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FLUORIDE CONTAMINATION STATUS OF GROUNDWATER IN MUDHOL TALUK, KARNATAKA, INDIA: CORRELATION OF FLUORIDE WITH OTHER PHYSICO-CCHEMICAL PARAMETERS.

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ABSTRACT
The present study deals with the physic-chemical parameters of ground water quality in Mudhol taluk of Bagalkot district, Karnataka, India. Research findings for fluoride content in drinking water reveals that, all the samples analyzed were found to be not exceeded the WHO 1995 drinking water standards and it reflects on health status of the consumers. The pH of the all samples was acidic to alkaline. The total dissolved solids and hardness were beyond permissible limit in the some samples.
Keywords: Mudhol taluk, permissible limits,water quality,WHO.

INTRODUCTION

The occurrence of the high fluoride concentrations in ground water is a problem faced by many countries, notably India, Srilanka and China, the rift valley countries in East Africa, Turkey and parts of South Africa. Fluoride epidemic has been reported in as many as 19 Indian states and Union Territories. India is one among the 23 nations in the world, where fluoride contaminated ground water is creating health problems. The state of Art Report of UNICEF confirms the fluoride problem in177 disricts of 20 states in India. The high fluoride levels in drinking water and its impacts on human health have increased the importance of defluoridation studies.[1-3] The magnitude of problem is sinking in and effects are being made towards defluoridation of drinking water, combating the debilitating fluorisis and taking steps to prevent and control the disease.[4,5]

Fluoride is well recognized as an element of public concern. Fluoride is present universally in almost every water(higher concentrations are found in groundwater),each crust, many minerals, rocks viz tooth pastes, drugs, cosmetics, chewing gums, mouth washes and so on.[6] Though small amount of it is beneficial for human health for preventing dental carries, it is very harmful when present in excess of 1.0 ppm. World Health Organization (WHO) and IS:10500 recommend that the fluoride content in drinking water should be in the range of 1.0-1.5 ppm.

An intake of more than 6 ppm of fluoride results in multidimensional health manifestations, the most common being dental and skeletal fluorosis.[7] Higher concentration of fluoride also causes respiratory failure, fall of blood pressure and general paralysis. Loss of weight, anorexia, anemia, wasting and cohexia and among the common findings in chronic fluoride poisoning. Continuous ingestion of non-fatal dose of fluoride causes permanent inhibition of growth. Fluoride ions inhibit a variety of enzymes often by forming complexes with magnesium ions other metal ions.[8]

Mudhol site location

Bagalkote is a newly formed district in November 1997 by bi-furcating Bijapur district. agalkote town is the district headquarters. The district is located in the northern part of the state of Karnataka. Historically Bagalkote district is significant because it was the Capital of the halukyan Empire of South India under

Pulakesi I. The Chalukyas ruled from 550 AD to 753 AD when the Rashtrakutas deposed this dynasty. The 12th Century social reformer Basavanna's 'Aikya Mantap' or holy samadhi and famous shiva temple is located in Kudalsangama in Hungund taluk of the district. Badami was the Capital of Chalukya dynasty. Badami, Aihole, Pattadakallu, Kudalasangama, Banashankari and Mahakoota are the important historical places in the istrict. Bagalkote district is bound by Bijapur in the north, Belgaum in the west, Dharwar in the south and Raichur in the east.

The district comprising of 6 taluks, occupies an area of 6593 sq.kms (constituting around 3.4 percent of the area of the state) and lies between 15° 49' & 16° 46' north latitude and 74° 58' & 76° 20' east longitude. The area is a gently undulating to a plain terrain, dotted with isolated hills. The elevation ranges from 480 to 729 metres amsl, sloping from west to east. The district falls in the Northern dry Agro-climatic zone and xperiences a semi-arid climate. It is one of the drought -prone districts of the State. The district is drained by the river Krishna and its tributaries Ghatprabha and Malaprabha. All these rivers enter district on the western side and flow in an easterly direction to join the Bay of Bengal. Krishna River enters the district at Terdal village in Jamkhandi taluk and flows in south-easterly direction and forms the northern boundary of the district separating it from Bijapur district. The Ghataprabha River flows in the middle part of the district and joins the Krishna in Chikkasangama village in Bilgi taluk. The Malaprabha flowing in the southern part, joins the Krishna at Kudal Sangama in Hungund Taluk. The Ghataprabha and Malaprabha canal systems serve the western parts of the district. The Dam across the Krishna river at Almatti and the canal systems serve the eastern parts. Rainfalls being as low as 560 mm annually, these canals are the lifelines, providing much needed irrigation and drinking water to the district. Central Ground Water Board has carried out Systematic when it was in the undivided Bijapur district and Reappraisal hydrogeological surveys after the formation of the district. Exploratory drilling was carried out during 1975-76, 1988-90 and 2004-07 in the district. Seventy bore wells were drilled by CGWB underground water exploration programme.

Mudhol (ಮುಧೋಳ)is a town in the Bagalkot District in the Northern part of the state of Karnataka, India.

It is about 60 km from the district headquarters of Bagalkot town on the left bank of the Ghataprabha River. It is famous for a breed of dog known as the Mudhol Hound. The Principality of Mudhol was one of the 9-gun princely states of British India, under the summit of Niranjan. The state measured 368 square miles (508 km²) in area. According to the 1901 census, the population was 63,001, with the population of the town itself at 8,359 in that year. In 1901, the state enjoyed revenue estimated at £20,000. The state flag, called 'Bavuta', was a triangular tricolor of horizontal bands, in order from the top: white, black and green. All color bands came to the point in the fly.

Geography

Mudhol is a large town located in the district of Bagalkot in the state of Karnataka in India. It has a population of about 48830 persons living in around 8860 households.

Mudhol is located at 16°21′N, 75°17′E,16.35°N, 75.28°E. It has an average elevation of 549 metres (1801 feet). Mudhol is also famous as hometown of well known Pulmonologist Dr. Zulfiqar Ali.

Demographics

As of 2007 India and mudhol census ,Mudhol has a population of 1,03,612. Males contributes 51% of the population and females 49%. Mudhol has an average literacy rate of 59%, male literacy is 60%, and female literacy is 40%. mudhol has an average ratio of 60:40 males and females. In Mudhol, 15% of the population is under 6 years of age. and the noticiable point of mudhol is it has a brand breed of Dogs called "Mudhol Hounds" famous for hunting. Kannada is the official language. Marathi is spoken widely.

Groundwater Quality

Groundwater is generally mildly alkaline, moderate to very hard and is of Sodium -Bicarbonate type. In phreatic zone it is more mineralized than in fractured zones. Specific conductance varies from 607 to

7000 micro mhos/cm at 25° C and chloride values range from 28 to 638 ppm. The concentrations of both these are found to be higher than the 'permissible limit' of Drinking water Standards in some isolated pockets. Otherwise, water is suitable for drinking and irrigation purposes. Nitrate pollution is noticed on a wide scale and is more prevalent in dug wells than in bore wells. Higher concentrations (>1.5ppm) of fluoride is found in many bore well samples and it is found in lesser (within permissible limit of 1.5 ppm) concentration in dug well samples. The concentration in general, increases with the depth of bore wells and this indicates the possible geogenic nature of fluoride.

Objectives and Scope

In view of the increased interest in recent years in fluoride concentrations in groundwater and impact to human health, the present study is focused on factors determining Fluoride levels in the groundwater of shallow and deep aquifers in and around Mudhol taluk of Bagalkot district and the identification of appropriate aquifer zones for fluoride safe drinking water.

Table-1: Fluoride content and Pysico-chemical parameters in the different parts of Mudhol taluka of Bagalkot district

S. No.	Area of Samples collected	Fluoride found in ppm	pH	TDS in ppm	Hardness in ppm
1	Kesargoppa public bore well	0.318	7.16	1837.9	588.5
2	Sameerwadi public bore well	0.266	8.19	1339.0	459.3
3	Belagali public bore well	0.341	7.32	1126.0	399.1
4	Mugalkod public tap	0.269	7.36	1078.0	428.5
5	Budni PM 1 public bore well	0.292	7.52	1008.0	523.4
6	Budni PM 2 public bore well	0.335	7.32	1126.0	436.5
7	Nagaral public bore well	0.225	7.52	1065.2	359.3
8	Dhavaleshwar public bore well	0.192	7.25	1152.1	415.5
9	Sanganatti public bore well	0.231	7.85	1484.5	785.2
10	Vajjarmatti public bore well	0.209	7.82	0587.1	383.9
11	Lokapur public bore well	0.238	8.38	0350.9	199.9
12	Nandaganv public bore well	0.322	7.53	1235.8	352.3
13	Akkimaradi public bore well	0.105	7.65	0698.2	213.2
14	Sayadapur Public bore well	0.162	7.35	0689.5	252.5
15	Mugalkod public bore well	0.325	7.52	1154.5	454.4
16	Kulali public tap	0.325	7.25	1125.3	358.2
17	Mudhol public bore well budni road	0.278	7.52	1052.3	299.9
18	Mudhol public bore well bilagi road	0.131	7.12	1032.3	439.0
19	Mudhol public bore well near buss stand	0.080	7.57	0891.5	799.9
20	Alagundi BK public bore well	0.060	6.60	0421.9	271.9
21	Malapur public tap	0.486	8.32	1044.5	220.5

22	Shirol public Bore well	0.164	8.10	1024.5	365.9
23	Shirol public tap water	0.359	7.90	1036.4	375.9
24	Konnur public Bore well	0.255	7.53	1127.4	718.4
25	Mantur public Bore well	0.314	7.69	10464	399.4
26	Machaknur public Bore well	0.389	7.26	1167.4	623.5
27	Timmapur public Bore well	0.258	7.39	1075.3	457.2
28	Jeergal public Bore well	0.189	8.14	1009.3	465.6
29	Chichakandi public Bore well	0.294	7.86	1088.8	395.4
30	Kasabajambagi public Bore well	0.335	7.25	1018.5	428.5
31	Malali public Bore well	0.369	7.95	1165.4	451.7
32	Halagali public Bore well	0.238	7.59	1097.3	395.3
33	Kataraki public Bore well	0.391	7.24	1122.3	365.5
34	Muddapur public Bore well	0.355	7.92	1006.4	396.4
35	Bisanal public Bore well	0.469	8.12	1087.2	525.7
36	Mahalingapur public Bore well	0.533	7.89	1085.5	545.4
37	Madhabanvi public Bore well	0.433	7.79	1104.3	496.6
38	Marapur public Bore well	0.497	8.02	1002.9	452.7
39	Hebbal public Bore well	0.335	7.57	0921.4	402.4
40	Soraganvi Bore well	0.422	7.27	1008.9	479.3
41	Alagur public Bore well	0.458	8.15	1005.5	388.7
42	Chikkalgundi public Bore well	0.554	7.79	0987.8	469.5
43	Chikkur public Bore well	0.415	7.78	1096.7	543.8
44	Bantanur public Bore well	0.355	8.13	0898.9	423.8
45	Bannurpublic Bore well	0.435	7.85	1154.8	489.8
46	Rugi public Bore well	0.547	7.89	1023.9	477.8
47	Jaliber public Bore well	0.482	7.79	1114.8	495.9
48	Metagudda public Bore well	0.458	7.79	1088.4	454.7
49	Dadanatti public Bore well	0.573	8.11	1006.8	412.5
50	Baragi public Bore well	0.472	7.87	1108.8	488.7

Table-2: Correlation between fluoride content and Other Physico-chemical parameters

S. No.	Fluoride found in ppm	pH	Correlation between Fluoride and pH	TDS in ppm	Correlation between fluoride &TDS	Hardness in ppm	Correlation between Fluoride &Hardness	Correlation between pH & TDS	Correlation between pH & Hardness	Correlation between TDS &Hardness =0.039199
1	0.318	7.16		1837.9		588.5				
2	0.266	8.19		1339		459.3				
3	0.341	7.32		1126		399.1				

4	0.269	7.36		1078		428.5				
5	0.292	7.52		1008		523.4				
6	0.335	7.32		1126		436.5				
7	0.225	7.52		1065.2		359.3				
8	0.192	7.25		1152.1		415.5				
9	0.231	7.85		1484.5		785.2				
10	0.209	7.82		587.1		383.9				
11	0.238	8.38		350.9		199.9				
12	0.322	7.53		1235.8		352.3				
13	0.105	7.65		698.2		213.2				
14	0.162	7.35		689.5		252.5				
15	0.325	7.52		1154.5		454.4				
16	0.325	7.25		1125.3		358.2				
17	0.278	7.52		1052.3		299.9				
18	0.131	7.12		1032.3		439				
19	0.08	7.57		891.5		799.9				
20	0.06	6.6		421.9		271.9				
21	0.486	8.32		1044.5		220.5				
22	0.164	8.1		1024.5		365.9				
23	0.359	7.9		1036.4		375.9				
24	0.255	7.53		1127.4		718.4				
25	0.314	7.69		10464		399.4				
26	0.389	7.26		1167.4		623.5				
27	0.258	7.39		1075.3		457.2				
28	0.189	8.14		1009.3		465.6				
29	0.294	7.86		1088.8		395.4				
30	0.335	7.25		1018.5		428.5				
31	0.369	7.95		1165.4		451.7				
32	0.238	7.59		1097.3		395.3				
33	0.391	7.24		1122.3		365.5				
34	0.355	7.92		1006.4		396.4				
35	0.469	8.12		1087.2		525.7				
36	0.533	7.89		1085.5		545.4				
37	0.433	7.79		1104.3		496.6				
38	0.497	8.02		1002.9		452.7				
39	0.335	7.57		921.4		402.4				
40	0.422	7.27		1008.9		479.3				
41	0.458	8.15		1005.5		388.7				
42	0.554	7.79		987.8		469.5				
43	0.415	7.78		1096.7		543.8				
44	0.355	8.13		898.9		423.8				
45	0.435	7.85		1154.8		489.8				
46	0.547	7.89		1023.9		477.8				
47	0.482	7.79		1114.8		495.9				
48	0.458	7.79		1088.4		454.7				
49	0.573	8.11		1006.8		412.5				
50	0.472	7.87		1108.8		488.7				
			Fluoride and pH r= 0.40045		fluoride &TDS r= 0.028696		Fluoride &Hardness r= 0 .114089	pH & TDS r= -0.00321	pH & Hardness r = - 0.03879	TDS &Hardness =0.039199

EXPERIMENTAL

Fifty samples were collected for comparative study. Samples were drawn with a precleaned plastic polythene bottle. Prior to sampling , all the sampling containers were washed and rinsed thoroughly with the ground water[9,10] The pH was measured using digital meter immediately after sampling. Total dissolved solids, fluoride and water hardness were determined by using standard methods.[11]

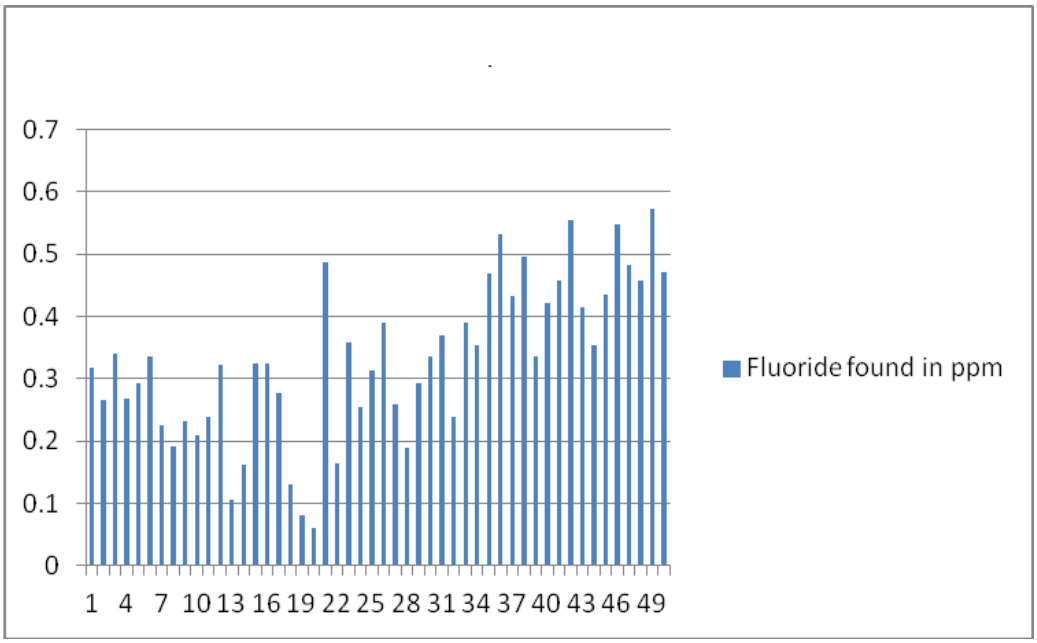

Fig.-1: Fluoride found in ppm

RESULTS AND DISCUSSION

All the ground water samples collected in study area were clear without any visible colour, odour and turbidity. The data obtained after analysis of all the samples was compiled and presented in Table-1. Fluoride concentrations in the study area varied between 0.06 (Sample No.20) to 0.573 ppm (Sample No.49). Almost all samples from Mudhol taluk water samples exhibited fluoride concentration less than the permissible limits. The low concentration of fluoride evidenced in these villages may be attributed to the source of water. In Nigeria low fluoride levels have been reported in most parts of the country, being≤0.3 ppm in 62% of the local government areas[12], with fluoride concentrations generally higher in North Central zones. In many countries, fluoride is purposely added to the water supply, tooth pastes and some times other products to promote dental health. It should be noted that fluoride is also found in some food stuffs and in air, so that the amount of fluoride people actually ingest may be higher than assumed. In relation to drinking water it is it is generally believed that too little (≤0.5mg/L) can affect bone and teeth structure.[13,14] Critical analysis of data of fluoride concentration clearly indicates that the deep aquifers are deficient of fluoride at all the study area. The common food stuffs have fluorine contents as follows: milk 0.07 to 0.2ppm, wheat 0.05ppm, rice 0.7ppm, eggs 1.2ppm, tea 3.2 to 178ppm, garlic and onion contain 10 to 17ppm.[15] The results reveal that pH ranged from 6.6 (Sample No.20) to 8.38 (Sample No. 11). Sample No.11 showed higher concentrations than the prescribed permissible limit for drinking water, i.e 6.6 to 8.38 of Indian standards.[15] TDS concentration in the samples studied varied between 350.9 (Sample No. 11) to 1837ppm (Sample No. 1). The prescribed permissible limit of TDS for drinking water is 500mg/L.[15] TDS concentrations above 500mg/L were noticed in most of the samples. Maximum TDS concentration was observed in sample No.1. Higher concentrations of TDS observed in the study area may be attributed to granite rocks present in the study area. All the samples analyzed showed lower concentrations of total hardness compared to the prescribed permissible limit for drinking water i.e 200mg/L. The maximum hardness was found (799 mg/L) NO.19.While minimum concentration (213.2mg/L) was found in Sample No.13.

Correlation of fluoride concentration with other physico-chemical parameters

In order to study relation between the fluoride concentration and other physic-chemical parameters studied,, correlation studies were performed as shown in Table-2. The fluoride values showed positive

correlation with pH(r=0.4005).[17] The relation between fluoride ion and pH is shown in Table-2.The principle ion contributing TDS are carbonate, bicarbonate, chlorides, fluorides, sulphates, nitrates, sodium, potassium, calcium and magnesium.[18] Where fluoride and TDS are low, the chance of substitution by fluoride ion is more and fluoride shows positive correlation with TDS (r=0.028696). In ground water, hardness is formed mainly due to carbonate, bicarbonate and chloride of Ca^{+} and Mg^{+}. Total hardness is higher in 18% of the water samples. An overall correlation analysis is almost a positive correlation between the concentration of fluoride ion with pH, TDS, and total hardness (r=0.114089). However pH and TDS and Hardness correlated negatively (r=-0.00321, r=-0.038793), while TDS and hardness correlated positively (r=0.039199). Out of several parameters, the researcher has correlated only a few linear regression analysis. The pairs are; (i) Fluoride and pH, (ii) Fluoride and TDS, (iii) Fluoride and Total hardness,(iv) pH and TDS, (v) pH and Hardness and TDS with Hardness.

CONCLUSION

Fluoride distribution is associated with pH, TDS and total Hardness and TDS and Hardness positive correlation is observed in these parameters. Negative correlations are observed in the parameters like pH and TDS, pH and Hardness respectively. This study reveals that the fluoride concentration of all the ground water samples analysed are less than 1.5mg/L which is bellow the permissible limits prescribed by ICMR, WHO and ISI. No dental fluorosis and skeletal fluorosis is noticed in study area. A ground water management programme is suggested. Environmental awareness of the health implication of fluoride is emphasized through education of public and community participation.

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