranging between 36°C and 37°C. Once the pathogens are discharged into the environment, they are very sensitive to the harsh conditions outside the human body. They are not able to resist increased temperatures and they do not have any protection mechanisms against UV radiation. Therefore, temperature and UV radiation can be used to inactivate the pathogens.

CONCLUSION

The water samples were collected from different places in Ahmedabad, Gujarat and studied under various methods on number of parameters such as pH, Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Dissolved Oxygen (DO). The study showed wide range of values under each test and samples were found to have inferior quality unsafe for drinking purposes at most of the places in Ahmedabad.

The present investigations has led us to conclude that the quality of water samples subjected to study was acceptable from majority of physicochemical parameters while as per the bacteriological standards, the water needs to be treated before using it for domestic purposes including drinking. Drinking contaminated water can expose human body to various water-borne diseases hence water treatment and improving quality of water before drinking is required. Based on the results of analysis, it is suggested that further detailed investigations of the water purifying plants, storage tanks and pipe lines as well as other sources of water may be carried out in future.

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