

SURVEY ON THE WATER QUALITY PARAMETERS OF FISH CULTURE PONDS OF THIRUVARUR DISTRICT

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Abstract: Water is a boundary of nature to the mankind and plays a pivotal role for the survival of all living organisms. Quality of ecosystem depends upon the physicochemical characteristics and biological diversity of the system. Hence an attempt has been made to study the physicochemical characters of fish culture ponds of Thiruvavarur District. All the physicochemical factors showed significant fluctuation from one region to another depending upon the soil properties. The heavy metals were found to be trace. Water quality largely depend upon the volume of water and water quality, generally domestic sewage with <50 ppm. BOD value is good depending upon the climatic conditions and their hydro biological soil qualities.

Keywords: fish, physicochemical parameters, BOD, trace, properties.

1. INTRODUCTION

Water is the most common solvent used in the general chemistry laboratory and is present in nearly all reaction mixtures studied in the typical teaching lab. Ex-biologists remind us of the literally "Vital" importance of water as they search for other planetary bodies which spot liquid water. Water is essential for "as we know it" whether one considers the high water content of even the simplest organisms, the speed with which chemical reaction occur in aqueous solution or ability of water to facilitate ion transport.

Water is boundary of nature to the man kind and plays a pivotal role for the survival of all living organisms. Water occupies about 71% of our planet Earth surface, whereas, the land part is only 29% .Of the 71% of water and only 3% constitute fresh water, which is present in ice caps, glaciers, rivers, lakes, ponds and streams. Aquaculture has been the tradition several parts if Asia. At present Aquaculture are the world's fastest growing food production sectors. In recent years aquaculture is being projected as possible solution to food problems faced by masses, it gives higher productivity per unit as compared to agriculture and animal husbandry (Bhuiyan and Gupta, 2007; Shiddamallaya and Pratima, 2008).

Aquatic ecosystems are particularly vulnerable to environmental change and many are, at present severely degraded. The availability of good quality water is an indispensable feature for preventing disease and improving quality of life. The physico chemical properties will also help in the identification of sources of pollution, for conducting further investigations on the exobiological impacts and also for initiating necessary steps for remedial actions in case of polluted water bodies. Therefore, the nature and health of any aquatic community are an expression of quality of the water. In recent years, increasing in human population, demand for food, land concession, and use of fertilizer have led to faster degradation of many fresh water resources. The discharge of urban, industrial, and agricultural waste has added the quantum of various harmful chemicals to the water body considerably altering their inherent physico-chemical characteristics. The monitoring of quality of such surface water by estimating hydro biological parameters is among the

major environmental priorities as it permits direct assessment of the status of ecosystems that are exposed to deleterious anthropogenic factors. The alteration in physico-chemical parameters leading to eutrophication has become a widely recognized problem of water quality deterioration (Venkatesharaju *et al.*, 2010; Fella Hamaidi-Chergui *et al.*, 2013). In order to utilize fresh water bodies successfully for fish production it is very important to study the physico-chemical factors, which influence the biological productivity of the water body (Tapashi Gupta and Mithra Dey, 2013). Nadeem (1994) studies on the effect of seasonal changes on physico-chemical parameters of Indian river water. Evaluation at physico-chemical and microbiological parameters of Vyazadi reservoir water (Agarkar and Garode, 2000). Steffii fried Brenden Mackie and Erin Nothwhr (2003) reported the nitrate and phosphate levels positively affect the growth of algae species found in Perry pond. Pullie and Khan (2003) studies on dissolved nutrients of Isapur Dam India. Mali and Gajaria (2004) studied the assessment of primary productivity and hydro biological characterization of a fish culture pond. Sachidananda Murthy and Yajusvedi (2006) studied the physico-chemical parameters at an aquaculture body in Mysore city. FAO (2012) the state of world fisheries and aquaculture. Shankar Ganesh *et al.* (2012) studied the isolation and identification of *Vibrio* sp. in *Channa paunctatus* from aquaculture form. Hunt *et al.* (2013) reported the chlorides in freshwater Water pond monitoring Manuali. Chandrakala *et al.* (2013) studied the comparative study on the antivibrio activity of *Vibrio* species, isolated from *Penaeus monodon*, *Sillago sihama* against species.

2. MATERIALS AND METHODS

The data for the present study were collected from November 2013 to March 2014 in freshwater fish culture ponds of Maruthapattinam, Mangudi, Aravathur and Srinivasapuram of Thiruvarur district, Tamil Nadu, India. The pH of the rearing water were recorded using the digital pH meter. By using thermometer the temperature of the rearing water was recorded. The various parameters such as colour, odour and electrical conductivity (dsm^{-1}) were analyzed. Anions such as carbonate, bicarbonate, sulphate, silicate, nitrite, fluoride and ammonium were analyzed. And the cations such as magnesium, sodium, potassium and zinc were analyzed. The heavy metals such as zinc, copper, iron, manganese, chromium, nickel, cadmium and lead were analyzed. Above said various parameters were analyzed at Soil Testing Laboratory, Tiruchirappalli.

3. RESULTS

The observations for physico-chemical parameters of water samples were collected from Maruthapattinam, Mangudi, Arvathur and Srinivasapuram along the Thiruvarur district, Tamilnadu. The observation revealed that the pH was neutral. All the parameters were high in November 2013 and low in February 2014. It is due to the nature of soil and seasons (Table1-4).

4. DISCUSSION

The physico-chemical and biological factors in the aquatic ecosystem either directly or indirectly affect the life activities of each and every organism in the culture system. The physical parameters such as temperature, pH, turbidity, total dissolved solids, alkalinity, Electrical conductivity, BOD and COD, Anions (Carbonates, Chloride, bicarbonates, sulphate, phosphate, silicate, trace elements). The cations such as calcium, magnesium, sodium and potassium and heavy metals of the freshwater fish culture pond. The hydrogen ion concentration of pH is important hydro biological parameters, which influence the growth and metabolism of aquatic organism. In the present study pH of the culture pond showed slight fluctuation. It was found to the alkaline range throughout the study period.

Turbidity or transparency is another important factor which has to be maintained in culture pond. Turbidity of water is caused by dissolved and suspended solids, dust particles, clay or slits and plank tonic organisms. The level of turbidity depends upon the bottom of the pond and depth of the water. The turbidity plays an important role in the productivity of the pond thereby controlling other physical factors. The penetration of light is affected by turbidity and therefore the temperature of water which also affected. In the present study transparency showed significant fluctuation but no seasonal variations. In the present study agrees with earlier observations (Haldar, 1990; Namal Kishone and Sanjay Kumar, 1992; Fisher *et al.*, 1998). The trace elements (or) cations calcium, magnesium, sodium and potassium were found in moderate amount. All most all the trace elements gradually decreased from November to February, 2014. It showed that there was a fluctuation irrespective seasons. The present study agrees with earlier observations (Faturoti *et al.*, 1995; Dhaman and Kaur, 2002, Said *et al.*, 2004; Krongkrkai, 2006; Ayse *et al.*, 2008).

Hulyal and Kaliwal (2011) reported the electrical conductivity is also important parameters of water and it depends on the nature and concentration of ionized salts. The more conductivity of water the lesser is its resistance to electric flow, thereby indicating higher concentration of dissolved salts and higher tropic status of the system. The electrical conductivity of water is due to ionization of dissolved organic and inorganic solids and becomes a major of total dissolved solids. The electrical conductivity is used as an index to select the suitability of water for agricultural purpose.

BOD indicates the presence of organic load in a water body, the maximum tolerance limit of which is 3 ppm for public water. BOD is the amount of oxygen required by the living organisms engaged in the utilization and ultimate destruction or stabilization of the organic matter (Hawkes, 1963). In the present investigation decrease in the BOD in November, December, January and February at the all samples.

COD determination is a measure of oxygen equivalent of the portion of the organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant. The COD values were higher which might be attributed to the nutrient enrichments, high salinity and sulphate content. In the present study COD range from 64.5 mg/L to 10.5 mg/l in all samples at November at 2013 to February 2014. COD is an important parameter for stream and industrial waste studies and control of waste treatment plants. In conjunction with the BOD test, the COD test is helpful in indicating toxic condition and the presence of biologically resistant organic substances (Usha *et al.*, 2006).

Hardness often employed as indicator of water quality depends on the concentration of carbonates and bicarbonates salts of calcium and magnesium carbonates and bicarbonates as reposed in their study on seasonal variations of abiotic factors of Manjara project eater reservoir in dist. Beed, Maharashtra, India (Chavan *et al.*, 2005). Increase in carbonates and bicarbonates in water may be due to leaching of rocks and dissolution by found waters as respond by (Resha Bhalla *et al.*, 2007). In the present study carbonates and bicarbonates were found to be higher in November 2013 and lower in February 2014 in all samples. In the present investigation all water quality parameters showed gradual decreased from November to February. The physical and chemical characteristics of water showed seasonal fluctuations interacting with one another and have a combined effect on animals and plants. Factors controlling the composition of natural waters are extremely named and include physical, chemical and biological processes.

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Table 1: Physico-chemical parameters of water samples in Thiruvapur district (November 2013)

S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
PHYSICAL PARAMETERS									
1.	Colour		> 1 hue		> 1 hue		> 1 hue		> 1 hue
2.	Odour				Agreeable		Agreeable		Agreeable
3.	Turbidity	14 15 16	15.3 ± 1.2	2 5 7	4.6 ± 2.0	19 20 23	20.6 ± 1.7	23 25 27	24.6 ± 1.6
4.	Total dissolved solids (mg/l)	605 608 609	607.3 ± 1.7	553 557 559	556.3 ± 2.4	680 682 685	682.3 ± 2.0	791 794 795	793.3 ± 1.7
5.	pH	7.63 7.69 7.70	7.67 ± 2.2	7.90 7.93 7.98	7.93 ± 0.9	8.07 8.10 8.12	8.09 ± 2.1	8.15 8.20 8.23	8.19 ± 1.9
6.	Electrical conductivity (dSm ⁻¹)	0.90 0.95 0.97	0.94 ± 1.9	0.83 0.87 0.88	0.86 ± 2.1	1.01 1.06 1.07	1.04 ± 2.5	1.23 1.26 1.27	1.25 ± 1.7
7.	BOD (mg/l)	1.84 1.85 1.90	1.86 ± 0.2	1.75 1.76 1.79	1.76 ± 0.16	1.80 1.82 1.88	1.83 ± 0.3	1.91 1.96 1.98	1.95 ± 0.2
8.	COD (mM/l)	50 56 57	54.3 ± 3.1	53 57 60	56.6 ± 2.8	60 62 69	63.6 ± 3.8	60 64 69	64.3 ± 3.6

S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
ANIONS									
9.	Carbonate (mg/l)		Nil		Nil	0.49 0.52 0.58	0.53 ± 1.3	0.60 0.62 0.69	0.63 ± 2.1
10.	Bicarbonate (mg/l)	251 256 259	255.3 ± 3.3	243 248 249	246.3 ± 2.6	260 262 269	263.3 ± 3.8	214 216 220	216.6 ± 2.4
11.	Chloride (mg/l)	187 189 190	188.6 ± 1.2	172 178 179	176.3 ± 3.0	180 196 197	191 ± 7.7	181 187 189	185.6 ± 2.9
12.	Sulphate (mg/l)	81 89 90	86.6 ± 4.0	91 97 100	96 ± 3.7	89 96 100	95 ± 4.5	181 187 189	185.6 ± 2.9
13.	Phosphate (mg/l)	0.01 0.06 0.19	0.05 ± 1.3	0.01 0.02 0.09	0.04 ± 2.2	0.02 0.03 0.10	0.05 ± 2.3	0.01 0.05 0.10	0.06 ± 1.5
14.	Silicate (mg/l)	4.20 4.26 4.30	4.25 ± 1.4	4.51 4.59 4.60	4.56 ± 2.0	4.62 4.68 4.70	4.66 ± 1.6	5.02 5.06 5.15	5.07 ± 1.8
15.	Nitrate (mg/l)	0.21 0.23 0.28	0.24 ± 1.9	0.15 0.21 0.30	0.22 ± 2.0	0.20 0.21 0.29	0.23 ± 2.3	0.14 0.25 0.29	0.22 ± 2.6

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S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
16.	Nitrite (mg/l)		Nil		Nil		Nil		Nil
17.	Fluoride (mg/l)	5.62 5.69 5.72	5.67 ± 1.7	5.17 5.21 5.32	5.23 ± 2.2	5.30 5.42 5.50	5.40 ± 1.1	5.40 5.48 5.51	5.46 ± 1.8
18.	Aluminium (mg/l)		Nil		Nil		Nil		Nil
CATIONS									
19.	Calcium (mg/l)	246 250 259	251 ± 5.4	209 214 221	230 236 240	235.3 ± 4.1	251 259 260	256.6 ± 4.0	
20.	Magnesium (mg/l)	121 126 130	125.6 ± 3.6	122 129 130	127 ± 3.5	130 136 139	135 ± 3.7	131 135 140	135.3 ± 3.6
21.	Sodium (mg/l)	53 65 70	62.6 ± 7.1	66 67 73	68.6 ± 3.0	50 54 60	54.6 ± 4.1	50 59 60	56.3 ± 4.4
22.	Potassium (mg/l)	0.10 0.13 0.21	0.14 ± 1.5	0.10 0.18 0.20	0.16 ± 1.7	0.11 0.16 0.26	0.15 ± 1.3	0.10 0.19 0.25	0.18 ± 2.0
TRACE ELEMENTS									
23.	Zinc (mg/l)	0.01 0.06 0.15	0.07 ± 1.9	0.00 0.02 0.09	0.03 ± 2.1	0.00 0.03 0.13	0.05 ± 2.0	0.00 0.05 0.15	0.06 ± 2.0
24.	Copper (mg/l)	0.00 0.01 0.10	0.03 ± 2.4	0.00 0.01 0.07	0.08 ± 1.5	0.00 0.02 0.11	0.04 ± 1.8	0.00 0.02 0.15	0.05 ± 1.9
25.	Iron (mg/l)	0.00 0.05 0.16	0.07 ± 2.3	0.00 0.06 0.18	0.08 ± 1.8	0.01 0.05 0.19	0.08 ± 2.1	0.00 0.04 0.13	0.05 ± 1.8

S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
26.	Manganese (mg/l)	0.00 0.02 0.12	0.04 ± 2	0.00 0.02 0.17	0.06 ± 1.3	0.0 0.2 0.9	0.36 ± 0.3	0.00 0.02 0.19	0.07 ± 1.5
27.	Chromium (mg/l)		Nil		Nil		Nil		Nil
28.	Lead (mg/l)		Nil		Nil		Nil		Nil

Sample I - Maruthapattinam

Sample II - Mangudi

Sample III - Aravathur

Sample V - Srinivasapuram

Table 2: Physico-chemical parameters of water samples in Thiruvavur district (December 2013)

S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
	PHYSICAL PARAMETER								
1.	Colour		< 1 hue		< 1 hue		< 1 hue		< 1 hue
2.	Odour				Agreeable		Agreeable		Agreeable
3.	Turbidity	13 15 24	17 ± 4.7	16 20 29	21 ± 5.4	12 15 19	15.3 ± 2.8	6 10 19	11 ± 5.5
4.	Total dissolved solids (mg/l)	625 627 632	628 ± 2.9	469 474 478	473 ± 3.7	554 570 580	568 ± 10.7	472 480 494	482 ± 9.0
5.	pH	7.00 7.02 7.08	7.03 ± 1.8	7.09 7.16 7.29	7.18 ± 2.0	7.19 7.23 7.38	7.26 ± 2.1	7.04 7.19 7.32	7 ± 0.7
6.	Electrical conductivity (dSm ⁻¹)	0.62 0.98 0.99	0.65 ± 0.6	0.64 0.74 0.88	0.75 ± 0.5	0.72 0.89 0.95	0.85 ± 0.7	0.61 0.75 0.79	0.71 ± 0.7
7.	BOD (mM/l)	2.7 2.8 2.6	2.7 ± 0.3	2.4 2.5 2.3	2.4 ± 0.6	2.7 2.8 2.6	2.7 ± 1.4	2.7 2.5 2.3	2.5 ± 0.8
8.	COD (mM/l)	19 25 29	24 ± 5.6	16 29 39	28 ± 9.4	25 32 43	33.3 ± 7.7	23 35 45	34.3 ± 8.9
ANIONS									
9.	Carbonate (mg/l)		Nil		Nil		Nil		Nil
10.	Bicarbonate (mg/l)	119 129 135	125.6 ± 6.7	135 145 150	143.3 ± 3.6	120 126 139	128.3 ± 4.5	139 143 149	143.6 ± 4.1
11.	Chloride (mg/l)	139 148 155	147.3 ± 6.5	145 156 169	156.6 ± 9.8	133 147 159	146.3 ± 10.6	143 159 161	154.3 ± 8.0
12.	Sulphate (mg/l)	51 65 70	62 ± 8.0	53 68 70	63.6 ± 7.4	41 57 63	53.6 ± 9.2	32 49 56	45.6 ± 10.0
13.	Phosphate (mg/l)	0.00 0.02 0.15	0.05 ± 1.9	0.00 0.03 0.20	0.07 ± 0.85	0.04 0.05 0.23	0.10 ± 1.4	0.00 0.02 0.25	0.09 ± 2.0
14.	Silicate (mg/l)	4.42 4.56 4.60	4.52 ± 1.6	4.19 4.25 4.39	4.27 ± 1.5	4.09 4.19 4.23	4.17 ± 2.1	4.10 4.17 4.29	4.18 ± 1.5
15.	Nitrate (mg/l)	0.03 0.05 0.12	0.06 ± 1.8	0.04 0.06 0.23	0.11 ± 1.5	0.02 0.04 0.19	0.11 ± 1.3	0.03 0.08 0.18	0.09 ± 1.3

S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
16.	Nitrite (mg/l)		Nil		Nil		Nil		Nil
17.	Fluoride (mg/l)	2.43 2.59 2.68	2.56 ± 1.7	2.58 2.65 2.71	2.64 ± 2.1	2.34 2.48 2.54	2.45 ± 0.5	2.34 2.47 2.58	2.46 ± 0.6
18.	Aluminium (mg/l)		Nil		Nil		Nil		Nil
CATIONS									
19.	Calcium (mg/l)	79 80 81	81 ± 7.7	74 75 76	76 ± 10.2	70 74 80	74.6 ± 4.1	80 86 89	85 ± 3.7
20.	Magnesium (mg/l)	55 56 57	54.3 ± 3.1	50 51 52	36 ± 17.0	53 54 55	55.3 ± 3.3	58 59 60	58.6 ± 3.6
21.	Sodium (mg/l)	20 26 29	25 ± 3.7	24 25 26	24.6 ± 1.6	22 23 24	24.6 ± 3.0	19 20 21	20.6 ± 1.7
22.	Potassium (mg/l)	0.11 0.12 0.13	0.13 ± 1.0	0.00 0.14 0.19	0.11 ± 2.2	0.15 0.16 0.17	0.15 ± 1.3	0.00 0.12 0.15	0.09 ± 2.6
TRACE ELEMENTS									
23.	Zinc (mg/l)	0.01 0.02 0.03	0.05 ± 1.9	0.01 0.02 0.03	0.06 ± 1.3	0.01 0.02 0.03	0.04 ± 2.0	0.02 0.03 0.04	0.05 ± 2.0
24.	Copper (mg/l)	0.00 0.01 0.02	0.02 ± 1.5	0.01 0.02 0.03	0.04 ± 2.0	0.00 0.01 0.02	0.03 ± 2.4	0.01 0.02 0.03	0.05 ± 3.5
25.	Iron (mg/l)	0.04 0.05 0.06	0.06 ± 2.1	0.05 0.06 0.07	0.08 ± 1.8	0.01 0.02 0.03	0.03 ± 2.1	0.02 0.03 0.04	0.04 ± 1.9
26.	Manganese (mg/l)	0.00 0.01 0.02	0.02 ± 1.2	0.02 0.03 0.04	0.05 ± 2.0	0.01 0.02 0.03	0.05 ± 1.9	0.02 0.03 0.04	0.05 ± 1.3
27.	Chromium (mg/l)		Nil		Nil		Nil		Nil
28.	Lead (mg/l)		Nil		Nil		Nil		Nil

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- Sample I - Maruthapattinam
Sample II - Mangudi
Sample III - Aravathur
Sample V - Srinivasapuram

Table 3: Physico-chemical parameters of water samples in Thiruvavur district

S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
PHYSICAL PARAMETER									
1.	Colour		< 1 hue		> 1 hue		> 1 hue		> 1 hue
2.	Odour				Agreeable		Agreeable		Agreeable
3.	Turbidity	8 10 14	11 ± 2.5	6 10 16	10.6 ± 4.0	12 15 19	15.3 ± 2.8	6 10 18	11.3 ± 4.9

4.	Total dissolved solids (mg/l)	442 445 449	445.3 ± 2.8	433 435 439	435.6 ± 2.5	375 378 379	377.3 ± 1.7	459 461 466	462 ± 2.9
5.	pH	7.10 7.15 7.22	7.16 ± 1.6	7.8 7.12 7.16	7.36 ± 0.3	7.22 7.26 7.29	7.25 ± 1.9	7.24 7.26 7.29	7.26 ± 2.0
6.	Electrical conductivity (dSm ⁻¹)	0.53 0.69 0.72	0.66 ± 2.2	0.63 0.68 0.70	0.67 ± 1.9	0.51 0.59 0.64	0.58 ± 1.8	0.69 0.72 0.73	0.71 ± 1.7
7.	BOD (mg/l)	2.7 2.8 2.6	2.7 ± 1.4	2.7 2.8 2.6	2.7 ± 0.3	2.7 2.5 2.3	2.5 ± 0.8	2.3 2.5 2.3	2.33 ± 0.8
8.	COD (mM/l)	19 20 28	22.3 ± 4.0	22 23 29	24.6 ± 3.0	23 25 28	25.3 ± 2.0	27 29 33	29.6 ± 2.6
ANIONS									
9.	Carbonate (mg/l)		Nil		Nil	0.49 0.52 0.58	0.53 ± 1.3	0.60 0.62 0.69	0.63 ± 2.1
10.	Bicarbonate (mg/l)	117 118 120	118.3 ± 1.2	122 124 129	125 ± 2.9	105 106 109	106.6 ± 1.7	129 130 134	131 ± 2.1
11.	Chloride (mg/l)	114 116 119	116.3 ± 2.0	115 119 121	125 ± 2.9	103 105 109	105.6 ± 2.4	141 142 145	146 ± 3.7
12.	Sulphate (mg/l)	51 56 59	53.3 ± 3.8	54 59 63	58.6 ± 3.6	52 54 60	55.3 ± 3.3	61 62 68	63.6 ± 3.0
13.	Phosphate (mg/l)	0.01 0.03 0.08	0.04 ± 1.8	0.01 0.02 0.12	0.05 ± 1.9	0.01 0.02 0.15	0.06 ± 1.1	0.02 0.03 0.11	0.05 ± 2.0
14.	Silicate (mg/l)	3.65 3.69 3.72	3.678 ± 1.9	3.53 3.58 3.62	3.57 ± 0.4	3.43 3.45 3.50	3.46 ± 1.9	3.53 3.56 3.59	3.56 ± 2.4
15.	Nitrate (mg/l)	0.00 0.01 0.06	0.02 ± 1.2	0.00 0.01 0.02	0.02 ± 1.3	0.01 0.03 0.08	0.04 ± 1.9	0.01 0.02 0.09	0.04 ± 2.0

(January 2014)

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S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
16.	Nitrite (mg/l)		Nil		Nil		Nil		Nil
17.	Fluoride (mg/l)	2.14 2.15 2.20	2.16 ± 1.4	2.33 2.36 2.42	2.37 ± 0.4	2.03 2.05 2.13	2.07 ± 1.3	2.12 2.14 2.25	2.17 ± 2.4
18.	Aluminium (mg/l)		Nil		Nil		Nil		Nil
CATIONS									
19.	Calcium (mg/l)	64 68 75	69 ± 4.5	62 65 67	64 ± 2.1	63 64 72	66 ± 4.0	61 62 67	63 ± 2.6
20.	Magnesium (mg/l)	53 56 57	55 ± 1.7	38 42 45	41 ± 2.9	40 46 47	44 ± 3.1	37 40 46	41 ± 3.7
21.	Sodium (mg/l)	11 16 18	15 ± 2.9	13 18 22	17 ± 3.7	17 19 29	21 ± 5.2	15 22 28	21 ± 5.3

S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
22.	Potassium (mg/l)	0.02 0.06 0.08	0.05 ± 2.5	0.04 0.05 0.09	0.06 ± 2.1	0.06 0.10 0.13	0.09 ± 1.9	0.05 0.11 0.24	0.13 ± 1.8
HEAVY METALS									
23.	Zinc (mg/l)	0.00 0.01 0.06	0.02 ± 1.2	0.00 0.01 0.23	0.04 ± 1.9	0.01 0.02 0.12	0.06 ± 1.1	0.00 0.02 0.09	0.04 ± 2.0
24.	Copper (mg/l)	0.01 0.02 0.16	0.06 ± 3.5	0.00 0.01 0.23	0.08 ± 1.9	0.01 0.02 0.13	0.06 ± 3.5	0.00 0.01 0.06	0.02 ± 1.2
25.	Iron (mg/l)	0.02 0.06 0.08	0.05 ± 2.5	0.03 0.05 0.12	0.06 ± 1.8	0.02 0.06 0.08	0.05 ± 2.5	0.02 0.04 0.15	0.07 ± 2.4
26.	Manganese (mg/l)	0.02 0.03 0.04	0.04 ± 1.8	0.01 0.02 0.16	0.06 ± 1.1	0.03 0.05 0.12	0.06 ± 1.9	0.01 0.02 0.03	0.04 ± 2.0
27.	Chromium (mg/l)		Nil		Nil		Nil		Nil
28.	Lead (mg/l)		Nil		Nil		Nil		Nil

Sample I - Maruthapattinam

Sample II - Mangudi

Sample III - Aravathur

Sample V - Srinivasapuram

Table 4: Physico-chemical parameters of water samples in Thiruvarur district

S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
PHYSICAL PARAMETER									
1.	Colour		< 1 hue		< 1 hue		< 1 hue		< 1 hue
2.	Odour				Agreeable		Agreeable		Agreeable
3.	Turbidity	4 5 6	5 ± 0.8	2 5 7	4.6 ± 2.7	3 5 8	5.3 ± 2.6	2 5 10	5.6 ± 3.8
4.	Total dissolved solids (mg/l)	356 359 360	358.3 ± 1.7	344 346 349	346 ± 2.0	319 320 322	320 ± 1.2	388 390 395	391 ± 2.9
5.	pH	7.19 7.21 7.23	7.21 ± 1.6	7.22 7.26 7.29	7.25 ± 1.9	7.10 7.19 7.20	7.16 ± 2.1	7.11 7.21 7.25	7.19 ± 2.7
6.	Electrical conductivity (dSm ⁻¹)	0.50 0.56 0.57	0.54 ± 2.2	0.52 0.54 0.60	0.55 ± 2.0	0.45 0.50 0.53	0.49 ± 1.1	0.50 0.61 0.64	0.58 ± 2.5
7.	BOD (mg/l)	1.84 1.85 1.90	1.86 ± 0.2	1.75 1.76 1.79	1.76 ± 0.16	1.80 1.82 1.88	1.83 ± 0.3	1.91 1.96 1.98	1.95 ± 0.2

8.	COD (mM/l)	8 15 18	13.6 ± 4.1	2 10 19	10.3 ± 7.0	12 18 20	16.6 ± 3.3	9 13 16	12.6 ± 2.9
ANIONS									
9.	Carbonate (mg/l)		Nil		Nil		Nil		Nil
10.	Bicarbonate (mg/l)	98 102 106	102 ± 3.2	108 115 116	113 ± 3.5	90 96 103	96.3 ± 2.1	100 116 119	111.6 ± 8.3
11.	Chloride (mg/l)	95 100 109	101.6 ± 7.9	102 105 108	105 ± 2.4	99 102 108	103 ± 3.7	100 115 120	111.6 ± 8.4
12.	Sulphate (mg/l)	35 42 50	42.3 ± 6.3	40 48 55	47.6 ± 6.1	38 43 48	43 ± 3.3	32 49 55	45 ± 9.7
13.	Phosphate (mg/l)	0.01 0.02 0.09	0.04 ± 2.2	0.00 0.05 0.16	0.07 ± 2.3	0.00 0.04 0.13	0.05 ± 1.8	0.00 0.02 0.17	0.06 ± 1.3
14.	Silicate (mg/l)	3.05 3.15 3.29	3.16 ± 0.2	2.44 2.69 2.92	2.68 ± 1.0	2.47 2.48 2.55	2.5 ± 2.2	2.42 2.56 2.62	2.53 ± 2.3
15.	Nitrate (mg/l)	0.01 0.02 0.16	0.06 ± 1.1	0.01 0.02 0.25	0.09 ± 1.9	0.02 0.03 0.16	0.07 ± 2.0	0.01 0.02 0.22	0.08 ± 1.6

(February 2014)

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S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
16.	Nitrite (mg/l)		Nil		Nil		Nil		Nil
17.	Fluoride (mg/l)	1.74 1.83 1.91	1.82 ± 1.5	1.61 1.82 1.96	1.79 ± 1.7	1.75 1.78 1.80	1.77 ± 1.3	1.84 1.93 1.98	1.91 ± 0.8
18.	Aluminium (mg/l)		Nil		Nil		Nil		Nil
CATIONS									
19.	Calcium (mg/l)	31 48 51	43.3 ± 8.8	20 43 50	37.6 ± 10.7	30 42 53	41.6 ± 9.3	23 45 49	42.3 ± 14.8
20.	Magnesium (mg/l)	5 28 35	22.6 ± 12.8	10 29 40	26.3 ± 12.3	19 24 39	27.3 ± 8.4	23 26 42	30.3 ± 8.3
21.	Sodium (mg/l)	14 15 16	15.3 ± 1.2	11 12 17	13.3 ± 2.5	6 10 9	11 ± 5.5	12 15 19	15.3 ± 2.8
22.	Potassium (mg/l)	0.00 0.05 0.16	0.07 ± 2.3	0.03 0.05 0.12	0.08 ± 1.8	0.00 0.05 0.15	0.06 ± 2.0	0.07 0.09 0.12	0.09 ± 1.3
HEAVY METALS									
23.	Zinc (mg/l)	0.01 0.02 0.16	0.06 ± 3.5	0.00 0.01 0.06	0.02 ± 1.2	0.00 0.02 0.15	0.05 ± 1.9	0.00 0.01 0.02	0.03 ± 2.4
24.	Copper (mg/l)	0.00 0.01 0.06	0.02 ± 1.3	0.00 0.01 0.05	0.02 ± 2.1	0.00 0.01 0.15	0.05 ± 1.1	0.00 0.01 0.30	0.10 ± 1.6

S. No.	Parameters	Replicate	Sample I	Replicate	Sample II	Replicate	Sample III	Replicate	Sample IV
			$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$
25.	Iron (mg/l)	0.04 0.06 0.23	0.11 ± 1.5	0.11 0.12 0.13	0.13 ± 1.0	0.02 0.06 0.08	0.05 ± 2.5	0.00 0.01 0.15	0.05 ± 1.1
26.	Manganese (mg/l)	0.00 0.01 0.21	0.07 ± 1.6	0.01 0.02 0.05	0.02 ± 1.8	0.00 0.01 0.25	0.08 ± 1.9	0.00 0.01 0.07	0.07 ± 1.5
27.	Chromium (mg/l)		Nil		Nil		Nil		Nil
28.	Lead (mg/l)		Nil		Nil		Nil		Nil

Sample I - Maruthapattinam

Sample II - Mangudi

Sample III - Aravathur

Sample V - Srinivasapuram

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