Asian Pac. J. Health Sci., 2014; 1(4): 385-395 e-ISSN: 2349-0659, p-ISSN: 2350-0964

The hydro - chemical and microbial analysis of ground water samples in two different districts of Madurai and Virudhunagar Districts, Tamil Nadu, India

R. Sasi Kumar[1]*, S. Priyadharshini[2]

[1]Department of Chemistry, Saiva Bhanu Kshatriya College, Aruppukottai, Tamil Nadu, India
[2] Department of Chemistry, Thiyagarajar College, Madurai, Tamil Nadu, India

Abstract

Ground water samples of open well and bore wells collected from different places in Madurai and Virudhunagar Districts were analyzed for their hydro – chemical characteristics and microbial studies. The ground water samples were studied during the month July 2014 from different villages. The various constituents monitored include the hydro – chemical characters like pH, alkalinity, hardness, chloride, total dissolved solids, fluoride, ammonia, nitrite, nitrate, phosphate and residual chlorine. Each parameter was compared with the standard permissible limit of the parameter as prescribed by World Health Organization (WHO). The water analysis reflected that out of 10 samples 2 are under acceptable quality. However in water samples from all the sites, microbial count exceeded the recommended permissible level of WHO. The study reveals that in few areas, water has high hardness, TDS, fluoride and nitrate content. Hence, ground water must be used for drinking after proper treatments viz., softening and defluoridation.

Keywords: Ground water, Hydro - Chemical parameters, Microbial analysis, Statistical analysis, WHO.

Introduction

Water is the precious gift of nature to all the living beings for sustenance. The suitability of water for domestic, agricultural and industrial purposes mainly depends on the chemical composition of surface and subsurface. Ground water is the major and preferred source for drinking all over the world even though its contribution is very less (i.e. only 0.6%) to the total water resources on earth. The degradation of water quality is mainly due to the increasing population, urbanization, industrialization and over – utilization of water resources. The ground water is getting polluted because of disposal of industrial effluents, hazardous wastes, sewage disposal and deep percolation of pesticides and fertilizers from activated fields.[1] Presence of various hazardous elements like arsenic, nitrate, sulphate, fluoride, other heavy metals etc., in underground water have been reported from different parts of India and world[3].

**Correspondence*
R. Sasi Kumar
Department of Chemistry, Saiva Bhanu Kshatriya College, Aruppukottai, Tamil Nadu, India
Email: sasi.che2011@gmail.com

Fluoride is an essential trace element for human metabolism. Its concentration in drinking water is the prime factor to decide whether fluoride is beneficial or harmful. In India, research on the assessment of water quality especially with reference to fluoride has been carried out by various workers[9]. Ingestion of excess of fluoride, most commonly in drinking water, can cause fluorosis which affects the teeth and bone[19]. The present study was therefore undertaken to investigate the qualitative analysis of some hydro - chemical parameters including natural fluoride levels in Madurai and Virudhunagar Districts, Tamil Nadu, India.

Materials and methods

Hydro–chemical Analysis of Water Quality Parameters

Selection of water sources and villages was done by random sampling procedure. Water samples of 10 in number (5 in the Madurai district and 5 in the Virudhunagar district) have been collected from bore wells and open well of two different districts at July, 2014. Ten locations selected for water sampling were Avaniyapuram, Pykara, Othakadai, Thiruparankundrum, Valayankulam in madurai district, Aruppukottai, Kariapatti, Kalkuruchi, Pandalkudi, Virudhunagar in

Virudhunagar district, Tamil Nadu, India. The samples were collected in sterilized bottles and analyzed for various hydro – chemical parameters. To analyze various parameters the standard procedures given in APHA (1998) was followed.

Statistical Analysis

The statistical parameters like mean, SD and coefficient of variances were calculated for hydro – chemical parameters. (i) The mean and standard deviations are used to know the chemical parameters which are deviating from WHO standard. Whenever mean exceeds the permissible limit fixed by WHO, it is concluded that those particular places are all contaminated with respect to that chemical parameter.

Microbial analysis

The microbial analysis like the number of microbial colonies were measured by standard plate count (SPC) using standard nutrient agar. Microbial analysis of 10 different water samples were studied within 24h of collection. The numbers of microbial colonies were counted by colony counter. All estimations were carried out using five replicates. The data are presented as mean of five independent determinations. The work was carried out at Liberty diagnostic and research center, Madurai, Tamil Nadu.

Results and discussion

Hydro – Chemical parameters

Area – wise chemical compositions of 5 water samples of Madurai District and 5 water samples of Virudhunagar District in the July 2014 are presented in Table 1 and Table 2. Descriptive statistics of water samples in Madurai District and Virudhunagar District are shown in Table 3. The hydro – chemical parameters are also represented as in figures. Area – wise microbial analysis of 5 water samples of Madurai and 5 water samples of Virudhunagar districts in the July 2014 are presented in Table 4 and Table 5 respectively.

Temparature

The temperature mean values of Madurai and Virudhunagar districts water samples were 31.6 °C and 29.4 °C respectively. The increase in temperature decreases the portability of eater due to expel of taste imparting CO_2 and other gases. Thus, the taste of sample differs from place to place. (Karunakaran *et al*., 2009)

pH

The pH mean values of the water samples in the Madurai and Virudhunagar districts were 8 and 7.58 respectively. This approves that the nature of ground water samples vary from slightly acidic and slightly alkaline.

Alkalinity

The alkalinity mean value of the water samples of Madurai and Virudhunagar Districts were 288 mg/L and 422 mg/L respectively. The cations like calcium and magnesium imparts alkalinity of water. The highest desirable limit prescribed by WHO is 250 mg/L for drinking purposes. The alkalinity of the samples is above the prescribed limit. The values (288 mg/L to 422 mg/L) are slightly higher than WHO level.

Hardness

The degree of hardness mean value of the water samples in the Madurai and Virudhunagar districts were 782 mg/L to 268 mg/L during the analysis. The highest desirable limit prescribed by WHO is 200 mg/L for drinking purposes. The hardness of the samples is above the prescribed limit. Analysis reveals that the hardness is greater than 200 mg/L. It means that the water is very hard. The values (782 mg/L to 268 mg/L) are slightly higher than WHO level. The variation and increase of hardness of well water 782 to 268 mg/L is unsuitable for drinking. Hardness prevents soap from lathering and increases the time for boiling the water. The cations like calcium and magnesium imparts hardness of water.

Chloride

The Chloride mean value of the water samples in the Madurai and Virudhunagar districts were 438 and 258 respectively. The Chloride values of water samples were found higher than WHO level (highest desirable limit prescribed by WHO is 200 mg/L). Analysis reveals that the Chloride is greater than 200 mg/L. It shows that the water is contaminated by some chloride salts.

TDS

The TDS content value of water samples in the Madurai District (mean 1809.6 mg/L) was comparatively greater than in the Virudhunagar District (mean 1137.6 mg/L). The TDS values of water samples were found higher than WHO level (highest desirable limit prescribed by WHO is 500 mg/L). Analysis reveals that the TDS is greater than 250 mg/L. It means that the water is contaminated by some solids. The values (782 mg/L to 268 mg/L) are slightly higher than WHO level. The variation and increase of TDS of well water 782 to 268 mg/L is unsuitable for drinking.

Fluoride

The fluoride mean value of water samples in the Madurai and Virudhunagar districts were 1 mg/L and 0.64 mg/L respectively. The fluoride values of water samples were found permissible level (highest desirable limit prescribed by WHO is 1.0 mg/L). If the fluoride content increases in water that will cause bone problem.

Ammonia (NH_3)

The ammonia value of water samples in the Madurai district (mean 0.3 mg/L) and Virudhunagar district (mean 0.34 mg/L). The ammonia values of water samples were found permissible level (highest desirable limit prescribed by WHO is 1.0 mg/L).

Nitrite (NO_2)

The nitrite mean value of water samples in Madurai and Virudhunagar districts were 0.74 mg/L and 0.74 mg/L respectively. The nitrite values of water samples were found permissiable level (highest desirable limit prescribed by WHO is 1.0 mg/L).

Nitrate (NO_3)

The nitrate mean value of water samples in Madurai and Virudhunagar districts were 62 mg/L and 39 mg/L respectively. The nitrate values of water sample were found higher than standard WHO except Virudhunagar district (highest desirable limit prescribed by WHO is 45 mg/L).

Microbial Analysis

The microbial analysis of water determines the portability 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 ten places were contaminated with high amount 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 bore well.

Table 1: Hydro – Chemical parameters of 5 groundwater samples of Madurai District at July 2014

BW= Bore well, OW= Open well, TDS= Total Dissolved Solids (mg/L), WHO= World Health Organization

Location	Source	Temp °C	pH	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	TDS (mg/L)
Avaniyapuram	BW	30	9	460	660	650	2124
Othakadai	OW	28	7	160	180	40	456
Pykara	BW	35	9	380	630	540	1860
Thiruparankundrum	BW	33	7.5	250	1380	460	2508
Valayankulam	BW	32	7.5	190	1060	500	2100
Standard WHO		25	7.5 – 8.5	250	200	200	500

Table 1a: continued

Location	Source	Fluoride (mg/L)	Ammonia (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Residual Chlorine (mg/L)
Avaniyapuram	BW	1	0.5	1	100	0	0
Othakadai	OW	1	0	1	45	0	0
Pykara	BW	1	0	1	45	0	0
Thiruparankundrum	BW	1.5	1	0.2	75	0	0
Valayankulam	BW	0.5	0	0.5	45	0	0
Standard WHO		1	1	1	45	1	1

BW= Bore well, OW= Open well, WHO= World Health Organization

Table 2: Hydro – Chemical parameters of 5 groundwater samples of Virudhunagar District at July 2014

Location	Source	Temp °C	pH	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)	TDS (mg/L)
Aruppukottai	BW	29	7	170	250	170	708
Kalkuruchi	BW	26	6.5	560	210	120	1068
Kariapatti	BW	30	7.2	480	350	250	1296
Pandalkudi	BW	32	8.2	660	180	270	1332
Vellakulam	BW	30	9	240	350	480	1284
Standard WHO		25	7.5 – 8.5	250	200	200	500

BW= Bore well, OW= Open well, TDS= Total Dissolved Solids (mg/L), WHO= World Health Organization

Table 2a: continued

Location	Source	Fluoride (mg/L)	Ammonia (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Residual Chlorine (mg/L)
Aruppukottai	BW	1	0	0.2	20	0	0
Kalkuruchi	BW	0.2	0.5	1	35	0	0
Kariapatti	BW	1	0.2	1	20	0	0
Pandalkudi	BW	0	1	0.5	45	0	0
Vellakulam	BW	1	0	1	75	0	0
Standard WHO		1	1	0	45	1	1

BW= Bore well, OW= Open well, WHO= World Health Organization

Table 3: Descriptive statistics of water samples in Madurai and Virudhunagar Districts

Parameters	Mean		σ		CV	
	Mdu	VNR	Mdu	VNR	Mdu	VNR
Temp	31.6	29.4	2.41	1.62	7.6	5.51
pH	8	7.58	0.84	0.89	10.5	11.74
Alkalinity	288	422	114.43	187.44	39.73	44.41
Hardness	782	268	408.72	70.54	52.32	26.32
Chloride	438	258	208.84	123.51	47.68	47.87
TDS	1809.6	1137.6	707.91	305.48	39.11	26.85
Fluoride	1	0.64	0.316	0.445	31.6	69.59
Ammonia	0.3	0.34	0.4	0.377	133.33	110.88
Nitrite	0.74	0.74	0.332	0.332	44.86	44.90
Nitrate	62	39	22.27	20.34	35.91	52.15
Phosphate	0	0	0	0	0	0
Residual Chlorine	0	0	0	0	0	0

Mdu= Madurai, VNR= Virudhunagar, TDS= Total Dissolved Solids, all the parameters are expressed in mg/L, σ= Standard Deviation, CV= Coefficient of variance

Table 4: Bacterial analysis of 5 groundwater samples of Madurai District

SPC method	Madurai District				
	Avaniyapuram	Othakadai	Paikara	Thirparankundrum	Valayankulam
10^{-1}	100020	95000	100000	98000	100300
10^{-2}	3128	2102	2369	1254	4152
10^{-3}	540	348	456	211	654
10^{-4}	98	65	78	45	121
10^{-5}	12	7	8	6	22

SPC = Standard Plate Count method

Table 5: Bacterial analysis of 5 groundwater samples of Virudhunagar District

SPC method	Virudhunagar District				
	Aruppukottai	Kalkuruchi	Kariapatti	Pandalkudi	Vellakulam
10^{-1}	84000	37000	20000	42000	43000
10^{-2}	2452	1810	1010	1954	1564
10^{-3}	220	320	120	169	243
10^{-4}	65	54	25	38	58
10^{-5}	4	6	3	8	7

SPC = Standard Plate Count method

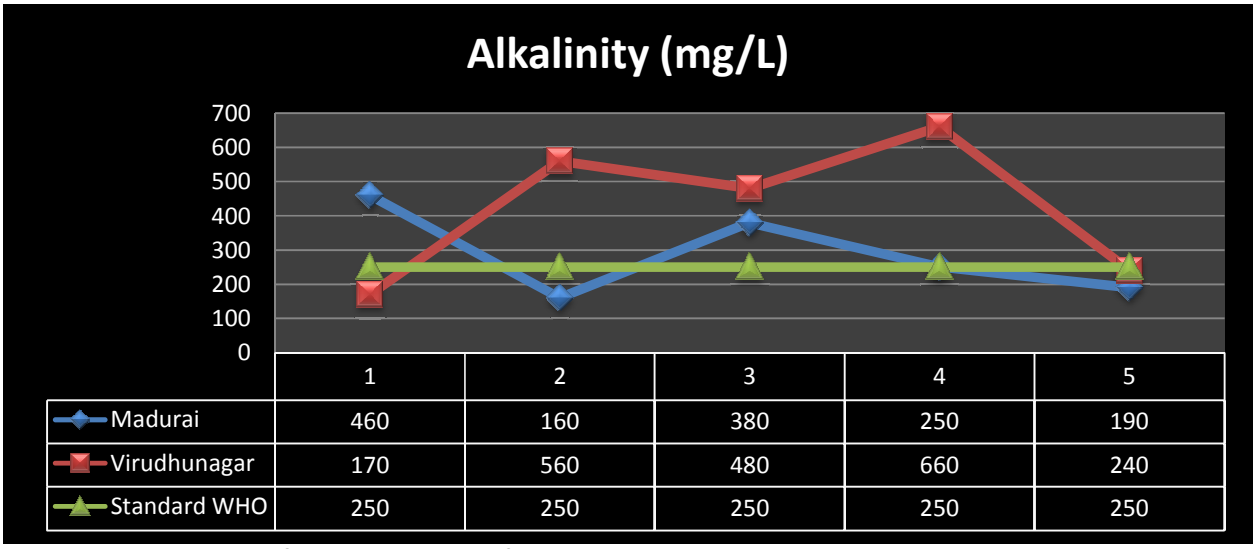


Fig 1: Comparison of Alkalinity content for water samples between Madurai and Virudhunagar Districts

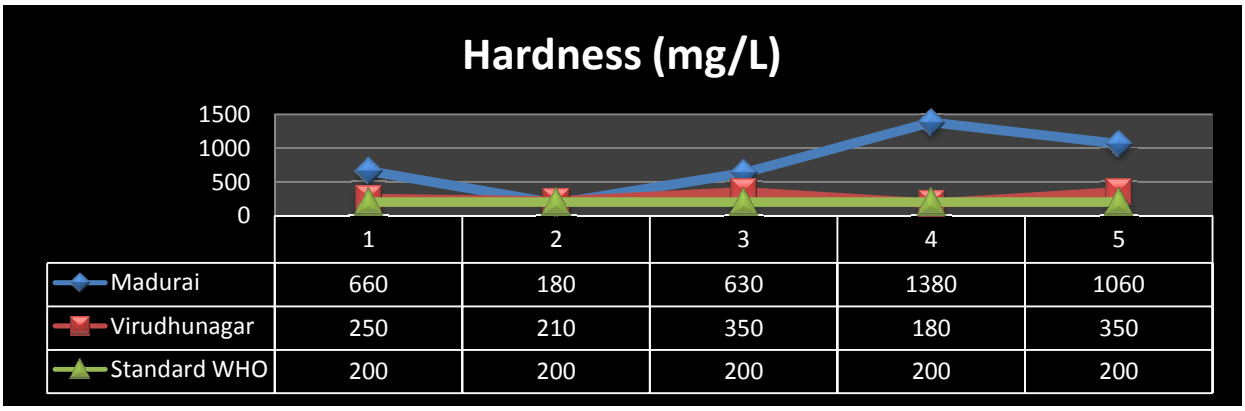


Fig 2: Comparison of Hardness content for water samples between Madurai and Virudhunagar Districts

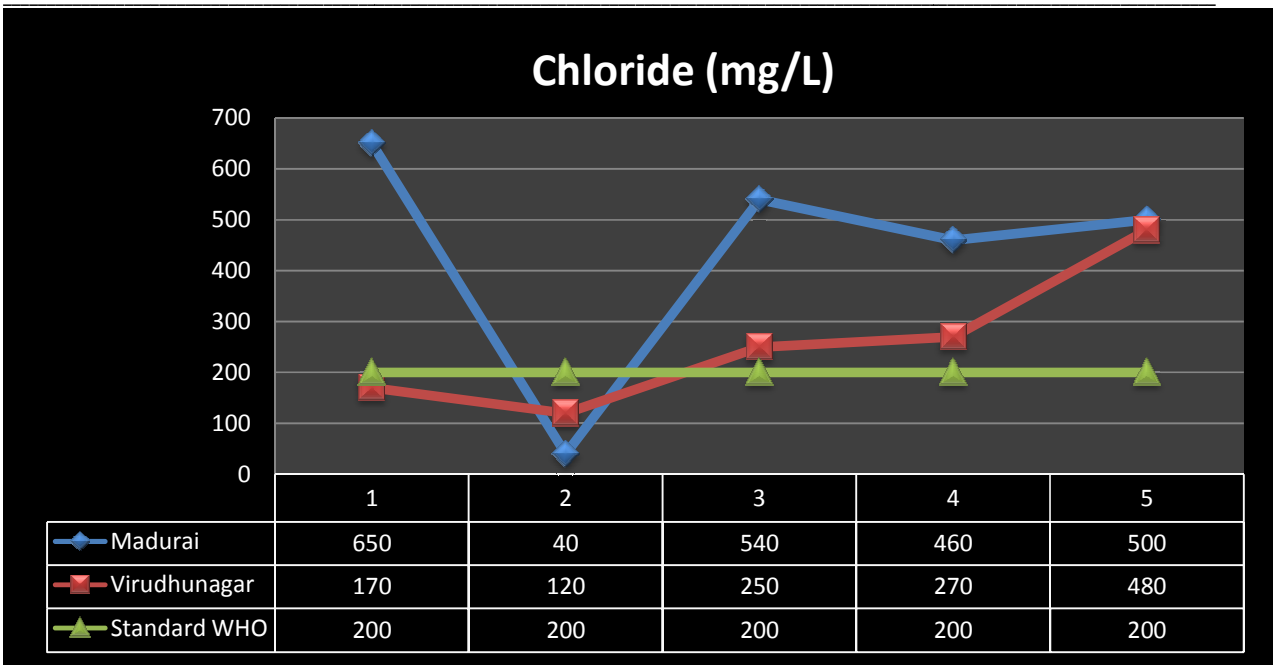


Fig 3: Comparison of Chloride content for water samples between Madurai and Virudhunagar Districts

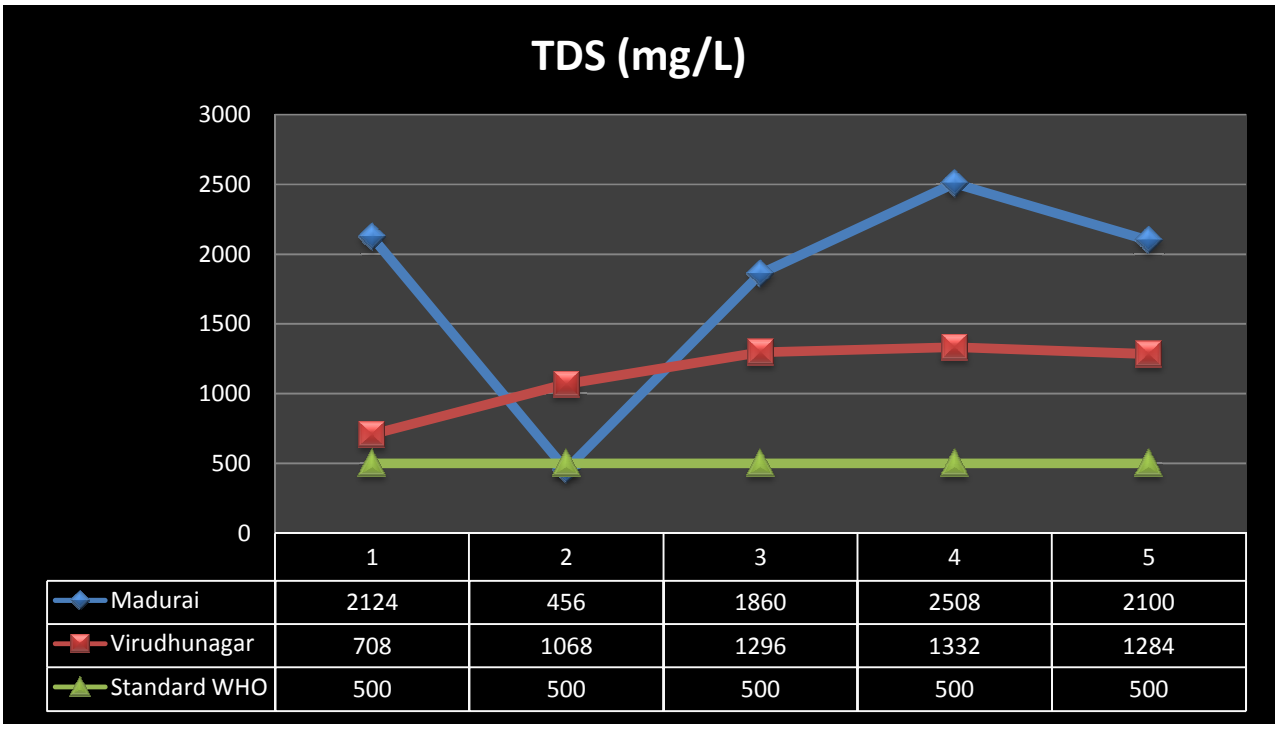
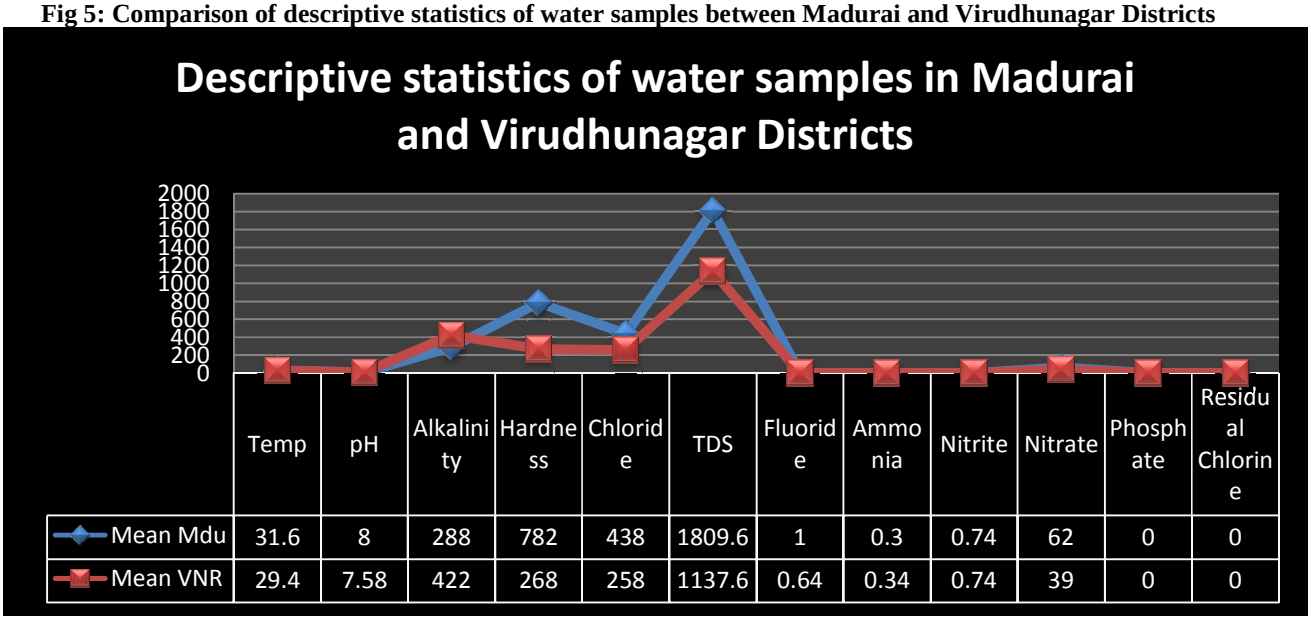


Fig 4: Comparison of TDS content for water samples between Madurai and Virudhunagar Districts

Fig 5: Comparison of descriptive statistics of water samples between Madurai and Virudhunagar Districts



	Temp	pH	Alkalinity	Hardness	Chloride	TDS	Fluoride	Ammonia	Nitrite	Nitrate	Phosphate	Residual Chlorine
Mean Mdu	31.6	8	288	782	438	1809.6	1	0.3	0.74	62	0	0
Mean VNR	29.4	7.58	422	268	258	1137.6	0.64	0.34	0.74	39	0	0

Conclusion

The hydro – chemical and microbial analysis were performed on ten water samples collected from Madurai and Virudhunagar Districts, Tamil Nadu, India by standard methods. These waters are used as such as drinking and other domestic purposes. The study would help the water quality monitoring and management in order to improve the quality of water with maintaining better sustainable management. Results obtained showed the pH of water samples vary from slightly acidic and slightly alkaline. The influence of rain fall on the carbonate and bicarbonate ions of water samples was observed. The comparative analysis suggests the distinct nature of different water samples and it depends on the geographical location, time zone and geological foundation. Comparatively Madurai district water was more polluted than Virudhunagar district water. This study would help to create and develop awareness among the people to maintain the quality of the ground waters. Hence it is suggested to exercise all the necessary precaution before the water is used for drinking and irrigation, otherwise, it may lead to much adverse health effect. People from the study area should drink only the treated water.

Management Plan

Proper treatments of water viz., water softening and defluoridation should be done to minimize the hardness and fluoride content in drinking water.

Acknowledgements

The authors thank to E. Muthuraman, Department of Microbiology, Liberty Diagnostic and Research Center, Madurai, Tamil Nadu, India for the help of the microbial studies. They also thank to R. Thangaraja for encouragement and support.

References

1. Meenakshi and Maheswari RC. Fluoride in drinking water and its removal. *J Haz Matter*. B2006;137:456 – 463.
2. Janardhana Raju N, Sangita Dey and Kaushik Das. Fluoride contamination in ground waters of Sonbhadra District, Uttarpredesh, India. *Current Science*. 2009;96(7):979 – 985.
3. Deepti Mishra, Manish Mudgal, Mohd Akram Khan, Prabha Padmakaran and Bchakradhar. Assessment of groundwater quality of Bhavnaga region (Gujarat). *J Sci & Industrial Research*. 2009;68:964-966.
4. Suman Mor, Bishnoi MS and Bishnoi MR. *Ind J Environ Prot*.2003;23(6):673.
5. Khaiwal Ravindra and Vinod K Garg. Hydro – chemical survey of ground water of Hisar city and assessment of defluoridation methods used in India, *Environ Monit Assess*. 2007;132:33 – 43.
6. Langenegger O. Ground water quality in Rural Areas of Western Africa, UNDP Project

INT/81/026, 1990. Edet AE, *Environ Geol*.1993;22:41.

7. Mufeed I Batarseh. The quality of potable water types in Jordan, *Environ Monit Assess.*2006;117:235 – 244.
8. Ramachandramoorthy T, Sivasankar V and Gomathi R. Fluoride and otherparametric status of ground water samples at various locations of the Kolli hills, Tamil Nadu, Indian. *JIPHE*.3. (2009).
9. Surindra Suthar, Vinod K Garg, Sushant and Sushma Singh. Fluoride contamination in drinking water in rural habitations of Northern Rajasthan, India, *Environ Monit Assess.* 2008;145:1 – 6.
10. Fetter CW. *Applied hydrology, New Delhi: CBS,* (1990).
11. Sawyer CN and McCarty PI. *Chemistry for sanitary engineers (2 nd ed.)* New York: McGraw Hill, (1967).
12. Sivasankar V and Ramachandramoorthy T. An Investigation on the pollution status ofholy aquifiers of Rameshwaram, Tamil Nadu, India. *Environ Monit Assess.* 2009;156:307 – 315.
13. World Health Organization, Guidelines for Drinking Water Quality (vol. 2.). *Health Criteria and other supporting information (2nd edn.),* Geneva: WHO. 231 – 233. (2004).
14. Karunakaran K, Thamilarasu P and Sharmila R. Statistical study on Physicochemical characteristies of Ground water in an around Namakkal, Tamil Nadu, India, *E – J Chem.* 2009;6(3): 909 – 914.
15. Tiwari TN and Mishra M. A preliminary assessment of water quality index of major Indian rivers. *Indian Journal of Environmental protection.* 1985;5(4):276 – 279.
16. Langelier WF. Chemical Equilibria in Water Treatment. *Journal of American Water Works Association.* 1946;38:169.
17. Murray JJ. Appropriate use of fluoride for human health. *World health organization*, Geneva, (1986).
18. Fazul Hoque AKM, Khaliquazzaman M, Hossain MD and Khan AK. Fluoride in different drinking water sources in Bangladesh. *Fluoride.* 2003;36(1):38 – 44.
19. Mariappan P, Yangnaraman V and Vasudevan T. Corrleation between Fluoride and alkalinity in Ground water of fluorosis Endemic –Salem District. *Indian journal of Environmental protection.* 1999;20(3):182-187.
20. Meta KV. Physico – chemical characteristics and statistical study of ground water of some places of Vadagam Taluka in Banaskantha District of Gujarat State (India). *Journal of Chemical Pharamacheutical Research.* 2010;2(4):663 – 670.
21. Patil VT and Patil PR. Physicochemical analysis of selected groundwater samples of Amalner town in Jalgaon District, Maharashtra, India, *Electronic Journal of Chemistry*. 2010;7(1):111-116.
22. Jha SK, Nayak AK, Sharma YK, Potential fluoride contamination in the drinking water of Marks Nagar, Unnao district, Uttar Pradesh, India, *Environ Geochem Health.* 2010;32:217-226.
23. Yadav JP, Suman Lata, Sudhir K Kataria and Sunil Kumar. Fluoride distribution in groundwater survey of dental fluorosis among school children in the villages of the Jhajjar District of Harayana, India. *Environ Geochem Health*. 2009;31:431-438.
24. Radha Krishnan R, Dhamaraj K and Ranjitha Kumari B.D. A comparative study on the physicochemical and bacterial analysis of drinking, borewell and sewage water in the three different places of Sivakasi. *Journal of Environmental Biology*. 2007;28(1)105-108.
25. Lilly Florence P, Paulraj A and Ramachandramoorthy T. Physico – Chemical analysis of groundwater samples of Veppanthattai Taluk in Perambalur District, Tamil Nadu, India. *International Journal of Advances in Pharmacy, Biology and Chemistry*. 2013;2(2):256-264.

Source of Support: NIL
Conflict of Interest: None