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V Karthika
Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

M Elayarajan
Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

A Raviraj
Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

BJ Pandian
Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Kallol Bhattacharya
Bidhan Chandra Krishi Vishwavidyalaya, Kalyani, West Bengal, India

Correspondence
V Karthika
Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Assessment of fluoride contamination in groundwater of Kundadam block, Tiruppur district, Tamil Nadu, India

V Karthika, M Elayarajan, A Raviraj, BJ Pandian and Kallol Bhattacharya

Abstract
Water is a prime natural resource and essential for life on earth. Fluoride in drinking water has both positive and negative effects on human health. Small concentration of F−is essential for normal mineralization of bones and the formation of dental enamel [7]. However, the excess concentration F−in groundwater causes adverse impact on human health. A fluoride concentration of 1ppm (1mg/L) in potable water is essential for healthy teeth and bones. However, at higher concentrations (>1.5 ppm), it has adverse effects such as causing dental and skeletal fluorosis. Fluorosis is one of the major health risks faced by people in India. This may be due to consumption of more fluoride through drinking water. As same water is being used for irrigation purpose, fluoride can also enter into the food chain and finally reach human beings. In the present study, the water samples from 20 revenue villages of Kundadam block, Tiruppur district, Tamil Nadu state were analyzed for fluoride content. Ground water samples were collected in 64 locations and analysed for various parameters including fluoride. Out of which 16 locations were found to contain more than permissible level (>1.5 mg/L) of fluoride in drinking water and 58 locations were contain minimum required quantity of fluoride in water to prevent dental caries and the remaining locations were not affected

Keywords: Fluorosis, ground water, kundadam, TDS, fluoride

Introduction
Water is one the most important natural assets and plays a vital role for all living organisms and plants to survive in this world. Safe drinking water is the primary need of every human being. Fresh water has become a scarce commodity due to over exploitation and pollution of water. Major contribution of water is derived from the ground water resources and in many areas, groundwater is the only fresh source available and hence protection of the ground water quality has become a critical component for welfare of humankind. There is a necessity of water for purposes like drinking; irrigation for crops and other purposes and therefore extraction of ground water becomes a mandate for policy planners in water budget planning.
The main source of fluoride in ground water is fluoride-bearing rocks, possessing rock bearing minerals that contribute to toxicity of domestic water. Also the content in ground water is a function of many factors such as availability and solubility of fluoride minerals, velocity of flowing water, pH, temperature and concentrations of calcium & bicarbonate ions in water. Among the water quality parameters, fluoride ion exhibits unique properties as its concentration in optimum dose in drinking water is advantageous to health and if the concentration exceeds the limit, this affects the health [5]. High fluoride concentration in the ground water and surface water in many parts of the world is a cause of great concern. It has been observed that there is a relationship between Calcium, Sodium and Fluoride [1]. The higher the fluoride level, the lower is that of Calcium. This may be as a result of the substitution of Na by Ca during the circulation of water in an aquifer or through carbonate precipitation. However, it is known that fluorites of these ions have low solubility [8, 2]. The positive correlation of Ca^{2+} with fluoride explicitly suggests that water hardness increases with depth, affirming the percolation of underground water through a medium rich in Ca. High fluoride in drinking water was reported from different geographical regions of Kundadam block of Tiruppur district. [9] has set a range of allowable concentration for fluoride in drinking water for a region depending on its climatic conditions, because the amount of water consumed and consequently the amount of fluoride ingested is being influenced primarily by the air temperature.

The most seriously affected states are Andhra Pradesh, Punjab, Odisha, Hariyana, Rajasthan, Gujarat, Tamilnadu and Uttar Pradesh. The present study was carried out to understand the present status of groundwater quality in Kundadam block of Tiruppur district in Tamil Nadu and to assess the possible causes for high concentration of fluoride in groundwater. Therefore, an attempt is made to analyze the water for fluoride content in the drinking water in some villages of Kundadam block of Tiruppur District of Tamilnadu State, India.

Materials and Methods

A total of 64 different locations, the ground water samples were collected from 16 revenue villages of Kundadam Block, Tiruppur District, Tamil nadu, India. The water samples were collected based on geographical positioning system. The water samples brought in pre cleaned plastic bottles and labeled with information like the date of collection, source and place of collection. Most of the samples are from bore wells and some from the open wells and used for drinking purposes in addition to agriculture. Fluoride concentration was analyzed by colorimetric method with the help of a commercially available (SPADNUS) reagent. Concentration of TDS is measured with the help of a digital TDS meter

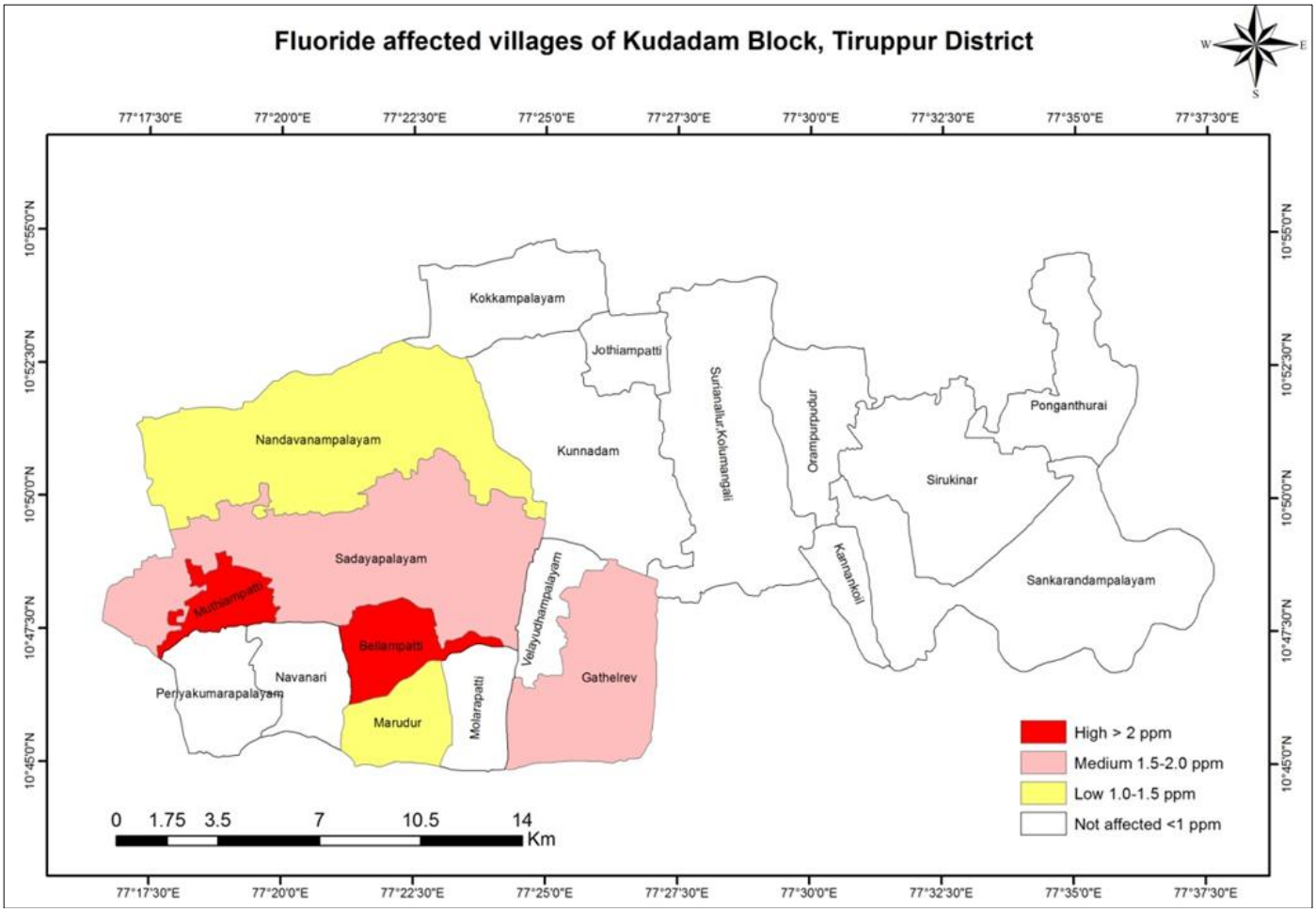

Fig 1: Fluoride contamination mapping of Kundadam block using GIS tools

Results and Discussion

Ground water samples were randomly collected from 64 different locations spreading over 16 revenue villages in Kundadam Block, Tiruppur District from the bore wells and open wells. The samples were collected during the months of July-August, 2017. In majority of these villages they are the only sources of potable water. The water is used for cooking and direct consumption in addition to agricultural purposes. All the ground water samples collected were clear without any turbidity, colour and odour. The water was tested for total dissolved solids (TDS) and fluoride. (Total Dissolved Solids Tds) The Bureau of Indian Standards (BIS) prescribed acceptable limit of TDS for drinking water is 500 mg/L. TDS concentration in the samples studied varied between 237 mg/L to 2406 mg/L. Most of the samples were found to contain TDS above the permissible limit. Higher concentration of TDS observed in the ground water samples may be attributed to Migmatite rocks present in the study area. Well water in Pellampatti village has TDS concentration of 2406 mg/l, which is above the permissible level of TDS in drinking water. The maximum TDS was observed in Pellampatti village (2406 mg/l) and lowest turbidity was observed in Nanthavanampalayam village (237 mg/l). High levels of TDS may aesthetically be unsatisfactory for bathing and washing [6]. It is generally inferior to palatability and may induce an unfavorable physiological reaction in the transient consumer [4, 3] observed greater values of TDS than that of ISI standard; the reason may be due to entry of pollutants.

Fluoride Concentration

Out of 64 different locations the ground water samples analyzed for fluoride, only in 16 locations the ground water exceed the maximum permissible limits of fluoride (1.5 mg L^{-1}) according to World Health Organisation (WHO). The results were presented in Table 1. In Muthaiyanpatti villages, the concentration of fluoride was found to be moderately

higher (1.5 – 2.0 mg L^{-1}) when compared to WHO standards for drinking water. The water from Muthaiyanpatti village found to contain more toxic level of fluoride concentration of more than 2.0 mg L^{-1}. In this village, teeth of many school and college-going students were discolored ranging from of yellow to brown in the form of spots or lines, which are the symptoms of dental fluorosis. In 58 different locations, the concentration of fluoride was found to be between 0 – 1.0 mg L^{-1}, which is less than minimum required quantity of fluoride in water to prevent dental caries. Interestingly the water from Muthaiyanpatti also contains TDS concentration of 1350 mg L^{-1} which is well above the permissible range of TDS in drinking water. Thus, the results indicate considerable variation of fluoride concentration among the analyzed ground water samples.

Table 1: Range of Fluoride in drinking water

Concentration of fluoride	Nature of Water
< 1.0 mg L^{-1}	Deficient
1.0 – 1.5 mg L^{-1}	Safe level
1.5 -2.0 mg L^{-1}	Moderately toxic
> 2.0 mg L^{-1}	Highly toxic

Table 2: Distribution of fluoride in different locations of Kundadam Block, Tiruppur District, Tamil Nadu

Concentration of fluoride	< 1.0 mg L^{-1}	1.0 – 1.5 mg L^{-1}	1.5 -2.0 mg L^{-1}	> 2.0 mg L^{-1}
Number of locations affected	58	2	2	2

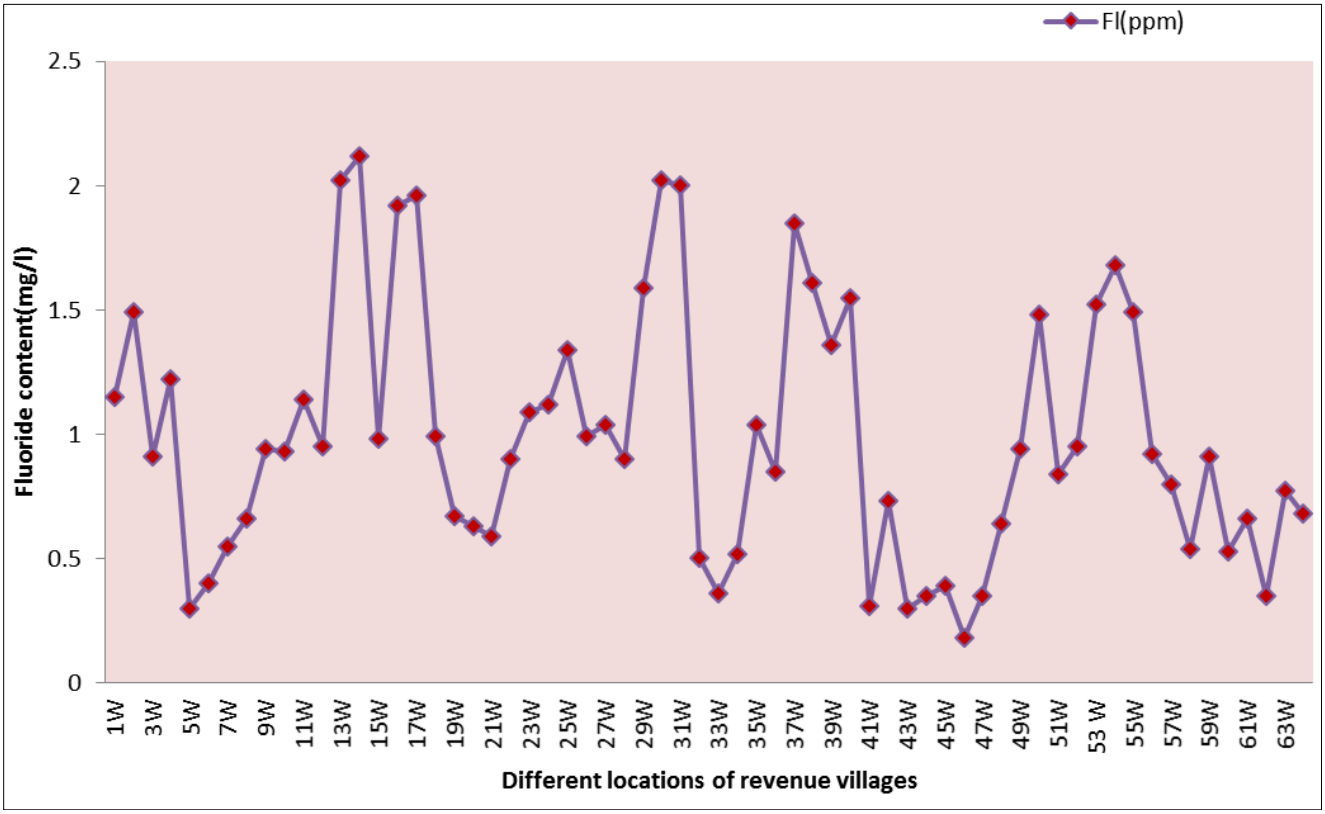

Fig 2: Fluoride content (mg/l) of ground water samples at different locations of Kundadam Block

Conclusion

From the study, it was observed that Kundadam block of Tiruppur district in Tamil Nadu is moderately fluoride endemic. About 25 per cent of the locations in this block have fluoride level more than the prescribed permissible limit in drinking water. High concentration of fluoride in the water may be due to geological formation. Therefore, the water from bore wells or wells in the affected villages is not safe. Purified surface water may be the best option for drinking. In these areas, usage of fluoridated toothpaste may be advised to prevent dental caries. It has been recommended to the government authorities to take serious steps to supply drinking water with low fluoride concern for the fluorosis-affected villages.

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