Monitoring of Fluoride Concentration in Karera and Narwar Blocks of Shivpuri District, India: Correlation with Physicochemical Parameters

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Abstract - Fluoride concentration in ground water samples was determined in 10 villages of Shivpuri district, M.P., India. 30 samples were collected and analysed for fluoride content along with pH, electrical conductivity, total dissolved solids (TDS), total hardness, total alkalinity, chlorides, magnesium, nitrates and iron. Fluoride concentration in the groundwater sample of these villages was found to vary between 1.22 to 4.9 mg/l. The high fluoride concentration in the ground water could be a major source of fluoride in water since the geological formation of this area consists of fluorite and Fluor apatite. The population of the study area especially village Hatheda and Dumduma seems to be severely affected by fluorosis. Dental and skeletal fluorosis and deformation of bones especially in adults were observed in the study area which indicates the excess fluoride concentration.

Key words: Fluoride, Dental Fluorosis, Skeletal Fluorosis, ground water.

I.   INTRODUCTION

Water is the precious gift of nature to the mankind and is very essential for the growth and maintenance of the body as it is the important part of all the biological processes. Ground water is the major source of drinking water in the urban as well as rural area. Fluoride (F⁻) concentration in water is one of an important aspect which affects the human health. The recommended [1] concentration of fluoride in drinking water is 1.50 mg/l. Low fluoride content (<0.60 mg/l) causes dental caries, whereas high (>1.20 mg/l) fluoride levels results in fluorosis[2]. The bureau of Indian standards (BIS)[3] prescribed a limit between 1.0 and 1.5 mg/l. The problem of high fluoride concentration is more pronounced in Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh, Punjab, Rajasthan, Tamilnadu and Uttarpradesh.[4]

  The disorder of teeth and bones is due to consumption of fluoride rich water [5]. It leads to dental as well as skeletal fluorosis. Dental fluorosis is characterized by permanent yellowish and brown discoloration of teeth. Children are highly susceptible to dental fluorosis. It is irreversible and can't be cured. Skeletal fluorosis affects both young and adults which starts with pain and stiffness of joints and leads to crippling deformities of the spine and major joints. Fluorosis has no treatment and hence is considered to be a deadly disease.

Fluoride in water is mostly of geological origin. The source of fluoride in ground water of the study area is mainly from geological occurrences. The lithological units of the study area consist of Archaen granite, genesis complex rocks, shale and limestone.

Ground water samples were collected from villages of Karera and Narwar blocks of Shivpuri district, Madhya Pradesh, India. The samples are analyzed for fluoride along with other chemical parameters.

II.   MATERIAL AND METHODS

Profile of study area

The total area of Shivpuri district is 10278 sq kms. It lies between 24°6´- 25°6´ North latitude and 77°0´-78°4´ East longitude at a M.S.L. height of 521.50 mt. It has 7 tehsils and 8 administrative blocks. Total population of the district according to 2011 census is 1,726,050.[6]

Water sampling

Sampling was done village wise and wherever wells and hand pumps exists in the study area. Samples were collected in the month of May 2015. Samples were collected in clean and sterile one litre polythene cans. Analysis was carried out for pH, Electrical conductivity, Total dissolved solids, Total hardness, total alkalinity, Calcium, Magnesium, chlorides, nitrates and fluoride by following standard techniques (Anonymous, 1976)[7].

III. OBSERVATION

Table 1. showing the values of physicochemical parameters including fluoride in the 30 water samples. Highlighted figures show the fluoride content more than the permissible limit.

Sample Nos	Name of village	TDS (mg/l)	pH	EC(μ mhos /cm)	Total hard Ness (mg/l)	Alkalinity (mg/l)	Mg (mg/l)	Ca (mg/l)	Cl (mg/l)	Nitrate (mg/l)	F (mg/l)
1	Hatheda	677	8.4	897	395	192	40	87.5	70.5	10.1	4.51
2	Hatheda	1425	8.15	1190	800	186	55	65	124.5	15.6	4.9
3	Hatheda	762.5	8.25	1215	383.5	326.5	59.5	48	79	12	3.6
4	Hatheda	603.5	7.79	967	314.5	219	67	55.5	80.5	10.05	2.25
5	Hatheda	1136	8.17	888	346.5	369	81	79	115.5	21	3.15
6	Bichi	769	8.5	913	264.5	316.5	63	72	78	14.35	2.62
7	Bichi	728	8.67	1147	291.5	320	82	118.5	212.5	24.3	1.97
8	Bichi	1623	8.02	2035	1088	192	103	197	347	70.6	3.01
9	Baroda	865.5	7.73	1334	425	256.5	37	147	163	20.2	1.7
10	Baroda	703	7.9	1328	400	277	60	126	154	14.5	2.16
11	Baroda	922.5	7.57	1270	435	378	73	119.5	76.5	40.2	1.67
12	Phulpur	2147	7.96	3480	904	441	124.5	130	626	61.7	2.95
13	Phulpur	595.5	7.67	832	406.5	276	51	133	67.5	13.2	2.36
14	Phulpur	1033	7.83	1181	599	233	102.5	114	146	31.8	3.56
15	Phulpur	974	8.3	1164	453	324	30	140.5	139	31.4	2.33
16	Dehretasani	735.5	8.0	1092	366.5	297	33.5	103.5	156	17.65	2
17	Dehretasani	946.5	8.4	999	537	218	92	87	89.5	57.5	1.69
18	Dehretasani	1142	8.34	1370	669.5	209.5	104.5	55.5	106	53.5	1.85
19	Dehretasani	606.5	7.28	627	256.4	215	33.5	121.5	149	29.5	1.26
20	Doni	496	8.7	628	207	186	42.5	72	132.5	9.4	3.4
21	Doni	788.5	8.2	955	273	212.5	50.5	131	244	27.2	2.57
22	Doni	639	7.57	724	400.5	176	29.5	139	89	25.7	2.52
23	Gokunda	817	8.59	1275	348	278.5	21	100.5	111.5	18.6	2.57
24	Gokunda	705.5	8	1093	334	279	24	120.5	106.5	41.5	1.86
25	Sehore	829.5	7.99	1234	402.5	352	36.7	126.5	62.6	37.1	1.64
26	Dumduma	638.5	8.05	1020	377	315.5	30.7	116	55.5	42.6	1.99
27	Dumduma	623	7.83	737	306.5	209.5	68.5	164.4	435.5	26.5	2.12
28	Sirsod	899	8.53	1308	457	331.5	32.5	140.5	212.5	60.5	4.51
29	Sirsod	815.5	7.56	811	344	412.5	87.5	105.5	610.5	69.5	1.66
30	Bichi(from kanker)	601	7.39	690.5	364	169	58.5	89.5	68	9.55	1.22

IV. RESULT AND DISCUSSION

The result revealed that fluoride concentration in the study area varied between 1.22 mg/to 4.9 mg/l. Out of 30 samples studied, only 2 samples were observed below the permissible limits. All other samples showed higher concentration of fluoride compared to the prescribed permissible values. Maximum fluoride conc. (4.9 mg/l) was observed in Hatheda village, while the minimum value (1.22 mg/l) was observed from the water that is brought from Kanker village to Phulpur village through pipelines. Village Hatheda (F- conc 4.9mg/l) and Dumduma (F-concentartion 4.51 mg/l), in particular showed higher concentrations of fluoride compared to the other villages studied. The presence of high concentration of fluoride may be due to the geological formation of the area. The rock types – granite and gneisses in this area attribute to the high concentration of fluoride in ground water. A visit to these villages and interaction with the inhabitants proved that the area is affected by dental and skeletal fluorosis. Prominent yellowish to brown patches on the teeth, weakening joints, skeletal deformations were observed in the population.

The results revealed that pH ranged from (7.28 to 8.59). Minimum pH (7.28) was observed from Phulpur village and maximum (8.59) was observed from village Hatheda. All the water samples were found to be within limit of pH but alkaline in nature. According to WHO (1996), the permissible limit for pH is 6.9 to 9.2. pH showed a positive correlation with fluoride.

The samples analyzed showed electrical conductivity varying between 627 μ mhos/cm to 3480 μ mhos/cm. All the samples showed values of EC exceeding the permissible limit for drinking water (300μ mhos/cm) as per the ISI standards [8]. Minimum value of EC (627 μ mhos/cm) was found in the village Sehore and maximum value of EC (3480 μ mhos/cm) was found in village Phulpur.

TDS concentration in the samples studied varied between 595.5 mg/l and 1425 mg/l. The prescribed permissible limit of TDS for drinking water is 500 mg/l [8]. TDS concentration above 500 mg/l was noticed in most of the samples .Minimum TDS concentration (595.5 mg/l) was observed from the well of Dumduma village and maximum TDS concentration (1425 mg/l) was obtained from Phulpur village. Higher concentrations of TDS observed in the ground water samples of the study area may be attributed to granite rocks present in the study area.

All the samples analyzed showed the higher concentrations of total alkalinity exceeding the prescribed permissible limit for drinking water, i.e, 200 mg/l [8]. The minimum concentration of total alkalinity (169 mg/l) was observed in the tap water brought from Kanker in Bichi village while the maximum concentration of alkalinity (441 mg/l) was observed from a well in Phulpur village. Higher concentrations of alkalinity were observed in most of the samples of the study area.

All the samples analyzed showed higher concentration of total hardness to the prescribed limit for drinking water i.e., 200 mg/l [8]. The maximum hardness(1086 mg/l) was found from the well of Bichi village and the minimum (207 mg/l) was found in the well of Dumduma village.

Some of the samples analyzed showed higher concentration of chlorides than the prescribed permissible limit for drinking water i.e., 250 mg/l 8. The maximum concentration of chlorides (626 mg/l) was found in the well of Phulpur village and the minimum (55.5 mg/l) was also found in the well of the same village.

Some of the water samples analyzed showed higher concentration of Nitrates than the prescribed permissible limit for drinking water i.e., 45 mg/l 8. The maximum concentration of Nitrates (69.5 mg/l) was observed in the well of Bichi village. The minimum concentration (9.4 mg/l) was observed in the tap water brought from village Kanker.

The relationship of F- with other geo-chemical parameters is examined by generating correlation matrix. The EC exhibits good positive correlation with TDS and total hardness. An average correlation of electrical conductivity is observed with magnesium and chloride. This is due to the fact that conductivity depends on total dissolved solids

and main constituents of TDS in water are (Ca^{2+}, Mg^{2+} and Cl^-). A moderate positive correlation of total hardness is observed with magnesium.

Graph showing high Fluoride concentration in the samples studied. The dotted line shows the permissible limit.
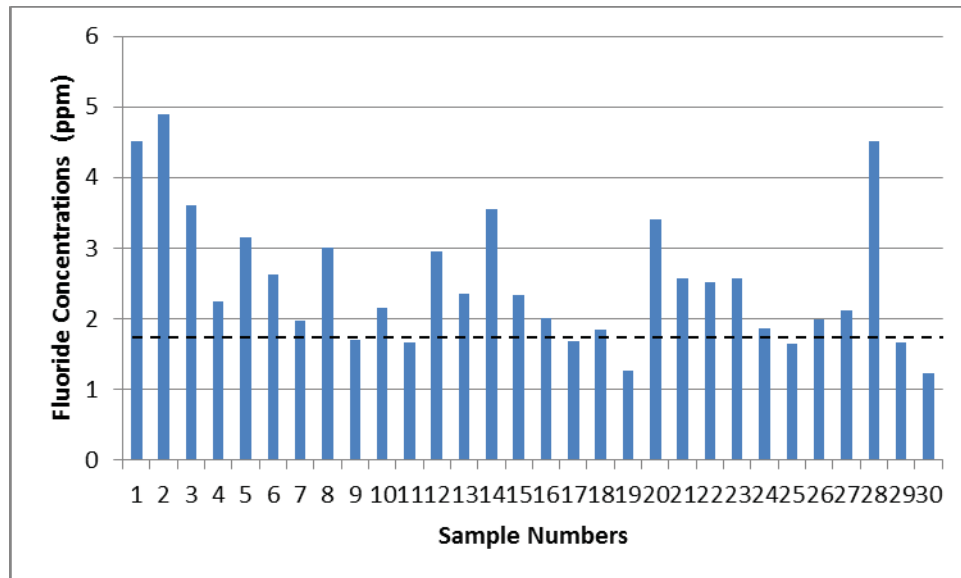
V. CONCLUSION

Most of the water samples in the study area evidenced excess fluoride concentration. 28 out of 30 samples studied showed high fluoride concentration. The excess fluoride concentration in the area may be attributed to the geological formation of that particular area and continuous depletion of ground water .The water in the study area is not suitable for domestic consumption without defluoridation. Water harvesting and defluoridation is suggested to combat with the problem.

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