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Comparitive analysis of some important physicochemical parameters of surface soil and underground water samples of fluorotic areas of Agastheeswaram Union, South India

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Abstract: **-** This paper analyses the fluoride concentration and some other important physicochemical parameters of 51 surface soil samples and 51 underground water samples of ten fluorotic areas of Agastheeswaram Union, South India. In all the fluorotic areas the surface soil samples were having fluoride levels greater than the undgerground water samples. The fluoride concentration in the soil was ranging between 2 to 3.5 ppm and in the water samples it was ranging between 1.3 to 2.7 ppm. Both the levels were found to be above the permissible limit. Other parameters such as p^H, alkalinity, total hardness, calcium, magnesium, chloride, salinity and sodium were also measured. Alkalinity and p^H were found to be higher than the permissible limit in all the soil and water samples at various seasons. Finally it was predicted that leaching of minerals from the soil is responsible for high fluoride content in water samples and this inturn is responsible for the prevalence of fluorosis in the study area.

Keywords: **-** *Fluoride, Fluorosis, Fluorotic, leaching, Physicochemical*

I. INTRODUCTION

Some elements are essential in trace amount for human beings, while higher concentration of these elements causes toxic effects, and fluoride is one among them. Concentration of fluoride between 0.6 to 1.0 ppm in potable water protects tooth decay and enhances bone development [1]. While higher levels greater than 1.5 ppm in drinking water pose a threat to human health [2]. Chronic fluorosis is a world wide problem nowadays [3]. The presence of fluoride content in the ground water samples can be attributed to geological deposits, geochemistry of location and extensive application of fertilizers like rock phosphates [4] and also depends on some physicochemical parameters such as p^H, alkalinity and temperature [5]. So the study was carried out to assess some important physicochemical parameters along with fluoride in surface soils and underground water samples in the ten fluorotic areas of Agastheeswaram Union and correlate them with the severity of fluorosis.

II. MATERIALS AND METHODS

First a door to door survey was conducted to determine the presence or absence of fluorosis using Dean's index. Next 51 underground water samples from ten fluorotic areas were collected in precleaned containers. Fluoride level was analysed using a fluoride ion selective electrode (Orion 9609 BNWP) along with TISAB-II solution in a 1:1 volume ratio with the samples.Then the analysis involved the determination of p^H using p^H meter of systronics made, calcium, magnesium and total hardness using complexometric titrations, alkalinity by normal titration, chloride by argentometric method and sodium using flame photometer of systronics made. Then 51 air dried surface soil samples from the same ten fluorotic areas were collected. Water extracts were prepared by mixing 40g of each samples with 100ml of distilled water. Then the extracts were analysed for fluoride and other physicochemical parameters by the same above said procedures.

III. RESULTS AND DISCUSSION

According to the survey report the overall prevalence of dental fluorosis in the study area was found to be 50.02%. Based on the prevalence of fluorosis the study area was classified into three categories as less endemic, moderately endemic and highly endemic.

3.1 Fluorotic areas I and II

Fluorotic area I (Azhagappapuram) and II (Anjugramam) come under highly endemic areas. Tables 1 and 2 shows the minimum and maximum values of physicochemical parameters in surface soil and underground water samples of fluorotic area I and II. In fluorotic areas I and II the surface soil contained higher values of fluoride and p^H than the underground water samples. The values of electrical conductivity, total hardness, calcium, magnesium, chloride, salinity and alkalinity of surface soils were lower than the underground water samples. The intensity of fluorosis was found to be proportional to the fluoride levels in the surface soils. Rice and coconut are cultivated in these areas. Rice is the staple food for the people of the study area. Phosphate fertilizers are used in large scale in these agricultural fields. The rock phosphate fertilizers and minerals present in soil undergo dissolution due to heavy rainfall during the monsoon seasons And increases the fluoride levels in soil and water sources gradually [6] in the study areas.

Table : 1 Values of physicochemical parameters in fluorotic area - I

S.No.	Parameter	Surface Soil		Underground Water Samples	
		Minimum	Maximum	Minimum	Maximum
1	Fluoride (ppm)	3.1	3.5	1.5	2.5
2	pH	8.6	9.1	7.2	8.9
3	Electrical Conductivity (mho/cm)	1146	1362	1540	1720
4	Total alkalinity (ppm)	127	354	236	495
5	Total hardness (ppm)	85	92	101	174
6	Calcium (ppm)	53	70	61	135
7	Magnesium (ppm)	15	37	11	81
8	Chloride (ppm)	8	14	8	92
9	Salinity (ppm)	12	22	14	166
10	Sodium (ppm)	30	69	25	92

Table : 2 Values of physicochemical parameters of fluorotic area II

S.No	Parameter	Surface Soil		Underground Water Samples	
		Minimum	Maximum	Minimum	Maximum
1	Fluoride (ppm)	2.9	3.0	2.0	2.6
2	pH	8.7	9.0	7.3	8.7
3	Electrical Conductivity (mho/cm)	410	562	938	1340
4	Total alkalinity (ppm)	156	211	310	489
5	Total hardness (ppm)	72	87	67	205
6	Calcium (ppm)	61	71	43	185
7	Magnesium (ppm)	11	16	22	55
8	Chloride (ppm)	25	35	36	123
9	Salinity (ppm)	46	64	65	223
10	Sodium (ppm)	107	198	83	316

3.2 Fluorotic areas III, IV and V

Fluorotic areas III (Marungoor), IV (Mylady), V (South Thamaraikulam) come under moderately endemic areas. Tables 3, 4 and 5 show the minimum and maximum values of physicochemical parameters of surface soil and underground water samples of fluorotic areas III, IV and V respectively. In fluorotic areas III, IV and V the surface soils contained higher values of fluoride and p^H than the underground water samples. All the other physicochemical parameters of the surface soils were found to be lower than the underground water samples. The values of fluoride and alkalinity in both the surface soil and underground water samples of those study areas were found to be higher than the prescribed limit. Normally higher alkalinity of water promotes leaching of fluoride and thus affects the concentration of fluoride in the ground water [7]. Agriculture and stone polishing were the major occupations for the people of those areas. Many of those affected working adults consume an average of 5 litres of water per day. This increases the fluoride level in the people as the fluoride

content of the water they consume is greater than the permissible limit.

Table : 3 Values of physicochemical parameters of fluorotic area III

S.No.	Parameter	Surface Soil		Underground Water Samples	
		Minimum	Maximum	Minimum	Maximum
1	Fluoride (ppm)	3.2	3.4	1.6	2.1
2	pH	8.9	9.1	7.3	8.7
3	Electrical Conductivity (mho/cm)	356	623	1299	1624
4	Total alkalinity (ppm)	112	316	220	595
5	Total hardness (ppm)	42	102	62	183
6	Calcium (ppm)	33	72	50	130
7	Magnesium (ppm)	6	32	7	81
8	Chloride (ppm)	103	120	201	206
9	Salinity (ppm)	186	354	362	372
10	Sodium (ppm)	40	103	52	241

Table : 4 Values of physicochemical parameters of fluorotic area IV

S.No.	Parameter	Surface Soil		Underground Water Samples	
		Minimum	Maximum	Minimum	Maximum
1	Fluoride (ppm)	2.1	2.4	1.6	2.2
2	pH	8.3	8.9	6.9	8.6
3	ElectricalConductivity (mho/cm)	862	963	1430	1817
4	Total alkalinity (ppm)	183	297	326	605
5	Total hardness (ppm)	72	102	90	201
6	Calcium (ppm)	61	90	61	161
7	Magnesium (ppm)	9	15	17	89
8	Chloride (ppm)	76	103	103	120
9	Salinity (ppm)	137	186	186	216
10	Sodium (ppm)	197	200	201	285

Table : 5 Values of physicochemical parameters of fluorotic area V

S.No.	Parameter	Surface Soil		Underground Water Samples	
		Minimum	Maximum	Minimum	Maximum
1	Fluoride (ppm)	2.0	2.5	1.5	2.0
2	pH	8.7	8.8	6.8	8.7
3	ElectricalConductivity (mho/cm)	336	852	1620	1871
4	Total alkalinity (ppm)	218	322	344	695
5	Total hardness (ppm)	79	102	100	239
6	Calcium (ppm)	50	77	53	177
7	Magnesium (ppm)	12	32	21	97
8	Chloride (ppm)	40	130	129	229
9	Salinity (ppm)	73	239	236	413
10	Sodium (ppm)	91	151	98	206

3.3 Fluorotic areas VI, VII, VIII, IX and X

Fluorotic areas VI (Theroor), VII (Mahadhanapuram), VIII (Theraikalpudur), IX (Kottaram) and X (Nallur) come under less endemic areas. Tables 6,7,8,9 and 10 shows the minimum and maximum values of physiochemical parameters of the surface soil and underground water samples of the fluorotic areas VI, VII, VIII, IX and X. In all those fluorotic areas the amount of fluoride in the surface soils and underground water samples exceeds the prescribed limit. Several processes namely dissolution of fluoride bearing minerals, ion exchange and evaporation concentration can locally account for high fluoride concentration in ground water of the study areas [8]. People of these study area were affected by fluorosis because of the fact that the people consumed locally available rice, coconut, vegetables and fruits which contain more fluoride level. Moreover they entirely depend upon borewell water containing higher fluoride.

Table : 6 Values of physicochemical parameters of fluorotic area VI

S.No.	Parameter	Surface Soil		Underground Water Samples	
		Minimum	Maximum	Minimum	Maximum
1	Fluoride (ppm)	2.4	3.2	1.6	2.1
2	pH	8.6	8.8	7.3	8.5
3	Electrical Conductivity (mho/cm)	425	936	913	1223
4	Total alkalinity (ppm)	228	342	231	584
5	Total hardness (ppm)	76	82	97	164
6	Calcium (ppm)	58	59	43	138
7	Magnesium (ppm)	18	23	22	63
8	Chloride (ppm)	132	140	132	184
9	Salinity (ppm)	238	257	238	332
10	Sodium (ppm)	52	76	73	133

Table : 7 Values of physicochemical parameters of fluorotic area VII

S.No.	Parameter	Surface Soil		Underground Water Samples	
		Minimum	Maximum	Minimum	Maximum
1	Fluoride (ppm)	2.6	2.7	1.9	2.1
2	pH	8.7	8.8	7.5	8.5
3	ElectricalConductivity (mho/cm)	574	745	1001	1521
4	Total alkalinity (ppm)	256	272	174	628
5	Total hardness (ppm)	73	86	141	341
6	Calcium (ppm)	55	61	98	250
7	Magnesium (ppm)	12	31	15	118
8	Chloride (ppm)	19	24	127	184
9	Salinity (ppm)	35	43	230	332
10	Sodium (ppm)	14	19	14	90

Table : 8 Values of physicochemical parameters of fluorotic area VIII

S.No.	Parameter	Surface Soil		Underground Water Samples	
		Minimum	Maximum	Minimum	Maximum
1	Fluoride (ppm)	2.0	2.1	1.5	1.7
2	pH	8.8	8.9	7.4	8.5
3	ElectricalConductivity (mho/cm)	963	978	1002	1691
4	Total alkalinity (ppm)	252	256	234	652
5	Total hardness (ppm)	86	96	110	163
6	Calcium (ppm)	70	78	90	146
7	Magnesium (ppm)	16	18	16	37
8	Chloride (ppm)	70	127	132	158
9	Salinity (ppm)	128	230	238	283
10	Sodium (ppm)	76	86	75	78

Table : 9 Values of physicochemical parameters of fluorotic area IX

S.No	Parameter	Surface Soil		Underground Water Samples	
		Minimum	Maximum	Minimum	Maximum
1	Fluoride (ppm)	2.9	3.0	1.4	2.0
2	pH	8.7	8.8	7.5	8.5
3	Electrical Conductivity (mho/cm)	530	726	1360	1559
4	Total alkalinity (ppm)	230	262	154	565
5	Total hardness (ppm)	86	105	101	270
6	Calcium (ppm)	71	82	15	230
7	Magnesium (ppm)	15	23	20	95
8	Chloride (ppm)	127	129	127	208
9	Salinity (ppm)	230	237	230	375
10	Sodium (ppm)	1.96	2.96	130	238

Table : 10 Values of physicochemical parameters of fluorotic area X

S.No.	Parameter	Surface Soil		Underground Water Samples	
		Minimum	Maximum	Minimum	Maximum
1	Fluoride (ppm)	2.0	2.3	1.3	1.9
2	pH	8.6	8.8	7.2	8.4
3	Electrical Conductivity (mho/cm)	1126	1141	1108	1326
4	Total alkalinity (ppm)	256	259	145	632
5	Total hardness (ppm)	95	97	110	159
6	Calcium (ppm)	74	75	62	120
7	Magnesium (ppm)	21	22	30	56
8	Chloride (ppm)	200	201	193	208
9	Salinity (ppm)	367	369	354	375
10	Sodium (ppm)	172	189	173	225

IV. CONCLUSION

Fluoride content and some important physicochemical parameters of 51 surface soil samples and underground water samples of Agastheeswaram Union, South India were evaluated. Almost all the surface soil samples were having higher fluoride and p^H values than the water samples. Both soil and water samples do not meet the quality parameters such as fluoride, alkalinity and p^H. Most of the people depend on vegetables and food grains cultivated in the study area. And they also depend upon the borewell water containing higher fluoride which is not suitable for consumption without prior treatment. The above said two reasons are responsible for the prevalence of fluorosis in the study area. People of Agastheeswaram Union should be educated about the hazards of consumption of high fluoride bearing water and they should be encouraged to defluoridate water before consumption.

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