INTERNATIONAL JOURNAL OF ENVIRONMENT
Volume-4, Issue-2, March-May 2015 ISSN 2091-2854
Received:3 March *Revised:14 April* *Accepted:6 May*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES FROM DIFFERENT AREAS OF THRISSUR DISTRICT, KERALA STATE, INDIA

Mity Thambi[1], Tom Cherian[2*], Anju Therese Jose[3], Sunaina Jamal[4]

[1]Department of Post Graduate Studies and Research in Chemistry, Catholicate College, Pathanamthitta – 689 647, Kerala

[2,3,4] Department of Post Graduate Studies and Research in Chemistry, Christ College, Irinjalakuda, Thrissur-680 125, Kerala

[*]Corresponding author: drtomcherian@gmail.com

Abstract

The analysis of groundwater quality of important town areas of Thrissur district was carried out during the pre-monsoon period of 2014. The Physicochemical and biological parameters such as temperature, turbidity, electrical conductivity, total dissolved solid, pH, alkalinity, chloride, salinity, total harness, calcium, magnesium, iron, phosphate, sulphate, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total coliform count and E. coli were determined. Most of the physicochemical parameters were observed above the desirable limit but below the permissible limit of drinking water standards of World Health Organization (WHO). Total coliform bacteria count values of different samples are within the permissible limit. The studies reveal that samples from Thrissur town (T), Guruvayoor (G) and Laloor (L) shows the presence of *E.coli* bacteria. All other samples were negative for *E.coli* bacteria. Dumping of wastes near road sides, flood due to heavy rains, improper waste management in hospitals, markets, flats etc increases the pollution of ground water. The results were compared with WHO guidelines, 2006 and Bureau of Indian Standards (IS: 10500, 1991) desirable limits for drinking water.

Key words: Physico-chemical characteristics, water quality parameters, ground water sample.

Introduction

Ground water is a renewable natural resource. Ground water is regarded as pure form of water. Various physico-chemical parameters have a significant role in determining potability of water (Bajpai et al., 2013). Water intended for human consumption must be free from harmful micro-organisms, toxic substances, excessive amount of minerals and organic matter. Ground water is less susceptible to bacterial pollution than surface water because the soil and rocks through which ground water flows screen out most of the bacteria. As per World Health Organization (WHO), safe and wholesome drinking water is a basic need for human development, health and well-being, and it is an internationally accepted human right. Due to continuous population growth, demand for fresh water has increased rapidly. Dumping of wastes near road sides, flood due to heavy rains, improper waste management in hospitals, markets, flats etc. increases the pollution of ground water. Various research groups have analysed the ground water quality at different locations of Kerala and the results are published (Harikumar et al., 1997; Dinesan et al., 2007; Abdul Hammed et al., 2004). Previous studies show that, ground water resources in Kerala are at a higher risk of environmental pollution and are susceptible to contamination (Hameed Shahul et al., 2000). Chemical contamination is one of the prominent problems associated with ground water. The main chemical contaminants include pesticides (Majid et al., 1991) and heavy metals (Yokota et al., 2001).

In this work an attempt has been done to study the physicochemical & biological characteristics of groundwater of important town areas of Thrissur district at pre-monsoon period. Thrissur is one of the important historical city of Kerala which is known as the cultural capital of Kerala. In order to trace the microbial contamination levels in the area and bacterial analysis for *E. Coli* was also done. The analysis of water quality of the aquifers of important town areas of Thrissur district was carried out during the pre-monsoon period of 2014.

Materials and methods

Study Area

The study area includes all the important towns of Thrissur district. The district has an area of 3032 sq.km and is located in the central part of the State. Thrissur is situated in south western India 10.52°N 76.21°E and is in the central part of Kerala, India. The town

areas selected are: Thrissur town (T), Wadakkanchery (W), Chelakkara (C), Kunnamkulam (K), Guruvayoor (G), Manaloor (M) and Laloor (L).

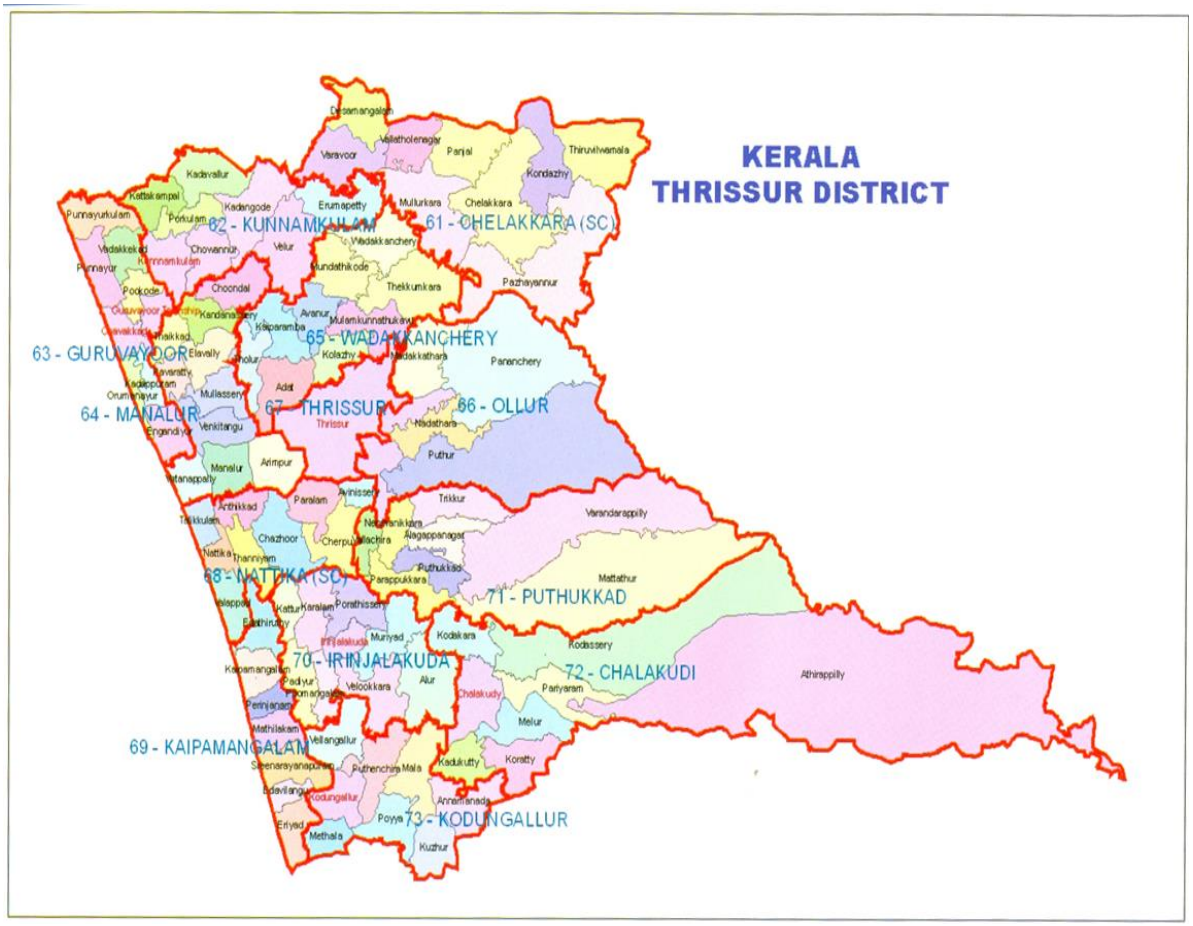

Figure 1. Thrissur District Map (Map of the study area)

Analytical Methodology

All the experiments are done according to the standard procedures (APHA, 2005; Mendham et al., 2000) and results are compared with the Drinking Water Standards of World Health Organization (WHO, 2011). Temperature and pH measured at the spot and other water quality parameters were done in laboratory. Samples were analysed for physical parameters like temperature, turbidity, EC, TDS, chemical parameters like pH, alkalinity, chloride, salinity, total hardness, calcium, magnesium, carbonates and bicarbonates, iron, nitrate, phosphate, sulphate, DO, COD and biological parameters like total coliform count and *E*-coli. Wells were randomly selected and they are so close to the town areas. The water samples were collected in one litre plastic containers. Before collecting the samples, the containers were washed thoroughly and rinsed twice. The samples were kept cool in darkness until the analysis was completed.

Results and discussion

The results of physicochemical analysis of all the samples are summarized in Table 1. Drinking water quality standards (WHO) are given in Table 2 and methodology used for the analysis of water samples are summarized in Table 3.

Table 1. Physicochemical and biological analysis of water samples from Thrissur district

S.No	PARAMETERS	T	W	C	K	G	M	L
1	Temperature (ºC)	30.9	30.8	30.1	30.8	30.7	30.9	28.6
2	Turbidity(NTU)	8.0	4.0	5.0	4.0	8.0	4.0	8.0
3	Electrical Conductivity(mS/cm)	790.0	228	151.1	374.0	226.0	152.7	820.9
4	Total Dissolved Solids (mg/L)	583.2	321.0	199.1	237.0	152.1	199.1	690.4
5	pH	6.06	7.13	6.10	6.89	7.01	6.49	5.49
6	Alkalinity (mg/L)	90	120	20.0	268	138	126	120
7	Chlorides(mg/L)	10.99	13.99	38.99	28.99	18.99	12.99	49.99
8	Salinity (mg/L)	22.01	25.68	71.56	53.20	34.86	23.84	91.73
9	Total Hardness (mg/L)	24	26	165.7	45.0	60.0	12.5	81.25
10	Calcium (mg/L)	4.9	8.3	43.2	18.7	21.6	3.01	23.7
11	Magnesium(mg/L)	2.9	1.0	15.9	2.6	5.9	1.03	9.8
12	Iron (mg/L)	0.0	0.09	0.07	0.0	0.03	0.03	0.0
13	Nitrate (mg/L)	0.4	1.01	0.4	1.9	0.5	0.2	1.9
14	Phosphate (mg/L)	1.02	0.8	1.01	0.7	1.2	0.6	1.0
15	Sulphate (mg/L)	0.5	0.5	0.7	0.4	0.3	0.5	0.3
16	Dissolved Oxygen DO (mg/L)	4.0	6.0	4.0	5.0	4.0	6.0	5.0
17	Biological oxygen demand BOD (mg/L)	18	6	7	5	20	15	23
18	Chemical oxygen demand COD (mg/L)	57	73	121.5	123.4	97.4	73.1	68.0
19	Total coliform MPN/100ml	9	4	3	5	8	7	10
20	*E.coli*	+	-	-	-	+	-	+

T- Thrissur town, W – Wadakkanchery, C- Chelakkara, K – Kunnamkulam, G – Guruvayoor, M – Manaloor, L – Laloor.

Table 2. Drinking water standards: WHO (1983, 1993, 2006 & 2011)

Parameters	Most desirable limit	Maximum permissible limit	Undesirable effects
Temperature(^{o}C)	-	-	-
Turbidity(NTU)	5 NTU	-	Disinfection
Conductivity (mS/cm)	400	2000	-
Total Dissolved solid(mg/L)	500	1000	Gastrointestinal irritation
pH	6.5 – 8.5	9.2	Taste
Alkalinity(mg/L)	200	600	Taste
Chloride (mg/L)	200	600	Salty taste
Salinity (mg/L)	200	600	Salty taste
Total Hardness (mg/L)	100	500	Scale formation
Calcium (mg/L)	75	200	-
Magnesium (mg/L)	50	150	Scale formation
Iron (mg/L)	-	0 .3	-
Nitrate (mg/L)	-	45	Methaemoglobinaemia
Phosphate (mg/L)	-	5	-
Sulphate (mg/L)	200	400	Laxative effect
Dissolved oxygen DO (mg/L)	4	6	-
Biological oxygen demand BOD (mg/L)	-	30	-
Chemical oxygen demand COD (mg/L)	-	250	-
Coliform 10CFU/100ml	-	10	Intestinal diseases
E.Coli	Absent	Absent	Intestinal diseases

Table 3. Methodologies Used for Analysing Water Samples

Sl No.	PARAMETERS	UNITS	METHOD
1	Temperature	ºC	Electrode Method
2	Turbidity	NTU	Turbidimetric method
3	Electrical Conductivity	mS/cm	Electrode Method
4	Total Dissolved Solids	mg/L	Electrode Method
5	pH	-	Electrode Method
6	Alkalinity	mg/L	HCl Titrimetric Method
7	Chlorides	mg/L	Argentometric Method
8	Salinity	mg/L	Argentometric Method
9	Total Hardness	mg/L	EDTA Titrimetric Method
10	Calcium Hardness	mg/L	EDTA Titrimetric Method
11	Magnesium	mg/L	EDTA Titrimetric Method
12	Iron	mg/L	Colorimetric Method
13	Nitrate	mg/L	Spectrophotometric method
14	Phosphate	mg/L	Stannous Chloride Method
15	Sulphate	mg/L	Gravimetric Method
16	Dissolved Oxygen (DO)	mg/L	Iodometric method
17.	Biological oxygen demand (BOD)	mg/L	Titrimetric Method
18	Chemical oxygen demand (COD)	mg/L	Titrimetric Method
19	Total coliform	MPN/100ml	-
20	*E.coli*	-	-

Temperature: The temperature was in the range of 28.6^0C - 30.9^0C. The variation in the water temperature may be due to different timings of collection and influence of weather.

Turbidity: Turbidity in water is due to colloidal and extremely fine dispersions. Suspended matter such as clay, silt, finely divided organic and inorganic matter, plankton and other micro -organisms also contributes to turbidity. Turbidity ranges from 4-8 NTU. The

permissible limit of turbidity is 5 NTU. Higher values may be due to human activities, decrease in the water level and presence of suspended particulate matter.

Electrical Conductivity: The conductivity measurement provides an indication of ionic concentrations. Electrical conductivity of groundwater ranges from 151-820.9 mS/cm. According to the drinking water quality standards of WHO (1993), the desirable and permissible limits of electrical conductivity is specified as 400 and 2000 mS/cm at 25^0C respectively.

Total Dissolved Solids: Analysis for Total dissolved solids (TDS) value ranges from 150-690 mg/L. According to WHO (1983), the desirable and permissible limits of TDS is specified as 500 mg/L to 1000 mg/L respectively. TDS values of Thrissur (T), and Laloor (L) are above the permissible limit and rest of the samples are below the limit. The excess of TDS disturb the ecological balance due to osmotic regulation and suffocation in aquatic fauna even in the presence of fair amount of oxygen. Water containing high solid concentration may cause constipation effects high level of TDS may aesthetically be unsatisfactory for bathing and washing.

pH: The pH value is an important index of acidity or alkalinity and the concentration of hydrogen ion in the ground waters. The standard range of pH is 6.5-8.5 (WHO, 1983). In this study the range is in between 5.49 – 7.13. Most of the samples show permissible limits except Thrissur (T), Chelakkara (C), Manaloor (M) and Laloor (L) are slightly acidic. The presence of organic matter and consequent bacterial activity lead to the production of CO_2 gas and it reacts with water to become carbonic acid. This makes the water slightly acidic and is an indicator of pollution.

Alkalinity: According to WHO (1993), the desirable limit of alkalinity is 200 mg/L and the permissible limit in the absence of alternate source is 600 mg/L. It is observed from the results that the alkalinity ranges from 20-268 mg/L. Alkalinity is not harmful to the human beings, still the water with less than 200 mg/l are desirable for domestic use.

Chloride: According to WHO (1993), the desirable and permissible limits of chloride specified as 200 mg/L and 600 mg/L. in the samples the chloride concentrations varies from 13.99–49.99 mg/L.

Salinity: Salinity is the saltiness or dissolved salt content of a water body. According to WHO (1993), the desirable and permissible limits of chloride specified as 200 mg/L and 600 mg/L. In the samples the salinity concentrations varies from 22-91.73 mg/L.

Total Hardness: Total hardness is defined as the total of temporary and permanent hardness. The hardness found in water is mostly due to calcium and magnesium. According to WHO (1984), the permissible limit of total hardness is 300 to 600 mg/L. The minimum and maximum concentration of total harness in this analysis is found to be 12.5-165.7 mg/L. High concentration of total hardness in water may cause kidney stone and heart disease in human.

Calcium: Calcium found in the observed well samples varies from 3 – 43.2 mg/L. the desirable limit of calcium in potable water is 75 mg/l by WHO (1993).

Magnesium: In the sample analysis magnesium ranges from 1.0 - 15.9 mg/L. The desirable and permissible limit of magnesium is 30 mg/l and 150 mg/l by WHO (1993).

Iron: Iron ranges from 0 – 0.09 mg/L. The maximum permissible limit of Iron for drinking water is 0.3 mg/L by WHO (1993). It is observed from the result that the samples from Thrissur town (T), Laloor (L) and Kunnamkulam (K) the iron values are below the detection limit.

Nitrate: Nitrate ranges from 0.2-1.9 mg/L. In the analysis all the sample values were found within the WHO (1983) limit. The maximum permissible limit of nitrate for drinking water is 45 mg/L by WHO (1983).

Phosphate: The result of analysis shows the minimum and maximum concentration of phosphate ranges from 0.6-1. 2 mg/L. The maximum permissible limit of Phosphate for drinking water is 5 mg/L by WHO (1983).

Sulphate: According to the drinking water quality standards of WHO (1984), the desirable and permissible limits of Sulphate is 200 mg/L and 400 mg/L respectively. The result of analysis shows the minimum and maximum concentration of sulphate ranges from 0.3 to 0.7 mg/L. High concentration of sulphate may cause intestinal disorders.

Dissolved Oxygen: Gaseous oxygen gets into water by diffusion from the surrounding air by aeration and also from aquatic photosynthesis. The permissible limit of dissolved oxygen in drinking water is 4- 6 mg/L. In all sampling points the dissolved oxygen level ranged from 4 – 6 mg/L

Biological oxygen demand: Biological oxygen demand is considered as a measure of how much oxygen is used by microorganism in aerobic oxidation or for the breakdown of organic matter in aquatic ecosystems. If the amount of organic matter in the ecosystems is high relatively more amount of oxygen is required for aerobic oxidation. The permissible limit of biological oxygen demand in drinking water is 30 mg/L. In all sampling points the biological oxygen demand ranged from 5 – 23 mg/L. All the values are in the permissible limit.

Chemical Oxygen Demand: According to the drinking water quality standards of WHO, the permissible limit of COD in drinking water is 250 mg/L. The value of chemical oxygen demand values ranges from 57- 123.4 mg/L.

Total Coliform Count: Coliforms are pollution indicators and are present in water due to faecal contamination of water**.** Coliforms bacteria can enter wells through direct discharge of waste from mammals and birds and from human sewage. According to the drinking water quality standards of WHO the permissible limit of coliform bacteria is 10 MPN /100 ml (MPN - Most Probable Number). In all sampling points the total coliform count ranged from 3 – 10 MPU/100ml.

E.coli : According to the drinking water quality standards of WHO the water should be free of *E.coli* bacteria. In this analysis all the values shows the presence of *E.coli* bacteria. It is observed from studies shows that (studies carried out at IRTC, Palakkad, Kerala) the samples from Thrissur town (T), Guruvayoor (G) and Laloor (L) shows the presence of *E.coli* bacteria. All other samples were negative for *E.coli* bacteria.

Conclusion

The analysis of groundwater quality of important town areas of Thrissur district was carried out during the pre-monsoon period of 2014. The Physicochemical and biological parameters such as temperature, turbidity, electrical conductivity, total Dissolved solid, pH, alkalinity, chloride, salinity, total harness, calcium, magnesium, iron, phosphate, sulphate, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total coliform count and E. coli were determined. Most of the physicochemical parameters above the desirable limit and but below the permissible limit of drinking water standards of World Health Organization (WHO). Total coliform bacteria count values of different samples are within the permissible limit. The studies reveal that samples from Trissur town (T), Guruvayoor (G) and Laloor (L) shows the presence of *E.coli* bacteria. All other samples were negative for

E.coli bacteria. Dumping of wastes near road sides, flood due to heavy rains, improper waste management in hospitals, markets, flats etc. increases the pollution of ground water.

References

Abdul, Hammed E. and Nazimuddin, M., 1999. Recovery behaviour of open wells in the Southern midland of Thiruvananthapuram district – A case study, Proceedings of 11th Kerala Science Congress, Kasaragod, 27 February to 1 March, 27-31.

APHA. 2005. Standard methods for the examination of water and waste water analysis, 21st Edition, American Public Health Association, Washington – DC, USA.

Bajpai, O., Mishra, S., Narendra, M., Mohanand, J., and Gupta, R., 2013, Physicochemical characteristics of Lakhnadevi temple water tank, Lakhna, Bakewar, Etawah, U.P. with reference to cyano bacterial diversity. International Journal of Environment, vol.1,20-28.

Dinesan, V. P., Dilna, P. T., Antu, C. D and Rajagopalan, S. P., 2007. Specific capacity and recovery characterizes of open wells in different aquifers – A case study for Calicut. Proceedings of the "International Workshop on Integrated Water Resources Management ((IWRM-2007), 5-7, February, 2007, Karnataka Environmental Research Foundation, Bangalore.

EPA, 2005. United States Environmental Protection Agency Basic Information about E. coli in Drinking Water

Hameed Shahul, A., Soni Dinil, C., Velaudhan, K. T and Vasu, K., 2000. Ground water Quality Deterioration due to Clay mining industry in a Mid land region of Kerala, International Conference on Integrated Water Resources Management for Sustainable Development, New Delhi, 19-21, December, 475-484.

Harikumar, P. S., Madhavan, K. and Remani, K. N., 1997. Drinking water quality of bore wells of thrissur District, Kerala, Proceeding of the International Conference on Management of Drinking Water Resources, Madras, 2-5 December, 21.

Majid, E., Richard, C., Peralta, H. E., Howard, D. and Terry, T., 1991. Accessing Pesticide contamination to Ground water; A rapid approach, ground water, vol-29, 862-868.

Mendham, J., Denney, R. C., Barnes, J. D., Thomas, M. J. K., 2000. Vogel's Quantitative Chemical Analysis, 6th Edition.

Yokota, H. K., Tanabe, M., Sezaki, Y., Akiyoshi, T., Miyata, K. K., Tsushima, S., Hironaka, H., Takafuji, H., Rahman, M., Ahmad, S. A., Sayed, M. H. S. U. and Farquee, M. H., 2001. Arsenic contamination of ground and pond water and water purification system using pond water systems in Bangladesh. Engineering Geology, Vol-60, 323-331.

WHO. 1971, 1983, 1993, 2006 & 2011.Guide lines for International Standards for Drinking Water Quality, World Health Organisation Geneva.