

## Assessment of Fluoride Content in Ground and Surface Water and its Environmental Impacts at Basavan-Bagewadi and Muddebihal Taluka of Bijapur District, Karnataka, India

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**Abstract:** An investigation was undertaken in 10 villages (28 samples) of Basavan-Bagewadi taluka and 11 villages (38 samples) of Muddebihal taluka of Bijapur district to assess fluoride and other physicochemical parameters. And also to assess the clinical symptoms like dental and skeletal fluorosis, joint pains and gastrointestinal diseases and to find out the severity of the disease. A check list developed with the help of available literature and in consultation with nutritionists was used to record clinical symptoms. A sample survey was made after examination for both sexes between the age of 8-50 years at Basavan-Bagewadi and Muddebihal taluka. Fluoride content varies from 0.40-6.40 mg/L and 1.10-7.10 mg/L. However 12 samples were within the range, while 16 samples were above the permissible limits at Basavan-Bagewadi Taluka where as in Muddebihal taluka all the values are above the permissible limits of WHO respectively. The results show that, out of the 2992 examined 824 (25.89%) people have dental and skeletal fluorosis, 274 (9.15%) people have joint pains, 167 (5.58%) have gastrointestinal discomfort and excessive thirst at different stages in Basavan-Bagewadi taluka. Among 2696 examined, 812(29.49%) people had dental and skeletal fluorosis, 432 (16.18%) people had joint pains, 415 (15.54%) people had gastrointestinal discomfort and excessive thirst at Muddebihal taluka of Bijapur district.

**Keywords:** Fluoride, Clinical symptoms, Dental and skeletal fluorosis, Gastrointestinal discomfort.

### Introduction

Fluorosis is an endemic disease resulting from excess intake of fluoride either through drinking water, food or dentifrices at concentration of 2.00 ppm or above. Fluorosis of

teeth has been reported to affect dental enamel. Chronic fluorine intoxication through drinking water containing above 10 ppm of fluorine results in pathological changes of bone leading to skeletal fluorosis<sup>1</sup>. While the dental fluorosis can be easily recognized, the skeletal involvement is not clinically obvious until the advanced stage of crippling is reached. Water is the medium of intake by humans<sup>2</sup>. Fluoride can rapidly cross the cell membrane and is distributed in skeletal and cardiac muscle, liver, skin<sup>3</sup> and erythrocytes<sup>4</sup>. Fluorosis is a major public health problem resulting from long term consumption of water with high fluoride levels. It is characterized by dental mottling and skeletal manifestations such as crippling deformities, osteoporosis and osteosclerosis clinical symptoms of dental and skeletal fluorosis in Gadag and Bagalkot districts of Karnataka is reported<sup>5</sup>.

In India, as many as 15 states are affected by endemic fluorosis and an extensive belt of high fluoride in water and soil is reported in south India<sup>6-9</sup>. Gulbarga district of Karnataka was found to be a fluorosis endemic area<sup>10-11</sup>. The documentation of clinical symptoms depicts the severity of the disorder and helps to plan for the corrective measures. Hence in the present investigation an attempt was made to record the clinical features of fluorotic patients in Basavan-Bagewadi and Muddebihal taluka of Bijapur district, Karnataka.

## Experimental

The study was conducted in ten endemic villages of Basavan-Bagewadi taluka and eleven villages of Muddebihal taluka of Bijapur district. A sample survey was made after examination for dental, skeletal, joint pains and gastrointestinal diseases of both sexes between the ages of 8-50 years. The permanent teeth were the only once examined. The examinations were carried out by one dentist to standardize the readings. The Jackson index method of dental fluorosis was used. There are no major surface water sources in the study area however, main sources of drinking water in selected area are open wells, hand pumps and bore wells.

### *Sample analysis*

A total of 28 samples from the villages of Basavan-Bagewadi taluka and 38 samples from the villages of Muddebihal taluka water sources were collected in polythene bottles, which were cleaned and finally washed with acid water, followed by rinsing twice with distilled water. The water samples collected were chemically analyzed. The analysis of water was done using procedure of standard methods<sup>12</sup>. Fluoride concentration was determined spectrophotometrically using Alizarin red-S and SPADNS reagents. The Alizarin red-S method was found useful in higher fluoride range while SPADNS reagent was employed in low fluoride range<sup>13</sup>.

## Results and Discussion

The findings of the present investigation are summarized in Tables 1 and 2 were also made with WHO drinking water standards<sup>14</sup>.

In the present study electrical conductivity values of the samples were found to be 0.80 to 4.62 and 1.19 to 9.48 mhos/cm. It shows that most of the samples were within the permissible limits (7.50-20.00 mhos/cm). However it is indicating high mineralization in that area. The pH value of study area ranges from 7.20 - 8.30 and 7.31- 8.5 and it is found to be well within the permissible limits prescribed for drinking water standards 9.65 - 8.5 (WHO 1970). The research finding revealed for TDS values ranging between 505-3424 mg/L and 3552-4117 mg/L respectively at Basavan-Bagewadi and Muddebihal taluka respectively.

**Table1.** Physicochemical characteristics of water quality in selected villages of Basavan-Bagewadi taluka.

S No.	Village	Source	Cond, mho/ cm	pH	TDS, mg/L	Total Hardness, mg/L	Ca, mg/L	Cl, mg/L	SO <sub>4</sub> , mg/L	Fluoride, mg/L
1	Karishyal			8.03	814.00	572.00	29.00	58.00	148.00	6.40
2	Abbihal	HP	1.40	7.8	964.00	589.00	53.00	98.00	195.00	2.80
3	Vandal	BW	2.80	8.10	1265.00	598.00	29.00	110.00	245.00	6.30
4	Gonal(RC)	BW	1.92	7.80	1362.00	600.00	32.00	130.00	310.00	6.40
5	Kadakol	BW	1.15	8.22	830.00	560.00	50.00	90.00	120.00	2.50
6	Sindageri	BW	2.12	7.80	1500.00	880.00	56.00	180.00	564.00	2.40
7	Maradagi L.T (RC)	W	3.60	8.00	2410.00	220.00	260.00	260.00	1290.00	3.80
8	Gani L T	BW	1.00	7.50	505.00	440.00	90.00	88.00	142.00	2.60
9	Areshankar	BW	1.20	1.20	480.00	480.00	14.60	35.00	110.00	6.00
10	Muddapur	BW	4.60	7.50	3424.00	600.00	120.00	660.00	1280.00	5.40
11	Sindageri	OW	1.90	8.30	1501.00	950.00	55.00	176.00	544.00	2.40
12	Nandihal	BW	2.03	7.40	1555.00	870.00	183.00	65.00	325.00	0.70
13	Yaranal	BW	4.62	7.50	3034.00	2380.00	675.00	1058.00	590.00	1.20
14	Hattarakihal	BW	2.10	7.67	1515.00	850.00	51.00	88.00	596.00	1.00
15	Rajanal	BW	1.14	8.00	770.00	460.00	60.00	84.00	45.00	2.60
16	Jeeralabhavi	BW	2.00	8.10	1418.00	725.00	75.00	270.00	205.00	1.50
17	Honnali	BW	1.60	7.50	1100.00	685.00	33.66	55.00	8.00	0.60
18	Ramabhapur	BW	4.40	7.50	2899.00	845.00	45.00	360.00	897.00	0.90
19	Nagatan	BW	1.80	7.25	1225.00	382.00	40.00	190.00	120.00	0.40
20	Hunshyal	BW	3.60	7.70	2500.00	1200.00	40.10	264.00	528.00	0.40
21	Madasnal	BW	2.30	7.39	1550.00	620.00	48.00	364.00	300.00	0.70
22	Ingnaal	BW	2.80	7.40	2220.00	800.00	64.12	630.00	425.00	0.50
23	Kaulagi	BW	1.70	7.48	1290.00	1040.00	278.00	352.00	180.00	0.60
24	Sikalawadi	BW	1.40	7.61	950.00	704.00	123.00	176.00	188.00	1.40
25	Akalawadi	BW	1.70	7.50	1150.00	952.00	169.00	204.00	552.00	1.38
26	Mukartial	BW	1.35	7.66	920.00	536.00	56.00	100.00	168.00	1.80
27	Angadageri	BW	0.80	7.67	558.00	456.00	47.00	72.00	44.00	2.00
28	Solawadagi	BW	2.37	7.64	1584.00	596.00	41.00	220.00	472.00	1.20

BW: Bore well HP: Hand pump OW: Open well

The analytical report reveals for total hardness concentration generally vary from 220-2380 and 160-3520 mg/L. The samples were found to be more than the desired limit of 300-600 mg/L as prescribed by WHO. Present investigation data states that for calcium values ranges from 14-675 and 16-454 mg/L and it indicates that the concentration were found to be more than the permissible limit prescribed for WHO (1970) drinking water quality standards. It is proved from the present research investigation report for chloride values ranges between 35-1058 mg/L and 31-1280 mg/L, the prescribed drinking water standards for chloride is 200-600 mg/L. The samples were found to be above the permissible limits of WHO (1970) prescribed drinking water standards. Sulphate values were from 8 -1290 mg/L and 15 - 1632 mg/L. These values were above the permissible limits of drinking water standards. Fluoride values vary from 0.40-6.40 mg/L and 1.10-7.10 mg/L. However 12 samples were within the range while 16 samples were above the permissible limits at Basavan-Bagewadi taluka where as in Muddebihal taluka all the values are above the permissible limits of WHO respectively.

**Table 2.** Physicochemical characteristics of water quality in selected villages of Muddebihal taluka.

S No.	Village	Source	Cond, mho/ cm	pH	TDS, mg/L	Total Hardness, mg/L	Ca, mg/L	Cl, mg/ L	SO <sub>4</sub> , mg/L	Fluoride, mg/L
1	A Davisomanal infront of pujari house	BW	2.10	7.5	544	896	1181.0	304	536.00	3.20
2	Hulagabal/Infront of hanuman temple	BW	3.33	7.5	2450	364	112.0	460	544.00	2.80
3	Khilarahatti/Nr Huligemma temple	OW	1.19	7.8	844	352	48.0	120	116.0	3.60
4	Garasangi /Nr basapa myageri field	BW	1.76	8.5	1001	216	40.0	104	280.0	6.60
5	Madri R C /Nr Siddappa meti field	BW	1.34	8.42	934	336	59.0	168	152.00	2.80
6	Handral /Infront of B Y Bidiri house	OW	1.76	8.50	1276	160	16.0	132	304.0	5.80
7	Kuchabal/Infront of Hadapad master	BW	1.78	7.31	1420	380	80.0	240	644.0	4.00
8	Kuchabal/ Nr Bhimashankar temple	OW	2.74	8.09	2100	600	126.0	420	848.0	2.80
9	Lingadahalli/Infront of M K Harijan	BW	2.70	8.19	2098	628	50.0	252	1024.0 0	4.50
10	Lingadahalli/Beside hanuman temple	BW	3.90	8.28	3020	544	43.0	480	1408.0	3.30
11	Bantanur (Tanda)/ Nr Kulkarni pond	OW	1.10	8.36	766	204	29.0	52	128.0	3.10
12	Gutakhandaki /Garasangapp Gowda kannal	BW	7.16	7.76	498	232	38.0	32	24.0	3.30
13	Geddalamari /Nr Bus stand	BW	9.48	7.67	544	372	54.0	80	32.0	1.60
14	Hadalageri /Infront of Durganna temple	OW	4.98	7.48	3490	1520	186.0	1072	464.0	3.10
15	Mudnal LT.2/In Tanda	BW	8.38	8.09	618	380	56.0	72	52.0	2.50
16	Budihal (PN)/Mallappa Koganur	BW	8.66	7.44	626	336	73.5	72	38.0	2.80
17	Budihal PN)/ Behind anganawadi Kendra	BW	7.14	7.30	546	304	65.5	40	24.0	3.0
18	Jangamural/Nr Govt. Primary School	BW	1.86	7.53	1260	280	46.0	128	320.0	4.20

*Contd...*

19	Malagaladinni / Infront of Hanumant Somanal house	BW	1.86	7.45	1360	444	89.5	220	240.0	2.50
20	HULLUR LT-1/Nr Basu Rathod house	BW	6.75	7.88	460	416	38.0	32	17.0	6.40
21	Jattagi /Nr Overhead water tank	OW	8.57	8.09	594	224	35.0	44	15.0	4.60
22	Koppal / In Shanteshwar Math Ingalgeriokkp	BW	6.47	7.78	426	208	48.0	24	18.50	7.10
23	Ingalageri /At Bus stop	BW	5.52	7.56	4117	3520	454.0	1280	16320	2.60
24	Chilmi /Nr kandoni house	BW	1.26	7.79	768	400	53.0	92	74.0	5.30
25	Kalagi /Nr Govt. Hospital	BW	1.32	8.20	830	248	50.0	176	160.0	6.50
26	Gonal (S.H.)/Nr Siddappa Chalavadi's house	BW	3.43	7.08	2510	1088	145.5	520	1152.0	2.90
27	Sarur (LT)/Nr D.P.Pandappa Field	BW	8.52	7.46	670	304	62.0	72	23.0	4.80
28	Bellur/Nr V.J. Deshmukh Field	BW	4.84	8.11	352	256	54.0	31	93.0	1.10
29	Gadisomnal(LT)/ infront of Shivalay temple	BW	6.88	8.61	490	68	11.0	32	13.0	3.50
30	Kolur /On Kolur tanda ways Madikeshwar	MWS	2.17	8.13	1606	412	81.5	204	480.0	6.20
31	Gudihal /Infront of primory school	BW	2.33	7.70	1642	416	40.0	184	608.0	3.40
32	Gudihal /Nr M.N.Nadaf house	BW	2.02	7.63	1412	332	64.0	200	528.0	5.30
33	Minijigi /At Ashraya colony	BW	1.99	7.33	1472	632	134.0	240	600.0	5.50
34	Shivapur /Open well outside the village	OW	1.90	8.0	1482	548	99.0	348	316.0	2.40
35	Jainapur /Infront of Primory school	BW	8.07	7.74	554	268	45.0	56	38.0	3.30
36	Amaragol /Inside the janata plot	BW	1.59	8.24	1094	324	59.0	156	232.0	2.60
37	Bhilebhavi / Nr Dyavappa Met field	BW	8.60	8.05	600	228	46.0	68	76.0	4.10
38	Nalatawad /Nr Basaveshwar high schhol	BW	1.66	7.56	1180	264	49.5	120	464.0	4.20

It is evident from the analysis data; it is obvious that the fluoride concentration is more than the limits for drinking purpose. Fluoride content of 1 mg/L in drinking water has no biological side effects<sup>15</sup>. Studies in these areas revealed that fluoride level is more than the permissible limit in the drinking water and consumed for a period of 5-10 years caused dental fluorosis. Between 4-8 mg/L for a period 15-20 years caused severe form of dental and mild form of skeletal fluorosis and if it exceeded 8 mg/L and consumed for 5-10 years or more caused severe form of dental and skeletal fluorosis. Therefore, drinking water is sufficient to produce severe form of dental and mild form of skeletal fluorosis consumed for a period of 15-20 years<sup>16</sup>. Clinical symptoms of dental and skeletal fluorosis in Gadag and Bagalkot districts of Karnataka is reported<sup>17</sup>. Health status of the people is varied in different villages because of severity of fluorosis, which is direct reflection of fluoride content of drinking water.

The Clinical symptoms of fluorotic patients from Basavan-Bagewadi and Muddebihal taluka at various age groups are presented in Table 3 and 4 respectively. The table demonstrates the fluorosis in the age group and clearly shows the prevalence of more advanced fluorosis, joint pains, gastrointestinal discomfort and excessive thirst in the older age groups. The result shows that 824 (25.89%) people of 2992 examined had dental and skeletal fluorosis, 302 (10.82%) joint pains, 326 (10.89%) gastrointestinal diseases at different stages at Basavan-Bagewadi taluka.

**Table 3.** The Clinical symptoms of fluorotic patients from Basavan-Bagewadi taluka.

Age in Years	No. of peoples examined	No. of peoples with dental and skeletal fluorosis	Percentage	No. of peoples suffering from joint pain	Percentage	No. of peoples with gastrointestinal discomfort	Percentage
8-16	697	109	15.63	82	11.88	155	22.23
17-25	1070	312	29.15	91	8.50	64	5.98
26-50	1225	403	32.89	129	10.53	107	8.73

**Table 4.** The Clinical symptoms of fluorotic patients from Muddebihal taluka.

Age in Years	No. of peoples examined	No. of peoples with dental and skeletal fluorosis	Percentage	No. of peoples suffering from joint pain	Percentage	No. of peoples with gastrointestinal discomfort	Percentage
8-16	845	175	20.71	82	8.16	123	14.55
17-25	733	230	31.37	82	11.18	107	14.59
26-50	1118	407	36.40	173	15.47	185	16.54

Out of 2696 people 812 (29.49%) skeletal and dental fluorosis, 347 (12.87%) joint pains, 415 (15.39%) gastrointestinal disease at Muddebihal taluka respectively. Lack of luster was the most common symptoms of dental fluorosis experienced by the subjects of Basavan-Bagewadi and Muddebihal taluka followed by browning of teeth. The dental fluorosis, joint pains and gastrointestinal diseases was more severe in Muddebihal taluka, which can be attributed to the differences in fluoride content of water in these two areas. Fluoride content of drinking water of Mundaragi taluka ranged from 4.00-10.5 ppm<sup>18</sup>. While that of Hunagund taluka ranged from 2.04-3.2 ppm<sup>19</sup>. The various grade of discoloration of teeth ranging from chalky white to yellow or brown with pitting. This difference being attributed to fluoride content of drinking water, poor nutritional and economic status in addition to the consumption of locally grown foods. The difference in fluoride content of water, intake of fluoride, temperature are the major factors responsible for the accumulation of higher fluoride leading to increased severity of the diseases<sup>20</sup>.

## Conclusion

From the result and discussion presented above the important role of drinking water in the incidence of fluorosis is obvious. It is therefore, essential that the villages affected by fluorosis be supplied with safe drinking water less than 1 mg/L fluoride, either by changing the water source to safer one or by adapting suitable treatment technique to remove fluoride in the existing sources. Since grains, vegetables and milk are also significant sources of fluoride to man, their fluoride content could be taken into account while fixing the safe level of fluoride in drinking water.

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