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Fluoride Contamination of Ground Water in Aatmakoor Mandal of Nalgonda District, Telangana, India

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Abstract: *Fluoride concentrations in ground water samples were determined in 26 villages of Aatmakoor Mandal of Nalgonda District, Telangana during pre and post monsoon seasons (May and October, respectively) of 2013. Fluoride concentrations in ground water samples of these villages varied between 1.12 to 4.67 and 0.73 to 3.25, with average of 2.48 and 1.74 ppm during pre and post monsoon seasons, respectively. As per drinking water standards, 92.3% (24 samples) of the ground water samples in pre-monsoon and 50% (13 samples) of the ground water samples in post monsoon have F content greater than that of maximum permissible limit of 1.50 ppm fluoride. Therefore drinking water is sufficient to produce severe form of dental fluorosis and mild form of skeletal fluorosis consumed for a long period. As far as irrigation is concerned, data show that none of the bore well and open well water samples have fluoride content above 10 mg L^{-1}, which is the safe limit for all type of crop plants. Thus, all water samples tested in this investigation can safely be used for agricultural purpose.*

Key words: *Fluoride; Groundwater; Permissible limit; Nalgonda; Telangana State.*

INTRODUCTION

Fluoride has long been recorded as one of the most significant natural ground water quality problems affecting arid and semi-arid regions of world. Around 200 million people from 25 nations have health risks because of high fluoride in groundwater (Ayoob and Gupta 2006). In India too, there has been an increase in incidence of dental and skeletal fluorosis with about 62 million people at risk due to high fluoride concentration in drinking water (Andezhath *et al.* 1999). Dental fluorosis is endemic in 14 states and 1,50,000 villages in India with the problem most pronounced in the states of Telangana, Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh, Punjab, Rajasthan, Tamil Nadu, and Uttar Pradesh (Pillai and Stanley 2002).

Nalgonda is the worst effected district with a presence of excess F in ground water in the state of Telangana. The main natural sources of inorganic fluoride (F) in soils of Nalgonda district are weathering and dissolution of rocks and minerals, emissions from volcanoes and marine aerosols (Rao and Mamatha, 2004). This high concentration of F affects all the life forms in the soil. In this paper, the data pertaining to fluoride concentrations in the ground water of Aatmakur mandal of Nalgonda district in Telangana state of India has been presented. For this, field samples from different sites were collected and analysed. The results obtained are presented and discussed in this paper.

MATERIALS AND METHODS

The study area forms a part of Nalgonda district, Telangana, which is located at a distance of 90 km away from Hyderabad (Fig. 1). This area experiences arid to semiarid climate. The study area goes through hot climate during the summer (March–May) with a temperature range from 30°C to 46.5°C, and in winter (November–January), it varies between 14°C and 29°C. The average annual rainfall in this area is about 1,000 mm, occurring mostly during south-west monsoon (June–September).

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Groundwater samples were collected during the pre monsoon (May) and *post monsoon* (October) season of 2013 from existing water sources (open wells and bore wells) with the help of a handheld Global Positioning System (GPS). Geographical information *viz*., latitude and longitude of the benchmark sites were recorded and ground water fluoride status maps can be prepared by depicting the element in water at village level. Totally 26 benchmark sites were fixed depending on the number of villages of study area for collection of water samples. Water samples were collected in clean polyethylene bottles of 600 ml capacity. The sampling bottles were soaked in 1:1 diluted HCl solution for 24 h washed with distilled water, and were washed again prior to each sampling with the filtrates of the sample. Samples collected were transported to the laboratory and fortified with 1 ml toluene to arrest any biological activity. The samples were stored at 4°C until used for fluoride analysis (APHA, 1985). Fluoride was analyzed by using Specific Ion Electrode method Wedepohl (1969).

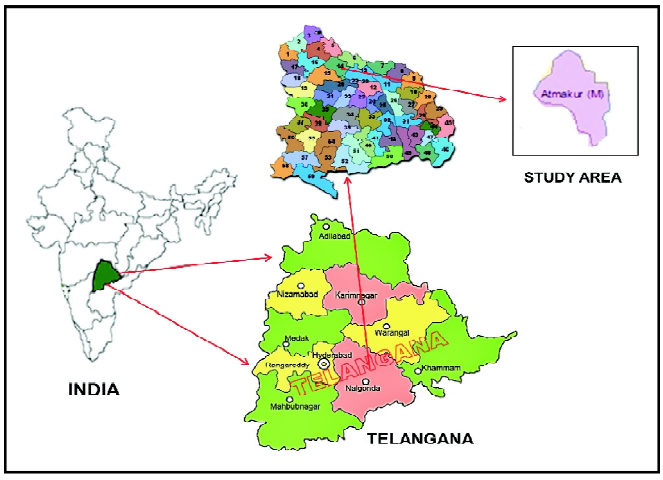

Figure 1: Location map of the study area

RESULTS AND DISCUSSION

Fluoride Content of Ground Water

Fluoride content of ground water collected from different villages of Narkatpally mandal of Nalgonda district during pre and post monsoon seasons are presented in Table 1. Fluoride present in the irrigation water samples collected during pre and post monsoon seasons varied from 1.12 to 4.67 and 0.73 to 3.25, with average of 2.48 and 1.74 ppm F, respectively. Lowest content of F was recorded in Muripirala village (1.12 and 0.73 ppm during pre and post monsoon seasons, respectively) while the highest was recorded in Regulakunta village (4.67 and 3.25 ppm during pre and post monsoon seasons, respectively). Especially higher F concentrations were observed in bore well water samples than open wells. Groundwater F status map during pre and post monsoon seasons are shown in figures 2 and 3.

According to FAO (1994), the normal and moderately suitable range of fluorides concentration in irrigation water is from < 19 ppm (1.0 me L^{-1}) and 19 to 171 ppm (1.0-15 me L^{-1}) F, respectively. Safe limit of 10 mg F L^{-1} of irrigation water has been proposed for all type of crop plants by Leone *et al*. (1948). The present investigation showed that none of the water samples were found to cross this limits and hence suitable for irrigation purpose. However continuous application of irrigation waters having toxic concentration of fluoride is likely to affect adversely the crop growth.

As per drinking water standards of ICMR (1975), the highest desirable concentration of F is 1.0 ppm in tropical countries and that of maximum permissible level is 1.50 ppm. Out of 26 samples, 92.3% (24 samples) of the ground water samples in pre-monsoon and 50% (13 samples) of the ground water samples during post monsoon have F content greater than that of maximum permissible limit of 1.50 ppm fluoride. Therefore drinking water is sufficient to produce severe form of dental fluorosis and mild form of skeletal fluorosis consumed for a long period. The rocks of this area possess fluoride content higher than the world average. Weathering of rocks and leaching of fluoride bearing minerals from the basement granitic rocks are the major reasons which contribute to elevated concentration of fluoride in groundwater. The other important natural phenomenon that contributes to high fluoride is evaporation (Brindha *et al*., 2010). Similar results reported by Reddy *et al*. (2009) and Kishore and Hanumantharao (2010) in Nalgonda district.

Table
Fluoride content in ground water samples collected in different villages of Aatmakoor mandal during pre (May) and post (October) monsoon seasons, 2013

S.No.	Village	Fluoride Content(ppm)	
		Pre-monsoon	*Post monsoon*
1	Lingarajpally	1.92	1.67
2	Pallerla	2.63	1.23
3	Siddapuram	2.61	2.58
4	Aatmakoor	3.14	3.12
5	Muripirala	1.12	0.73
6	Polimarajulabai	3.25	1.27
7	Elicabavi	3.97	2.53
8	Modugunta	1.85	0.75
9	Singaram	2.13	1.26
10	Chandapalli	2.45	2.37
11	Chamapur	1.87	1.05
12	Regulakunta	4.67	3.25
13	Koratikal	2.31	2.21
14	Duppally	1.74	1.69
15	Kashammakunta	1.95	1.25
16	Thukkapuram	2.67	2.29
17	Raheemkhanpeta	3.95	1.52
18	Kurella	1.87	0.96
19	Khapraipalli	3.32	1.98
20	Timmapur	2.76	2.73
21	Raipally	1.85	0.99
22	Sarvepally	2.13	1.06
23	Kondapuram	2.64	2.52
24	Muthyreddygudem	1.45	1.39
25	Chada	1.73	1.36
26	Katepally	1.75	0.98
	Range	1.12-4.67	0.73-3.25
	Mean	2.48	1.74

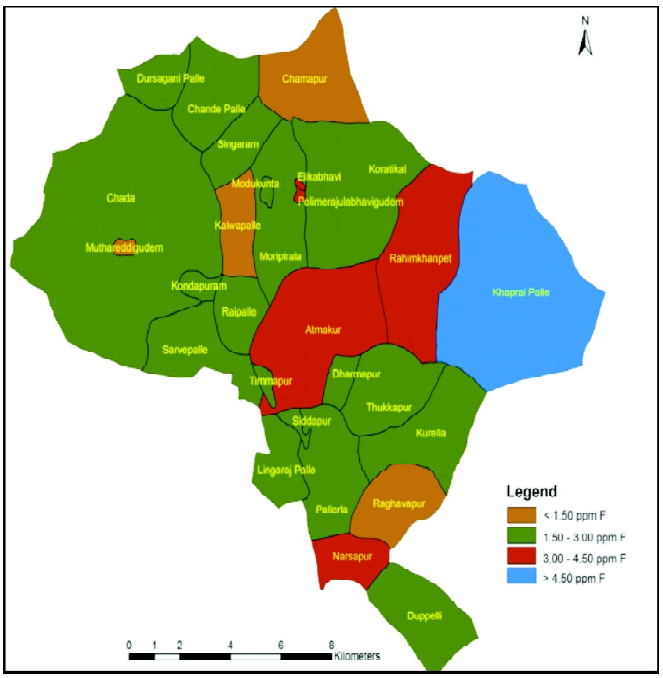

Figure 2: Ground water fluoride status map of Aatmakoor mandal (*pre-monsoon*, 2013)

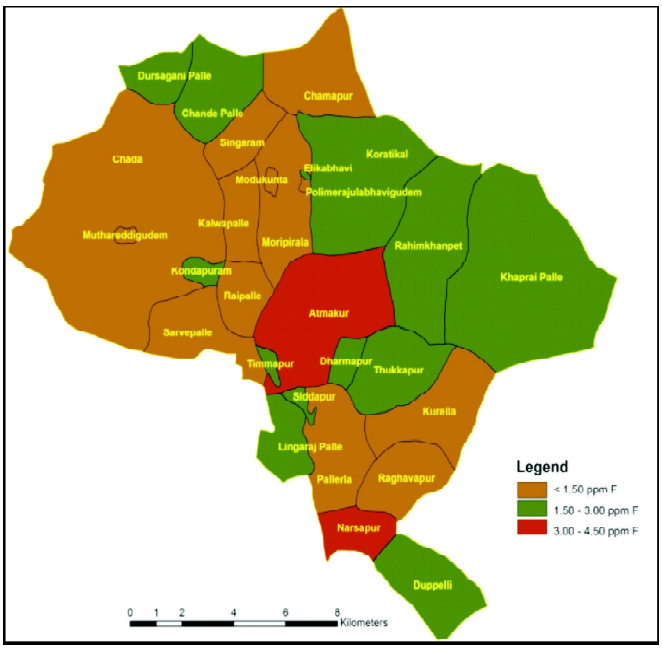

Figure 3: Ground water fluoride status map of Aatmakoor mandal (*post monsoon*, 2013)

Seasonal Variations of Fluoride in ground water

When compared to two seasons, the concentration of fluoride in groundwater during *post monsoon* was lower than the *pre-monsoon*. Seasonal distribution is found significantly and the variation of fluoride is dependent on many factors. Generally, a high rate of evapo-transpiration and over exploitation of groundwater resources for agricultural and drinking water purposes during *pre-monsoon* season causes a low freshwater exchange and results in precipitation of salts, including F rich salts, temporarily in the top layers of the soil. During *post monsoon* season, the infiltrating waters leach these soils and replenishment of the groundwater by rainfall indicated a clean recharge from external sources. Hence, the concentration of fluoride is observed to be greater in the *post monsoon* season

groundwater than in *pre-monsoon* season. As a result, 92.3% (24 samples) of the total groundwater samples from the *pre-monsoon* season are above the permissible limit of fluoride (1.50 ppm), compared to 50% (13 samples) of those from the *pre-monsoon* season.

Seasonal distribution of fluoride is also dependent on amount of soluble and insoluble fluoride in source rocks, the duration of contact of water with rocks and soil temperature, rainfall and oxidation- reduction process (Mahapatra *et al*., 2005 and Paya and Bhatt, 2010).

CONCLUSIONS

High concentration of fluoride in groundwater of up to 4.67 ppm was measured. Thus, out of 26 ground water samples analyzed during the study, 24 samples in pre monsoon and 13 samples in post monsoon had fluoride above the permissible limit. The use of groundwater for drinking purpose from these wells has to be restricted. Suitable measures such as defluorinating the ground water before use and recharging the groundwater by rainwater harvesting need to be practiced to improve the groundwater quality in this area.

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