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European Journal of Experimental Biology, 2011, 1 (1):183-189



Physico Chemical and microbial assessment of drinking water from different water sources of Tiruchirappalli District, South India

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ABSTRACT

A study was undertaken to investigate the quality of drinking water samples in and around Tiruchirappalli district. Pollution of water bodies is one of the areas of major concern to environmentalists. Water quality is an index of health and well being of a society. Industrialization, urbanization, and modern agriculture practices have direct impact on the water resources. These factors influence the water resources quantitatively and qualitatively. Examination of the physico-chemical profiles of the bore well, open well and corporation water samples of Tiruchirappalli District, Tamil Nadu, India showed that the open wells were highly polluted with very high levels of total dissolved solids, total alkalinity and total hardness, and the bore wells with fluoride content higher than the permissible limit of the World Health Organisation. The deep aquifers had higher fluoride levels than the open well aquifers. Microbial pollution was recorded in 12.0% of bore wells, 11.1% of open wells and 6.3% of corporation water samples

Keywords: aquifers, drinking water quality, fluoride, microbial contamination, pollution.

INTRODUCTION

Water is the major constituent of all living things and needed by them for various purposes. The demand for quality drinking water had changed considerably with the development in olden days, the only requirement of drinking water was that it should be free flowing and non turbid. The need for better environment and health cannot be over emphasized. With increasing industrialization, urbanization, and growth of population, India's environment has become

fragile and has been causing concern [1]. Urbanization has direct impact on water bodies as the settlement takes place around the vicinity of water bodies and due to lack of space people have tendency to encroach upon the lake [2]. Ground water is the chief source of drinking water in India and this is only 0.61 % of the total available water on the Earth. [3] Reported that only 4% of world's freshwater resources are available in India while India inhabitants 14% of the world population. Indian population the per capita availability of water is steadily reducing; and when this drops below 1700 m³ / person / year, India will be water stressed.

Water is a good solvent and picks up impurities easily. Pure water is tasteless, colorless, and odorless is often called the universal solvent. When water is combined with carbon dioxide to form very weak carbonic acid, an even better solvent results. As water moves through soil and rock, it dissolves very small amounts of minerals and holds them in solution. Calcium and magnesium dissolved in water are the two most common minerals that make water "hard." The degree of hardness becomes greater as the calcium and magnesium content increases and is related to the concentration of multivalent cations dissolved in the water.

Excessive groundwater exploitation has resulted in lowering of water table in rural and urban areas of India. The water quality parameters decide the portability of water [4]. This paper evaluates the quality of drinking water from three different sources *viz.*, open wells, bore wells, and corporate water supply in the Tiruchirappalli District, Tamil Nadu, and India.

MATERIALS AND METHODS

Sites

The study was conducted in Tiruchirappalli district from October 2010 to March 2011. Sixty water samples were collected, 20 samples from the bore wells, 20 from the open wells and 20 from the corporation water of the present study area.

Sample Collection

Water samples were collected for both physiochemical and bacteriological analysis. Samples were collected during the day between 9:00 hrs and 13:00 hrs. Water samples for physiochemical and bacteriological analysis were collected aseptically in sterile containers and placed in a cooler at room temperature and transported to the Laboratory for analysis within 2 hours from collection. When immediate analyses were not possible, the samples were preserved at 4⁰C.

Laboratory sites

Physicochemical analyses (total hardness, total alkalinity, total dissolved solids and fluoride) were done following [5] for the assessment of drinking water quality. pH of water samples were recorded at the site during sampling period. Microbial studies were carried out by MPN method [6].

RESULTS AND DISCUSSION

Physiochemical analysis

The table presents physiochemical analysis of the water samples from different sources (Tables 1-3). Analysis of sample showed high levels of Total Dissolved Solids (TDS – 4020 mg/l), Total

Alkalinity (TA - 480 mg/l), Electrical Conductivity (EC – 820 mS), Total solids (TA - 4100 mg/l) and Salinity (3470 mg/l), in (open well) koothaipar were as pH (8.21) was high in (corporation water) panamangalam. Samayapuram (open well) recorded high level of Total Hardness (TH – 1571 mg/l). Bore well water samples recorded high levels of (TSS - 654 mg/l) Total Suspended Solids and Fluoride (F – 2.42) in Kondaiyam Pettai and Manachanallur water sample.

Table 1. Physico-Chemical profile of bore well water samples collected from Tiruchirappalli District, South India

Physio-chemical variable ^a											
S. No.	Place	Depth feet	pH	EC mS	Salinity mg/l	TA mg/l	TH mg/l	TS mg/l	TDS mg/l	TSS mg/l	F mg/l
1	Ammayapuram	198	6.87	1.20	510	246	395	604	547	48	0.98
2	Manapparai	180	7.09	1.29	649	325	475	798	684	109	2.09
3	Veerappur	132	7.84	2.36	1143	254	421	1321	1154	55	0.45
4	Kailashnagar	109	6.28	1.29	676	269	578	703	667	13	1.39
5	Thuvakkudi	103	6.84	4.65	2567	159	1257	2123	2507	53	1.65
6	Pappakurichi	125	6.43	5.49	2678	176	1490	2846	2745	49	1.37
7	Vengure	108	7.45	1.54	508	138	356	608	538	57	1.67
8	Cantonment	94	6.75	2.54	1189	254	598	1254	1189	34	1.09
9	Thilainagar	45	7.34	1.76	899	239	521	1023	965	29	1.21
10	Chatram bus stand	58	7.08	4.34	600	276	789	850	740	18	0.59
11	Uraiyur	62	6.43	4.98	2432	312	928	2650	2700	21	1.28
12	Kondaiyam Pettai	57	7.45	0.75	430	198	354	512	438	654	2.42
13	Anbil	49	7.87	4.87	2300	479	240	2245	2281	35	1.29
14	Lalgudi	56	7.81	1.80	650	320	451	1429	745	70	1.44
15	Valady	51	7.32	1.73	876	298	429	1050	949	56	1.25
16	Thalakkudi	48	7.35	1.34	650	287	387	765	645	87	1.39
17	Pettavathalai	65	7.50	2.18	1030	276	487	1131	1030	49	1.56
18	Manachanalur	100	7.64	0.65	315	139	219	410	325	73	2.34
19	Thuraiyur	198	5.56	2.65	1205	119	581	1450	1245	129	0.91
20	Venkadachalapuram	209	7.30	5.98	2830	198	1571	3040	2901	98	1.94

Microbiological analysis

The microbial study was performed on randomly selected 25 samples. Of the 25 samples, 20 samples were found to have microbial numbers within the maximum permissible limit of 1 coliform per 100 ml as per the safe drinking water act [7] . An open well sample at manthurai, somparasampetai (MPN: 28, 23/100 ml), a sample of corporation supply at sirugampure (MPN: 24/100 ml) and samples from three bore well sources at pappakurichi, Upliapuram and kondaiyampetai (MPN: 35, 29 and 42/100 ml, respectively) have registered positive presumptive test results. Immediate action is needed to circumvent this problem and necessary antimicrobial disinfectants should be employed in the water sources.

This study has presented the physiochemical and microbiological analysis of water samples taken from different area from Tiruchirappalli district.

The WHO Guidelines for drinking water quality states that the pH range of drinking water should fall between 6.5 and 8.0.

Table 2. Physico-Chemical profile of open well water samples collected from Tiruchirappalli District, South India

S.No	Place	Depth (feet)	Physio-chemical variable ^a								
			pH	EC (mS)	Salinity (mg/l)	TA (mg/l)	TH (mg/l)	TS (mg/l)	TDS (mg/l)	TSS (mg/l)	F (mg/l)
1	Manapparai	180	7.25	2.60	1350	180	600	790	980	70	1.50
2	Edaiyappatti	200	6.90	1.90	280	150	432	640	720	130	1.80
3	Seegampatty	240	7.50	3.20	380	193	357	810	1340	210	1.78
4	Milaguparai	75	5.75	2.50	430	128	298	730	2050	170	1.60
5	Maathur	60	7.00	2.80	315	217	216	1200	1040	360	1.45
6	Somasampetai	30	6.50	0.90	545	315	254	840	650	260	1.20
7	Kambarasampetai	25	7.80	1.75	350	180	382	620	1350	260	1.30
8	Mukkumbu	30	7.40	2.45	560	160	449	1020	730	250	1.98
9	Poovaloor	80	6.90	3.00	450	220	192	930	1030	340	1.60
10	Thiruvanaikovil	30	7.25	2.58	380	340	274	840	890	294	1.80
11	Manthurai	40	7.50	1.85	540	160	221	730	820	275	1.45
12	Ariyamangalam	35	5.80	2.45	510	164	260	600	480	120	1.80
13	Koothaipar	40	6.80	8.20	3470	482	510	4100	4020	360	1.40
14	Samayapuram	100	6.40	4.86	1780	280	1783	1230	2040	398	1.90
15	Aamoor	150	7.90	2.59	650	190	321	350	430	273	1.56
16	Sirugamboor	200	6.75	2.50	540	170	282	1080	850	239	1.60
17	Thiruvallari	180	7.65	3.10	580	168	359	930	740	154	1.74
18	Uppliyapuam	250	7.50	2.50	540	184	301	680	840	180	1.20
19	Koppampatti	280	6.90	1.50	450	191	217	740	820	258	1.28
20	Sobanapuram	230	5.70	2.75	580	238	240	820	1230	360	1.30

^aEC- Electrical Conductivity; TA-Total Alkalinity; TH-Total Hardness; TS- Total Solids; TDS-Total Dissolved Solids; TSS- Total Suspended Solids

Table 3. Physico-Chemical profile of corporation water samples collected from Tiruchirappalli District, South India

S.No	Place	pH	Physio-chemical variable ^a								
			EC (mS)	Salinity (mg/l)	TA (mg/l)	TH (mg/l)	TS (mg/l)	TDS (mg/l)	TSS (mg/l)	F (mg/l)	
1	Nachi kuruchi	6.82	1.09	320	131	197	480	356	47	1.20	
2	Puthanatham	7.83	0.74	340	160	230	400	400	34	0.98	
3	Thoppampatty	6.79	0.69	320	145	342	530	490	50	0.80	
4	Usilampatty	7.56	1.34	320	137	214	400	397	48	1.40	
5	Aangarai	7.64	0.87	330	129	254	440	450	35	0.93	
6	Thirumanamedu	6.76	0.67	340	165	276	400	390	45	0.85	
7	Ediyatrumangalam	8.04	0.95	430	161	320	480	345	32	1.00	
8	Ellakudi	7.47	0.71	320	189	534	410	450	40	0.89	
9	Allure	7.56	0.87	360	163	350	560	465	48	0.70	
10	Jeeyapuram	6.76	0.79	340	198	260	500	400	35	1.25	
11	KK nagar	6.45	0.99	350	134	180	430	387	40	1.30	
12	Palakkarai	7.54	0.68	320	167	540	480	470	32	1.15	
13	Ambikapuram	7.65	1.00	360	189	320	450	380	47	1.31	
14	Konalai	6.39	0.93	340	124	230	400	360	30	0.90	
15	Sirugannur	7.87	0.65	350	156	231	450	400	33	1.10	
16	Panamangalam	8.21	0.70	360	178	340	400	420	46	1.20	
17	Karattampatti	7.86	0.84	320	169	346	470	395	38	0.95	
18	Thuraiyur	7.21	0.93	340	183	430	400	370	39	0.90	
19	Sikkathumbur	6.54	0.76	340	149	320	450	346	40	1.30	
20	Vairichettipalayam	7.45	0.87	380	146	290	430	400	47	1.05	

^aEC- Electrical Conductivity; TA-Total Alkalinity; TH-Total Hardness; TS- Total Solids; TDS-Total Dissolved Solids; TSS- Total Suspended Solids

Table 4. Microbial analysis of the water samples collected from Tiruchirappalli District, South India

S.No	Sampling Place	Source	MPN Index per 100 m l
1	Amayapuram	BW	3
2	Manapparai	OW	<2
3	Usilampatti	PW	<2
4	Kondayampetai	BW	29
5	Vengure	BW	5
6	Milagu parai	OW	<2
7	Navalpattu	BW	<2
8	KK nagar	CW	<2
9	Somarasampetai	OW	23
10	Palakkari	CW	<2
11	Pappakurichi	BW	35
12	Ellakudi	CW	<2
13	Kailash nagar	BW	<2
14	Jeeyapuram	BW	21
15	Manthurai	OW	28
16	Poovalur	OW	<2
17	Konali	CW	<2
18	Valadi	BW	4
19	Sirugambur	CW	24
20	Manachanallur	BW	<2
21	Thuraiyur	OW	<2
22	Petavathalai	BW	5
23	Uppliapuram	PW	42
24	Koppampatti	OW	<2
25	Venkadachalapuram	BW	4

^aCW = Corporation water; ^aBW= Bore well water; ^aOW= Open well water;
^aPW= Panchayath water; ^bMost Probable Number

The current study found bore well, open well and corporation water samples ranged from 5.72 to 8.54, 6.70 to 7.90 and 6.39 and 8.21, respectively (Tables 1-3). The alkaline nature of bore well samples was greater than that of open well samples. Earlier report by [8] has also reported higher alkalinity in the bore well water of Pandharkawada area, Yavakmal district, Maharashtra, India. Generally low pH values obtained in the water might be due to the high levels of free CO₂ which may consequently affect the bacterial counts [9].

Fifty two percent of samples from bore wells, 22% from open wells, and 87% from corporation water samples fell within the permissible limit (1500 mg/l) of World Health Organization [4] with regard to TDS. The higher TDS in open well sources may be attributed to the percolation of effluents into these aquifers from various automobile and small scale industries located in the study area.

The high hardness of groundwater in the study area may be attributed to its open wells. The total alkalinity (TA) of the samples except an open well source at samayapuram (1783 mg/l) and two samples from corporation water supply at Ellakudi (534 mg/l) and Palakkari (540 mg/l) have exceeded the permissible limit of 120 mg/l [4].

The Fluoride level was within the allowable limit of 1.6 mg/l in 56% of the bore well samples, in 77% of the open well samples and 75% of the corporation water samples. The fluoride level in

the deeper aquifers was more than the shallow aquifers. Similar findings were reported by [10]; [11]; [8] in other parts of India. Fluoride is level from 0.7 to 1.2 mg/l is essential in drinking water [12] and its excess presence will be toxic resulting in dental fluorosis, skeletal fluorosis and non-vertebral fractures, especially hip fractures. Apart from fluorosis, high intake of fluorides may also cause gastrointestinal complaints such as loss of appetite, nausea, vomiting, ulcer pain in the stomach, constipation and intermittent diarrhoea and flatulence [13]; [14];[15];[16]. The adolescent age group is most vulnerable to fluoride pollution and it is a worldwide problem [4]. The samples exceeding the fluoride level greater than 1.5 mg/l are need to be defluorinated with immediate attention in order to prevent the negative impacts of high fluoride levels on human populations at the study area.

The higher the ionisable solids the greater will be the Electrical Conductivity (EC). In the present study area electrical conductivity ranged from 648 to 5880 mS in the bore well waters, 790 to 8100 mS in the open well waters and 635 to 4120 mS in the corporation waters.

Salinity ranged from 310 to 2820 mg/l in the bore well samples, 380 to 3860 mg/l in open well sources and from 310 to 1990 mg/l in the corporation water sources in the present study area, which are within the permissible limit of [4] for potable waters.

High levels of coliform bacteria were present in water samples taken from both source and point of use. Total coliform counts in most cases were >250 CFU/100mL, this was far above the accepted WHO standard (0 CFU). Thuraiyur open well and Koppampatti open well samples did not show such high total coliform counts.

The effects of drinking contaminated water results in thousands of deaths every day, mostly in children under five years, in developing countries [4]. In addition, diseases caused through consumption of contaminated water, and poor hygiene practices are the leading cause of death among children worldwide, after respiratory diseases [18]. Thus lack of safe drinking water supply, basic sanitation, and hygienic practices is associated with high morbidity and mortality from excreta related diseases.

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