International Journal of Allied Practice, Research and Review
Website: www.ijaprr.com (ISSN 2350-1294)

# Status of Fluoride Contamination in Soil, Water and Vegetation at Kadipani Fluorspar Mine

**Punita Parikh, Rahul Parikh and Bhavya Dhoria**
Department of Botany, Faculty of Science, The M. S. University, Vadodara

**Abstract-The current research reported fluoride content in soil and water samples collected from various sites of fluorspar mines at Ambadungar, Dist Vadodara. This site geologically contains large reserves of hydrothermal fluoride deposits that are associated with carbonatites. Because of fluoride containing minerals in these host rocks it was hypothesized that fluoride might have accumulated in water, soil and vegetation of the area. The results of fluoride in water samples collected from 6 different villages varied from 0.8 to 3.28 mg/l. with minimum concentration of fluoride in the village Manavant (0.80 mg/l) and the highest in the village Raisingpur II (3.28 mg/l). The total fluoride content of soil samples ranged from 1.3 to 9.2µg/g. The water soluble fluoride content of soil samples ranged from 0.275 to 1.75mg/l. Among four different plant species i.e. *Cassia tora, Eriophorum comosum, Holoptelia integrifolia* and *Pupalia lappacea; P. lappacea* was found to accumulate highest concentration of fluoride in its roots.**

**Key words:** ***Ambadungar, Fluorspar mines, water soluble fluoride***

## I. Introduction

Fluoride contamination in water, soil, and vegetation is a major concern due its toxicity and threat to human life and the environment. Fluoride is a common nonmetal contaminant. Excessive fluoride levels have negative impact on economic productivity and adult and children's health and development [1]. Fluoride concentration as high as 86 mg/l has been reported from Motipura village of Haryana, India [2]. Though most of the fluoride accumulation in human body occurs through fluoride-contaminated drinking water, substantial amounts can also be ingested through crops and vegetables irrigated with fluoride-contaminated water [3].

Fluoride is a non-biodegradable element that accumulates in soil, plants, humans and is the most phytotoxic among pollutants [4]. From the soil, fluoride is absorbed by roots and then transported via xylem to the transpirating organs, the leaves, where it accumulates with adverse effects [5]. In water, fluoride reacts with some other elements, and then turns into salts and finally deposits as sediments on soil [6].

Ambadungar (Vadodara district) fluorspar mine is located at an altitude of 620 metres from MSL. The outstanding geological feature of the Amba Dungar complex is the bold exposures and clear intrusive relationship between different carbonatite units. Large reserves of hydrothermal fluorite deposits (11.5 million tones) are associated with the carbonatites [7]. Workers of the mining site are continuously exposed to fluoride either from groundwater consumption which leads to fluorosis of dental or skeletal type. Henceforth, no studies have been undertaken till date to analyze fluoride content in the soils of this area. Therefore, the present work is aimed at estimation of fluoride content in soil and water samples collected from certain endemic fluoride villages and also to find out fluoride accumulation in plant species growing in the vicinity of the area.

## II. Materials and Methods

**Study area:**

The study area i.e. Kadipani is located 11 kms away from Kawant taluka of Vadodara district. The Ambadungar fluorspar mines are located 21º59’51.08”N latitude and 74º3’44.56”E longitude, covering an area of 31.2 ha. The climatic conditions of the study area are semi arid with temperature varying from 35ºC to 20ºC. Rainfall is scanty and thus groundwater is the only source for both drinking and irrigation purpose.

**Water, soil and vegetation sampling:**

Random stratified sampling of soil was done and was stored in plastic bags for further analysis. Water samples were collected from the nearby villages of the mining site, from different sources such as, bore wells and hand pumps and were stored in polypropylene carboys bottles. Vegetation samples were collected from fluoride pockets, sun dried and stored for further analysis.

**Determination of fluoride content in water:**

Fluoride concentration in water samples was determined electrochemically, using fluoride ion selective electrode (Orion 96-09 ion selective electrode). Standard fluoride solutions (0.1-10 mg/l) were prepared from a stock solution (100mg/l) of sodium fluoride. TISAB III was used for determination of fluoride.

**Determination of fluoride content in soil and vegetation:**

Determination of total fluoride content in soil and vegetation samples was estimated through NaOH fusion method [8]. This method involves fusion of soil and vegetation samples with 16N NaOH in Ni crucibles placed in muffle furnace and slowly raising the temperature to 600ºC for half an hour, followed by dissolving the residue by heating with water on a hot plate. After the treatment samples were removed, allowed to cool, and then 10 ml of distilled water was added to the samples with stirring to adjust the pH to 8-9. Then the samples were filtered and transferred to 100 ml volumetric flask and diluted with double-distilled water to 100 ml. To

the 5 ml of the above extract, 5 ml of TISAB solution was added and mixed, and the fluoride measurement was estimated through fluoride ion selective electrode (Orion 96-09 ion selective electrode). The detection limit of method (LOD) was 0.05 mg/l.

## III. Results and discussion
## IV.

**Fluoride Concentration in water:**

The level of fluoride in water samples varied from 0.8 to 3.28 mg/l. Out of the 6 villages, the lowest fluoride content was found in the water sample of village Manavant (0.80 mg/l) whereas, the highest fluoride content was found in the water sample of village Raisingpur II (3.28 mg/l). This type of result was obtained by Tekle et al.,1995 [9]. In their study, fluoride concentration in water samples collected from deep wells ranged from 1.6-36 mg/l. Also, dental and skeletal fluorosis was found to be prevalent in different age groups of people in the village Raisingpur. The high fluoride concentration might be attributed to fluorspar rocks containing largely the fluoride bearing minerals which in turn is influenced by semiarid climatic condition of the region. The results indicate that because of rock and water interaction, fluoride gets accumulated in water samples. Similar results had been obtained by Subba Rao and Devadas 2003[11].

**Soluble and total fluoride content in soil:**

The concentrations of soluble fluoride and total fluoride in the soil samples are presented in Figure 1. As shown in Figure 1, the total fluoride content of soil samples ranged from 11 to 70 mg/kg . The water soluble fluoride content of soil samples ranged from 13.4 to 92.8 mg/kg. The results obtained show similarity to the work done by Saini et al., 2012.[10] They reported that total fluoride content from 0-45 cm surface soil samples had ranged from 79.65 to 679.63 µg/g. Our results indicate high concentration of biologically available fluoride in soil samples.

**Fluoride concentrations of soil:**

The results of fluoride accumulation in flora are shown in Table 1. As depicted in the table, *Pupalia lappacea* which is a leafy plant accumulates highest amount of fluoride in roots, stem and leaves as compared to other plants under study. Also roots of this species accumulated highest amount of fluoride than in stem and leaves. In general it can be said that fluoride accumulation in the roots is higher than in leaves, stems and seeds. This might be due to high affinity of fluoride at the surface of roots. In the roots; there are symplastic and apoplastic pathways by which fluoride can be transported. Fluoride can be transported by the symplastic or apoplastic pathway in the roots. Our results are in agreement with Muggler and Paper, 2003[12].

**Table 1 - Fluoride content in vegetation:**

| Species name | Fluoride in roots (µg/g) | Fluoride in stem (µg/g) | Fluoride in leaf (µg/g) |
|---|---|---|---|
| ***Cassia tora*** | 12 | 8.7 | 20.5 |
| ***Eriophorum comosum*** | 8.8 | - | 24.6 |
| ***Holoptelia integrifolia*** | 78 | 9.2 | 54.7 |
| ***Pupalia lappacea*** | 1880 | 454 | 128 |

## V. Conclusion

Water samples from 6 villages of Ambadungar fluorspar site reported that Raisingpur II has the highest fluoride content in water samples; i.e. 3.28 mg/l. The total fluoride content of soil samples ranged from 1.3 to 9.2µg/g. whereas water soluble fluoride content of soil samples ranged from 0.275 to 1.75mg/l. indicating low bioavailability of fluoride. *Pupalia lappacea* accumulated highest fluoride content in its roots.

## VI. Acknowledgment

The authors are thankful to Department of Science and Technology, New Delhi for providing financial support.

## VII. References

[1] Abrugi, D. A., & Pelig-Ba, K. B. (2011). Assessment of fluoride content in tropical surface soils used for crop cultivation. *African Journal of Environmental Science and Technology*, 5(9), 653-660.

[2] Garg V K, Suthar S, Singh S, Sheoran A, Garima M, Jain S (2009) Drinking water quality in villages of southwestern Haryana, India: assessing human health risks associated with hydrochemistry. Environ Geol 58(6):1329-1340.

[3] Poureslami HR, Khazaeli P, Nooric GR (2008). Fluoride in food and water consumed in Koohbanan (Kuhe Banan), Iran. Fluoride 41(3):216-219

[4] Fornasiero, R. B. (2001). Phytotoxic effects of fluoride, *Plant Science*, 161, 979-985.

[5] Davison, A., & Weinstein, L. W. (1998). The effects of fluoride on plants, *Earth Island*, 13, 257-264

[6] Molla, A. R., Fazlul Haq, A. K. M., Kazi Md, & Fazlul H. (2007). Measurement of the concentration of fluoride in the sol of different areas of Savar and its effects on environment, *BRAC University Journal*, 1, 13-17.

[7] Viladkar S. G. Evolution of Calciocarbonatite Magma: Evidence from the Sövite and Alvikite Association in the Amba Dongar Complex, India.

[8] McQuaker, R. N., & Gurney, M. (1977). Determination of total fluoride in soil and vegetation using an alkali fusion-selective ion electrode technique, *Analytical Chemistry*, 49, 53-56.

[9] Tekle-Haimanot, R., Fekadu, A., Bushera, B., & Mekonnen, Y. (1995). Fluoride levels in water and endemic fluorosis in Ethiopian Rift Valley. *Ngurdoto, Tanzania October 18-21, 1995*, 12.

[10] Saini, P., Khan, S., Baunthiyal, M., & Sharma, V. (2013). Mapping of fluoride endemic area and assessment of F− 1 accumulation in soil and vegetation.*Environmental monitoring and assessment*, *185*(2), 2001-2008

[12] N. S. Rao & D. J. Devadas: Environmental geology December 2003, Volume 45, Issue 2, pp 243-251 date: 05 Sep 2003 Fluoride incidence in groundwater in an area of Peninsular India.

[13] Ladina Muggler Term Paper, HS 2009; an assessment of fluoride availability and uptake by plants in fluoride contaminated soils.

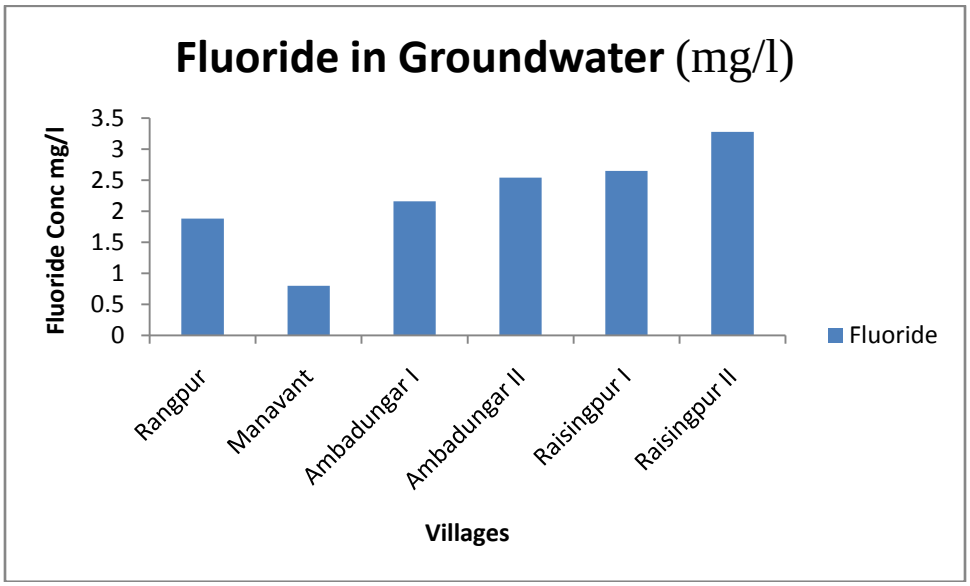


Figure 1

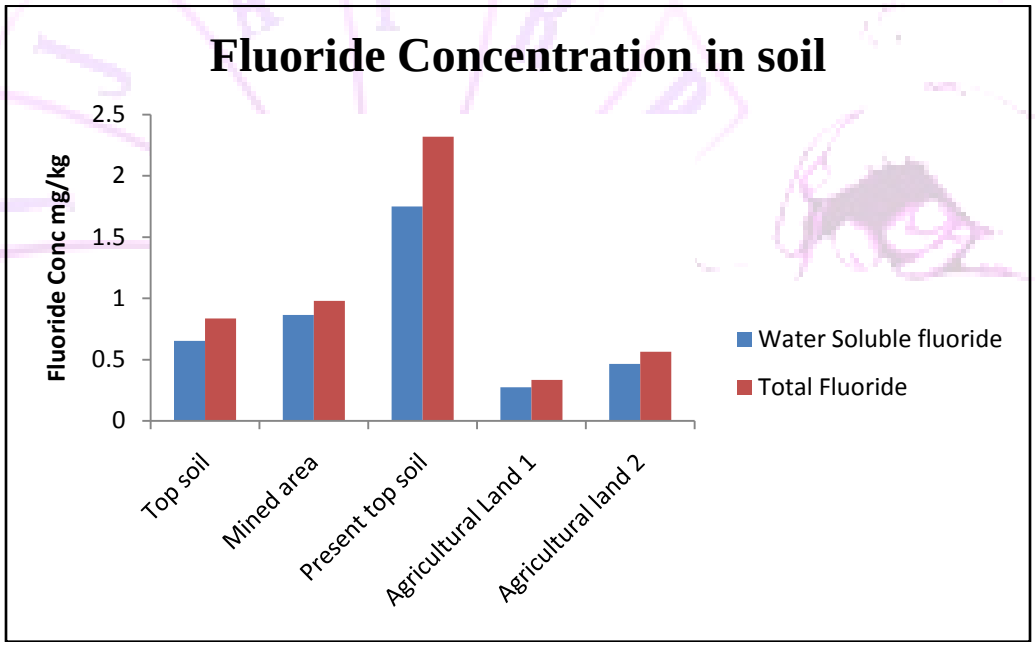


**Figure 2**