

## Hydrochemistry of Groundwater of Thirumanur Area, Tamil Nadu (India)

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Perambalur is the most backward district in the state of Tamil Nadu (India). It has ten unions, of which Thirumanur union has historical importance and is blessed with fertile lands. Thirumanur union has Kollidam river and Pullambadi canal as rich sources of water for irrigation. Thirumanur union has large number of Chozha temples at various places like Thirumalapadi, Periyamanai, Kamarasavalli, Thoothur, Senapathimudikondan, Kandaradhitham, Keelapalur and Melapalur. Thirumanur union being the south end union of Perambalur district, has Trichy district and Tanjore district as its neighbours. Thirumanur union has an area of 64 hectare, of which 48 hectare is under cultivating land. This union has maximum number of thirty-six villages. Though most of the villages use river water as their major source of drinking, they also use groundwater as their other source. Lot of work has been done and published already on the groundwater quality of many villages in other different unions of the Perambalur district. But in the Thirumanur union, there was need to undertake the study to assess the drinking water quality in the region. Hence, ten villages of Thirumanur union were selected, where the people use groundwater for drinking, and the water samples were subjected to systematic analysis. The depth of the bore wells varied from 100-200 feet. The values obtained for different parameters were compared with the standard values given by ISI / ICMR / WHO and the variations were notable for the parameters like nitrate and total hardness for few samples. Therefore, a medical survey was carried out to study the harmful effects on the society due to these two parameters at the villages-Keelapazhur, Palanganatham and Venganur.

**Key words:** Potability, limestone deposits, methaemoglobinaemia

### Introduction

Although water pollution is an age old problem, in this modern age, the problems like growing population, sewage disposal, industrial waste, radioactive waste, etc. have polluted our water resources so much that about 70% rivers and streams, not only of India but of all the countries, contain polluted waters<sup>1</sup>.

### Materials and methods

Ten different villages at Thirumanur Union in Perambalur District, Tamil Nadu, India were selected (**Fig. 1**) for testing potability of drinking water sources. The sampling sites are rural places and the samples are the major sources of drinking for the villagers, which are all borewell water samples. The details of the samples are given in **Table 1**. Grab samples were collected in polythene bottles, which were previously cleaned. The analysis was carried out systematically both volumetrically and by instrumental techniques. The procedures were followed from standard books and manual<sup>2,3</sup>. The analysis was carried out immediately for pH, electrical conductivity, and odour and for all the other parameters within three hours

of sampling time. Analysis was carried out during April and May 2004.

### Results and discussion

Different physical parameters studied are appearance, colour, odour, taste, turbidity, electrical conductivity and total dissolved solids. The values obtained for these parameters are given in **Table 2**. Different chemical parameters studied are pH, alkalinity, total hardness, calcium, magnesium, iron, manganese, sodium, potassium, ammonia, nitrate, chloride, fluoride, sulphate and phosphate. The values obtained after the analytical study are given in **Table 3**. The values were compared with the standard values given by ISI and ICMR shown in **Table 4**.

Of the physical parameters studied, variations were observed for the parameters-electrical conductivity and total dissolved solids. The standard value for EC is 1500 microsiemens cm<sup>-1</sup> according to WHO<sup>4</sup>. The electrical conductivity value is an index to represent the total concentration of soluble salts in water<sup>5</sup>. The electrical conductivity value of sample S<sub>10</sub>, which is the sample of the

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**Table 1 :** Details of the sampling locations

Sample No.	Sampling location	Union	Population		
			Male	Female	Total
S <sub>1</sub>	KURUVADI	Thirumanur	1399	1382	2781
S <sub>2</sub>	THIRUMALAPADI	Thirumanur	1352	1366	2718
S <sub>3</sub>	KEELAPALUR	Thirumanur	2216	2172	4388
S <sub>4</sub>	ELAKURICHI	Thirumanur	3031	2855	5886
S <sub>5</sub>	ELENATHAIKUDAM	Thirumanur	2179	2330	4509
S <sub>6</sub>	THUTHOOR	Thirumanur	1359	1424	2783
S <sub>7</sub>	POONDI	Thirumanur	1895	2194	4089
S <sub>8</sub>	PALANGANATHAM	Thirumanur	1961	1990	3951
S <sub>9</sub>	SATHAMANGALAM	Thirumanur	1384	1333	2717
S <sub>10</sub>	VENGANUR	Thirumanur	1140	1184	2324

**Table 2 :** The values obtained for physical parameters in the study area.

Sr. Parameters No	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>5</sub>	S <sub>6</sub>	S <sub>7</sub>	S <sub>8</sub>	S <sub>9</sub>	S <sub>10</sub>
1 Appearance	Clear & Colourless	Clear & Colourless	Clear & Colourless	Clear & Colourless	Clear & Colourless	Clear & Colourless	Clear & Colourless	Clear & Colourless	Clear & Colourless	Clear & Colourless
2 Colour	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
3 Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4 Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
5 Turbidity (NTU)	1	1	1	1	1	1	1	1	1	1
6 Electrical conductivity Microsiemens cm <sup>-1</sup>	461	1205	1250	1190	1270	737	1212	1410	853	2260
7 TDS, mg/L	322	843	1575	833	889	515	1198	1827	618	2282

**Table 3 :** The values obtained for chemical parameters in the study area.

Sr. Parameters No	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>5</sub>	S <sub>6</sub>	S <sub>7</sub>	S <sub>8</sub>	S <sub>9</sub>	S <sub>10</sub>
1 P <sup>H</sup>	7.2	7.2	7	7.5	7.4	7.5	7.5	7.1	7.3	7.1
2 Alkalinity	164	248	268	386	316	268	296	480	180	392
3 Total Hardness	88	340	800	308	256	200	300	472	240	480
4 Calcium	21	80	76	74	62	48	57	104	45	73
5 Magnesium	8	33	146	30	24	19	32	50	30	71
6 Iron	0	0	0.2	0	0	0	0	0.4	0	0
7 Manganese	0	0	0	0	0	0	0	0	0	0
8 Sodium	14	136	292	158	161	62	280	380	88	490
9 Potassium	3	54	152	32	36	16	72	138	22	176
10 Ammonia	0	0	0	0	0	0	0	0	0	0
11 Nitrite	0	0	0	0.19	0.11	0.14	0	0.4	0	0.1
12 Nitrate	6	56	155	16	16	6	57	107	65	145
13 Chloride	36	134	430	130	170	71	275	375	103	600
14 Fluoride	0.6	0.4	0.2	0.2	0.2	0.2	0.6	0.6	0.2	0.4
15 Sulphate	10	69	45	42	106	13	85	239	85	186
16 Phosphate	0	0.72	0	0	0	0.96	0	0	0	0.72
17 Tidy's	0	0.1	0	0	0	0.1	0	0	0	0.1

Except pH, all values are given in mg/L

**Table 4 :** Standard values for potability

Sr.No.	Parameters	ISI Standard
<i>Physical Parameters</i>		
1	Appearance	Clear & colour less
2	Colour	Colourless
3	Taste	Tasteless
4	Odour	Odourless
5	Turbidity	10 NTU
6	Electrical Conductivity	—
7	TDS	1500 - 3000 (ICMR)
<i>Chemical Parameters</i>		
1	pH	6.5 to 8.5*
2	Alkalinity	600
3	Total Hardness	600
4	Calcium	200
5	Magnesium	100
6	Iron	1
7	Manganese	0.3
8	Sodium	—
9	Potassium	—
10	Ammonia	1.0
11	Nitrite	1.0
12	Nitrate	100
13	Chloride	1000
14	Fluoride	1.5
15	Sulphate	400
16	Phosphate	1.0
17	Tidy's	1.0

\* Except pH the values for all the parameters are given in mg/L.

ICMR - Indian Council of Medical Research.

ISI - Indian Standard Institution.

village Venganur, was found to exceed the standard value given by WHO. Though the variation is less, it is notable. It is observed that waters with high electrical conductivity values are predominant in sodium and chloride ions. While concentrations of both ions are considered together for all ten samples, sample S<sub>10</sub> alone was found to have both the ions at higher concentration. The reason behind this may be continuous usage of synthetic fertilizers and minerals.

A medical survey was carried out in three villages-Keelapazhur, Palanganatham and Venganur, where the values of nitrate were observed high. The doctors of these villages were contacted and enquired about occurrence of methaemoglobinaemia, the disease otherwise called as blue baby syndrome. People staying at various locations in these villages were enquired of early death of infants after the body becoming blue. From the survey, it was revealed that no medical report on such disease was observed. The drinking water source of the village Keelapazhur (S<sub>3</sub>) having highest value of total hardness among all the samples, was expected to have harmful effects, like kidney stone formation and other related

diseases. The villagers were surveyed for these diseases, and rare occurrence was reported.

The sample S<sub>10</sub>, which is a drinking water source of Venganur was found to have the highest value of total dissolved solids (TDS) as 2280 mg/L compared with other nine samples. The highest value of TDS could be due to low water levels within the aquifers and sediment effect<sup>6</sup>. Dissolved material results from the solvent action of water on solids, liquids and gases. Like suspended material, dissolved substances may be organic or inorganic in nature. Inorganic substances may be dissolved in water. Water may come in contact with these substances in the atmosphere, on surfaces and within the soil. Decay products of vegetation, organic chemicals and gases are common organic dissolved constituents of water<sup>7</sup>.

Among the different chemical parameters analysed, variations were observed comparing with the standard values for the parameters-total hardness (TH) and nitrate. Sample S<sub>3</sub>, the drinking water source of the village Keelapazhur was found to have the TH value as 800 mg/L. Keelapazhur is 11 kilometers from Ariyalur and Ariyalur has limestone deposits. So the greatest value of total hardness was found due to dissolution of limestone, natural accumulation of salts in contact with soil and geological formation. Al<sup>3+</sup> and Fe<sup>3+</sup> may also contribute to the hardness of water. About 600 million years ago, Ariyalur was under sea. Sea receded from this locality during late cretaceous period, which resulted in the formation of terrestrial ecosystem. Therefore, it is a rich source of limestone deposits and fossils ranging from protozoa to vertebrates<sup>9</sup>. The values of sodium and potassium ions were found comparable with the values reported by Sudarshan<sup>4</sup>. The desirable nitrate value for drinking water prescribed by ISI is 100mg/L. The values of nitrate for all water samples, except S<sub>3</sub>, S<sub>8</sub> and S<sub>10</sub> were found within the permissible limit. The samples S<sub>3</sub>, S<sub>8</sub> and S<sub>10</sub> were taken from the drinking water sources at the villages Keelapazhur, Palanganatham and Venganur respectively. The main source of nitrate pollution was found to be the heavy use of nitrate fertilizers in these regions. All these three places have plenty of cultivating land and this may be the reason for excess nitrate ions. The major contributors of nitrate in groundwater are decaying organic matter, sewage, burnyard wastes and nitrate fertilizers. Biological oxidation of nitrogenous substances that come in sewage and industrial waste or produced indigenously in the waste<sup>5</sup> is also an important source of nitrate in ground water.

### Conclusion

Among 10 borewell water samples analysed, except three samples, all the samples were found to have the values according to the standard values prescribed by ISI/ICMR for all the parameters. The samples S<sub>3</sub>, S<sub>8</sub> and S<sub>10</sub> after analysis

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revealed that the water needs denitrification and ion exchange process in addition. General filtration methods should be adopted for all the samples and especially for  $S_3$ ,  $S_8$  and  $S_{10}$ . The medical survey reports revealed that there were no adverse effects observed on the people.

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