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Original Research Paper

Studies on Groundwaters of Mysore City with Special Reference to Fluoride Concentration

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ABSTRACT

A two-year study of the seasonal variations in fluoride concentration was carried out from November 2006 to October 2008 in the groundwaters of Mysore city with five zones. The fluoride concentration in the water samples of east and west zones showed significant seasonal changes during both the years. However in north, south and central zones, fluoride concentration did not establish any variations in both the years. The highest fluoride value of 0.46 mg/L was recorded in the west zone and the lowest of 0.22 mg/L in the east zone. The probable causes for such variations in fluoride concentration in these groundwater samples have been discussed.

INTRODUCTION

Water is one of the most important constituents of the living organisms, and regarded as supporting life for general purpose and carrier to maintain active systems (Padmavathy et al. 2003). Fluoride is a key aspect of water quality in rural water supply system, which potentially affects the sustainability of water if it exceeds its permissible limit. At first in 1937, the excessive fluoride in groundwater was reported in India in the state of Andhra Pradesh. Approximately 62 million people including 6 million children suffered from fluorosis because of consumption of water with high fluoride concentrations (Susheela 1999). Seventeen states in India have been identified as endemic for fluorosis and Tamilnadu is one of them. The amount of fluoride occurring naturally in groundwater is governed by climate, composition of the host rock and hydrogeology (Gupta et al. 2006). The major sources of fluoride in groundwater are fluoride bearing rocks such as fluorspar, cryolite, fluorapatite and hydroxylapatite. The fluoride content is a function of many factors such as availability and solubility of fluoride minerals, velocity of flowing water, temperature, pH, concentration of calcium and bicarbonate ions in water etc. (Meenakshi et al. 2004).

In Indian subcontinent, the higher concentration of fluoride in groundwater is associated with igneous and metamorphic rocks. According to WHO (2004) and BIS (1996) standards, the fluoride in drinking water should be within a range that slightly varies above and below 1 mg/L. WHO has set a range of allowable concentration of fluoride in drinking water for a region depending on its climatic conditions, because the amount of water consumed and consequently the amount of fluoride ingested is being influenced primarily by the air temperature (Galan & Lamson 1953, Mohan et al. 1995, Ramanaiah et al. 2006). In temperate regions where water intake is low, fluoride concentration up to 1.5 mg/L is acceptable.

Groundwater contamination with fluoride possesses a severe health problem. If fluoride is ingested beyond the limit of tolerance of human body, it may cause three types of fluorosis, namely skeletal fluorosis (affecting bone), dental fluorosis (affecting teeth) and non-skeletal fluorosis (affecting soft tissues) (Thakare et al. 2006). Low concentration of fluoride below 0.5mg/L causes dental caries (Praharaj et al. 2004). In Karnataka, fluoride level and water quality in rural areas of Mandya district was carried out by Krishna (2002). Srikantaswamy et al. (2007) made an assessment of groundwater status around industrial areas of Mysore city, and Kumar (2010) worked on fluoride content of bore well waters in Mysore city. However, these investigations cover only certain period of seasons. Hence, the present investigation has been carried out to make a systematic analysis of fluoride concentration with respect to three well marked seasons in Indian climate, in the groundwater of five zones of Mysore city.

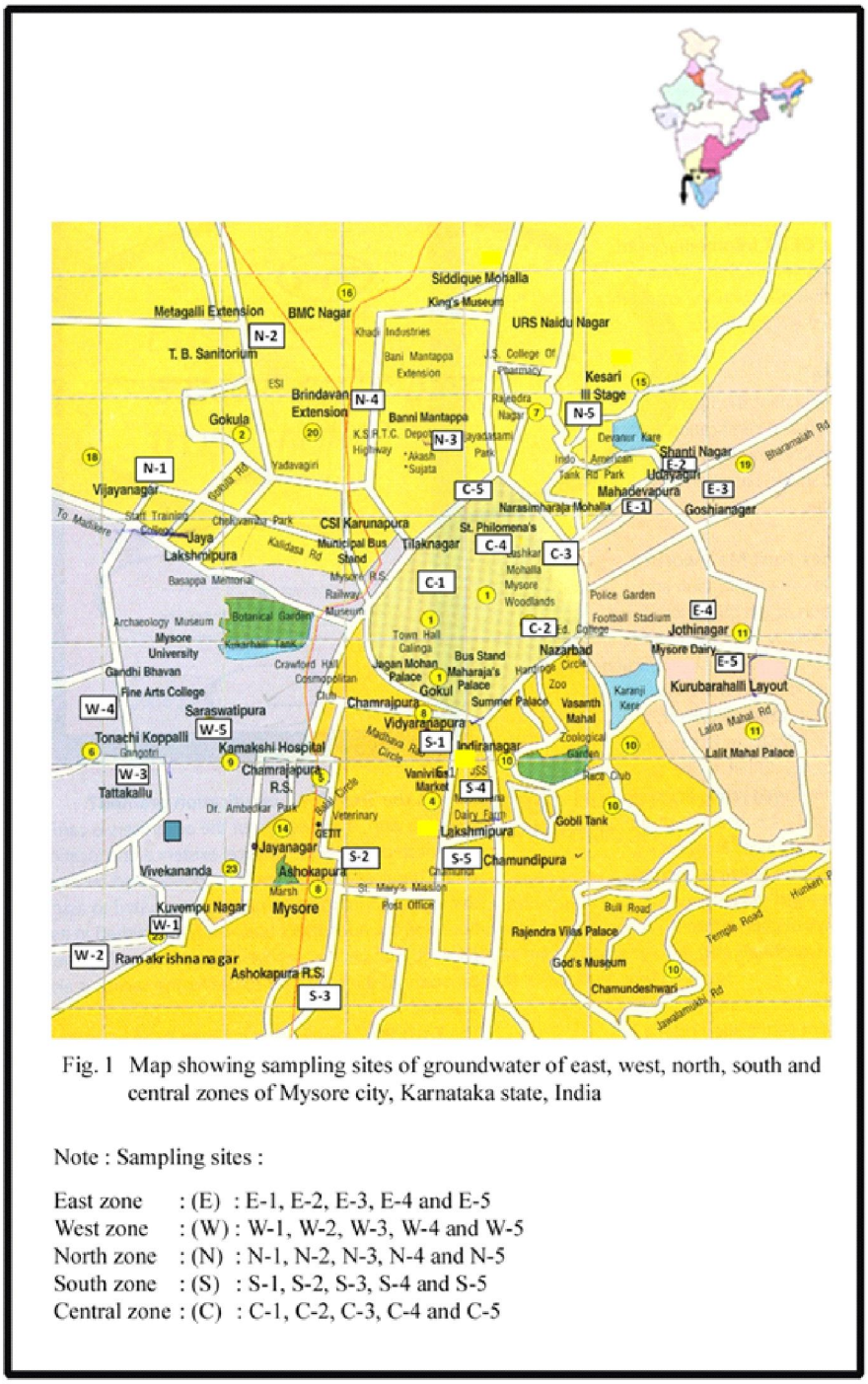

Fig. 1 Map showing sampling sites of groundwater of east, west, north, south and central zones of Mysore city, Karnataka state, India

Note : Sampling sites :

East zone : (E) : E-1, E-2, E-3, E-4 and E-5
West zone : (W) : W-1, W-2, W-3, W-4 and W-5
North zone : (N) : N-1, N-2, N-3, N-4 and N-5
South zone : (S) : S-1, S-2, S-3, S-4 and S-5
Central zone : (C) : C-1, C-2, C-3, C-4 and C-5

MATERIALS AND METHODS

Study area: Mysore city is the second largest city in the State of Karnataka. It is located at 12°18'-12'30° N and 76° 39'-76.65°E and has an average altitude of 770 m above sea level. It is situated in the southern region of the State of Karnataka, at the base of the Chamundi Hills and spreads across an area of 128.42 km^2. It is situated in the interfluves of two rivers, River Cauvery and River Kabini.

Sample collection: The selected sampling sites for the present investigation are shown in Fig. 1. The water samples were collected from bore wells (hand pumps) in five different (east, west, north, south and central) zones of the Mysore

Table 1: Summary of fluoride parameter in groundwater of east, west, north, south and central zones, November 2006-October 2008

S. No.	Parameters	Sampling zones									
		East		West		North		South		Central	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
1	Fluoride	0.26	0.22-0.33	0.4	0.36-0.46	0.32	0.27-0.38	0.32	0.28-0.38	0.26	0.24-0.3

Table 2: Seasonal variation in the fluoride parameters in the groundwater of east zone of Mysore city, first and second year of seasonal study, November 2006 to October 2008.

S. No.	Parameter	Year	Pre-Monsoon (Summer)	Monsoon (Rainy)	Post-Monsoon (Winter)	'F'-Value	'P'-Value
1	Fluoride	2006-07	$0.25^{ab}\pm0.05$	$0.33^{b}\pm0.05$	$0.22^{a}\pm0.04$	7.095	0.009**
2	Fluoride	2007-08	$0.25^{ab}\pm0.05$	$0.34^{b}\pm0.05$	$0.22^{a}\pm0.04$	6.995	0.010*

Note: Values are Mean ± SD, [1]Values obtained from ANOVA post hoc nonparametric test, **= Highly significant, P<0.001; *=Significant, P<0.05; NS = Non significant, P>0.05. Mean values with different superscripts are significantly different (P<0.05, Student-Newman-Keuls test)

Table 3: Seasonal variation in the fluoride parameters in the groundwater of west zone of Mysore city, first and second year of seasonal study, November 2006 to October 2008.

S. No.	Parameter	Year	Pre-Monsoon (Summer)	Monsoon (Rainy)	Post-Monsoon (Winter)	'F'- Value	'P'-value
1	Fluoride	2006-07	$0.38^{ab}\pm0.06$	$0.46^{b}\pm0.04$	$0.36^{a}\pm0.05$	4.603	0.033*
2	Fluoride	2007-08	$0.39^{ab}\pm0.05$	$0.46^{b}\pm0.04$	$0.37^{a}\pm0.05$	4.007	0.046*

Note: As per Table 2.

Table 4: Seasonal variation in the fluoride parameters in the groundwater of north zone of Mysore city, first and second year of seasonal study, November 2006 to October 2008.

l No.	Para-meter	Year	Pre-Monsoon (Summer)	Monsoon (Rainy)	Post-Monsoon (Winter)	'F'- Value	'P'-value
1	Fluoride	2006-07	$0.32^{a}\pm0.08$	$0.39^{a}\pm0.07$	$0.28^{a}\pm0.10$	2.059	0.170^{NS}

Note: As per Table 2.

Table 5: Seasonal variation in the fluoride parameters in the groundwater of south zone of Mysore city, first and second year of seasonal study, November 2006 to October 2008.

S. No.	Parameter	Year	Pre-Monsoon (Summer)	Monsoon (Rainy)	Post-Monsoon (Winter)	F'- Value	'P'-value
1	Fluoride	2006-07	$0.30^{a}\pm0.13$	$0.38^{a}\pm0.11$	$0.28^{a}\pm0.10$	1.054	0.379^{NS}
2	Fluoride	2007-08	$0.29^{a}\pm0.12$	$0.38^{a}\pm0.11$	$0.29^{a}\pm0.11$	0.925	0.423^{NS}

Note: As per Table 2.

city during 2006-2008. The PVC bottles were placed under the hand pump to collect the sample after 5 minute running of water. All the precautionary measures were taken to prevent contamination and analysed for the fluoride. The analysis of fluoride was carried out seasonally and the method used for the analysis was as prescribed by APHA (1998). The results obtained were evaluated in accordance with the standards prescribed by BIS (1996) and WHO (2004). The physico-chemical parameters of water samples measured (mean values) during the study period from November 2006 to October 2008 are given in Table 1. The statistical analysis (Mean ± SD and 'F' and 'P' values obtained through one-way ANOVA post hoc non parametric Student-Newman-Keuls test) of the season-wise grouped data, is given in Tables 2-6.

RESULTS AND DISCUSSION

The mean value of fluoride in groundwater of east and central

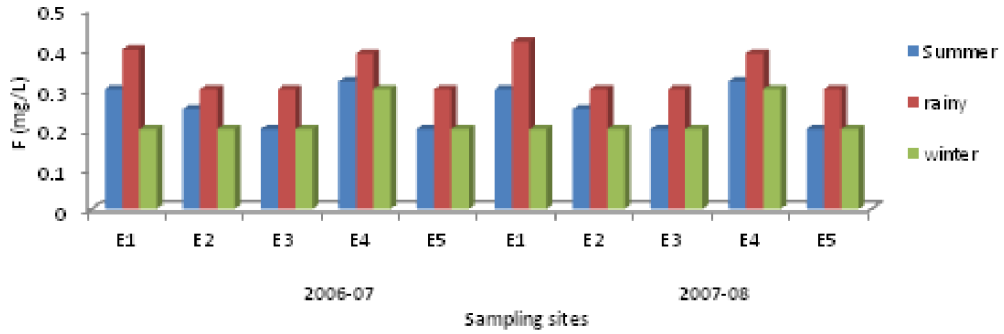

Fig. 2: Fluoride in East zone

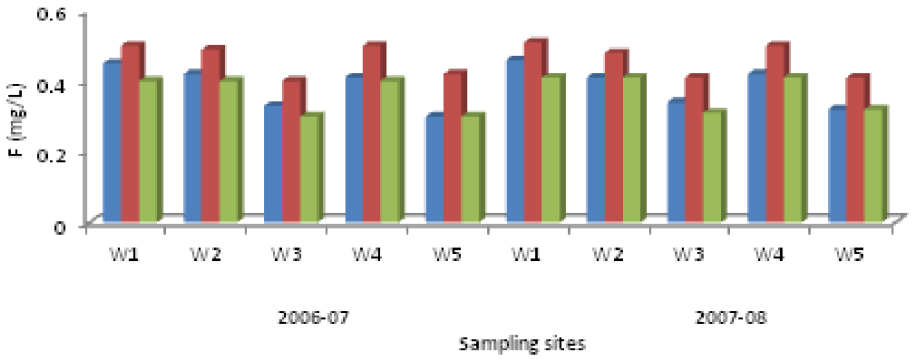

Fig. 3: Fluoride in west zone

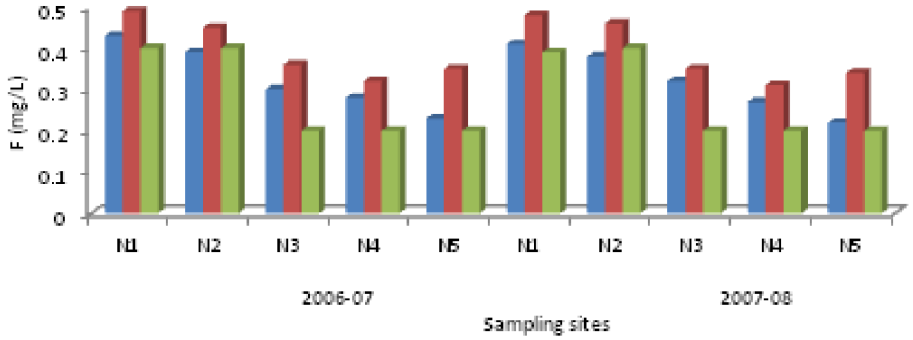

Fig. 4: Fluoride in north zone

zones were similar (0.26mg/L). However, the north and south zones were also shown similar (0.32mg/L) mean values in fluoride concentration but it was 0.4mg/L in west zone (Table 1). The fluoride measured in the groundwater of east zone was 0.22mg/L in winter season (2006), but increased during summer to 0.25mg/L and then rose to 0.33mg/L during rainy season of 2007. From then it gradually decreased to 0.22 mg/L in winter and again increased to 0.34 mg/L in rainy season 2008 (Fig. 2). It is noteworthy that the lowest fluoride of 0.22 mg/L measured in the groundwater of east zone was the lowest recorded value among the five sites studied (Table 1). The season-wise grouped data revealed that there were clearcut significant seasonal changes in the fluoride concentration of the groundwater of east zone in the first and second year of the study. It was noticed that fluoride value was low in the winter season and high in the summer season of both the years of study (Table 2).

In the water samples of west zone, the fluoride concentration was initially 0.36 mg/L in winter season and gradually increased to 0.46 mg/L in rainy season of 2007. Further it gradually decreased to 0.37 mg/L and again rose to 0.46 mg/L in rainy season of 2008 (Fig. 3). It is noteworthy that the fluoride content of 0.46 mg/L measured in the groundwater of west zone was the highest recorded value

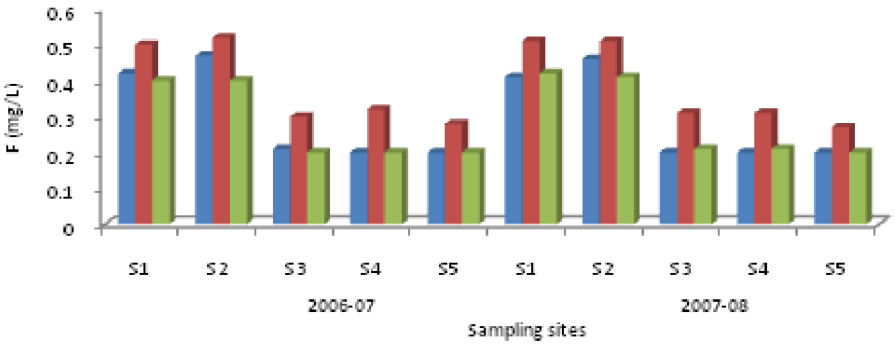

Fig. 5: Fluoride in south zone

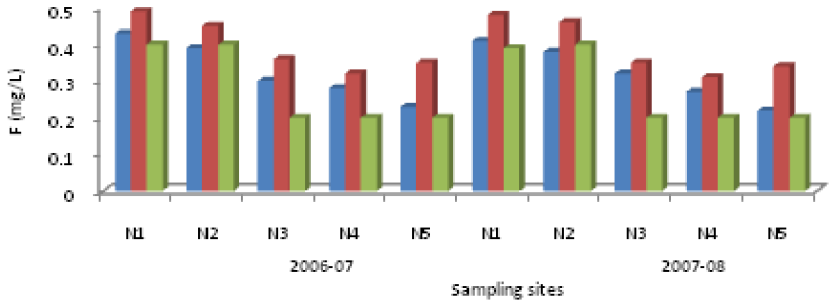

Fig. 6: Fluoride in central zone

among five zones studied (Table 1). The season-wise grouped data revealed that there was a significant seasonal change in the fluoride of west zone water sample in the first and second year of study. It was also noticed that the fluoride concentration was maximum in rainy season and minimum in winter season of both the years of study (Table 3).

The fluoride in the north zone of groundwater was 0.28 mg/L in winter season, but later increased (0.32 mg/L) during summer of 2007 and rose to 0.39 mg/L in rainy season. Thereafter, the fluoride concentration gradually decreased to 0.27 mg/L in winter (2007) and again increased to 0.38 mg/L in rainy season of 2008 (Fig. 4). The season-wise grouped data did not establish any significant seasonal changes in the fluoride of groundwater of the north zone during both the years of study (Table 4).

The fluoride concentration of groundwater of south zone was 0.28 mg/L in winter season of 2006 and increased to 0.30 mg/L during 2007 of summer season. Further, it increased to 0.38 mg/L in rainy season and later decreased to 0.29 mg/L in winter. The fluoride concentration remained same (0.29 mg/L) in summer of 2008 and then rose to 0.38 mg/L in rainy season of 2008 (Fig. 5). The season-wise grouped data revealed that there were no significant seasonal changes in the fluoride content of groundwater of the south zone in both the years of the study period (Table 5).

The fluoride content in central zone was 0.24 mg/L in winter season of 2006, and remained same (0.24 mg/L) till summer of 2007. It again increased to 0.33 mg/L in rainy season. Further, the fluoride concentration gradually decreased to 0.24 mg/L in winter and rose to 0.33 mg/L in rainy season of 2008 (Fig. 6). The season-wise grouped data revealed no significant seasonal changes in the fluoride of groundwater of the central zone in both the years of study period (Table 6).

Groundwater contamination with fluoride poses a severe health problem. If fluoride is ingested beyond the limit of tolerance of human body, it may cause three types of fluorosis, namely skeletal fluorosis, dental fluorosis and non-skeletal fluorosis. It causes skeletal and dental manifestation which includes nervousness, depression, tingling sensation of finger and toes, excessive thirst and tendency to urinate more frequently. It may also lead to muscular manifestation like muscle weakness, stiffness, pain and loss of muscle power (Thakare et al. 2006, Mali 2007). In the present investigation, the maximum fluoride value of 0.46 mg/L was observed in the west zone during the rainy season and a minimum of 0.22 mg/L in the east zone during winter season. The east and west zones showed significant seasonal changes in both the years of study compared to other three zones (north, south, central). Such irregular and excess fluoride

Table 6: Seasonal variations in the fluoride parameters in the groundwater of central zone of Mysore city, first and second year of seasonal study, November 2006 to October 2008.

S. No.	Parameter	Year	Pre-Monsoon (Summer)	Monsoon (Rainy)	Post-Monsoon (Winter)	'F'- Value	'P'-value
1	Fluoride	2006-07	$0.34^{a}\pm0.06$	$0.33^{a}\pm0.07$	$0.24^{a}\pm0.05$	3.509	0.063^{NS}
2	Fluoride	2007-08	$0.25^{a}\pm0.05$	$0.33^{a}\pm0.08$	$0.24^{a}\pm0.05$	3.044	0.085^{NS}

Note: As per Table 2.

concentration in these groundwater samples may be attributed to the geological formation of that particular area and rapid groundwater depletion. This is in agreement with the findings of Garg et al. (1998a, 1998b) and Ramanaiah et al. (2006). The concentration of fluoride may also come from fertilizers, pesticides, domestic wastes and industrial wastes (Gupta et al. 1994, Mariappan 1996, Suresh 1996, Choubisa 1997). In the present study, fluoride content was within the permissible limits (1.5 mg/L) prescribed by BIS (1996) and WHO (2004) standards.

CONCLUSION

Possible relationship to human activities and other management issues covering the pattern of use of the groundwater has an impact on the quality of water available to the city. The deteriorating influence of the natural environment and anthropogenic activities needs elucidation for management of water resources. The impact of increasing human population and abuse of this vital resource gives an alarm for sustaining the quality of life. The current investigation is illustrative on the description and evaluation of fluoride as factors influencing the quality of water which determine survival and health of future generations. However, the overall picture that emerges out of the study warrants for strict vigilance and continuous treatment of these groundwater bodies for domestic consumption and sustainable management.

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REFERENCES

BIS 1996. Standards for water for drinking and other purposes, India. Bureau of Indian Standards, New Delhi.

Choubisa, S.L. 1997. Fluoride distribution and fluorosis in some villages of Banswara district of Rajasthan. Indian J. Environ. Health, 39: 281-288.

Galan, D.J. and Lamson, G.G. 1953. Climatic and endemic dental fluorosis, Public Health Deptt., 68: 497.

Garg, V.K., Arti, D.S.C. and Deephika 1998a. Fluoride distribution in the groundwater of Jind district, Haryana, India. Ecol. Environ. Conserv., 4: 19-23.

Garg, V.K., Sharma, I.S. and Bishnoi, M.S. 1998b. Fluoride in underground waters of Uklana town, District Hisar, Haryana. Pollut. Res., 17: 149-152.

Gupta, S., Banerjee, S., Saha, R. Datta, J.K. and Mondal, N. 2006. Fluoride geochemistry of groundwater in Birbhum, West Bengal, India. Fluoride, 39: 318-320.

Gupta, S.K., Gupta, R.C. and Seth, A.K. 1994. Several clinical and dental fluorosis. Indian Pediatr., 31: 439.

Kannan, S.K and Ramasubramanian, V. 2011. Assessment of fluoride contamination in groundwater using GIS, Dharmapuri district, Tamilnadu, India. Int. J. Engg. Science, 3: 1077-1085.

Krishna, C.B.M. 2002. Fluoride level and water quality in rural area of Mandya district. Indian J. Environ. Prot., 22: 742-745.

Kumar, C.S.C. 2010. Fluoride content of bore well water in Mysore city of Karnataka, India. Nat. Environ. Pollut. Technol., 9: 155-156.

Mali, D.S. 2007. Prevalence of fluorosis and defluoridation of water: An overview. Indian J. Environ. Prot., 27: 459-466.

Mariappan, P. 1996. Discussion on fluoride contribution to surface waters from subsurface strata: A case study. J. IWWA, 28: 184.

Meenakshi, V.K, Garg, Kavita, Renuka and Malik, A. 2004. Ground-water quality in some villages of Haryana, India: Focus on fluoride and fluorosis. J. Hazard. Mater., 106B: 85-97.

Mohan, V.S., Nikhila P. and Reddy, S.J. 1995. Determination of fluoride content in drinking water and development of a model in relation to some water quality parameters. Fresenius Environ. Bull., 106: 85-97.

Padmavathy, S., Amali, R.E., Raja, P., Nagarajan and Kavitha, B. 2003a. A study of fluoride level in potable water of Salem district and an attempt for defluoridation with lignite. Indian J. Environ. Prot., 23: 1244-1247.

Praharaj, A.K., Mohanta, B.K. and Nanda, N.K. 2004. Studies on groundwater quality of Rourkela, Orissa. Pollut. Res., 23: 399-402.

Ramanaiah, S.V., Mohan, S.V., Rajkumar, B. and Sarma, P.N. 2006. Monitoring of fluoride concentration in groundwater of Prakasham district in India: Correlation with physico-chemical parameters. J. Environ. Science and Engg., 48: 129-134.

Srikantaswamy, S., Krishnegowda, P.H. and Raghunath, T. 2007. Assessment of groundwater status around industrial areas of Mysore city, Karnataka, India. J. Ecotoxicol. Environ. Monit., 17: 463-471.

Suresh, T.S. 1996. Fluoride in groundwater of Chiknayakanahalli taluk, Tumkur district, Karnataka, India. Workshop on Challenges in Groundwater Development, Madras University, 185-188 pp.

Susheela, A.K. 1999. Fluorosis management programme in India. Curr. Sci., 77: 1250-1256.

Thakare, S.B., Parwater, A.V. and Rao, M. 2006. Status of fluoride and study of endemic fluorosis - An overview. Environ. Pollut. Control., J. 9: 1-3.

Tripathi, I.P., Richhariya, N. and Tamrakar, S. 2008. Studies on water of rural areas of Satna district with special reference to fluoride concentration. Indian J. Environ. Prot., 28: 173-176.

Veeraputhiran, V. and Alagumuthu, G. 2010. A report on fluoride distribution in drinking water. Int. J. Environ. Sciences, 1: 558-566.

WHO 2004. Guidelines for Drinking Water Quality. Volume 1, World Health Organization's Recommendations, Geneva.