



SEASONAL VARIATION OF FLUORIDE CONCENTRATION IN GROUNDWATER OF JALNA MUNICIPAL AREA, MAHARASHTRA

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Abstract:

Groundwater is the primary source of drinking water in many semi-arid regions of India, including Jalna city in Maharashtra. Fluoride is a naturally occurring constituent of groundwater and its concentration is largely controlled by geological formations and seasonal hydrogeochemical processes. The present study aims to assess fluoride concentration in groundwater of the Jalna Municipal area and to evaluate its seasonal variation during pre-monsoon and post-monsoon periods. Five representative groundwater sampling locations were selected from different parts of the city, and samples were analyzed using standard ion-selective electrode methods. The results indicate that fluoride concentration varies seasonally, with comparatively higher values observed during the pre-monsoon season and lower concentrations during the post-monsoon period due to dilution effects of rainfall recharge. All measured fluoride values were found to be well within the permissible limits prescribed by the World Health Organization (WHO) and Bureau of Indian Standards (BIS). The study concludes that groundwater in Jalna city is presently safe for drinking with respect to fluoride content; however, continuous monitoring is recommended to ensure long-term water quality and public health protection.

Keywords: Groundwater, Fluoride, Seasonal Variation, Jalna, Drinking Water Quality, Semi-Arid Region, BIS Standards, WHO Guidelines

Introduction

Water makes up 71% of the Earth's surface, predominantly in the form of seas and oceans. Approximately 3.4 million individuals (primarily children) perish annually due to diseases linked to water. On our planet, 97.2% of water is saline, while only 2.8% is freshwater, with 20% of that being groundwater. Once groundwater becomes polluted, it cannot be purified by merely halting the source of contamination. The World Health Organization states that roughly 80% of diseases in humans result from contaminated water. [11,12]



Groundwater quality is a key determinant of the suitability of water for drinking and domestic use, particularly in semi-arid regions of India where groundwater serves as the principal source of potable water. Fluoride is a naturally occurring ion in groundwater, released primarily through water–rock interaction involving fluoride-bearing minerals. At low concentrations, fluoride is beneficial in preventing dental caries by strengthening tooth enamel; however, long-term consumption of water containing elevated fluoride levels can lead to dental and skeletal fluorosis, posing significant public health concerns. Several regions of Maharashtra have reported fluoride-related groundwater problems, emphasizing the need for localized assessments. Seasonal variations, especially monsoon rainfall, play a crucial role in modifying groundwater chemistry by influencing recharge, dilution, and mineral dissolution processes, thereby affecting fluoride concentrations. Therefore, evaluating seasonal variations of fluoride in groundwater is essential to understand its spatial and temporal distribution and to ensure the availability of safe drinking water[4,9].

Study Area:

Jalna city is located in the Marathwada region of Maharashtra and experiences semi-arid climatic conditions. The area is characterized by hot summers and moderate rainfall concentrated during the southwest monsoon. Due to limited surface water availability, the population of Jalna depends largely on groundwater sources such as bore wells and dug wells for drinking and domestic purposes. The geological formation of the region mainly consists of Deccan Trap basalt, which plays a crucial role in controlling groundwater quality. Rapid urbanization and increasing water demand have intensified the reliance on groundwater resources. Understanding the groundwater quality of Jalna city is therefore essential for sustainable water management and public health protection.

Objectives:

To determine fluoride concentrations in groundwater samples of the Jalna Municipal area during pre- and post-monsoon seasons and to evaluate seasonal variations in fluoride levels in relation to their suitability for drinking water purposes.

Methodology:

Five groundwater sampling locations were selected within the Jalna Municipal area to represent different land-use patterns and groundwater utilization zones. The selected sites include Old Jalna area (S1), Bus Stand area (S2), Deulgaon Raja Road area (S3), Krishna Nagar



area (S4), and Shivnagar area (S5). These locations were chosen to ensure spatial coverage across the city and to assess variations in fluoride concentration in groundwater used for drinking purposes. Groundwater samples were collected in clean, fluoride-free polyethylene bottles during the pre-monsoon and post-monsoon seasons. The collected samples were analyzed for fluoride concentration using standard laboratory techniques such as the ion-selective electrode method, following prescribed water quality analysis procedures. The analytical results were compared with drinking water standards. According to the World Health Organization (WHO), the guideline value for fluoride in drinking water is 1.5 mg/L. The Bureau of Indian Standards (BIS: IS 10500–2012) prescribes an acceptable limit of 1.0 mg/L and a maximum permissible limit of 1.5 mg/L in the absence of an alternative water source. Fluoride concentration beyond these limits may lead to dental and skeletal fluorosis[1,2,10].

Results and Discussion:

Fluoride Concentration in Groundwater:

The fluoride concentration measured in groundwater samples is presented in Table 1.

Table 1: Fluoride concentration in groundwater samples

Sr. No	Sample ID	Fluoride (mg/L) - Pre-Monsoon	Fluoride (mg/L) - Post-Monsoon
1	S1	0.13	0.03
2	S2	0.18	0.07
3	S3	0.31	0.12
4	S4	0.16	0.11
5	S5	0.21	0.16

Seasonal Variation

The fluoride concentration in all samples was observed to be higher during the pre-monsoon season. This increase may be attributed to reduced groundwater levels and enhanced rock–water interaction during dry periods. Post-monsoon samples showed lower fluoride concentration, likely due to dilution caused by rainfall recharge. Similar seasonal trends have been reported in fluoride studies conducted in various parts of Maharashtra.

Drinking Water Suitability: All recorded fluoride concentrations were significantly below the permissible limit of 1.0–1.5 mg/L for drinking water. This indicates that the groundwater of Jalna city is presently safe with respect to fluoride concentration. However, continuous



monitoring is recommended to detect any future changes influenced by climatic and anthropogenic factors.

Conclusion:

The study reveals that fluoride concentration in groundwater of Jalna Municipal area shows clear seasonal variation, with higher values during pre-monsoon and lower values during post-monsoon. All analyzed samples contain fluoride within acceptable drinking water limits, indicating no immediate fluoride-related health risk. Regular groundwater quality monitoring is suggested to ensure long-term safety and sustainable utilization of groundwater resources in the region.

References:

1. APHA (2023). Standard Methods for the Examination of Water and Wastewater, 24th Edition
2. Bureau of Indian Standards. (2012). *IS 10500:2012 – Drinking water – Specification*. New Delhi: BIS.
3. Deng, X., Zhang, L., Xu, R., Zeng, M., He, Q., Xu, D., & Qi, Y. (2022). Do cooperatives affect groundwater protection? Evidence from rural China. *Agriculture*, 12(7), 1016. <https://doi.org/10.3390/agriculture12071016>
4. Ndra Roy, S., & Dass, G. (2013). Fluoride Contamination in Drinking Water-A Review. *Resources and Environment*, 3(3), 53–58. <https://doi.org/10.5923/j.re.20130303.02>
5. Koliyar, J. G., Patil, P., Sahoo, S. K., & Patra, A. C. (2021). Spatial distribution of uranium and its associated water quality parameters (Drinking/Groundwater) in Raigad district of Maharashtra. *Sustainable Climate Action and Water Management*, 125-130. https://doi.org/10.1007/978-981-15-8237-0_10
6. Kolekar, S.S. (2017). Physicochemical analysis of groundwater quality parameters. *Journal of chemical and pharmaceutical science*, 10(1), ISSN:0974-2115
7. Research on groundwater fluoride occurrence in Marathwada region, Maharashtra. State-level groundwater studies
8. Studies on fluoride distribution in groundwater of Nanded district, Maharashtra. India Science and Technology Portal.
9. Thombal, D.U., Ambhure, R.U., and Mirgane, S.R. Fluoride concentration in groundwater of Sailu Tehsil, Maharashtra. *CWE Journal*



10. Trivedi RK and Goyal PK. Chemical and Biological Methods for Water Pollution Studies, Environmental Publications, Karad, India. 1986
11. Wagh, G., & Bhutekar, D. (2025). *InSight Bulletin: A Multidisciplinary Interlink International Research Journal Assessment of the impact of seasonal variations on groundwater quality in Chowka Village Creative Commons*.
<https://doi.org/10.5281/zenodo.16260492>
12. Wagh Gorakshanath, Bhutekar Digambar, & Kale Amol. (2025). Assessing Uranium Contamination in Groundwater: A Comprehensive Review for India. In *Journal of Indian Association for Environmental Management* (Vol. 45, Issue 1).
<http://op.niscair.res.in/index/php/JIAEM/index>
13. WHO. Guidelines for drinking water quality. World Health Organisation. 4th Edition, Geneva. Switzerland, 2011, p.137.