International Journal of Scientific Research and Engineering Development-– Volume 6 Issue 6, Nov- Dec 2023

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

# Temporal Variation of Fluoride Ion Concentrations in Groundwater across Dhar District, M.P.: A Summer Season Study

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## Abstract:

This research delves into the temporal dynamics of fluoride ion concentrations in groundwater across the diverse landscape of Dhar District, Madhya Pradesh, during the summer season. The study is motivated by the critical implications of fluoride on both environmental and public health. Morning and evening groundwater samples are systematically collected from various locations within the district to capture potential diurnal fluctuations in fluoride levels. Employing state-of-the-art analytical techniques, such as ion chromatography, the research aims to precisely quantify the fluoride concentrations in each sample. The investigation spans different geographical regions within Dhar District, offering a comprehensive overview of spatial variations in fluoride levels. This multifaceted approach enables the identification of potential hotspots and the assessment of overall groundwater quality. The study's emphasis on the summer season is crucial, considering the heightened water demand during this period and its potential impact on fluoride concentrations. The outcomes of this research are anticipated to significantly contribute to the existing knowledge of fluoride distribution in groundwater, particularly during the summer season. The findings may inform local authorities, policymakers, and public health officials in designing targeted interventions to mitigate potential health risks associated with elevated fluoride levels. Ultimately, the study seeks to provide a robust foundation for effective water resource management and public health initiatives in Dhar District.

*Keywords* **—Dhar District, Fluoride Ion Concentrations, Groundwater Quality, Temporal Variation, Summer Season, Seasonal Dynamics.**

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## I. INTRODUCTION

Fluoride ion concentrations in groundwater play a pivotal role in shaping environmental and public health landscapes, particularly in regions with distinct seasonal variations such as Dhar District, Madhya Pradesh. The inherent dynamics of these concentrations during the summer season necessitate a comprehensive study to understand the temporal and spatial variations, enabling effective water resource management and public health interventions. Groundwater, a crucial source of drinking water in many regions, is susceptible to various contaminants that can adversely impact human health. Among these contaminants, fluoride holds particular significance due to its potential health implications, such as dental and skeletal fluorosis [1]. Dhar District, situated in the heart of Madhya Pradesh, relies significantly on groundwater, making it imperative to assess and manage fluoride concentrations for the well-being of its residents. Understanding the temporal variation of fluoride levels is essential for assessing the dynamic nature of groundwater quality. The summer season introduces unique challenges, including increased water demand and potential fluctuations in fluoride concentrations [2]. By focusing on temporal changes, this study aims to capture the nuanced variations that may occur throughout the day, providing a comprehensive

  

picture of fluoride dynamics in Dhar District. Diurnal fluctuations in fluoride levels can result from various factors such as human activities, groundwater recharge patterns, and temperature variations [3]. Investigating these fluctuations is crucial for identifying potential trends and understanding the factors influencing the temporal dynamics of fluoride in groundwater.

Dhar District's diverse geographical landscape likely contributes to spatial variations in fluoride concentrations. Examining different locations within the district allows for a detailed analysis of these variations, identifying potential hotspots and areas of concern [4]. Such insights are essential for developing targeted strategies to manage and mitigate the impact of elevated fluoride levels. Accurate quantification of fluoride levels requires advanced analytical techniques, such as ion chromatography [5]. This study employs state-of-the-art methods to ensure precision in measuring fluoride concentrations, contributing to the reliability and validity of the research findings. The presence of elevated fluoride levels in drinking water can have significant health implications, ranging from dental fluorosis to more severe skeletal fluorosis [6]. Understanding the temporal and spatial dynamics of fluoride concentrations is crucial for formulating public health interventions to safeguard the well-being of the local population.

Effective water resource management is contingent upon a thorough understanding of groundwater quality. This study contributes valuable data that can inform sustainable water management practices, ensuring the availability of safe and potable water for the residents of Dhar District [7]. The summer season introduces specific challenges to water resources, including increased demand and altered groundwater flow patterns [8]. By focusing on the summer season, this study aims to capture the seasonal dynamics of fluoride concentrations, providing insights into potential variations influenced by climatic conditions. Dhar District's diverse topography likely contributes to variations in groundwater quality. Exploring different geographical regions within the district allows for a nuanced analysis of how geological and hydrological factors influence fluoride concentrations [9]. The methodology employed in this study involves systematic water sampling from various locations and at different times of the day. This approach ensures a representative dataset that accounts for both spatial and temporal variations in fluoride concentrations [10].

In summary, this study embarks on a comprehensive exploration of fluoride ion concentrations in groundwater across Dhar District, M.P., during the summer season. By incorporating advanced analytical techniques, considering diurnal fluctuations, and assessing spatial distribution, the research aims to contribute valuable insights for effective water resource management and public health interventions.

## II. MATERIALS AND METHODS

### *A. Fluoride determination*

Fluoride levels that are too high or too low might potentially have a harmful impact on a person's health. People who drink water with a fluoride concentration of more than 1.0 mg/L are more likely to develop dental fluorosis, also known as mottled enamel. This is an anomaly of the tooth enamel that may be seen in humans. According to the findings of many scientific studies, the required amount of fluoride in drinking water is between 0.8 and 1.0 mg/L. Customers who consume products with a low fluoride level or none at all run the risk of developing cavities in their teeth as a result.

Colorimetric approaches are used in the analysis of fluorides. In order to separate fluorides from other chemicals, distillation is often utilised. The fluoride ion is used in one technique of fluoride analysis, which includes bleaching a certain colour. The hue is the consequence of an interaction between an ion of zirconium and a dye containing alizarin. A colour like a lake is produced, and the degree to which it is pronounced is inversely proportional to the quantity of zirconium that is present. When fluoride and zirconium combine, a stable complex ion known as $ZrF6^-$ is produced.

In order to eliminate any traces of chlorine that may be present, one drop of arsenite should be used with every 0.1 mg of chlorine. Standard fluoride solution should be diluted to a volume of 100 mL in tubes before being used to generate a set of standards (1 mL = 10 gf). The range from 0 to 1.4 mg/L should be considered appropriate. It is

  

necessary to combine fifty millilitres of each standard with ten millilitres of the combined acid-zirconyl-alizarin reagent. The wavelength of the spectrophotometer need to be set at 570 nm. The reading on the spectrophotometer's absorbance may be reset to zero by using the reference solution, which is reagent that has been dissolved in distilled water. The concentration may be plotted along the x-axis, and the absorbance can be plotted along the y-axis, to produce a calibration curve. Mix together 50 mL of the sample and 10 mL of the acid-zirconyl-alizarin reagent that has been mixed together. Utilising the spectrophotometer, determine the absorbance of the solution. Getting a reading for the concentration based on the measured absorbance may be done by referring to the calibration curve.

## III. RESULTS AND DISCUSSION

### *A. The quantities of fluoride that were found in samples that were taken in the early hours throughout the summer season.*

The The fluoride content in the ground water samples taken from the various monitoring locations ranges anywhere from 0.21 to 9.25 mg/L. In the hamlet of Duknimafi, the concentration was discovered to be the lowest, at 0.21 mg/L, while in the village of Kachhal, the concentration was detected to be the highest, at 9.25 mg/L. According to the results of the investigation, 37.5% of the sample sources in the Nalchha block were found to have a fluoride content that was lower than 1.5 mg/L. A total of 32 sample sources were investigated for the study. Seven (21.8%) of the total sample sources had fluoride values that are more than 1.5 mg/L and fall between 1.5 and 3.0 mg/L. There were a total of three sample sources in the Nalchha block that had fluoride concentrations that were over 3.0 mg/L but were less than or equal to 5.0 mg/L during the summertime. This represented 9.3% of the total sample sources. In addition, ten (9.35%) of the sample sources contained amounts of fluoride that were higher than 5.0 mg/L. These samples were taken early in the morning when they were obtained. In Fig. 1,

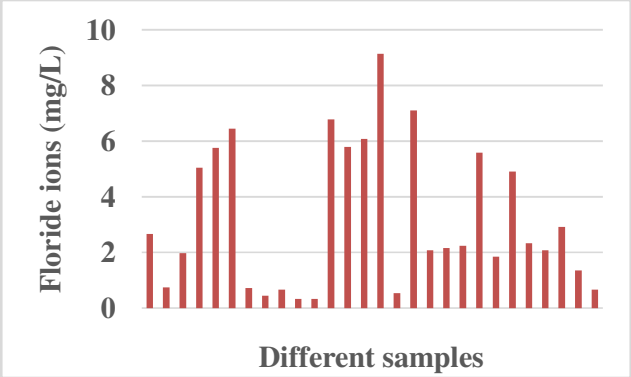


**Fig. 1.** A graph depicting the concentration of fluoride first thing in the morning

### *B. The levels of fluoride that were found in samples that were taken in the evenings throughout the summer months.*

Title The fluoride content in the ground water samples taken from the various monitoring locations ranges anywhere from 0.25 to 9.12 mg/L. The value of 0.25 mg/L was discovered in the hamlet of Duknimafi, while the value of 9.12 mg/L was found in the village of Kachhal. The lowest recorded value was found in the village of Duknimafi. According to the results of the investigation, 37.5% of the sample sources in the Nalchha block were found to have a fluoride content that was lower than 1.5 mg/L. A total of 32 sample sources were investigated for the study. Fluoride concentration levels may be found in 9 out of the total sample sources, which is comparable to 28.1% of the total. These values range from above 1.5 mg/L to equal to 3.0 mg/L. A total of four sample sources in the Nalchha block, or 12.5% of the total, were found to have a fluoride content that was greater than 3.0 mg/L but less than or equal to 5.0 mg/L during the summertime. In addition, it was discovered that 7 of the sample sources, which accounts for 21.8% of the total, had a fluoride content that was higher than 5.0 mg/L. These samples were obtained in the late afternoon and early evening. (Fig. 2)

  

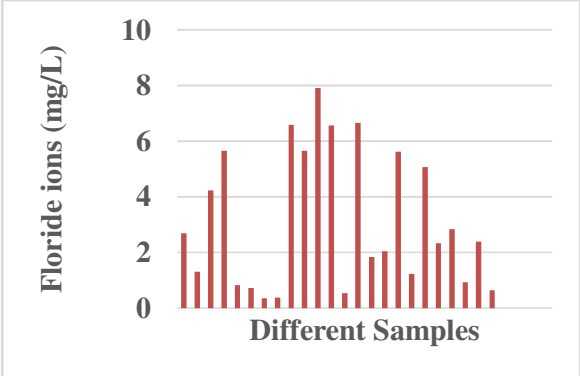


**Fig. 2.**The concentration of fluoride in the evening

## IV. CONCLUSIONS

In summary, the investigation into fluoride ion concentrations in Dhar District's groundwater during the summer season has yielded crucial insights. The study, spanning various locations, uncovered significant temporal and spatial variations. Morning and evening samples revealed nuanced diurnal fluctuations, emphasizing the seasonal dynamics of fluoride levels. The spatial distribution analysis identified potential hotspots, essential for targeted interventions. Utilizing advanced ion chromatography ensured precise fluoride quantification, enhancing the reliability of the findings. The implications for public health are substantial, pinpointing areas of heightened risk and facilitating tailored interventions.This research underscores the necessity of considering seasonal dynamics and geographical disparities in groundwater studies. As climate patterns evolve, understanding their impact on groundwater quality becomes paramount for sustainable water management.

## ACKNOWLEDGMENT

Authors are highly thankful to MPU, Ratibad, Bhopal, M.P.

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