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Study of Fluoride of Groundwater in Two Blocks of Dungarpur District, Rajasthan, India

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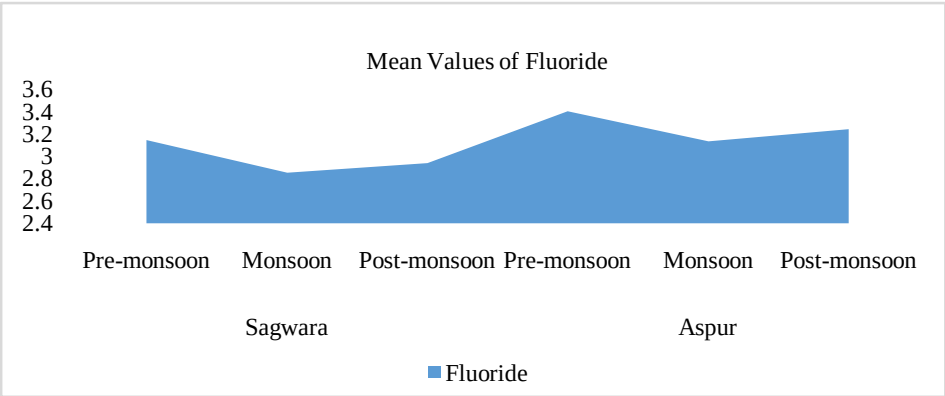
ABSTRACT

In most places of the world, groundwater is the primary source for a variety of purposes. Low or excessive concentrations of particular ions are a significant issue because they make groundwater unfit for various uses. Fluoride is one such ion that has been associated to health problems in many countries around the world. The purpose of this study was to investigate the fluoride levels in groundwater in the Aspur and Sagwara blocks of Rajasthan's Dungarpur district. Fluoride is a naturally occurring mineral in groundwater, but an excessive amount of fluoride in drinking water can cause dental fluorosis, skeletal fluorosis, and bone deformation in both infants and adults. In this context, 30 ground water samples were collected from different villages of Aspur and Sagwara blocks, during pre-monsoon, monsoon and post monsoon seasons and samples were analysed using standard method of APHA to determine fluoride concentration in groundwater. The results were compared with the drinking water standard of fluoride, prescribed by BIS and WHO. The results of analysis revealed that the concentration of fluoride in Aspur and Sagwara blocks, were higher than its desirable limit (1mg L^{-1}). The graphical representation show that the fluoride concentrations increase during pre-monsoon season in both the blocks, and peeks of graph indicated that the fluoride level was comparatively higher in Aspur block. The one-way ANOVA test was also conducted to estimate significant or non- significant value of fluoride in Aspur and Sagwara blocks. The all values were found non- significant (p =0.152 which is>0.05) in both the blocks.

Graphical Abstract:



Mean values of Fluoride in both the blocks during different seasons.

Keywords: Groundwater, Concentration, Fluoride, Fluorosis, One-way ANOVA.

INTRODUCTION

Groundwater is a valuable fresh water resource and account for about 2/3 of the fresh water reserves of the world [**1**]. It is a part of water cycle that present underground in saturated zones beneath the land surface. The upper surface of the saturated zone is known as the water table from where it is been obtained. Groundwater is the main source of drinking water in urban as well as in rural areas of India. The water requirement is fulfilling mainly from tanks, tube wells and dug wells [**2**]. Now a day's groundwater quality deterioration and availability of safe drinking water is a great problem throughout the world due to many anthropogenic activities. Among the various contaminants, presence of fluoride is a major concern in groundwater. Fluoride is a chemical element which is present most frequently in groundwater, and it is one of the most important toxicological environmental hazards on earth. The presence of fluoride in groundwater is due to leaching and weathering of fluoride-bearing minerals from rocks and sediments. Fluoride enters the bodies of humans and animals through a variety of sources, including fluoridated drinking water, plants and crops grown on fluorotic soils, certain edible marine animals, phosphate feed supplements containing fluoride, mineral mixtures, medicines, cosmetics, airborne fluoride, and industrial fluoride [**3, 4**] Groundwater containing high fluoride concentration (>1.5 mg L^{-1} according to WHO 2011) affected more than 260 million people around the world [**5**]. Fluoride in small amounts (<0.5mg L^{-1}) is good for dental health it minimize the risk of dental caries, while its higher concentrations (>1.5 mgL^{-1}) may causes fluorosis [**6**].

Aspur and Sagwara blocks are rural areas and the people of area rely on groundwater as main source of drinking water and the people of areas facing problem related to fluoride, which is clearly seen in the people of these two blocks like dental and skeletal fluorosis. Hence these two blocks are selected for present investigation.

MATERIALS AND METHODS

Dungarpur district is one of the smallest districts in Rajasthan, which is situated in the southern part of Rajasthan and western part of India. The district is a tribal rural area of the state, where most of the population is illiterate and depends upon farming for their livelihood. Geographically the district is almost triangular in shape, it belongs to pre Cambrian Aravalli range and district has semi-arid dry climate with a very hot summer season which get an average annual rainfall of 761.7 mm. It is located between 23.20° and 24.01°N latitude and 73.22° and 74.23°E longitude. Its North side bounded by Udaipur district and east by Banswara district, in its south and west has common border with Gujarat state. The most of part of the district is characterized by a rugged terrine, it has an area of 3781 sq. km and its population according to the census of 2011 is 1,388,906. The district is divided in to five blocks Aspur, Bicchiwara, Dungarpur, Sagwara and Simalwara (Figure 1). For the present investigation Aspur and Sagwara blocks of the district were selected as study area.

To analyze fluoride level in groundwater of these two block 30 (15 samples from each block) groundwater samples were collected in different season (pre monsoon, monsoon and post monsoon seasons) from hand pump and bore wells of different villages of both the blocks. Fluoride concentration in collected water samples was quantified spectrophotometrically at 570 nm using the conventional SPADNS method [**7**]. In this approach, fluoride combines with zirconium (SPANDS) solution (in an acidic environment) and bleaches the colour of SPANDS due to the creation of zirconium fluoride (ZrF^{2-}). Because bleaching is a function of fluoride ions, it is proportional to fluoride concentration. It follows the law of beer in the other direction.

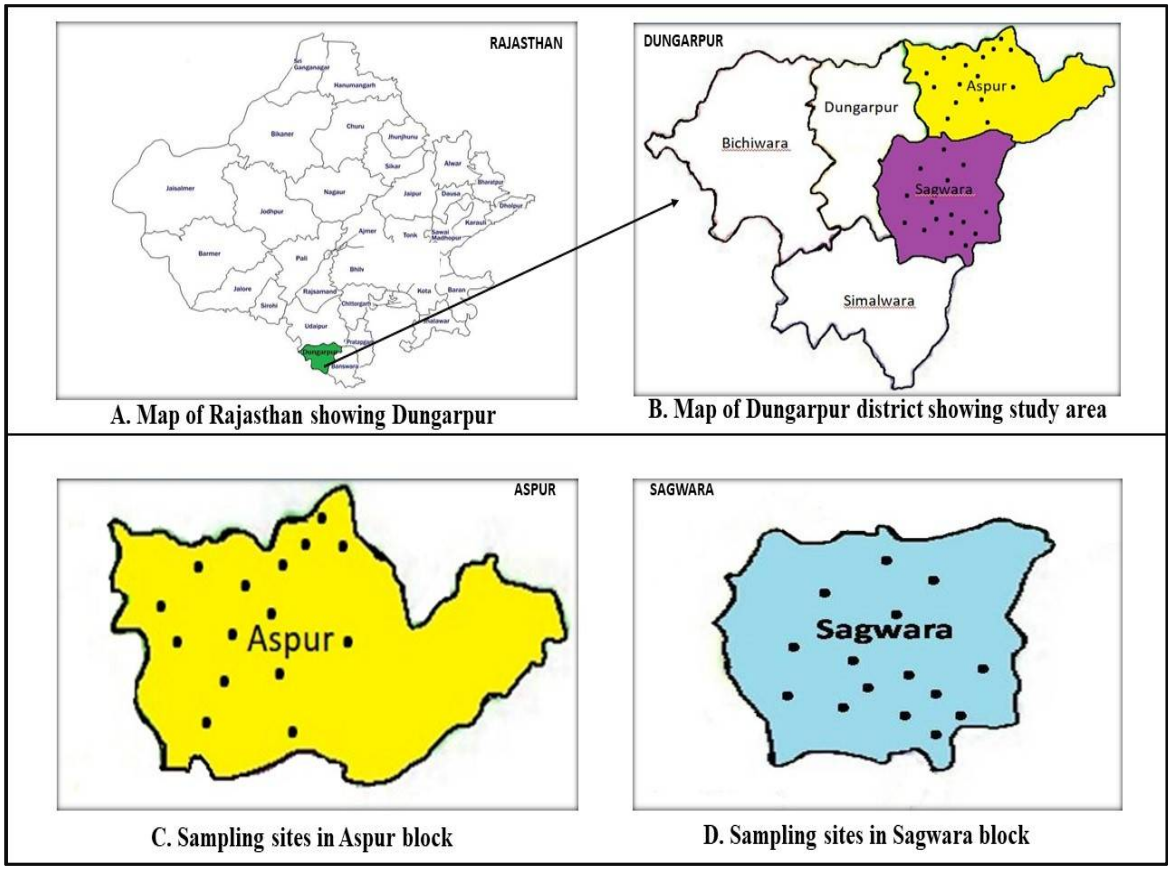


Figure 1. Maps showing sampling sites in study area of Dungarpur district in Rajasthan.

The results of groundwater analysis were compared with standard prescribed by WHO [**8**] and BIS, [**9**] to determine significance or non- significance value of fluoride in both the blocks and one way ANOVA test also cunducted to compare the fluoride contamination of groundwater in both the blocks.

RESULTS AND DISCUSSION

The results of current investigation were compared with the drinking water standard of Bureau of Indian Standards (BIS) as well as World Health Organization (WHO), which have set fluoride concentration 0.6 mg L^{-1} to 1.0 mg L^{-1} as desirable limit of drinking water and up to 1.5 mg L^{-1}as maximum permissible limit for fluoride in drinking water in absence of any alternate source of drinking water [**8**, **9**]. According to the results the fluoride level varied from 1.45 mg L^{-1} to 4.57 mg-^{1} in Aspur block while it ranged from 0.77 mg L^{-1} to 4.46 mg L^{-1} in Sagwara block, which stated that the concentration of fluoride in groundwater samples is very high in both the blocks of Dungarpur district as compared to the standard permissible limit of fluoride (Table 1 and 2). The high fluoride concentration in ground water in Dungarpur district also reported by Choubisa in his study conducted to evaluate Fluoride distribution in drinking groundwater in Rajasthan, India [**4**] and Upadhyay Jayana also found high fluoride value in the district during study of fluoride in five blocks of Dungarpur **[10**]. Fluoride is an ionic state of Fluorine, a halogen element that is not found in its elemental state in nature. It reacts with positively charged ions such as calcium due to its highly electronegative property. Fluoride (F^-) is commonly found in nature as fluorspar or fluorite (CaF_2), cryolite (Na_3AlF_6), Sellaite (MgF_2), and fluorapatite (Ca (F_2Cl) PO_4) [**8**]. The most prevalent fluoride mineral found in the environment is fluorspar, often known as fluorites. It can be found in sedimentary rocks, whereas cryolite can only be found in igneous rocks. Fluoride minerals are normally insoluble in water, and it only appears in groundwater when conditions favour their

dissolution or when high fluoride-containing effluents from industry are dumped into water bodies [**11**]. Fluoride is the 13th most abundant element in environment [**12**] and it is the 12th most hazardous elements in biosphere [**13, 14**]. In our body fluoride found in bones and teeth therefore it's optimum concentration is necessary for the health, as it helps in dental enamel formation and mineralization of bones. The deficiency of fluoride may cause diseases like dental caries and osteoporosis in children. On the other hand, ingestion of excess fluoride in drinking water can cause dental fluorosis and skeletal fluorosis in children as well as adults.

Table 1. Showing data of fluoride in sampling sites of Aspur block in premonsoon, Monsoon and post monsoon seasons of 2021

S. No.	Locations	Pre monsoon (Data in mg L^{-1})	Monsoon (Data in mg L^{-1})	Post monsoon (Data in mg L^{-1})
1.	Badoda	4.57	4.10	4.35
2.	Ogle	2.87	2.54	2.68
3.	Kanthadi	3.89	3.55	3.73
4.	Katisore	4.35	4.05	4.18
5.	Khalile	2.87	2.84	2.86
6.	Khudarada	3.98	3.67	3.82
7.	Lilwasa	2.85	2.84	2.59
8.	Movai	4.10	3.90	3.98
9.	Nepalpura	1.56	1.10	1.45
10.	ParadaItiwar	3.95	3.62	3.77
11.	PardaThoor	3.20	2.98	3.00
12.	Punjpur	2.56	2.40	2.48
13.	Ramgarh	4.35	4.00	4.15
14.	Rayaki	4.10	3.83	3.85
15.	Toka/wasa	1.86	1.62	1.74

Table 2. Showing data of fluoride in sampling sites of Sagwara block in pre monsoon, monsoon and post monsoon seasons of 2021

S. No.	Locations	Pre monsoon (Data in mg L^{-1})	Monsoon (Data in mg L^{-1})	Post monsoon (Data in mg L^{-1})
1.	Bhilura	3.89	3.40	3.54
2.	Diwdachhota	1.74	1.58	1.70
3.	Khadgda	2.92	2.47	2.54
4.	Gowadi	3.45	3.30	3.42
5.	Gamdabrahmniya	0.90	0.77	0.88
6.	Obari	2.99	2.66	2.73
7.	Decha	3.54	3.56	3.38
8.	Barbodaniya	4.46	4.18	4.25
9.	Tamatiya	2.87	1.85	1.90
10.	Varda	2.83	2.52	2.67
11.	Ranoli	3.20	3.25	3.22
12.	Kokapur	3.98	3.60	3.80
13.	Mandav	2.46	2.18	2.27
14.	Padwa	3.72	3.50	3.62
15.	Limbod	4.27	3.98	4.12

In the present investigation, to compare fluoride concentration in groundwater samples of two blocks of district, one-way ANOVA test was also conducted, the results of ANOVA test are shown in below table 3.

Table 3. Showing ANOVA test applied for fluoride parameter of Aspur and Sagwara blocks of Dungarpur district

Block	N	Minimum	Maximum	Mean	Standard Deviation	't'	P-Value
Aspur block	45	1.45	4.57	3.261	0.910	1.443	0.152
Sagwara block	45	0.77	4.46	2.979	0.940		

The results of ANOVA test show that there was not a significant difference in fluoride value of both the blocks (t = 1.443, p value 0.152 > 0.05), and the high fluoride concentration found in both the blocks. The mean value of fluoride found comparatively high in Aspur block (3.261 mg L^{-1}) than Sagwara block (2.979 mg L^{-1}). To make the results clear, graphical representation of fluoride concentration in different seasons in both the blocks were also prepared.

The graphical representation of statistical data analysis shows mean value of fluoride in Aspur and Sagwara blocks during pre monsoon, monsoon and post monsoon season of year 2021 (Figure 2). The seasonal variation in fluoride concentration was observed in different season. The graph showing mean value of fluoride was maximum in Pre-monsoon season than monsoon and post monsoon while the minimum mean value found in monsoon season in both the blocks which indicate the precipitation minimize the fluoride concentration in monsoon season due to dilution of fluoride, on the other hand in pre monsoon it is comparatively high in both the blocks. The bars of graph also clearly showing high concentration of fluoride in Aspur black than Sagwara block in all three season.

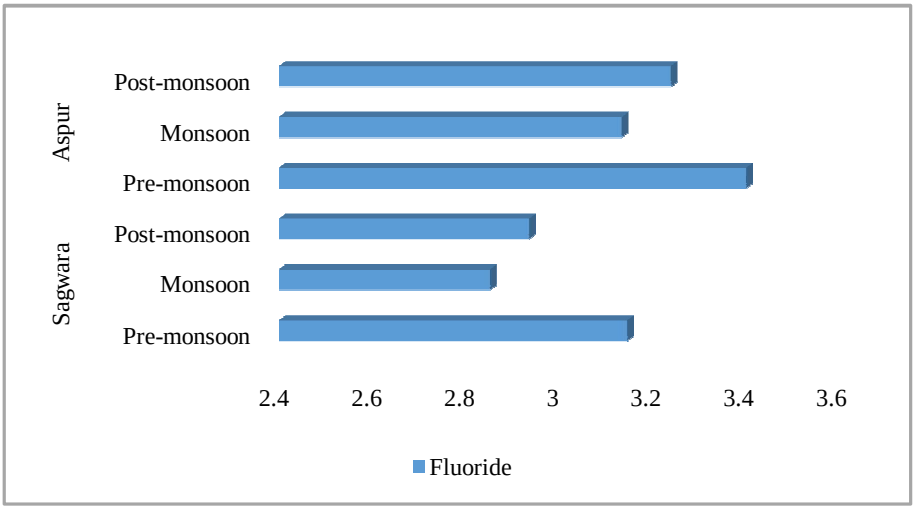


Figure 2. Shows mean value of fluoride in both the blocks during different season.

The main sources of naturally occurred fluoride in ground water are weathering of fluoride rich rocks. Mostly high fluoride level in groundwater is found at floor of mountains and in sediments of marine origin, Phosphate containing fertilizer can also increase fluoride concentration in groundwater [**15**]. All these sources are responsible for the high fluoride concentration in groundwater of study area.

A. Deformation of knee joints B. Mottling of teeth or Dental fluorosis

Figure 3. Showing health issues associated to excess fluoride consumption.

The evidences of high fluoride concentration were observed in the many people of the study area where people are facing complications of mottling of teeth or dental fluorosis, skeletal fluorosis, forward bending of vertebral column, deformation of knee joints and other parts of body and even paralysis (paraplegia, quadriplegia). All symptoms were clearly indicated high fluoride concentration in both Aspur and Sagwara blocks (Figure 3).

APPLICATION

The goal of this study is to raise public awareness of elevated fluoride levels in drinking water, potential repercussions of excess fluoride in the study area, and prevention techniques. We hope that the wide overview provided in this paper provides sufficient knowledge to protect people in the research area from fluorosis and other chronic health risks.

CONCLUSION

Therefore, it is concluded that fluoride concentration in groundwater of both Aspur and Sagwara blocks were higher than maximum permissible limit of fluoride in drinking water (1.5 mg L^{-1}). The major reasons of high fluoride in groundwater could include natural weathering of fluoride-containing rocks and mining in the examined area. So it is clear that the groundwater of study area is polluted, and it is not safe for drinking purpose. To make water potable Defluoridation techniques like adsorption, KAZA'S Carbons-Tools of Defluoridation, ion exchange, coagulation, precipitation, reverse osmosis and electro-dialysis should be adopted as remedial action in Study area.

REFERENCES

[1]. A. Narsimha and V.Sudarshan, Hydro-Geochemistry of Ground Water in Basara Area, Adilabad District, Andhra Pradesh, India. *Journal of Applied Geochemistry*, **2013**, 15(2), 224-237.
[2]. R. P. Kumar, B. Vijayalakshmi, Assessment of fluoride concentration in ground water in Madurai district, Tamilnadu, India, *Research Journal of Pharmacy and Technology,* **2017**, 10(1), 309-310.
[3]. D. Raj and E. Shaji,Fluoride contamination in groundwater resources of Alleppey, southern India, *Geoscience Frontiers,* **2017**, 8 (1), 117-124.
[4]. S. L. Choubisa, Fluoride distribution in drinking groundwater in Rajasthan, India, *Current science,* **2018,** 114(9), 1851-1857.
[5]. E. Podgorski, P. Labhasetwar, D. Saha, **M.** Berg, Prediction modeling and mapping of groundwater fluoride contamination throughout India, *Environ. Sci. Technol*., **2018**, 52(17), 9889-9898.
[6]. S. K. Jha, R. K. Singh, T. Damodaran, V. K. Mishra, D. K. Sharma and D. Rai, Fluoride in Groundwater: Toxicological exposure and remedies, *Journal of Toxicology and Environmental Health*, Part B, **2013,** 16, 52-56.
[7]. APHA, AWEF, Standard Methods for Examination of Water and Wastewater (23rd edition). American Public Health Association Washington D. C. **(2017)**
[8]. A. Jain and S. K. Singh, Prevalence of fluoride in ground water in Rajasthan state: Extent, contamination levels and mitigation, *Open Journal of Water Pollution and Treatment,* **2014,** 1 (2), 50-57.
[9]. BIS Indian Standard Specification for drinking water. B.S.10500. Bureau of Indian Standards, New Delhi. **(2012).**
[10]. J. Upadhyay, N. Rai, Study of fluoride in groundwater of five blocks of Dungarpur district, *Indian J. Environ and Ecoplan,* **2011**, 18 (1), 145-151.
[11]. P. Mamatha, S. M. Rao, Geochemistry of fluoride rich groundwater in Kolar and Tumkur Districts of Karnataka, *Environmental Earth Sciences,* **2010,** 61 (1),131-142.

[12]. C. K. Singh,R. Kumari, R. P. Singh, S.Shashtri,V. Kamal, S. Mukherjee, Geochemical modelling of high fluoride concentration in groundwater of Pokhran area of Rajasthan, India, *Bulletin of environmental contamination and toxicology*, **2011**, 86(2), 152-158.
[13]. V. Kimambo, P. Bhattacharya, F. Mtalo, J. Mtamba, A. Ahmad, Fluoride Occurrence in Groundwater Systems at Global Scale and Status of Defluoridation - State of the Art, Groundwater, *Sust. Dev.*, **2019**, 9(2), https://doi.org/10.1016/j.gsd.2019.100223.
[14]. K. K. Tiwari, G. Krishan, G. Prasad, M. C. Mondal, V. Bhardwaj, Evaluation of fluoride contamination in groundwater in a semi-arid region, Dausa District, Rajasthan, India, *Groundwater for Sustainable Development*, **2020**, 11 ,1-10.
[15]. K. Brindha, L. Elango, Fluoride in Groundwater: Causes, Implications and Mitigation Measures. In: Monroy, S.D. (Ed.), *Fluoride Properties, Applications and Environmental Management*, **20111**, 111-136.