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A comparative study on the physicochemical and bacterial analysis of drinking, borewell and sewage water in the three different places of Sivakasi

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Abstract: *The drinking, borewell and sewage water in the Sanmugasikamani Nadar(S.N) street, Naivatti Nadar(N.N) street and Thiruthangal area of Sivakasi has been studied. The various constituents monitored include the physicochemical characters like pH, total solids, total dissolved solids, total suspended solids; chemical parameters like total alkalinity, acidity, free CO_2, dissolved oxygen, total hardness, calcium, magnesium, chloride, salinity and bacterial parameters like standard plate count (SPC), total coliform count (TCC), faecal coliform count (FCC), faecal streptococcal count (FSC). Most of the physicochemical characters of drinking and borewell water were within the ISI permissible level. However in water samples from all the sites, bacterial count exceeded the recommended permissible level of WHO. Introduction of sewage into the drinking and borewell water was the main reason for the bacterial contamination. The boiling of water is therefore advisable before consumption. The physicochemical and bacterial characters of the sewage water were unworthy. The sewage water recycling was necessary to minimize the water born diseases.*

Key words: *Physical parameters, Chemical parameters, Bacterial parameters, WHO*

Introduction

Almost 70% of the water in India has become polluted due to the discharge of domestic sewage and industrial effluents into natural water source, such as rivers, streams as well as lakes (Sangu and Sharma, 1987). About 95% of rural population living in India depends on ground water for domestic use (Moharir *et al.,* 2002). The water quality cheracterstics is denoted by knowing the physical parameters like pH, TS, TDS, TSS and chemical parameters like total alkalinity, free CO_2, DO, total hardness, Ca, Mg, chlorinity, salinity and bacterial parameters like SPC, TCC, FCC and FSC. According to WHO estimate about 80% of water pollution in developing country, like India is carried by domestic waste. The improper management of water systems may cause serious problems in availability and quality of water (Subba Rao and Subba Rao, 1995). In our country 70% of the water is seriously polluted and 75% of illness and 80% of the child mortality is attributed to water pollution (Zoeteman, 1980). The healthy nature of underground water has also altered (Dasgupta and Purohit, 2001). The industrial pollutants associated with organic matter, inorganic dissolved solids and other unwanted chemicals cause serious ground water problems (Tyagi *et al*., 2000). During the past decade, widespread reports of ground water contamination have increased public concern about drinking water quality (Yanggen and Born, 1990). The sewage water gets accumulated in the form of stagnant water and if there are any drinking water pipes near to that area, there is a chance for the intrusion of sewage water in drinking water pipelines.

For presence of pathogenic bacteria, the coliform group of bacteria can be detected by testing the sample. It causes health hazards to the human beings. In Sivakasi, the availability of water is mostly depended on borewell and surface water from Vembakkottai reservoir. The people in that area suffers from health hazards. Therefore, present study was aimed to analyse the physicochemical and bacteriological properties of drinking water, borewell water and sewage water in that area.

Materials and Methods

The water qualities of three water samples (drinking, borewell and sewage water) from three different places (S.N street, N.N street and Thiruthangal) of Sivakasi were studied for physicochemical and bacteriological parameters. The water samples were collected in borosil glass bottles, in the month of January and February 2004. The collected samples were stored at 4°C. The pH of the water samples was measured by using the electrometric methods and other physicochemical parameters were analyzed by standard methods given in APHA (1989). The bacteriological analysis like the number of bacterial colonies, number of total coliform,faecal coliform and faecal streptococci were measured by standard plate count (SPC), most probable number (MPN),faecal coliform count (FCC) and faecal streptococcal count (FSC) respectively. All the collected water samples were analysed within 24 hr. The numbers of bacterial colonies were counted by colony counter. All estimations were carried out using five replicates. The data presented are mean of five independent determinations.

Results and Discussion

Physicochemical and bacteriological quality of different water samples are shown in the Tables 1, 2 and 3. The permissible limit of pH in the water is 6.5 to 8.5 (ISI). The pH values of borewell water of N.N street and the sewage water of S.N street were within the permissible limit. This was positively correlated by the pH of Ganga and Ghaghara river water where the alkalinity

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Table - 1: Analysis of physicochemical parameters

Water samples and sites	Physical parameters				Chemical parameters							
	pH	TS mg/l	TDS mg/l	TSS mg/l	Total alkalinity mg/l	Free Co_2 mg/l	DO mg/l	Total hardness mg/l	Ca mg/l	Mg mg/l	Cl mg/l	Salinity mg/l
S.N. Street												
Drinking water	7.5	250	50	200	220	30.8	4.22	160	8.81	32.56	97.9	176.8
Borewell water	9.0	320	240	80	250	39.8	3.24	1380	11.22	329.34	869.0	1568.6
Sewage water	8.0	350	200	150	250	66.0	--	560	32.86	111.44	222.9	402.4
N. N. Street												
Drinking water	7.8	290	150	140	210	70.4	3.26	166	24.86	25.33	42.6	76.9
Borewell water	8.5	300	260	40	730	39.6	4.46	640	72.94	11.56	568.0	1025.2
Sewage water	9.0	370	290	80	910	624.8	--	610	192.3	31.66	568.4	1058.5
Thiruthangal												
Drinking water	7.3	330	210	120	270	17.6	5.27	192	25.65	31.18	39.76	71.7
Borewell water	9.8	550	450	100	390	48.4	4.87	840	22.44	190.98	1082.4	1953.1
Sewage water	9.4	490	320	170	830	488.4	--	660	164.2	63.33	543.8	981.6
ISI standard	6.5 - 8.5		1000		600			200	75	50	1000	

TS = Total solids, TDS = Total dissolved solids, TSS = Total suspended solids, DO = Dissolved oxygen

Table - 2: Analysis of bacterial population by various plate count methods

Various plate count methods	S. N. street			N.N. street			Thiruthangal		
	Drinking water	Borewell water	Sewage water	Drinking water	Borewell water	Sewage water	Drinking water	Borewell water	Sewage water
Standard plate count									
10^{-1}	30063	28940	314217	24601	22173	1509806	63	276	423059
10^{-2}	2128	3061	29863	3178	2089	201678	29	26	71352
10^{-3}	243	290	2507	273	213	14028	8	9	6027
10^{-4}	28	24	268	23	19	1623	3	4	673
10^{-5}	6	3	24	2	3	154	1	2	89
Faecal coliform count									
10^{-1}	126	2163	260687	75	8116	214272	93	697	248045
10^{-2}	21	204	24281	9	908	21730	27	87	21063
10^{-3}	5	18	2519	1	87	1783	10	13	2035
10^{-4}	1	4	256	1	5	158	2	5	176
Faecal streptococcal count									
10^{-1}	--	--	--	--	--	--	39	158	254
10^{-2}	--	--	--	--	--	--	15	22	27
10^{-3}	--	--	--	--	--	--	7	9	11
10^{-4}	--	--	--	--	--	--	1	3	7

ranged from 7.3 to 7.9 (Gupta, 2003). The pH value of Morana River was also in the alkaline range (Musaddiq, 2002). The remaining water samples exceeded the permissible limit. The reason for the alkaline range may be due to mixing up of the alkaline chemicals, soap and detergents *etc.* produced due to industrial, commercial and residential activities. The ISI permissible pH values containing water is suitable for domestic use and irrigation purposes.

The total solids (TS) in the drinking water of S.N. street and borewell water of N.N street were positively correlated with Ganga river water sample in Kathal Nala at Balia district situated in the eastern U.P. (Gupta, 2003). The TS content of the remaining water samples were high. The amount of the total dissolved solids of the drinking, borewell and sewage water samples collected from all the above three places were within the permissible limit as per ISI (1000 mg/l). This was positively correlated with the river water samples of the Ranchi district, were the total dissolved solids ranged between 50 to 450 mg/l (Roy and Kumar, 2002). The deterioration of the quality of water was mainly due to the concentration of the total dissolved solids (Agarwal and Kannan, 1996). The high amount of the total suspended solids were observed in the drinking, borewell and sewage water samples collected from all the above three places. These results were positively correlated with Pitamahal Dam reservoir water in summer, winter and rainy seasons (Patel, 1999).The high amount of the total suspended solids is mainly due to the discharge of industrial and domestic waste (Palanivel and Rajaguru ,1999).

Table-3: Analysis of total coliform count by MPN test. (Cappuccino and Sherma, 1996)

Water sites and samples	Number of tubes positive test			MPN Index per 100ml
	3 of 10ml each	3 of 10ml each	3 of 10ml each	
S.N. Street				
Drinking water	3	1	1	75
Borewell water	0	0	0	<2
Sewage water	3	3	3	1600
N.N. Street				
Drinking water	0	0	0	<2
Borewell water	3	0	0	23
Sewage water	3	2	0	93
Thirunthangal				
Drinking water	0	0	0	<2
Borewell water	3	0	0	23
Sewage water	3	3	3	1600

The permissible limit of alkalinity in the water sample is 600 mg/l (ISI). Total alkalinity in the water samples, except borewell and sewage water of N.N street and sewage water of Thiruthangal were within the permissible level. This result was positively correlated with the borewell water of Chirala town at Prakasam district, which was in the range of 110 to 850 mg/l (Srinivasa Rao and Venkateswarlu, 1999). The reason for the high amount of the alkalinity in the water is due to the wastewater discharge from industries. The drinking and borewell water of all the above three places were noted to have less amount of free CO_2 value than the sewage water of all the above three places. Dissolved gases such as O_2, CO_2, H_2S might be present in the water due to the addition of impurities.

The level of the oxygen in water (3 to 5 mg/l) is an indicator of healthy state of water and values below 3 mg/l are hazardous to human. The dissolved oxygen values in the drinking and borewell water samples collected from all the above three places were more than 3 mg/l. These results were positively correlated with the dissolved oxygen values in the drinking water of Bhusawal Corporation, which ranged from 6.6 to 7.8 mg/l (Patil *et al.*, 2002). The dissolved oxygen contents were absent in the sewage water of all the above three places. The decomposition and oxidation of organic matter reduce the solubility of oxygen in water. The reason for the low dissolved oxygen content was due to high decomposition of organic matter, which indicates a high pollution load in the water. The deficiency of the oxygen in the water is shelter for bacteria and other pathogens, which are anaerobic and injurious to human health.

The total hardness (TH) represents the concentration of calcium and magnesium. The desirable limit of total hardness is 200 mg/l in water as per ISI. TH of the drinking water of all the above three places were within the desirable limit. TH of the borewell water and sewage water of all the above three places were high when compared with the desirable limit. This result was positively correlated with the total hardness of the water samples collected from Chirala Town at Prakasam district (Srinivasa Rao and Venkateswarlu, 1999). The high level of total hardness is due to mixing of sewage effluents into the river. The permanent hardness is mainly caused by chlorides and sulphates (Roy and Kumar, 2002). The desirable limit of calcium content in water is 75 mg/l. The calcium content in the drinking and borewell water of all the above three places and sewage water of S.N street were within the desirable limit. The calcium content in the sewage water of N.N. street and Thiruthangal exceeded the permissible limit. This result was positively correlated with the calcium content of the drinking water samples in eastern part of the Hisar at Haryana, where the calcium content ranged from 12 to 160 mg/l in the drinking water (Garg *et al*., 1999). The high quantity of calcium may be because of entry of calcium by leaching process of the rocks into the water body.

The desirable limit of magnesium in water is 50 mg/l as per ISI. The Mg content of the drinking water samples of all the above three places and the sewage water of N.N street were within the desirable limit. The remaining water samples exceeded the desirable limit. This result was positively correlated with the magnesium content of the water samples collected from the village of Velsao at Goa, which ranged from 60 to 110 mg/l (Subhadradevi Gandi *et al*., 2003). The high concentration of magnesium adversely effect domestic use of water.

The permissible limit of chloride content in water is 1000 mg/l. as per ISI. The Cl content of the drinking and borewell water of all the above three places and the sewage water of S.N. Street and N.N. Street were within the permissible limit. The Cl content of Thiruthangal sewage water exceeded the permissible limit. This result was positively correlated with the chloride content of the ground water in Prakasam district (Srinivasa Rao and Venkateswarlu, 1999). The high concentration of chloride is due to dissolution of salts, soil erosion and discharge effluents into the water sources. The salinity values in the drinking water samples collected from all the above three places were low in amount than other water samples. The reason for the high amount of salinity might be the dissolution of organic waste due to discharge of industrial effluents containing high concentration of chlorides.

The bacteriological analysis of water determines the potability of water. The Canadian maximum acceptable concentration of bacteria in the drinking water is 500 colonies per ml. All the water samples in the above three places were contaminated with high amont of bacterial population than Canadian acceptable limit. The reason for high number of bacterial colonies might be due to inadequate maintenance of water reservoirs and the percolation of sewage into borewell. The desirable limit of coliform in water is 10 MPN/100ml (ISI). The total coliform in the bore water of S.N. street, drinking water of N.N. street and Thiruthangal were with in the permissible evel (<2MPN/100ml). The same results of total coliforms were

also observed in the mineral water (Aqua natural water) in Bhusawel Corporation (Patil *et al*., 2002). The remaining water samples exceeded the desirable limit. The same results of the high number of total coliforms were observed in the Umian lake water in both pre monsoon and post monsoon seasons (Rajurkar *et al*., 2003). The reasons for the high number of total coliforms were due to the discharge of human and animal faces into the water bodies.

The *Escherichia coli* and *Klebsiella pneumoneae* are included in the faecal coliforms. All the water samples were contaminated with more number of faecal coliforms. It was positively correlated with the faecal coliform in the Umian lake water (Rajurkar *et al*., 2003). The more number of faecal coliform indicated the presence of faecal material from warm blooded animals. The faecal streptococci group comprises of *Streptococcus faecalis, S.bovis*, *S.equinus and S.avium,* since they commonly inhabit the intestinal tract of human and warm blooded animals. All kinds of water samples of S.N street and N.N street were not contaminated by faecal *streptococci.* The faecal *streptococci* group were found only in the drinking,borewell and sewage water samples of Thiruthangal. It was positively correlated with the faecal *streptococci* group in Ooranis and well water samples at Ramanathapuram district, in the range of 0.0 to 2.8 x 10 FS/100ml (Joshi *et al*., 2002). The reason for the high number of faecal streptococci might be due to addition of human and warm blooded animals excretae.

Most of the physicochemical parameters were found to be suitable for domestic uses even though, the bacterial parameters such as SPC, TCC, FCC and FSC exceeded the standard limit.Therefore boiling of water is essential before consumption of water by the people living in the S.N street, N.N Street and Thiruthangal.The sewage water must be pretreated and then disposed of into the environment for avoiding health hazards.

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