Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2016, 8(4):179-185

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Prevalence of Dental Fluorosis in southeastern part of Anantapur District, Andhra Pradesh

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ABSTRACT

This study was carried out to assess the fluoride concentration in groundwater in some villages of southeastern part of Anantapur district Andhra Pradesh, India, where groundwater is the main source of drinking water. The main objective of this study was to assess the association between water fluoride levels and prevalence of dental fluorosis among school children of Anantapur District, India. Fluoride in presently studied sites was recorded in the ranges of 0.5 and 5.7 mg/L. The fluoride concentration in the Mudigubba Mandal (1.7-5.7 mg/L) and in the Nallamada Mandal (0.5-4.8 mg/L), Kadiri Mandal (1.5-5.1 mg/L). The percentage of school children suffering from dental fluorosis are: 56.3% in Mudigubba; 38.4% in Nallamada and 52.3% in Kadiri Mandals. From this study, it has been found that Rall Ananathapuram, Sankepalli, Uppalapadu, Jonnalakothapalli, Mudigubba, Vankarakunta, Donnikota, Sanevaripalli, Vellamaddi, Nallamada, Pulagampalle, Patnam, Eguvapalli, Kadirikuntlapalli, Yerradoddi, Kutagulla and Alampur are the fluoride endemic villages, where the fluoride level in drinking water is above 1 mg/L. The results of the present study revealed that there exists a significant positive correlation between fluoride concentration in drinking water and dental fluorosis in high-fluoride villages. As per the desirable and maximum permissible limit for fluoride in drinking water, determined by WHO or by Bureau of Indian Standards, the groundwater of about 95% of the studied sites is not consumable for drinking purposes. Due to the higher fluoride level in drinking water several cases of dental fluorosis have appeared at alarming rate in this region. The result suggests that the groundwater should be used by the residents only after defluoridation.

Keywords: Dental fluorosis, Fluoride distribution, Ground water, School children, south eastern part of Anantapur, A.P.

INTRODUCTION

Groundwater is a significant water resource in India for domestic, irrigation, and industrial needs. More than 85% of rural and 50% of urban domestic water requirements are being met from groundwater resources, while irrigation accounts for around 92% of groundwater extraction [1]. Pollution of the groundwater due to geogenic and anthropogenic factors often render the groundwater unpotable as consumption of such water can lead to various health-related complications. Fluorine is the 13th most abundant and naturally occurring element in the Earth's crust and is the lightest member of the halogens. It is the most electronegative and reactive of all the elements and as a result, elemental fluorine does not occur in nature, but is found as fluoride mineral complexes. Fluoride has a significant mitigating effect against dental caries if the concentration is approximately 1 mg/L. However, continuous consumption of higher concentrations can cause dental fluorosis and in extreme cases even skeletal fluorosis. The WHO guideline value for fluoride in drinking water is 1.5 mg/L [2].

In India, due to scarcity of suitable potable water resources, especially in hard rock terrain, almost 60-65 million people drink fluoride contaminated groundwater. Due to this an estimated population of about 2.5 to 3 million people mainly in the state of Andhra Pradesh, Jharkhand, Gujarat, Madhya Pradesh, Punjab, Rajasthan, Tamil Nadu and Uttar Pradesh are affected by fluorosis [3-6]. Fluoride in groundwater is more common in crystalline igneous rocks and alkaline soils located in semiarid climate which exist in the southeastern parts of Anantapur district, A.P. The main source of fluoride in groundwater is considered to be fluoride-bearing minerals such as fluorspar (CaF_2), fluorapatite [$Ca_5(PO_4)_3F$], cryolite, and hydroxylapatite in rocks [7]. Also during its complex flow history, groundwater passes through various geological formations leading to consequent contamination in shallow aquifers which is largely tapped for drinking water supply in India [8]. High fluoride concentrations are especially critical in developing countries, largely because of lack of suitable infrastructure for treatment. Generally, most groundwater sources have higher fluoride concentrations than surface water. As groundwater percolates through the weathered rock in the aquifers, it dissolves fluoride bearing minerals, hence releasing fluoride into solution [9]. The main source of fluoride in groundwater is basically from the rocks minerals. High fluoride concentrations and fluorosis in the country are commonly associated with rural areas, arid, semi-arid climate, granites, gneisses, and advanced stage of groundwater development [10-16].

Groundwater is the major drinking water source in the villages of southeastern part of Anantapur district, Andhra Pradesh State. The aim of the study is to identify and quantify the level of fluorosis in the community residing in rural areas of southeastern part of Anantapur district, A.P, to analyze the fluoride content in the water samples collected from sources used for consumption by people exhibiting clinical signs of fluorosis and to correlate the above results and decide if defluoridation is needed for the water from these sources. Endemic fluorosis occurring due to consumption of groundwater polluted with fluoride is threatening the health of millions of people in India and therefore is a challenging and extensively studied national health problem [13,15,17]. Endemic fluorosis as well as its prevalence and severity is poorly known in A.P except for a few studies [18,19]. The present study examined the occurrence of fluoride in groundwater in Mudigubba, Nallamada, Kadiri revenue mandals of Andhra Pradesh state. The study area is located between East 77^0 15’0” - 78^0 50’0” longitudes and 14^0 0’0” -14^0 35’0” North latitudes and falls in the Survey of India Toposheet Nos. 57 F/14, F/15, F/16, J/3, J/4 and covering an area of 1136.3 sq. km (Figure 1). The present study was undertaken to assess the fluoride content of underground water and the prevalence of dental fluorosis among school children, in the villages of southeastern part of Anantapur District, Andhra Pradesh, India. The objective of this paper is to present a systematic approach to evaluate the distribution of fluoride in the groundwater sources with reference to its concentration, depth.

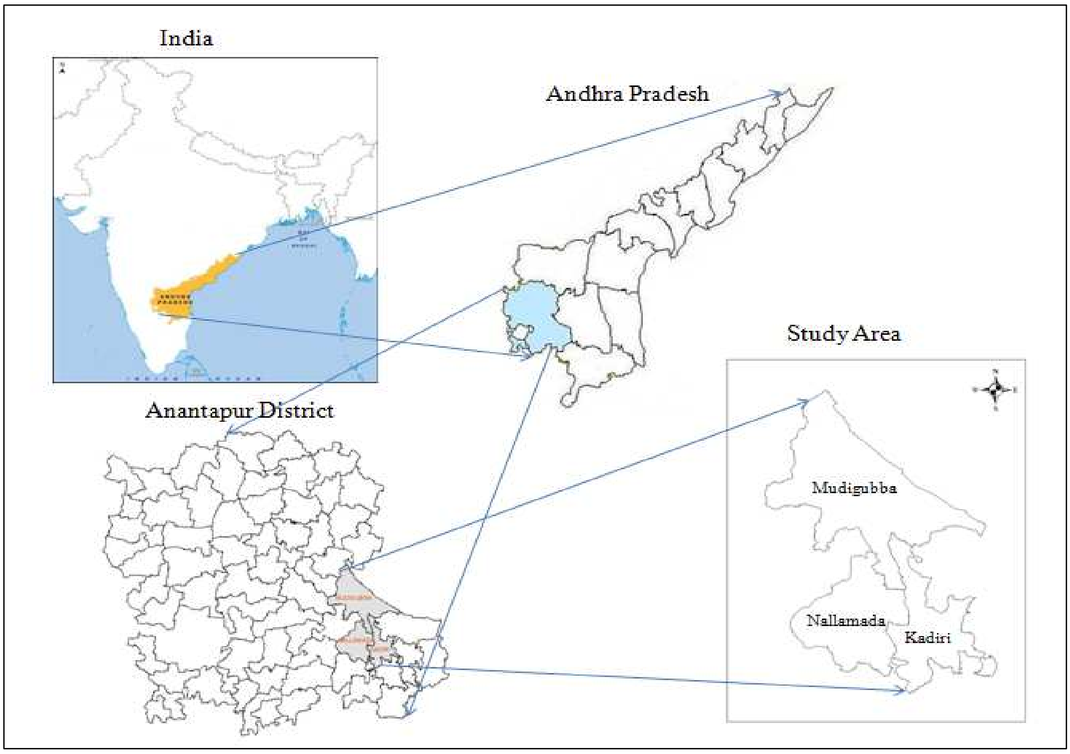

Fig. 1: Location of normal and fluoride endemic areas in Mudigubba, Nallamada and Kadiri Mandals of Anantapur district, Andhra Pradesh, India

EXPERIMENTAL SECTION

The groundwater source is drawn by hand pumps, tube wells, and open wells. In the present study only 30 villages were chosen, 10 villages from each mandal. The location map of the study area is shown in figure1. The exact location of study area with scale is displayed in Table 1, 2 and 3. Water samples were collected from each village from local hand pumps, tube wells, and open wells. A total of ten samples were collected from selected sources of each village to represent the water quality of the whole area. The samples were collected in precleaned polythene bottles with 1 litre capacity and transported to the laboratory.

The fluoride concentration in groundwater is determined electrochemically, using the ion selective electrode method. The electrode used is an Orion fluoride electrode, coupled to an Orion electrometer. Standards fluoride solutions (0.1-10 mg/L) are prepared from a stock solution of sodium fluoride (100 mg/L). To estimate the concentration, the water samples are diluted with equal volumes of total ionic strength adjustment buffer (TISAB) of pH 5.2 before fluoride estimation. The composition of TISAB solution was as follows: 58 g NaCl, 4 g of CDTA (Cyclohexylene diamine tetra acetic acid) and 57 mL of glacial acetic acid per litre [20]. All the experiments were carried out in triplicate and the results were found reproducible with ±3% error.

Table 1: Location of study areas in Mudigubba mandal of Anantapur District

S.No	Villages	Latitude	Longitude
1	Ralla Anantapuram	$14^0$35’39.76”N	$77^0$91’87.77”E
2	Sankepalli	$14^0$35’17.31”N	$77^0$96’03.19”E
3	Uppalapadu	$14^0$34’95.13”N	$77^0$92’81.93”E
4	Jonnalakothapalli	$14^0$35’04.23”N	$77^0$91’24.44”E
5	Mudigubba	$14^0$34’87.12”N	$77^0$99’41.36”E
6	Mangalamadaka	$14^0$31’09.08”N	$77^0$97’82.55”E
7	Sankepalli Brahmanapalli	$14^0$38’91.91”N	$78^0$00’45.72”E
8	Malakavemula	$14^0$26’99.00”N	$78^0$05’35.80”E
9	Timmanayanipalem	$14^0$39’61.40”N	$78^0$07’94.57”E
10	Gunjepalli	$14^0$34’95.71”N	$77^0$96’31.51”E

Table 2: Location of study areas in Nallamada mandal of Anantapur District

S.No	Villages	Latitude	Longitude
1	Vankarakunta	$14^0$18’61.12”N	$77^0$99’14.74”E
2	Reddipalli	$14^0$17’67.08”N	$78^0$03’61.06”E
3	Donnikota	$14^0$10’90.15”N	$78^0$05’87.48”E
4	Sanevaripalli	$14^0$31’42.84”N	$78^0$04’73.51”E
5	Vellamaddi	$14^0$23’38.34”N	$78^0$03’60.28”E
6	Nallamada	$14^0$14’17.63”N	$77^0$98’18.60”E
7	Pulagampalle	$14^0$07’84.19”N	$78^0$07’22.44”E
8	Charupalle	$14^0$16’80.19”N	$78^0$09’45.15”E
9	Kurumala	$14^0$09’54.02”N	$78^0$01’29.56”E
10	Gopepalli	$14^0$13’10.58”N	$78^0$03’65.19”E

Table 3: Location of study areas in Kadiri mandal of Anantapur District

S.No	Villages	Latitude	Longitude
1	Patnam	$14^0$23’38.40”N	$78^0$09’31.18”E
2	Eguvapalli	$14^0$07’76.70”N	$78^0$10’59.75”E
3	Kadirikuntlapalli	$14^0$17’32.73”N	$78^0$16’35.39”E
4	Yerradoddi	$14^0$16’77.29”N	$78^0$13’29.22”E
5	Kutagulla	$14^0$14’38.84”N	$78^0$15’15.07”E
6	Alampur	$14^0$19’20.07”N	$78^0$17’07.32”E
7	Pandulakunta	$14^0$18’71.39”N	$78^0$18’62.25”E
8	Mutyalacheruvu	$14^0$10’11.43”N	$78^0$08’55.43”E
9	Chippalamadugu	$14^0$19’12.98”N	$78^0$10’35.99”E
10	Kadiri	$14^0$11’31.30”N	$78^0$16’03.87”E

RESULTS AND DISCUSSION

The groundwater in free from colour and odour and taste in slightly saline. The fluoride content in groundwater varied greatly in different villages. Fluoride concentrations (mean ± standard deviation) of more than 1.5 mg/L and its relationship with the severity of dental fluorosis among with school children in the villages are given in the tables 1-3. Selected mandals i.e. Mudigubba, Nallamada and Kadiri lie in southeastern part of Anantapur District. Groundwater is the only source of drinking in these villages. High concentration of fluoride in groundwater is common in the fractured hard rock zone with pegmatite veins [21]. High fluoride level in drinking water causes dental decay and physiological deformations. Manifestation of dental fluorosis in Bapanakunta village of Anantapur District is shown in Figure 4. Fluoride ion from these minerals that leached into the groundwater may contribute to high fluoride concentrations in the drinking water sources [22]. The results indicate that the school children in the age group of 5 to 14 years and village people in the age group of 25 to 70 years are equally affected by dental fluorosis. Prevalence of fluorosis due to the consumption of more fluoride through drinking water among children may also adversely affect the fetal cerebral function and neurotransmitters [23-26].

The fluoride distribution varied between 1.7-5.7 mg/L in ten villages of the Mudigubba Mandal. The mean value for fluoride in highest in Ralla Ananthapuram village (5.7 mg/L) and in the lowest in the Sankepalli village (1.7 mg/L). Total 817 children screened from ten villages in the Mudigubba Mandal (below 18 years) 460 (56.30%) are affected by dental fluorosis with varying grades. Dental fluorosis between these individuals is chalky white (23.26%), yellowish brown (27.50%), and brownish black (11.30%) with 16.00% showing horizontal streaks, 10.00% spots, and 12.00% both spots and streaks. (Table 4; Figures: 2&3). The worst fluoride affected villages are Ralla Anantapuram, Sankepalli, Uppalapadu, Jonnalakothapalli, Mudigubba, Mangalamadaka, Sankepalli Brahmanapalli, Malakavemula, Timmanayanipalem, Gunjepalli.

Table 4: Incidence and severity of the dental fluorosis in school children at Mudigubba Mandal of Anantapur District

S.No	Villages	Fluoride Concentration (ppm)		No. of individuals examined	No. of affected individuals (%)
		Range	Mean±SD		
1	Ralla Anantapuram	3.5-5.7	4.6 ± 1.5	90	70 (78%)
2	Sankepalli	1.7-2.3	2.0 ± 0.4	105	60 (57%)
3	Uppalapadu	2.8-3.1	2.9 ± 0.2	70	50 (71%)
4	Jonnalakothapalli	2.6-3.0	2.8 ± 0.2	85	40 (47%)
5	Mudigubba	3.0-4.2	3.6 ± 0.8	120	95 (79%)
6	Mangalamadaka	2.0-4.0	3.0 ± 1.4	110	52 (47%)
7	Sankepalli Brahmanapalli	3.5-4.0	3.7 ± 0.3	82	36 (44%)
8	Malakavemula	2.7-3.0	2.8 ± 0.2	60	22 (37%)
9	Timmanayanipalem	3.4-4.0	3.7 ±0.4	50	20 (40%)
10	Gunjepalli	2.4-2.5	2.4 ± 0.07	45	15 (33%)
Total		--	--	817	460 (56.30%)

In ten villages of the Nallamada Mandal, the fluoride distribution is in the range of 0.5-4.8 mg/L. The mean value for fluoride is highest in the Sanevaripalli village (4.8 mg/L) and is lowest in the Reddipalli village (0.5 mg/L). Total 427 children screened from ten villages in the Nallamada Mandal (below 18 years), 164 (38.4%) are affected by dental fluorosis with varying grades. Dental fluorosis between these individuals is chalky white (20.00%), yellowish brown (23.00%), and brownish black (10.00%) with 19.00% showing horizontal streaks, 13.00% spots, and 15.00% both spots and streaks (Table 5; Figures: 2&3). The worst fluoride affected villages are Vankarakunta, Donnikota, Sanevaripalli, Vellamaddi, Nallamada, Pulagampalle, Charupalle, Kurumala, Gopepalli.

Table 5: Incidence and severity of the dental fluorosis in school children at Nallamada Mandal of Anantapur District

S.No	Villages	Fluoride Concentration (ppm)		No. of individual examined	No. of affected individuals (%)
		Range	Mean±SD		
1	Vankarakunta	3.8-4.1	3.9 ± 0.2	75	20 (27%)
2	Reddipalli	0.5-0.7	0.6 ± 0.1	40	15 (38%)
3	Donnikota	2.5-3.1	2.8 ± 0.4	55	25 (45%)
4	Sanevaripalli	3.1-4.8	3.9 ± 1.2	45	12 (27%)
5	Vellamaddi	2.3-4.7	3.5 ± 1.6	38	16 (42%)
6	Nallamada	2.5-4.3	3.4 ± 1.2	42	20 (48%)
7	Pulagampalle	2.5-3.1	2.8 ± 0.4	36	16 (44%)
8	Charupalle	2.6-4.2	3.4 ± 1.1	22	10 (45%)
9	Kurumala	3.0-4.5	3.7 ± 1.06	40	17 (43%)
10	Gopepalli	1.8-4.5	3.1 ± 1.9	34	13 (38%)
Total		--	--	427	164 (38.4%)

The fluoride distribution varied in the range of 1.5-5.1 mg/L in ten villages of the Kadiri Mandal. The mean value for fluoride is highest in the Patnam village (5.1 mg/L) and is lowest in the Pandulakunta village (1.5 mg/L). Total 607 children are screened from ten villages in the Kadiri Mandal (below 18 years), 318 (52.30%) are affected by dental fluorosis with varying grades. Dental fluorosis among these individuals is chalky white (21.00%), yellowish brown (22.00%), and brownish black (9.0%) with 17.00% showing horizontal streaks, 15.00% spots, and 16.00% both spots and streaks (Table 6; Figures: 2&3). The worst fluoride affected villages are Patnam, Eguvapalli, Kadirikuntlapalli, Yerradoddi, Kutagulla, Alampur, Pandulakunta, Mutyalacheruvu, Chippalamadugu, Kadiri.

Table 6: Incidence and severity of the dental fluorosis in school children at Kadiri Mandal of Anantapur District

S.No	Villages	Fluoride Concentration (ppm)		No. of individual examined	No. of affected individuals (%)
		Range	Mean±SD		
1	Patnam	2.7-5.1	3.5 ± 1.1	85	42 (49%)
2	Eguvapalli	1.6-4.0	2.8 ± 1.6	70	40 (57%)
3	Kadirikuntlapalli	4.0-5.0	4.5 ± 0.7	62	30 (48%)
4	Yerradoddi	1.8-3.5	2.6 ± 1.2	43	27 (63%)
5	Kutagulla	2.2-3.2	2.7 ± 0.7	45	20 (44%)
6	Alampur	1.7-2.5	2.1 ± 0.5	48	23 (48%)
7	Pandulakunta	1.5-3.0	2.2 ± 1.06	62	28 (45%)
8	Mutyalacheruvu	2.2-2.5	2.3 ± 0.2	50	15 (30%)
9	Chippalamadugu	1.5-2.4	1.9 ± 0.6	42	18 (43%)
10	Kadiri	2.2-3.0	2.6 ± 0.5	100	75 (75%)
Total		--	--	607	318 (52.30%)

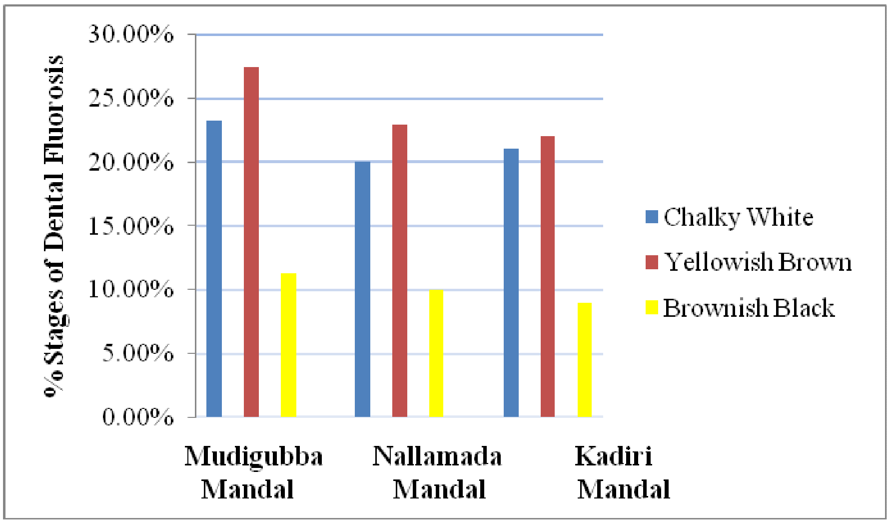

Figure 2: Percentage prevalence of different stages of dental fluorosis

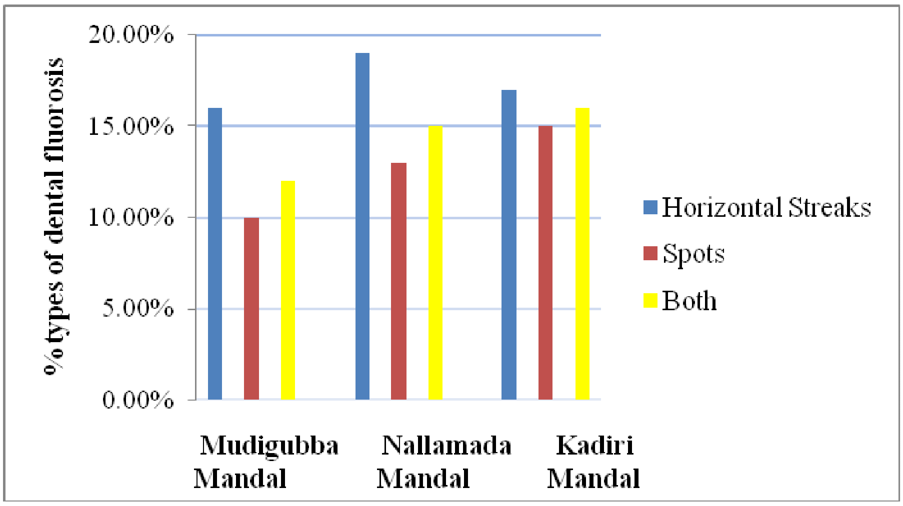

Figure 3: Percentage prevalence of types of dental fluorosis

Fluoride concentration in the environment is closely associated with human health. Apart from drinking water, infants commonly consume milk and powder-based milk formulae; Milk is known to interfere with the rate of fluoride absorption. Milk and milk products diminish the fluoride availability through the gastrointestinal tract by 20-50% in human, due to the presence of high calcium concentrations [27-29]. Milk is also rich in fats, which increase the lag time of the food or beverage in the stomach [28,29]. Moreover, the rate of prevalence of fluorosis among the milk-consuming children is lower than that of non-milk consuming children [30]. This study gives an overview of the existing caries and the treatment needs in school children of the southeastern part of Anantapur district and helps in implementing programs to achieve optimal health for children. Identification and prediction of the exact location of fluoride endemic villages through mapping of fluoride endemic areas are highly useful to government agencies for supplying water with optimal fluoride level, installing defluoridation plants and for conducting awareness creation programmes.

Figure 4: Dental Fluorosis from Bapanakunta Village of Anantapur District

The approximate depth of the sources of the samples shows a positive correlation with the fluoride concentration which indicates the source of fluoride to be fluorite or apatite minerals present in the Precambrian granite or granitic gneiss of the underground basement (Fig: 5)

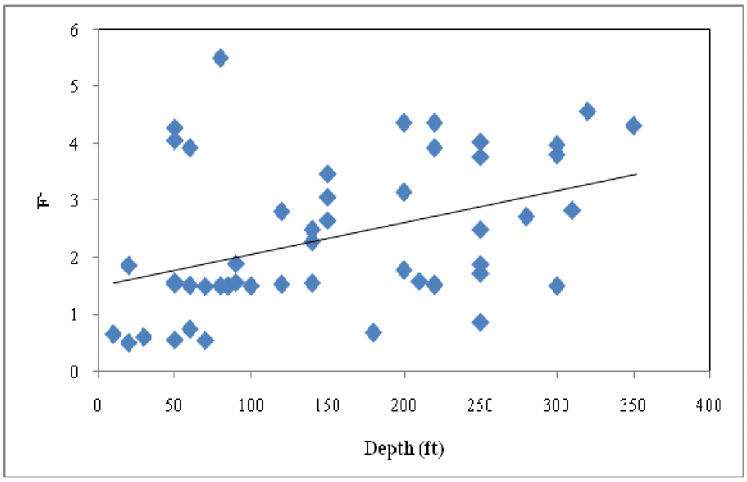

Fig. 5: Correlation of Depth of Source with fluoride concentration in selected Groundwater samples

CONCLUSION

The southeastern part of Anantapur district, A.P India, is a typical region showing endemic fluorosis caused by drinking water. Groundwater (well, hand pump, and tube wells) is the main source of drinking water for village residents. Dental fluorosis among children was significantly correlated with the level of fluoride in drinking water. The fluoride concentration in the mudigubba Mandal (1.7- 5.7 mg/L) and in the Nallamada Mandal (0.5-4.8 mg/L), Kadiri (1.5-5.1 mg/L). Out of the 817 children screened from ten villages in the Mudigubba mandal (below 18 years), 460 (56.30%) were affected by dental fluorosis with varying grades. Out of the 427 children screened from ten villages in the Nallamada mandal (below 18 years), 164 (38.4%) were affected by dental fluorosis with varying grades. Out of the 607 children screened from ten villages in the Kadiri mandal (below 18 years), 318 (52.30%) were affected by dental fluorosis with varying grades. Endemic dental fluorosis continues to be a challenging national health problem in India. In summary, it is very important to assess the benefits of fluoride as a method for caries prevention; however, the risk to fluorosis should also be considered, since its availability from several sources might easily lead to doses above the recommended levels, contributing to an increase in the prevalence of fluorosis. In determining the optimum fluoride levels of a water supply, the climate, source of water supply, drinking habits and other factors influencing the quantity of water ingested should be carefully considered. Active steps must be taken to partially defluoridate the water before distribution to reduce the morbidity associated with fluorosis. Similar surveys are required in other parts of India to identify areas with high water fluoride content and determine the extent and manner in which defluoridation can be carried out. The present study gives an overview of the extent of fluorosis and stresses the treatment needs in school children through implementing programmes to achieve optimal health.

Acknowledgments
The work was funded by the Department of Science and Technology (DST), New Delhi under the Fast track Young Scientist scheme (Project no: SR/FTP/ES-50/2007). The financial support from DST for carrying out this study is gratefully acknowledged. The authors are grateful to Dr. R. V. Jayanth Kashyap, Assistant Professor, Department of English, Yogi Vemana University, Kadapa, A.P for his proof reading and comments on an earlier version of the manuscript.

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