



ISSN : 0973-7057

Int. Database Index: 616 www.mjl.clarivate.com

Groundwater fluoride contamination in Bhaunr Village of Rajauli Block of Nawada District, Bihar

Anil Kumar Singh^a, Peeyush Kumar^{b*} & Vishal Patel^c

^aDepartment of Chemistry, A.N. College, Patna, Bihar, India

^bUniversity Department of Environmental Sciences, Magadh University, Bodhgaya, Bihar, India

^cProject Associate, Centre for Fluorosis Research, A.N.College, Patna, Bihar, India

Received : 24th May, 2021 ; Revised : 25th June, 2021

Abstract- Fresh water is one of the important resources needed to maintain life on the earth. However due to water pollution, the quality of water has got degraded. Many groundwater sources in the villages of Rajauli block of Nawada district, Bihar have been found to have fluoride above the maximum permissible limit of 1.5 mg/L. The groundwater sources of Bhaunr village of Rajauli block are highly contaminated by Fluoride (F⁻). In one of the sources the level of fluoride has reached a peak value of 7.51 mg/L. Intake of fluoride contaminated water has led to a disease called Fluorosis in the people living there. All the four types of fluorosis - dental, muscular, skeletal and non-skeletal fluorosis have been reported in the village.

Key words: Groundwater, fluoride, fluorosis, contaminate, degrade

INTRODUCTION

Fresh water is one of the most important resources needed to maintain life on the earth. 71% of the earth's surface is covered with water. Out of which 97% is present in oceans and seas as saltwater. 2.5% of the global water is present as freshwater in glaciers and polar ice caps. 0.5% of the water is available for human use.¹ However due to natural reasons and human activities, water in many sources has got contaminated. Surface water is polluted due to human activities. Groundwater contamination has occurred due both natural as well as man-made reasons. Presence of toxic chemicals in water has led to degradation of water quality. There are many areas where the groundwater is not fit for drinking or cooking purposes.²

One such contamination is caused due to the presence of fluoride ions (F⁻) ions in groundwater.³

There are 20 states in India where the groundwater is contaminated by fluoride ions.⁴ In Bihar Nawada is one among the 11 districts where groundwater contamination is in worse condition. The Rajauli block of Nawada district is one of the worst fluorosis endemic areas.⁵ Bhaunr is a village in Rajauli where the level of fluoride in groundwater is high. It is located in Sirodabur Panchayat. It is 5 km away from sub-district headquarter Rajauli. The village has a total area of 190 hectares. The population is 723 as per the 2009 census.⁶ It is located at 24.60° N latitude and 85.49° E longitude.⁷

The intake of fluoride rich water leads to a disease called fluorosis. The maximum permissible limit of fluoride in drinking water as per the WHO guidelines is 1.5 mg/

*Corresponding author :

Phone : 9608396566, 7739530164

E-mail : peeyush.kumar90@gmail.com

L.^{8,9} But maximum groundwater sources have their fluoride level higher than the maximum permissible limit of 1.5 mg/L and in one source it has touched the value of 7.51 mg/L. Several visible cases of fluorosis have been found in Bhaunr. Fluoride free water is an essential requirement in the village. Governmental and non- governmental organisations need to take certain steps to meet the need of fluoride free water to the villagers so as to reduce the severity of this disease.

Fluorosis can be divided into four categories- dental fluorosis, skeletal fluorosis, non-skeletal fluorosis and muscular fluorosis.

Dental fluorosis: Brown stains appear on the teeth which disfigures the teeth. In some cases chalk white patches appear on the teeth indicating initial fluorosis. Severe cases include degradation of the brown stained teeth which sometimes result into complete breaking of the teeth.¹⁰

Skeletal fluorosis: It is a bone disease caused by excessive deposition of fluoride ions in the bones. It causes damage to bones and pain in the joints. It also causes deformity of bones. In many cases of skeletal fluorosis knock knee and bow legs is also observed.^{11,12}

Non-skeletal fluorosis: This includes symptoms like tingling sensation of fingers and toes, excessive thirst and tendency to urinate more frequently, nervousness, depression etc. Abdominal pain is also a symptom of non-skeletal fluorosis.¹³⁻¹⁵

Muscular fluorosis: Symptoms include stiffness and pain in the muscle and loss of muscle power.¹⁶

All the four types of fluorosis are prevalent in Bhaunr village. Maximum people of the village are suffering from any of the four fluorosis cases.

MATERIALS & METHODS

The method of sampling and testing includes the following processes:

1. Collection of water samples from different groundwater sources of Bhaunr village.
2. Testing of fluoride in water samples.

1. Collection of water samples from different groundwater sources of Bhaunr village

The different groundwater source from Bhaunr where the groundwater is contaminated by fluoride was identified by sampling and testing the groundwater sources by the 'Aquasol Kit'. Water from different groundwater

sources were collected during the year 2018. Water was collected from hand pumps and bore wells of that area- the depth of which ranged from 80 ft to 130 ft.

2. Testing of fluoride in water samples

Water samples were collected in 0.5 L size plastic bottles. A total of 21 samples of different drinking water sources were analysed. The water samples were collected during three consecutive seasons- pre monsoon, monsoon and post monsoon seasons during 2018. The samples were numbered from 1 to 21. The samples were then analysed in the Centre for Fluorosis Research, Department of Chemistry, A.N. College, Patna. The samples were analysed by the Ion Selective Electrode Method.¹⁷



Fig. 1- A case of Dental Fluorosis



Fig. 2- A case of Skeletal Fluorosis (bow legs)

RESULTS & DISCUSSION

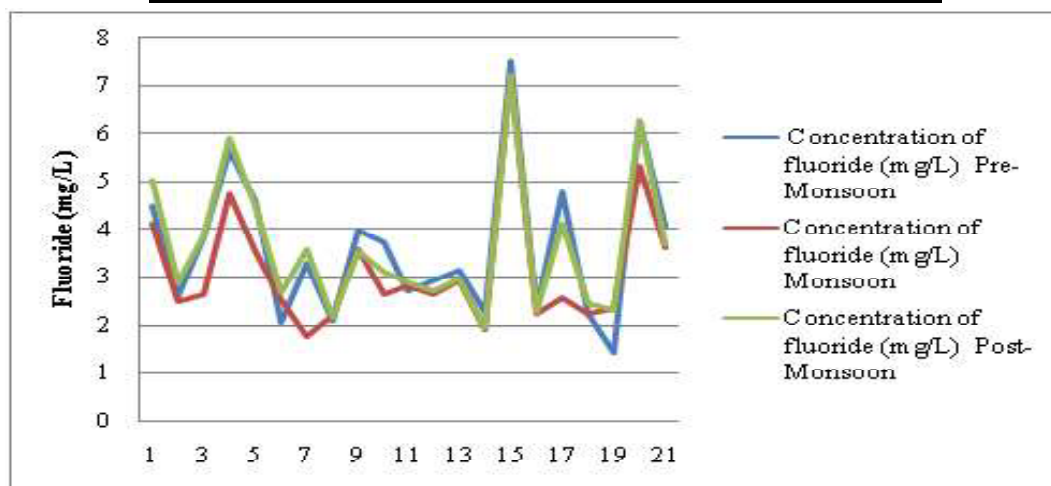
Most of the groundwater sources in Bhaunr village were highly contaminated with fluoride.

Out of the 21 sources tested almost all the drinking water sources showed the presence of fluoride above the permissible limit. In one of the groundwater sources the concentration of fluoride was as high as 7.51 mg/L which is much higher than the maximum permissible limit of 1.5 mg/L. The fluoride concentration in most sources showed

the peak value during the pre-monsoon period and minimum during the monsoon period. The inhabitants of that area reported the problems of joint pains, muscular pains and dental problems. All the four types of fluorosis are prevalent in that village. Since most of the people get sufficient nutrition, so the severity of the disease is less in this village as compared with the neighbouring villages where the severity of fluorosis is high due to lack of nutrition.

Table 1- The level of fluoride in the groundwater sources of Bhaunr

Sample no	Concentration of fluoride (mg/L) Pre-Monsoon	Concentration of fluoride (mg/L) Monsoon	Concentration of fluoride (mg/L) Post-Monsoon
1	4.48	4.12	5.05
2	2.61	2.47	2.88
3	3.83	2.62	3.88
4	5.67	4.73	5.92
5	4.59	3.55	4.49
6	2.04	2.52	2.69
7	3.30	1.75	3.60
8	2.08	2.20	2.16
9	3.97	3.57	3.56
10	3.72	2.64	3.12
11	2.73	2.82	2.89
12	2.93	2.61	2.71
13	3.15	2.91	2.97
14	2.28	1.91	1.95
15	7.51	7.21	7.21
16	2.36	2.23	2.27
17	4.78	2.54	4.11
18	2.25	2.24	2.47
19	1.44	2.32	2.30
20	6.28	5.32	6.26
21	4.04	3.59	3.68



Graph 1- Fluoride concentration in different water samples of Bhaunr Village

CONCLUSION

The groundwater sources of Bhaunr are highly contaminated with fluoride. Due to high fluoride contamination in the groundwater sources, fluorosis has crippled in the village. Several cases of fluorosis have been found in that area.

REFERENCES

1. Durack, P. J. 2015. Ocean salinity and the global water cycle. *Oceanography*. **28(1)**: 20-31.
2. Ojo, O. I., Otieno, F. A., & Ochieng, G. M. 2012. Groundwater: Characteristics, qualities, pollutions and treatments: An overview. *International Journal of Water Resources and Environmental Engineering*. **4(6)**: 162-170.
3. Ali, S., Fakhri, Y., Golbini, M., Thakur, S. K., Alinejad, A., Parseh, I. & Bhattacharya, P. 2019. Concentration of fluoride in groundwater of India: a systematic review, meta-analysis and risk assessment. *Groundwater for Sustainable Development*. **9**:100224.
4. Adimalla, N., Venkatayogi, S., & Das, S. V. G. 2019. Assessment of fluoride contamination and distribution: a case study from a rural part of Andhra Pradesh, India. *Applied Water Science*. **9(4)**: 1-15.
5. Kumar P. & Singh A.K., 2021. Study of fluorosis problems in Hardia Sector D (Jajpur Village) of Rajauli block of Nawada district, Bihar. *Biospectra*. **16(1)**:37-40.
6. villageinfo.in/bihar/nawada/rajauli.html
7. <https://nawada.nic.in/about-district/district-profile/>
8. Tiwari, A. K., Singh, A. K., & Mahato, M. K. 2017. GIS based evaluation of fluoride contamination and assessment of fluoride exposure dose in groundwater of a district in Uttar Pradesh, India. *Human and Ecological Risk Assessment: An International Journal*. **23(1)**: 56-66.
9. WHO. 1996. Guideline for drinking water quality, second edition, vol. 2, Health criteria and other supporting information, World Health Organization, Geneva.
10. Revelo-Mejía, I. A., Hardisson, A., Rubio, C., Gutiérrez, Á. J., & Paz, S. 2020. Dental fluorosis: the risk of misdiagnosis-a Review. *Biological Trace Element Research*. 1-9.
11. Ramesh, M., Malathi, N., Ramesh, K., Aruna, R. M., & Kuruvilla, S. 2017. Comparative evaluation of dental and skeletal fluorosis in an endemic fluorosed district, Salem, Tamil Nadu. *Journal of Pharmacy & Bioallied Sciences*. **9(Suppl 1)**: S88.
12. Mondal, D., Dutta, G. & Gupta, S. 2016. Inferring the fluoride hydrogeochemistry and effect of consuming fluoride-contaminated drinking water on human health in some endemic areas of Birbhum district, West Bengal. *Environmental Geochemistry and Health*. **38(2)**: 557-576.
13. Shruthi, M. N. & Anil, N. S. 2018. A comparative study of dental fluorosis and non-skeletal manifestations of fluorosis in areas with different water fluoride concentrations in rural Kolar. *Journal of Family Medicine and Primary Care*. **7(6)**:1222.
14. Susheela A.K. 1998. Proceedings of the 1st International Specialized Conference on Water Quality and its Management, New Delhi. 292-300.
15. Patil, M. M., Lakhkar, B. B., & Patil, S. S. 2018. Curse of fluorosis. *The Indian Journal of Pediatrics*. **85(5)**: 375-383.
16. Ashok Kumar, Vikas Kumar Singh and Kamal Kishor Singh. 2018. Effect of Fluorosis on Village Folks of Rajauli, Bihar. *Journal of Applicable Chemistry*. **7(6)**:1795-1804
17. Mendes, A. L. G., Nascimento, M. S., Picoloto, R. S., Flores, E. M., & Mello, P. A. 2020. A sample preparation method for fluoride detection by potentiometry with ion-selective electrode in medicinal plants. *Journal of Fluorine Chemistry*. **231**:109459.
