

**STUDIES ON DISTRIBUTION OF FLUORIDE IN WATER SOURCES OF HYDERABAD, AP,  
(INDIA)**

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**SUMMARY**

Hyderabad city is situated adjacent to a known severe endemic area of fluorosis. The area comprises a granitic rock terrain, which contains fluoride bearing minerals. Comprehensive studies have therefore been conducted to evaluate the incidence of fluoride in water sources and determine the factors influencing the distribution of fluorides.

Results have shown that the important factors influencing the excessive incidence of fluoride in water are likely to be

- (a) availability of soluble fluoride in weathered rocks and soils
- (b) adequate contact with circulating water
- (c) evaporation and evapotranspiration
- (d) low calcium and magnesium content of soils and circulating water and excessive bi-carbonate of water.

**INTRODUCTION**

Fluorosis is endemic in many areas of India. There is no cure for this chronic and crippling disease, which is a major public health hazard affecting several millions of people in India. In Andhra Pradesh, several thousands of people in as many as 17 districts are suffering from fluorosis. Nalgonda district is one of the severely affected districts where several hundreds of people are suffering from advanced skeletal fluorosis.

Hyderabad, the capital of Andhra Pradesh, is situated adjacent to Nalgonda. The objective of the present study was to carry out a comprehensive examination of the incidence of fluoride in water, soil and rock, and to find out the factors influencing the distribution of the toxic ion.

An attempt to determine the distribution of fluoride in granite rocks, adjacent soil strata and waters in the areas where high incidence of fluorides is observed and certain hydrogeological factors that influence the fluoride, has been made.

Granite rock samples, soil and water samples from different locations in the city have been collected and analysed for salient chemical parameters.

## **MATERIALS AND METHODS**

In order to determine the fluoride content and other salient chemical characteristics of rocks, soil and water, 10 samples of rocks, 20 samples of soil and 300 samples of surface water bodies and groundwater, have been collected from various parts of Hyderabad and were analysed.

Rock samples were analysed for total fluoride, acid soluble fluorides and total calcium and magnesium contents. Soil samples were analysed for pH, water soluble, acid soluble and total fluorides along with water soluble calcium and magnesium ions and alkalinity. Water samples were analysed for pH, alkalinity, hardness and fluoride.

The results of rock, soil and water samples were studied for :

1. Variation in fluoride content
2. Frequency distribution of fluorides, and
3. Acid soluble fluorides.

Water samples were collected in polythene bottles from all available water sources (surface and sub-surface). Similarly, rock and soil samples from the near-by areas were also collected.

## **EXPERIMENTAL**

Total and acid soluble fluorides were determined by the ion selective fluoride method after necessary pre-treatment. Rock samples

were crushed to fine powder and fused with sodium carbonate and zinc oxide as for the procedure of Ingram [1]. Acid soluble fluorides in rocks were determined by digesting the rock samples in nitric acid (10% : 50 ml) for 30 minutes and the solution thus obtained was used for estimation of fluoride by ion selective electrode method. For analysis of calcium and magnesium, the rock powder has been digested by a mixture of nitric, perchloric and concentrated hydrofluoric acids (10; 20; 15 ml) for 24 hours, finally followed by the addition of perchloric acid (5% : 20 ml) and from the aliquot calcium and magnesium were estimated.

## RESULTS AND DISCUSSION

All granite rock samples, collected in different parts of Hyderabad city, contained fluoride in widely varying amounts. In all the areas, the samples collected in close proximity showed radically different concentrations of fluoride as shown in Table I. A similar observation was made by Venkatachary [2] earlier in another area in the State. Correns [3] observed that the fluoride content of igneous rocks depends not only on the stage of crystallization during the cooling of magma and on the mode of crystallization, but also on the fluoride content of the original magma.

TABLE I

### Salient chemical characteristics of rocks

Parameter	Concentration in ppm		
	Mean	Min	Max
Total Fluoride	920.0	195.0	2375.0
Acid soluble F	267.0	35.0	850.0
% Calcium (as CaO)	5.15	2.4	8.5
% Magnesium (as MgO)	2.8	1.8	3.9

The total fluoride content ranges from 195 to 2375 ppm with an average of only 920 ppm. In contrast, higher levels of total fluoride were reported for adjacent endemic area (Nalgonda) by Ramamohanarao [4] (ranging from 325 to 3200 with a mean of 1436 ppm) as shown in Table II:

TABLE II

**Comparative characteristics of rocks**

Parameter	Concentration in ppm	
	Hyderabad	Nalgonda
Total fluoride	920.0	1436.0
Acid fluoride	267.0	412.0
% Calcium (as CaO)	5.1	4.2
% Magnesium (as MgO)	2.8	1.8

The acid soluble fluoride content of rocks ranges from 35 to 850 ppm with a mean of 267 ppm, while random samples of Nalgonda district have a mean value of 412 ppm.

**DISTRIBUTION OF FLUORIDES IN SOIL**

All soils were examined for pH, alkalinity, total acid soluble and water leachable fluoride and calcium and magnesium ions. The analysis was carried out by following standard methods. Wide variations are also observed in F content of soils. See Table III.

TABLE III

**Salient chemical characteristics of soils**

Parameter	Concentration in ppm		
	Mean	Min	Max
Total fluoride	212.0	70.0	460.0
Acid soluble F	22.0	5.0	48.0
Water soluble F	6.7	0.5	14.0
Calcium (as CaO)	1750.0	1290.0	2240.0
Alkalinity (as CaO <sub>3</sub> )	3410.0	2800.0	4400.0

The Hyderabad soils have a mean distribution of 212 ppm total fluoride, 22 ppm acid soluble F and 6.7 ppm water soluble F. The total fluorides in Nalgonda soils were reported to range from 56 to 2780 ppm with a mean of 482 ppm.

It was observed that Nalgonda soils are more alkaline than those of Hyderabad. The results also indicate that the soils of Nalgonda are obviously distinct from those of Hyderabad, in that, they derive excess alkalinity by the presence of hydrogen carbonates of alkali metals and have comparatively low calcium content. It is therefore inferred that the high frequency distribution of fluoride bearing minerals in Nalgonda rocks and soils is responsible for excessive incidence of fluoride in water.

#### DISTRIBUTION OF FLUORIDES IN WATER

300 samples of water drawn from various tanks and borewells situated in Hyderabad have been examined for pH, total solids, specific conductance, alkalinity, sulphates, chlorides and fluorides using the standard methods [5]. See Table IV.

TABLE IV

##### Salient chemical characteristics of water

Parameter	Concentration mean (mg/l)				
Fluoride	1.0	2.4	6.8	3.3	0.9
Hardness (as CaCO <sub>3</sub> )	450.0	400.0	560.0	440.0	330.0
Alkalinity (as CaCO <sub>3</sub> )	310.0	390.0	260.0	580.0	190.0

The concentrations of fluoride were determined by the selective ion electrode method using Orion (SA) fluoride electrode and Orion ion analyser meter 401A model. Wide variations were also seen in the chemical parameters of water. The fluoride concentration in Hyderabad waters

ranges from 0.1 to 4.4 mg/l with a mean of 1.2 mg/l. In contrast, waters of Nalgonda have F ranging from 0.1 to 20.0 mg/l with a mean of 2.36 mg/l. The characteristics of Nalgonda waters are at variance with those of Hyderabad waters, which normally have hardness values exceeding the alkalinity, indicating presence of non-carbonate hardness.

#### FLUORIDE DISTRIBUTION IN SURFACE WATERS

The samples drawn from various water sources revealed a very low concentration of fluorides, ranging from 0.3 to 1.0 mg/l as shown in Table V.

TABLE V

##### Distribution of fluorides in Hyderabad (surface waters)

Area	Concentration in mg/l (range)
Miralam tank	0.8 - 1.0
Osman Sagar tank	0.5 - 0.6
Hussain Sagar tank	0.3 - 0.4
Himayathsagar tank	0.4 - 0.6

#### FLUORIDE DISTRIBUTION IN GROUNDWATER

No correlation was found between fluoride content of water and depth of the well. For relative studies, certain samples from borewells situated in highly weathered areas were also examined. Surprisingly, the concentration of the fluorides is found to be very high, when compared to less weathered areas. Obviously, the degree of weathering appears to be the apparent reason for high incidence of fluorides specially in these areas. In order to determine possible variations of season on the

fluoride contents of the groundwater, in different seasons, samples have been collected and analysed. The results in Table VI indicated that there is no appreciable variation.

TABLE VI

**Seasonal variation of fluoride**

Area	Concentration (mg/l)		
	Summer	Rainy Season	Winter
Miralam tank	2.2	2.0	2.2
Osman Sagar tank	3.5	3.0	3.3
Hussain Sagar tank	0.9	0.8	0.9
Himayathsagar tank	1.6	1.3	1.5

**CONCLUSIONS**

Several factors which are likely to influence the fluoride in water are :

- (a) Frequency of distribution of easily weathered fluoride bearing minerals.
- (b) Accessibility of circulating water to those minerals, and
- (c) The influence of other ions, present in rocks, soils and circulating water.

It is considered that fluoride contents of the original igneous rocks were transferred to sedimentary rocks and to metamorphic rocks and then to the resulting soils. The concentration of fluoride ion in groundwater is attributed to the rocks through which it flows. Fluoride bearing pink and porphyritic granites have been located in several high fluoride tracks of Nalgonda as well as in Hyderabad. The investigations [6] have revealed that excessive alkalinity might have been responsible for high incidence of fluorides in Nalgonda waters while in Hyderabad significant amount of calcium in soils and circulating waters might be retarding leaching of fluoride.

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