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AN INVESTIGATION OF FLUORIDE CONTAMINATION IN GROUNDWATER OF YADGIR DISTRICT, KARNATAKA

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ABSTRACT: The study was taken up to investigate the fluoride concentration in the groundwater of Yadgir district. A total of ninety groundwater samples were collected from different locations of Yadgir, Shorapur, Shahpur taluks of Yadgir district during post monsoon season. The samples were collected and analysed for major cations and anions along with fluoride as per standard methods. The chronic exposure to higher level of fluoride of drinking water led to dental or skeletal fluorosis, the severity of the problem is directly related to its dose. The fluoride value of groundwater samples was found to range from 0.21 mg/L in Naganur village to maximum of 4.8 mg/L in Hurasgundagi village. The results of fluoride value indicated that 31.18 % of the groundwater samples had fluoride concentration exceeding the BIS permissible limit of 1.5 mg/L. An increasing trend in fluoride concentration was observed with respect to sodium (r = 0.72) and calcium (r=0.44), illustrating a positive and strong correlation between them in the study area. It was concluded that the fluoride-rich groundwater in the Peninsular Gneisses and granitic area of the study area, could be attributed to longer residence time and interaction with fluoride-bearing minerals in the bedrock in the study area. It was suggested to adopt Nalgonda de-fluoridation technique and better management practices of harvesting and conservation of rainwater to overcome the fluoride problem.

Keywords: Groundwater, drinking water quality, Fluoride, Health problem, Mitigation and Control.

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1. INTRODUCTION

Groundwater is considered to be the major source of drinking, approximately 90% Indian populations are dependent on groundwater for drinking and other purpose [1] as ground water becomes a most suitable fresh water resource with an optimum level of dissolved salts. Enhanced usage rate, unplanned growth, unrestricted exploration and discharge of the waste water through open drainage led to changes in water quality and the availability of groundwater [2]. Particularly in developing countries, hazardous contaminants such as heavy metals, pesticides, arsenic, nitrate and fluoride affect the groundwater quality [3, 4]. The major sources of fluorides in groundwater are from the leaching of fluoride rich minerals since high fluoride levels are observed with hard rock areas found naturally [5, 6,] as well as in deeper geological formations [7]. In addition to this, man-made activities by application of phosphate fertilizers, sewage sludge or pesticides in addition to associated with sodium bicarbonate water type and relatively low calcium and magnesium concentration such water types usually have high pH values [8,9]. High concentration of fluoride in groundwater is a considerable health problem in many regions of the world. The presence of high amount of fluoride in groundwater was observed in peninsula and arid to semiarid region of north-western India. A significant part of India has fairly good distribution of fluoride contamination ground water [10, 11] and Groundwater-fluoride problems have been recorded in over 200 districts in 19 Indian states. In Andhra Pradesh, Gujarat, Rajasthan, and Telangana, 50–100% of districts are affected by high-fluoride drinking water. In Bihar, Haryana, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Tamil Nadu, and Uttar Pradesh, 30–50% of districts are affected; and in Chhattisgarh, Delhi, Kerala, and West Bengal, the figure is less than 30% (RGNDWM, 1993). The high range of fluoride concentration of was observed viz., 5.2 mg/l in Medak district, Andhra Pradesh , 15 mg/l in Nawabganj Block, Uttar Pradesh and 18 mg/l in Jaipur, Rajasthan as against the drinking water permissible limit of 1.5 mg/l [12, 13, 14]. According to State Maharashtra pollution control (2011), 1183 villages spread over 28 districts of Maharashtra are affected by excess fluoride. Studies by several researchers have also confirmed that the solubility of fluoride is controlled by alkaline pH and different soil types [15, 16, 17,], where as [18] observed the maximum groundwater fluoride concentration of 2.3 mg/L in Arsikere taluk, Karnataka through geological formations. Similarly in Ranebennur taluk, 87% of the samples of the study area are exceeding the permissible limits of fluoride that could be indication of arid climates characterized by high evaporation rates are associated with high fluoride concentrations in groundwater [19], it also influenced by increasing groundwater residence time in the aquifer systems [20, 21, 22]. The fluoride contamination is one of the overlooked water quality parameters, which has the potential to affect the occurrence of dental and skeletal fluorosis for 62 million people [23]. Since, an investigation of fluoride concentration in drinking groundwater is important to find solution for the fluoride problem as well as to demarcate the fluoride rich locations; an attempt was made in the present study to assess the fluoride level in the ground water of Yadgir district, Karnataka, India.

Study area

Yadgir district lies in the northern part of Karnataka between 16 11' – 16 50'N Latitudes and 76 17' - 77 28' E longitudes, with a geographical area of 5234.4 Sq. Km. The district comprises of 3 taluks namely, Shahapur, Yadgiri and Shorapur **(Fig 1)**. There are 16 hoblies, 117 Gram Panchayats, 4 Municipalities, 8 Towns/Urban agglomeration and 487 inhabited and 32 un-inhabited villages. The district is mainly comprises the Peninsular Gneiss and granites. Central, northeastern and southwestern part comprises of sedimentary formations viz. sandstone, quartzite, shale, slate, limestone and dolomite Deccan Trap basalts cover eastern parts [24].

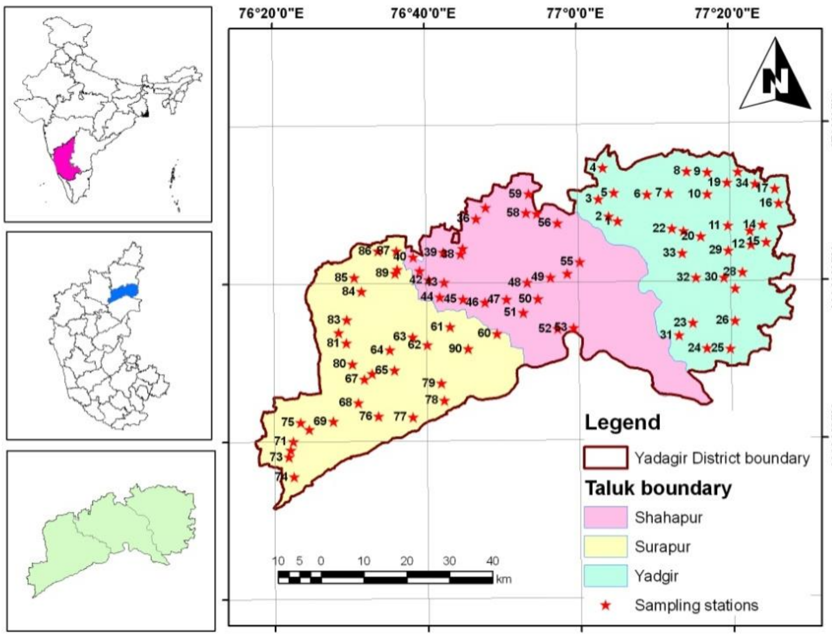

Fig 1. Map showing sample locations of study area

2. MATERIALS AND METHODS

A total of 90 groundwater samples were collected from different locations of the study area which covers the three taluks of Yadgir, Shorapur, Shahpur in Yadgir district, Karnataka (**Fig 1)**, during post-monsoon season 2018. The samples were collected from bore wells which were being used for drinking and other domestic purposes. The samples were collected in pre-cleaned and sterilized polyethylene bottles of two litre capacity. The groundwater samples were analyzed physico-chemical parameters as per the Standard methods [25] and various precautionary measures were taken during transportation of samples laboratory to avoid contamination.

3. RESULTS AND DISCUSSION

Fluoride is one of the considerable anions determines the quality of groundwater. The distribution of fluoride levels in groundwater samples were presented in **Fig 2**. Fluoride concentration in groundwater of Yadgiri district was found in range of 0.21 mg/L in Naganur village to maximum of 4.8 mg/L in Hurasgundagi village. It was also evident from **Fig 2** that fluoride content among 31.18 % of the groundwater samples (viz., 29 samples) exceeded the BIS permissible limit of

1.5mg/L and remaining groundwater samples were found within the permissible limit.

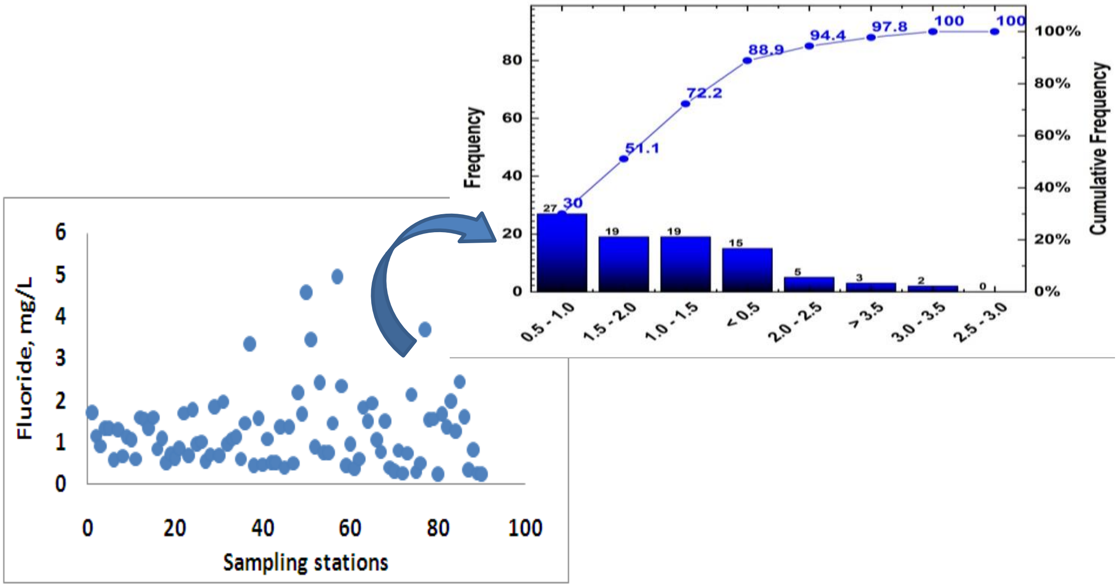

Fig 2. Spatial Variation and frequency distribution for Fluoride in the ground water samples of Yadgir district

A significant range of fluoride concentration was observed it may be due to chemical composition of different rocks. The data of TDS, major cations and anions of groundwater were generated and their relation was shown in **figures 3, 4 and 5**. The chemical weathering of minerals results in the formation of Ca^- and Mg^- carbonates which helps as good sinks for fluoride ions Fig 4 and 5, and alkaline pH controls the fluoride content [26], the similar observation made by [15]. The fluoride-rich groundwater in the Peninsular Gneiss and granites area is may be due to release of fluoride from the fluoride-bearing minerals in the rocks [27, 28, and 29]. The chronic exposure to higher level of fluoride of drinking water led to dental or skeletal fluorosis, the severity of the problem is directly related to its dose. Dental fluorosis or mottled enamel' is normally observed where fluoride interacts with enamel causing discoloration and the chances of teeth loss. Children are having the more risk as the fluoride affects the teeth and bones particularly in the growing stage. It was also observed that an increase in Na+ in groundwater is associated with increasing F− concentration as revealed by positive correlation coefficient value of 0.72. Similar trend was also observed between fluoride and calcium (r=0.44) and Fluoride and magnesium (R = 0.32), suggesting geological origin for high fluoride in groundwater. It can be concluded from the above that the Fluorite, the main mineral that controls the geochemistry of F− in most environments is found in significant amount in granite, granite gneisses, and pegmatite [30]. The regions in the study area with fluoride problem can be solved by adopting Nalgonda de-fluoridation technique which is simple, low cost and effective techniques can adopted at both domestic and community based levels [31].

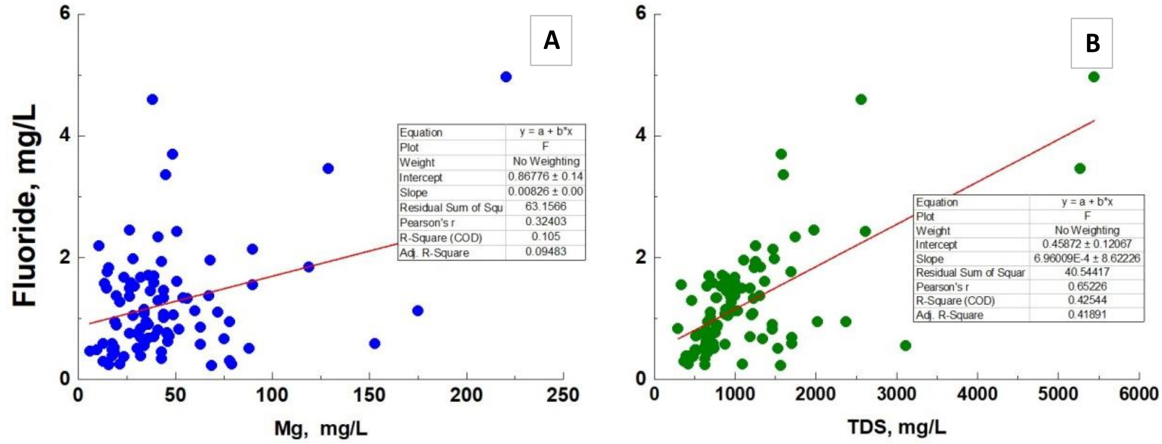

Fig 3. Plot of (A) F vs Mg and (B) F vs TDS in the ground water from the study area

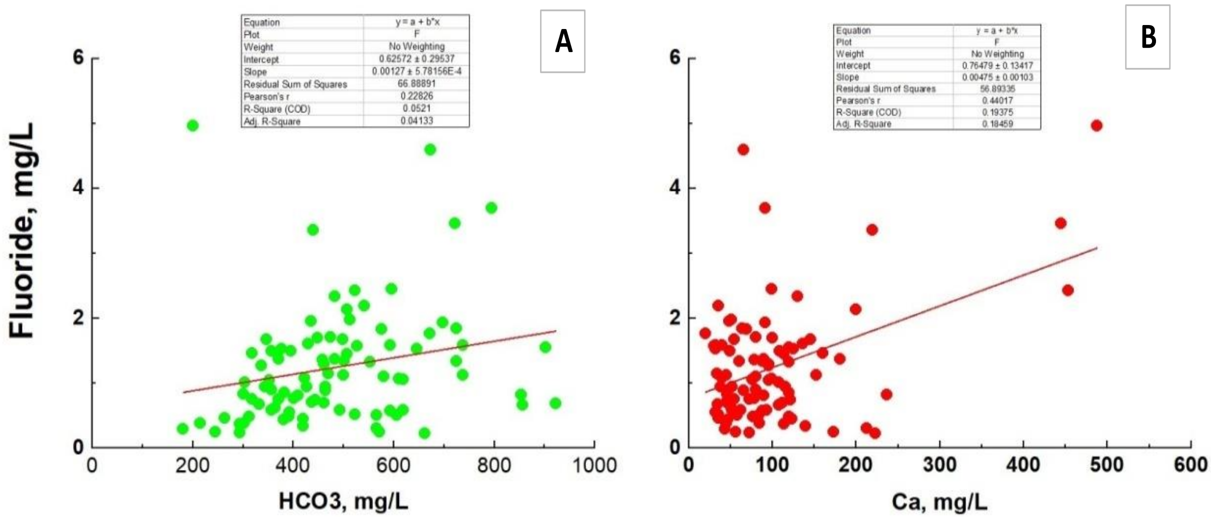

Fig 4. Plot of (A) F vs HCO_3 and (B) F vs Ca in the ground water from the study area

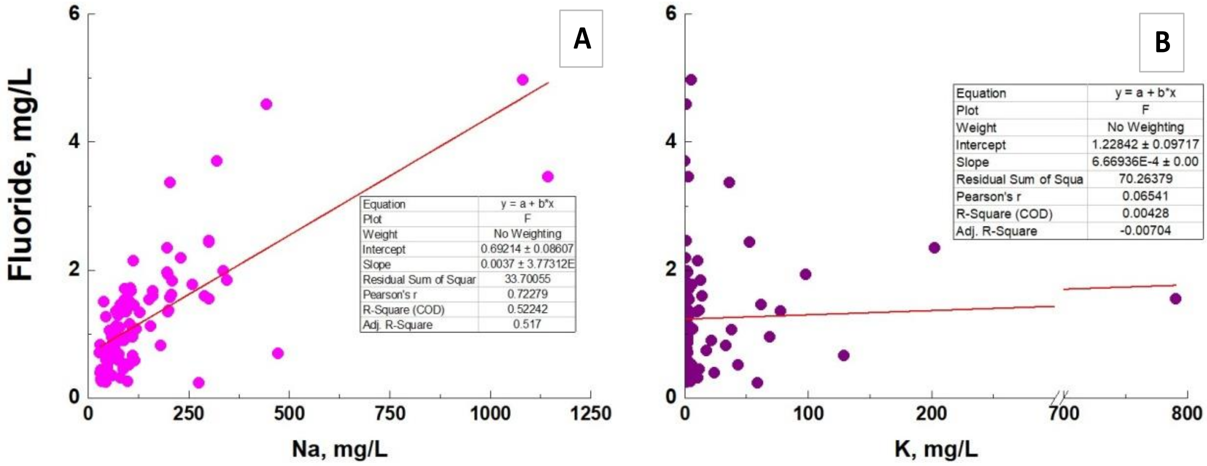

Fig 5. Plot of (A) F vs Na and (B) F vs K in the ground water from the study area

4. CONCLUSION

The village-wise Fluoride distribution in drinking groundwater sources of the study area which helps in management of health problems associated fluoride in Yadgir district through precautionary measures. Fluoride concentration in groundwater of Yadgiri district was found in wide range between 0.21mg L in Naganur village to maximum of 4.8mg L in Hurasgundagi village. The fluoride level of about 31.18 % of the groundwater samples were exceeded the maximum permissible limit as per the BIS. Bedrock containing fluoride bearing minerals and longer residence time may be responsible for the high F^- in the groundwater of the study area. The surface filtration technique is highly significant to increase the volume of aquifer which helps in diluting the fluoride particularly in arid and semi arid regions [32]. Although the Nalgonda de-fluoridation technique was not successful up to the mark in many parts of India due to lack of community participation and responsibility, it is recommended to adopted this simple, low cost and effective technique like use of activated alumina or electrodialysis both at domestic and community based levels to solve the fluoride problem. Alternately, it was suggested to adopt the better management practices of harvesting and conservation of rainwater to overcome the fluoride problem.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

No Animals/Humans were used for studies that are base of this research.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

The authors confirm that the data supporting the findings of this research are available within the article.

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CONFLICT OF INTEREST

Authors have no conflict of interest.

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