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Research Article

PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER FLUORIDE CONTENT AND WATER QUALITY IN DEVLI TEHSIL OF TONK DISTRICT(RAJASTHAN)

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ABSTRACT
The present study deals with the physico-chemical parameters of ground water quality in Devli Tehsil of Tonk district, Rajasthan, 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. Water Samples were collected and analyzed for physico-chemical characteristics of ground water. It was observed that fluoride concentration ranges from 0.5 mg/L to 16.2 mg/L, pH from 7.43 to 9.38, electrical conductivity from 1730-4578, Calcium concentration from 32-360 mg/L, alkalinity from 134-916 mg/L and chloride from 182-1428 mg/L in the study area.

Keywords: *Fluoride, Fluorosis, Devli Tehsil*

INTRODUCTION
Water is an essential natural resource which is Present in abundance and free gift of nature however chemical composition of surface or subsurface water is one of the prime factors on which the suitability of water for domestic, industrial and agriculture purpose depends. Fresh water occurs as surface water and ground water in which groundwater contributes only 0.6% of the total water resources on earth. It is major and preferred source of drinking water in rural and urban areas particularly in India. Fluoride frequently occurs in igneous as well as in metamorphic rocks especially in alkali rocks, granite, basalt, shale, clays and calcium phosphate rocks is the main sources of fluoride. Fluoride is mainly found in ground water when derived by the solvent action of water on the rocks and the soil of the earth's crust. Fluoride is the most electronegative of all chemical elements and is never encountered in nature in the element form. It is seventeenth in the order of frequency of occurrence of the elements and represents about 0.06 to 0.09% of the earth's crust (Wedepohl, 1974). Fluoride is an essential element for life. During its low concentrations fluoride deficiencies can arise but at high fluoride concentrations other deleterious effects can certainly transpire. In relation to drinking water it is generally believed that too little (< 0.5 mg l-1) or too much (> 1.5 mg l-1) can affect bone and teeth structure (Edmunds and Smedley, 1996, 2003). It very necessary to understand the present contamination level, distribution and developing a methodology for safe drinking water source. The health problems arising as a result of fluoride contamination are more wide spread in India.

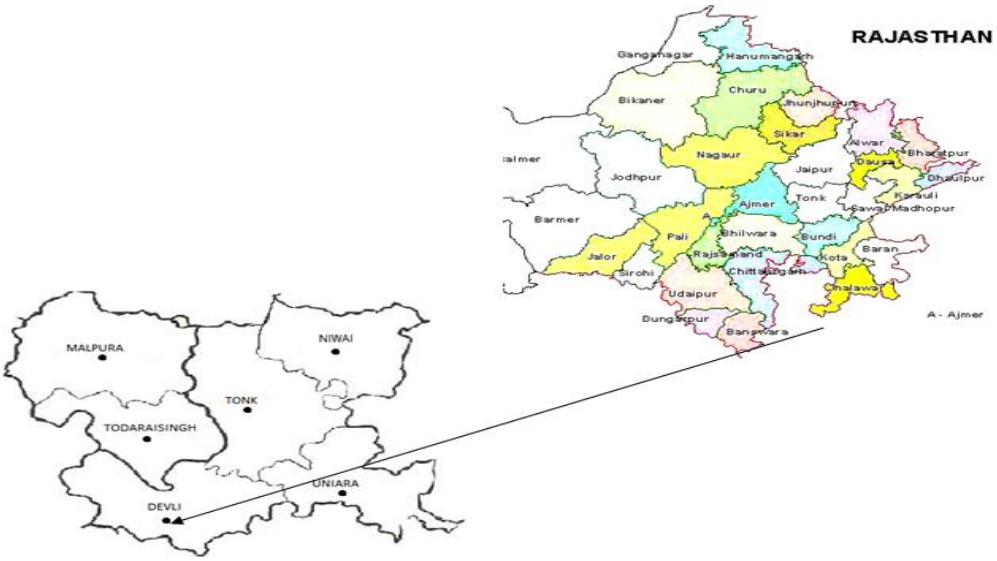
Surface water scarcity is one of the major reason due to which Rajasthan has to depend on ground water Resources to a great extent. Ground water content high fluoride concentration in all the 33 districts of Rajasthan in which 23 districts have serious health related issues (Agrawal *et al.,* 1997; Maithani *et al.,* 1998; Datta *et al.,* 1999). Estimation finds that 65% of India's villages are exposed to fluoride risk (UNICEF, 1999). Higher fluoride concentration exerts a negative effect on the course of metabolic processes and an individual may suffer from skeletal fluorosis, dental fluorosis, non- skeletal manifestation or may be the combination of above (Susheela and Kharb, 1990; Susheela and Kumar, 1991). Fluorosis has assumed global status in the public health point of view which become pandemic now a days (Pillai and Stanley, 2002). Rajasthan is one of the state in India which was seriously affected by high fluoride concentrations. Due to limited water resource in Rajasthan Peoples of several districts are forced to consume water with high fluoride concentration up to 44 mg l-1 (Agrawal *et al.,* 1999). The present study has therefore undertaken to analyze the fluoride content of ground water sample in Devli tehsil of Tonk District, Rajasthan.

Study Area

Topography

Tonk district is located in north eastern part of Rajasthan bordering Jaipur in north. Swaimadhopur in the east Bundi & Bhilwara in south & Ajmer in the west. Devli Tehsil is located in the south of Tonk district and is surrounded by Ajmer, Bhilwara, Bundi, Districts. The tehsil head quarter Devli is connected by NH-12 and it is situated at 167 km from the Jaipur. Devli is located at 25°35′N 73°37′E 25.58°N 73.62°E. It has an average elevation of 296 metres (971feet) above mean sea level. The total area of the Tehsil is 153969 hectares (Map). The terrain is marked by mostly flat hills in between near the Bisalpur dam.

The climate of the Devli Tehsil is hot and dry. Therefore the present study of ground water of the fluoride affected area has been carried out. The objective of the present study has been to render and facilitate ground water exploration more precisely in the fluoride free zone, based on characteristic and distinct ground water quality of area. It further provides avenues for developing more effective, economically, affordable and practicable defluoridation technology at village level.



MATERIALS AND METHODS

Sample Collection

Groundwater sample was collected randomly from 30 villages in Devli tehsil (Tonk district) of Rajasthan as given in Table 1. Total 150 water samples (5 samples per villages) were collected in pre cleaned poly ethylene bottles and brought to the laboratory for analysis, physio-chemical parameters analysis were conducted using standard techniques like pH, Electrical conductivity, TDS (Total Dissolved Solid), Total hardness, Calcium Hardness, Chloride and alkalinity were determined with water testing kit (APHA prescribed) (model 161 E) as per standard methods given in APHA, (2005). Fluoride concentration was determined with the help of selective ion meter 9 mettler Toledo MA 235 pH/ion Analyzer) standard procedure for determining the fluoride followed (APHA, 2005). Total ionic strength adjustment Buffer (TISAB) was used to maintain a suitable ionic strength and also to avoid complex formation.

RESULTS AND DISCUSSION

Result

Fluoride content Analysis with other physico-chemical Parameters present in the Table 1. The different samples collected from the study area (30 villages) of Devli Tehsil and their analytical results reveal that pH ranges from 7.43 to 9.38 and pH of water samples remain within the permissible limit i.e. Is 6.9 to 9.2. Minimum pH (7.43) was found in Kanwarpura village and maximum pH (9.38) was found in Daberkala village. A positive correlation has been seen between ph and fluoride.

Table 1: Physico- Chemical analysis of groundwater samples in Devli Tehsil of Tonk District (Rajasthan)

S.NO.	Name of village	pH	Electrical conductivity (mmhos/cm)	TDS (mg/L)	Alkalinity (mg/L)	Chloride (mg/L)	Total hardness (mg/L)	Calcium hardness (mg/L)as caco3	Fluoride ppm
1	Balunda	8.22±0.15	3221±9.97	1867±6.81	427±7.03	752±8.86	426±3.80	183±11.02	5.16±0.14
2	Beejwar	7.82±0.05	2589±8.09	1421±4.47	249±10.12	443±8.39	824±6.51	295±6.32	2.38±0.07
3	Bhanwarthala	8.33±0.16	3298±10.79	1924±6.04	494±6.04	863±5.24	375±6.16	156±7.84	6.27±0.16
4	Dabarkala(Harijan Basti)	9.38±0.08	4578±12.38	3276±10.37	916±8.39	1428±3.67	139±5.24	32±5.24	16.23±0.25
5	Dabarkala(sitaram ji mandir)	8.93±0.09	4013±11.06	2495±10.27	844±6.82	1283±9.03	183±2.74	71±5.96	13.69±0.09
6	Deoli	7.85±0.03	2663±8..74	1447±6.04	256±14.26	438±4.12	810±7.18	291±4.74	2.53±0.10
7	Devkheda	7.68±0.15	2361±9.66	1307±5.61	213±11.42	356±8.54	897±4.94	321±6.52	1.55±0.16
8	Dhandholi	8.28±0.09	3253±8.31	1906±18.60	482±5.24	817±6.51	398±5.09	168±5.43	5.72±0.10
9	Ganwari	8.42±0.07	3356±5.70	1992±8.39	593±10.31	1050±6.12	337±6.32	128±4.47	7.15±0.07
10	Gerota	7.73±0.02	2473±6.81	1392±7.44	232±9.84	407±9.35	865±7.68	305±9.21	1.94±0.11
11	Hadoti	8.14±0.25	3169±7.90	1845±10.12	413±6.40	778±7.90	440±5.61	190±6.59	4.83±0.09
12	Heerapura	7.93±0.15	2785±5.38	1563±7.44	293±9.35	569±5.70	703±6.20	254±4.47	3.20±0.08
13	Hisampura	8.85±0.07	3869±9.97	2306±8.86	768±7.44	1126±7.78	195±7.96	85±6.59	11.32±0.11
14	kanwarpura	7.43±0.10	1730±6.81	1026±6.32	134±10.17	182±1.58	1020±4.30	370±5.78	0.56±0.13
15	Kharoi	7.65±0.09	2239±7.71	1257±6.40	204±12.18	294±4.94	925±7.03	332±2.54	1.30±0.04
16	kishanpura	7.59±0.09	2110±6.32	1153±9.30	191±9.19	272±5.38	952±5.47	343±8.27	1. 17±0.06
17	Modhosinghpura	8.09±0.0.18	3018±8.39	1756±5.14	381±10.60	732±9.51	495±9.82	201±7.96	4.58±0.07
18	Nasirda	8.45±0.12	3398±8.74	2046±9.87	621±6.32	998±3.16	309±5.87	117±12.38	7.58±0.16
19	Nayawas	7.95±0.08	2839±7.17	1594±9.51	308±8.39	602±6.18	665±9.24	241±6.32	3.58±0.13
20	Panwar	8.37±0.09	3321±7.28	1963±7.51	543±6.81	914±8.54	360±8.39	141±6.51	6.59±0.11
21	Phoolsagar	7.87±0.06	2645±6.96	1469±4.63	261±7.28	482±6.67	785±3.16	273±9.43	2.81±0.04
22	Raghunathpura	8.49±0.11	3456±11. 89	2075±8.63	659±8.39	1018±6.40	270±7.58	108±5.70	7.83±0.06
23	Rajmahal	9.06±0.17	4142±9.67	2738±7.75	872±7.18	1362±8.86	170±6.20	53±8.09	14.78±0.20
24	Ramthala	8.54±0.06	3568±8.86	2120±9.669	697±6.32	1027±5.83	246±6.04	101±7.96	8.96±0.19
25	Sangpura	7.89±0.08	2689±5.87	1492±5.83	270±11.55	506±3.67	750±1.58	267±5.95	2.97±0.07
26	Sangrampura	8.72±0.04	3632±6.81	2174±7.176	743±9.2 5	1209±8.09	218±6.67	93±9.82	10.84±0.16
27	Shrinager	7.98±0. 0.11	2965±6.96	1648±7.78	331±8.74	667±3.80	598±6.82	223±8.21	3.95±0.08
28	Thawala	8.39±0.05	3347±8.54	1974±6.20	573±7.45	972±4.63	354±5.24	136±7.64	6.84±0.02
29	Titria	8.03±0.15	2976±7.61	1693±6.96	352±7.84	769±6.08	532±8.22	214±6.81	4.24±0.02
30	Tokerwasbundi	7.52±0.18	1962±7.44	1108±6.04	176±7.61	243±3.16	975±6.32	354±6.04	0.82±0.08

All the values are means ± S.D.

Total samples showed electrical conductivity more than permissible limit ranging from 1730 to 4578 mmhos/cm (Table 1). Calcium hardness range from minimum of 32 mg/l in Kanwarpura village to 360 mg/l in Daberkala village.

53% villages are wit in permissible limit and 47% villages are having total hardness above than permissible limit.

High value of alkalinity gives an undesirable taste to water. Alkalinity of villages ranged from 134 mg/L to 916 mg/L against to 200 mg/L. 13% villages are within permissible limit and 47% villages are having Alkalinity above than permissible limit.

Chloride concentration ranges from 182 mg/L in kanwarpura to 1428 mg/L in Daberkala village.

As permissible limit suggested by WHO, 3% of samples possessed lower concentration of chloride, 37% samples with in limit of WHO standard and 60% higher concentration of chloride. In the study area fluoride concentration ranges from 0.5 ppm to 16.2 ppm. Out of 30 villages, 16 villages have fluoride concentration in water ranges from 0.5–5.0 ppm, 9 villages from 5.1–10 ppm and 5 villages from 10.1 to 16.2 ppm.

Table 2: Showing WHO and USPH Standards of Drinking water

Parameters	WHO	USPH
Fluoride(mg/L)	1-1.5	1.5
PH	6.9-9.2	-
E.C.(mmho/cm)	-	300
TDS(mg/L)	500-1500	-
Total hardness(mg/L)	100-500	-
Ca-hardness(mg/L)	75-200	-
Chloride(mg/L)	200-600	250
Alkalinity(mg/L)	200	-

Discussion

Fluoride contamination is major health hazard in many parts of the district. A few symptoms of fluorosis types could be seen by naked eye and need not so many investigations. Table 2 shows the mineral containing fluoride and there chemical composition which enter into the ground water sources through rocks.

Table 3: Minerals containing fluoride

S. No.	Mineral	Chemical Composition	Rocks
1.	Fluorspar	$[CaF_2.3Ca_3(PO_4)_2]$	Pegmatite Pneumatolitic Deposits
2.	Fluorite	CaF_2	Pegmatite metamorphosed limestone
3.	Lepidolite	$K_2(Li,Al)_5(Si_6Al_2)O_{20}(OHF)_4$	Gabbros, Dolerites
4.	Tremolite	$Ca_2(MgFe^{+2})_5(Si_8O_{22})(OHF)_2$	Clay
5.	Rock Phosphate	$NaCa_2(MgFe^{+2})_4(AlFe^{+3})(SiAl)_8O_{22}(OHF)_2$	Limestone, Fossils

Result revealed that the villages having fluoride concentration Equal to 1.5 mg/L they were found healthier than the villages having concentration more than 1.5 mg/L shows ill effect because the required amount of fluoride is necessary to prevent or control disease like dental caries. Whereas due to the high

uptake of fluoride skeletal fluorosis feeling of burning and tingling in the limbs, pain in the bones and joints, formation of gas in stomach, lack of appetite chronic fatigue and weakness of muscles are also reported by people. The people of this area have also complaint of severe pain and stiffness in the neck, back bone and joints. The present study was done at Devli Tehsil in Tonk district. A more detailed study is necessary for better understanding of the source and effects of fluoride problem in Tonk district. In the study area local people ingesting the groundwater have not received medical attention till date since these people are dependent on the groundwater for domestic use.

So more investigation are needed. To reduce side effect of fluoride defluoridation technique like Nalgonda can be adopted because the Nalgonda technique using alum and line is easily applicable at both domestic and community level and treated water contains permissible amount of fluoride. Public awareness and public participation also can play an important role in controlling fluorosis problem.

Conclusion

High Fluoride concentration in Devli Tehsil of Tonk district is mainly due to dissolution from fluoride bearing minerals like Fluorspar, Fluorite etc. It's a fact that low amount of fluoride (0.3-1.0 mg/L) in drinking water is helpful in the prevention of dental caries and in treatment of osteoporosis. However, high intakes of fluoride create health hazards because of its profound affinity for calcified tissue. It interacts closely with body tissues to produce chronic disease known to cause dental fluorosis, skeletal fluorosis (includes severe pain, stiffening of body joints, deformation of bones, pain in joints etc), osteosclerosis, thyroid, cardiovascular, gastrointestinal, reproductive, developmental effects etc.

Fluorosis is a widely known disease in Rajasthan and due to this lack of awareness education and poor sanitation the people are suffering from fluorosis in so many villages of Rajasthan. To reduce the ill effect of fluoride defluoridation technique like Nalgonda can be adopted because the Nalgonda technique using alum and line is easily applicable at both domestic and community level and treated water contains permissible amount of fluoride. Present study will help to understand the route of entry of fluoride in the human being through drinking water with high fluoride and food containing fluoride more than the permissible limits. Also the results of this study will serve as the data base for the future researchers in this field.

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