

Assessment of Groundwater Quality with Special Prominence on Iron and Fluoride Contamination

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Abstract: The Fluoride (F⁻) is essential for normal bone growth, but its higher concentration in the drinking water poses great health problems like fluorosis in many parts of India. In this paper we examined fluoride and iron distribution in some drinking water sources of Rajnandgaon district, Chhattisgarh, India. Fifteen drinking water samples were collected from manually operated hand pumps established by government of Chhattisgarh and privately owned bore well in residential localities of studied habitations during non- monsoon period. Iron was determined by 1, 10 Phenanthroline methods using a colorimeter at 520nm. Fluoride water was determined by SPADNS method (colorimetric) by using a colorimeter at 570nm. The result reveal that the iron and fluoride concentrations in the existing ground water in Rajnandgaon District is ranging >0.3 to < 4p.p.m. and >0.5 to < 17p.p.m. A good number of water samples contain fluoride at an alert level. Further, the study also includes the fluoride removal technique for the suitability of ground water for drinking in study area.

1. INTRODUCTION

The significance of environmental water quality monitoring has been increasingly recognized over the last few decades. Presently, drinking water quality has become a serious issue of concern for human, mainly in developed and developing countries worldwide [1]. The chemical nature of water is one of the most imperative criteria that determine its usefulness for a precise need and as such not all the waters are fit for drinking and potable purposes.

Apart from fluoride, arsenic and nitrate are few of major water pollutants which cause large scale health issues, but in cutting-edge the most serious pollutant is fluoride [2]. Fluoride in drinking water has both beneficial and harmful effects on human health[4-8]. World Health Organization (WHO) has established permissible limit of fluoride in drinking water of 1 mg/L [1]. As demonstrated in the research conducted in many countries, fluoride concentration in drinking water sources considerably exceeds the allowable limit (Table 1)

TABLE1: Fluoride concentration in water supplies in some countries of the world

Name of the country	Fluoride concentration in water(mg/l)
USA	2.40
Romania	2.75
Bulgaria	3.10
Great Britain	3.38
Saudi Arabia	3.55
China	4.55
France	4.75
Denmark	5.35
India	8.50

The above facts motivated to take the present investigation for which the fifteen drinking water samples were collected from different hand pumps at three blocks of Rajnandgaon district of Chhattisgarh. This survey of fluoride and iron level along with physic-chemical characteristics in drinking water may help in identification and reporting of sensitive area in Rajnandgaon district.

2. MATERIAL AND METHODS

2.1 Location

The study area Rajnandgaon district is situated in the central part of Chhattisgarh. Geographically, the district lies between 21°06'N 81°02'E. The district covers an area of 8,022 km² and falls under tropical climatic region. The headquarters of Rajnandgaon District is located on the Mumbai-Howrah line of South-Eastern Railways and the National Highway (NH) 6 is also passing through the town of Rajnandgaon. Figure 1 shows the locations of three blocks in Rajnandgaon district such as Dongargadh, Rajnandgaon and Dongargaon are selected for the present study.

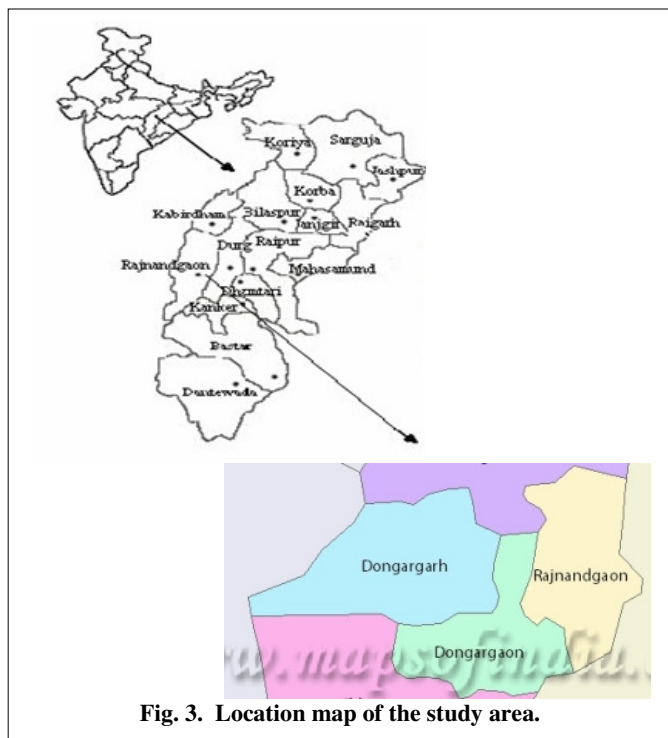


Fig. 3. Location map of the study area.

2.2 Water sample collection

Total fifteen groundwater samples were randomly selected from various parts of the 3 blocks such as Dongargadh, Rajnandgaon and Dongargaon in Rajnandgaon District. All these water samples were collected during pre-Monsoon (Dec-March) periods year 2015. From each selected site of the study area, a total of 5 water samples were collected from various deep tube wells which are being used for drinking purposes in the selected sight. These fresh groundwater samples are stored in three-liter polythene cans after flushing out some quantity of water from the source for a period of 5 minutes. The physical parameters i.e. pH, TDS and EC values were determined at the spot immediately after collection. Preservative (1:1 HNO₃ solution to pH < 2 about 3ml/l sample) is added to each water sample at the time of sampling and the containers were sealed. These samples were tested for physico-chemical parameters like pH, Total Dissolved Solids, Calcium, bicarbonate, Fluoride and the metal like Iron.

TABLE 2. Block wise sample collection summary

Name of the Development Block	Sample Identification No	Number of Samples	Water Source
Dongargadh	A1,B1,C1,D1,E1	5	Tube Well
Dongargaon	A2,B2,C2,D2,E2	5	Tube Well
Rajnandgaon	A3,B3,C3,D3,E3	5	Tube Well

The samples without preservatives are also collected for the analysis and Fluoride content.

2.3 Analysis of fluoride and other Ions

In the analysis, the pH of samples was measured with the help of digital pH meter. Turbidity was measured by Digital Turbidity meter, Electrical conductivity was measured by conductivity meter, TDS was measured with the help of Digital TDS meter. The hardness (total hardness and Ca²⁺) and alkalinity are determined by titration method. Iron was measured by 1, 10 Phenanthroline method using a colorimeter (EA312) at 520 nm. Fluoride in water was determined by SPADNS method by using a colorimeter (EA312) at 570 nm.

3. RESULT AND DISCUSSION

3.1 Physico-chemical characteristics

The results of physico-chemical pertinent characteristics such as pH, Total Dissolve Solid and Hardness for various samples collected during Pre Monsoon period from various sites the groundwater existing in Rajnandgaon district are given in Table 3. The obtained result of all the samples the minimum end scale of pH value is in the range between > 4.0 < 7.50 indicating the existing ground water in Rajnandgaon district is slightly acidic in nature. Furthermore, the TDS values for all the selected study locations in the Rajnandgaon District are <800 which is well within the limit of BIS: 10500 (2010) standards.

3.2 Chemical Characteristics

TABLE 3. Physical and Chemical pertinent characteristics of groundwater in Rajnandgaon District

Location	pH	EC (ms/cm)	TDS (ppm)	Hardness (ppm)
A1	7.15	1.10	550	400
B1	7.03	1.11	560	396
C1	7.05	1.70	840	632
D1	7.22	1.19	560	384
E1	7.07	1.32	640	464
A2	6.91	1.47	740	588
B2	6.88	1.38	690	480
C2	7.07	1.68	790	576
D2	7.03	1.25	630	460
E2	7.02	1.08	540	440
A3	7.02	1.30	660	524
B3	6.85	1.51	750	484
C3	6.89	1.10	550	328
D3	7.09	0.98	490	308
E3	7.0	1.08	540	360

Chemical distribution of fluoride in ground water of three blocks of Rajnandgaon observed are given in Table 2. In addition, the concentration of ions such as Ca^{2+} , HCO_3^- and F^- and metal such as Fe are estimated and the results are in Table 4. The result obtained for Ca^{2+} ions are in the ranges of 268-520mg/L, HCO_3^- ions are in the ranges of 287-437 mg/L, Fe^{2+} ions in the ranges of 1.3 to 4.7 mg/L and fluoride are in the range of 2.5 to 17.0 mg/L.

TABLE 4: The concentration ranges of Ca^{2+} , HCO_3^- and F^- in mg/l of groundwater in Rajnandgaon District

Location	Ca^{2+}	HCO_3^-	Fe^{2+}	F^-
A1	280	287.28	2.0	7.9
B1	280	300.90	3.9	17.0
C1	520	314.64	4.7	3.0
D1	344	288.64	1.3	6.8
E1	300	332.42	1.3	15.8
A2	340	365.25	1.3	16.3
B2	300	326.95	2.0	8.5
C2	340	436.39	2.0	6.8
D2	328	325.58	2.0	2.5
E2	404	366.62	2.0	6.8
A3	400	369.36	2.0	10.0
B3	356	437.76	4.7	15.0
C3	268	429.55	2.8	16.6
D3	240	313.27	2.8	5.0
E3	320	314.64	1.3	8.5

4. CONCLUSION

The present study was to evaluate the iron and fluoride concentration in the ground water existing in the three blocks such as Dongargadh, Rajnandgaon and Dongargaon in the Rajnandgoan district, Chhattisgarh.

The iron and Fluoride concentration of ground water were found over the permissible limit. Further, the study also includes the fluoride removal technique for the suitability of ground water for drinking in study area.

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