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RESEARCH ARTICLE

Assessment of fluoride contamination in groundwater and its impact on human health

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Abstract Fluoride (F^-) pollution of ground water is as incredibly harmful for both people and plants. Fluoride concentration of at least 0.6 mg/l is required for human consumption as it will help to have stronger teeth and bones. Fluride toxicity is a major concerning more than 25 countries all over the world. Present research work was directed to assess the physical and compound properties of groundwater. Water samples were collected from rural areas of Meerut city. Different physico-chemical boundaries like pH, Salinity, Turbidity, Total hardness (TH), Electrical conductivity(EC), Total dissolved solids (TDS) and fluoride were observed in order to find out the pollution level of water samples. In the present investigation, a wide range of variations was recorded. Water samples of different sites showed pH 7.69 to 7.96, EC 0.83 to 0.50 ms, TDS 310 to 540 mg/l, salinity 00.5 to 00.2 ppt, turbidity 1.14 to 0.15 NTU, Fluoride 1.132 to 1.532 mg/l. It was seen that 100% of groundwater areas have advancement of fluoride concentrations above 1 mg/l; consequently this groundwater is unsuitable for drinking and irrigation purposes.

Keywords: Fluoride, groundwater, physico-chemical and contamination.

Introduction

People depend on groundwater not just as a wellspring of drinking water yet additionally for different agriculture, industrial, and sporting employments. Groundwater comprises 97% of all out worldwide freshwater, and in numerous districts establishes the single biggest accessible supply of fresh drinking water (WHO 2004). With the approach of industrialization and current agriculture, there is force based on groundwater in conditions of both quality and accessibility of the different point and nonpoint contaminant in groundwater, fluoride is one of worry, as this component has extensive impact on human well being.

Fluoride is one of the components fundamental for human life. Lack or overabundance of fluoride in the climate is firmly related with human wellbeing outcomes (Zhang *et al.* 2003). Fluoride when consumed at less than 0.5 mg/L produces antagonistic wellbeing outcomes counting dental caries, absence of development of dental enamel, and lack of mineralization of bones, particularly in kids, though unreasonable uptake of fluoride (>1 mg/L) may prompt loss of calcium from tooth grid, exasperating cavity formation and dental fluorosis enlistment (WHO 1996). Therefore, the fear of dental fluorosis increments more quickly than the decrease in dental decay with ascent of fluoride concentration. Although, skeletal fluorosis happens whenever the fluoride (>3 ppm) is available in drinking water and the water is being polished off for around 8-10 years (Nawlakhe and Bulusu 1989). In general, the signs of dental fluorosis were noted in youngsters up to the age of 12 yr (Apambire *et al.* 1997).

The issue of high concentrations of fluoride in groundwater sources has now become one of the most significant toxicological also geo-ecological issues in India (Agrawal *et al.* 1997). Fluoride pollution in groundwater and fluorosis because of ingestion of this component through drinking water are spreading at a disturbing rate in

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India; although, the exact evaluations of the specific number of individuals confronting hazard of subjection stays unknown. The explanation is the absence of systematic review and outline of fluoride-impacted regions. The investigations done up until these point are area explicit and not standardized. The United Nations has announced the years 2005 to 2015 the "Decade of Water for life"; still, for a huge number of individuals safe drinking water isn't accessible. Arrangements are expected to alleviate the suffering of the impacted subjects and to decrease fluoride openness. The point of this survey was along these lines to empower per users to like an outline of the geochemistry and fluoride pollution in groundwater, note outcomes of human exposure and unfavorable wellbeing impacts, and propose conceivable medicinal measures emerging from fluoride toxicity.

Fluoride contamination in groundwater

Global scenario

The fact that approximately 200 million human beings from among 25 countries the world over might be exposed to fluorosis (Chandrajith *et al.* 2007). These nations incorporate Argentina, the United States, Morocco, Algeria, Libya, Egypt, Jordan, Turkey, Iran, Iraq, Kenya, Tanzania, South Africa, China, Australia, New Zealand, Japan, Thailand, Canada, Saudi Arabia, Persian Gulf, Sri Lanka, Syria and India (Mameri *et al.* 1998). Many pieces of China, India, and Sri Lanka are impacted by fluoride toxicity. In Sri Lanka, the fluoride fixation was found up to 10 mg/L in groundwater, especially in the Dry Zones, which prompted dental and skeletal fluorosis (Dissanayake 1991). In the Wet Zone, the lower fluoride fixation may be expected to escalated precipitation and long-term draining of fluoride from the translucent bedrock. According to a United Nations Environment Program- World Health Organization (UNEP-WHO) specialized report (UNEP-WHO 1992), the nations that lie between the scopes of 10° and 30° north and south of the equator and where environment is tropical and semiarid endure widely from endemic fluorosis. This might be expected to poor monetary circumstances and malnourishment of the populace.

Indian scenario

Almost 12 million of the 85 million tons of fluoride stores on the world's outside layer are found in India (Teotia et al., 1981). In India, the main instance of endemic fluorosis was accounted for in Prakasam District of Andhra Pradesh (Shortt *et al.* 1937), when the sickness was common in just four states, in particular, Andhra Pradesh, Tamil Nadu, Punjab, and Uttar Pradesh. During 1960-1986, 9 additional states were recognized as fluorosis endemic, and in 1991, 13 of India's 32 states and domains were reported to have normally high concentrations of fluoride in water (Mangla 1991), however as revealed by UNICEF (1999), fluorosis rose to 17 states constantly 1999 and at present fluorosis is endemic in 20 out of 32 constituent conditions of India (Choubisa *et al.* 2001). The most truly impacted regions are Andhra Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Tamil Nadu, and Uttar Pradesh (Kumaran *et al.* 1971, Teotia *et al.* 1984). It is assessed that 62 million individuals, including kids, experience the ill effects of dental, skeletal, or nonskeletal fluorosis on account of utilization of fluoride contaminated water (Susheela 1999). The high centralizations of fluoride in groundwater are a consequence of disintegration of fluorite, apatite, and topaz from the nearby bedrock (WHO 2006). 65% of India's towns are uncovered to fluoride hazard (Kumaran *et al.* 1971). The fluoride fixation in groundwater of India varies impressively from 0.12 to 24.17 ppm (Kumar and Gopal 2000) however, a higher fluoride centralization of 48 mg/L was too seen in the Rewari area of Haryana (Kumaran *et al.* 1971).

Material and methods

Water samples were collected in October, 2018 for assessment of Fluoride content. Five handpump water samples were collected from the different regions of Meerut district i.e. Bhawanpur, Gokulpur, Dedwa, Saini, Ulakhpur situated near the Kali River. Samples were collected in the plastic containers. Prior to examining, the handpump was continually siphoned for 5 minutes to restrict the effect of static water in the groundwater. All plastic bottles were washed multiple times totally with the water to be examined. All these water samples were analysed for physiochemical properties using different standard techniques, i.e., pH, Electrical counductivity (EC), turbidity, salinity, Total dissolved solids (TDS) and fluoride. The pH, Turbidity, Electrical conductivity, Salinity, and TDS were estimated quickly by utilizing advanced meter and Soil analysis kit (Biogen Scientific). Fluoride was estimated by Sodium 2-1-8-dihydroxy-3,6-naphthalene disulphonate (SPADNS) reagent (Clesceri *et al.* 1998).

Measurement of fluoride content

(A) Preparation of SPANDS solution

The reagent was prepared by using Sodium 2-(Para Sulpho Phenyl azo)- 1, 8-dihydroxie- 3, 6 napthalene disulphonate (SPANDS), Zirconyl Chloride Octahydrate ($ZroCl_2.8H_2O$) and concentrated HCl. 958 mg SPANDS was disintegrated in distilled water and was diluted to 500mL. 133 mg Zirconyl Chloride Octahydrate ($Zro\ Cl_2.8H_2O$) was added in off around 25 ml of SPANDS solution and was trailed by addition of 350 ml Conc.HCL. The final volume was kept up with at 500 ml with distilled water. The SPANDS reagent added the double distilled water was utilized for setting the reference point (zero) of the Spectrophotometer. The stock mixture of fluoride was ready by using 0.221 g of anhydrous Sodium fluoride, which was mixed in distilled water and was diluted to 1 liter. The stock mixture was diluted by sequential dilution to get ready various concentrations of standard fluoride mixture (0.1 to 5.0 mg/l).

(B) Estimation of fluoride in water samples

For assessment of fluoride, 40 ml of water sample was taken in volumetric flask and added zirconyl-spands reagent in every flask and blended well. Then, the intencity of magenta-red colour was estimated on the spectrophotometer at 570 nm utilized blank on the standard curve.

Result and Discussion

In the present study, five water samples collected from different sites of Meerut city, Uttar Pradesh, were chemically examined for six physio-chemical parameters like pH, EC, turbidity, salinity, TDS and Fluoride.

Statistical analysis

The physico-chemical data were first statistically investigated to show the overall attributes of groundwater. The obtained data were examined by one-way investigation of change (ANOVA) using SPSS 16.0 software. Using Duncan's Multiple Range Test (DMRT) at $p \geq 0.05$ remarkable distinction in mean compared with standard value is shown using bars with various letters.

The pH value of the groundwater samples was between 7.69 and 7.96. It was seen from figure that the pH, in all the groundwater samples (100%) is under the recommended limit of 6.5-8.5 respectively. In water, Total Dissolved Solids were made mostly out of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, natural matter, salt and different particles. The TDS was found in the range of 310 to 540 mg/lit. Bhawanpur Site showed highest value than the recommended limit (500 mg/l) given by BIS, while the lowest value 310 mg/l was observed in Gokulpur site. Electrical conductivity (EC) is the estimation of electrical current going through the water. Normally, it is connected with the disintegrated materials or solute concentration existing in the groundwater. The electrical conductivity of the samples was between 500 to 830 ms. Bhawanpur site showed highest value while, Gokulpur site showed lowest value of electrical conductivity. The salinity of groundwater samples was observed between 00.2 to 00.5 ppt. Bhawanpur site showed minimum value 00.5 ppt while Gokulpur site showed minimum value 00.2 ppt. The turbidity of the groundwater samples was observed in the range of 0.15 to 1.14 NTU. Ulakhpur site showed highest value 1.14 NTU than the prescribed limit 1 NTU given by BIS. Bhawanpur site showed lowest value 0.15 NTU. The data investigations showed that the variation inside these parameters at various areas was not high. Also, the variation range is extremely narrow as reported by the Manjesh Kumar and Ramesh Kumar (2012). The physico-chemical boundaries like pH, D.O., E.C., T.D.S., alkalinity, turbidity, Ca (calcium) and Mg (magnesium) hardness, complete hardness, NO3 (nitrate), F (fluoride), Fe (iron) and Cl^- (chloride) have been tried. It was observed that boundaries are not within limit on

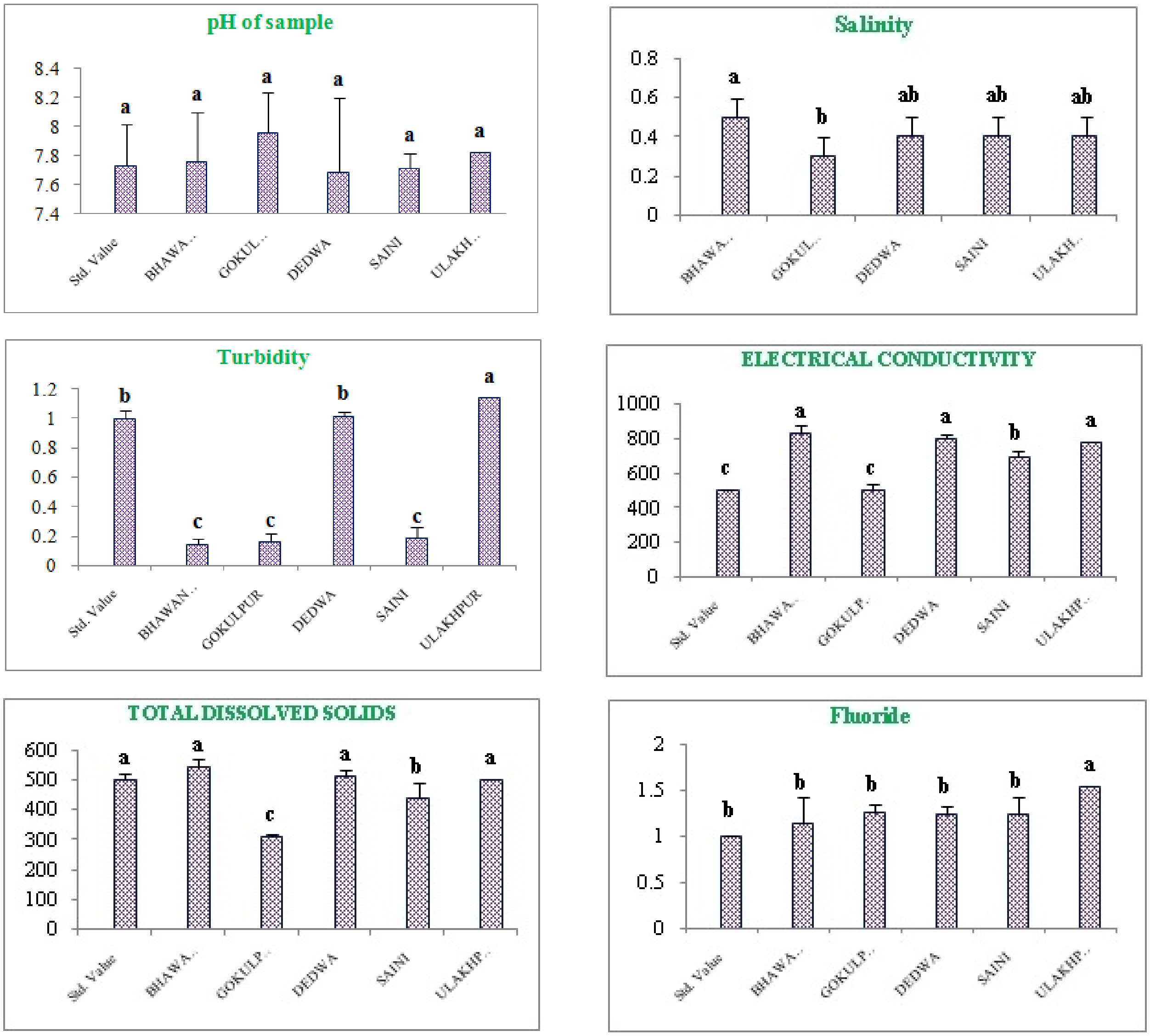

Figure 1: Shows a summarized result of physiochemical parameters of groundwater samples at the five locations in Meerut district.

W.H.O. principles.

The fluoride range of groundwater samples were observed in between 1.132 to 1.532 mg/l. The spatial varieties of F^- in the groundwater samples are presented in Figure 1. All sites showed highest value than the recommended limit (1mg/l) given by BIS. The most significant level of Fluoride in groundwater was detected in Ulakhpur site. An aggregate of 29.9% of the samples surpassed the reasonable furthest reaches of 1 mg/l prescribed by BIS. The same result was also reported by the, Azbar and Tu¨rkman (2000) who revealed that fluoride centralization of drinking water Eskisehir and Isparta was in the ranges of 1.9-7.5 and 3.8-4.9 mg/l, separately. In provincial areas of Northern Rajasthan, India the mean fluoride content of drinking water was observed 2.82 mg/l (Suthar *et al.* 2008). In another study, Raju Janardhana and Sangita Dey (2006) found that Fluoride concentration in the ground waters of the review region varied from 0.483 to 6.7 mg/l and 47% of samples had high fluoride content than the most extreme reasonable limit (1.5 mg/l). Paoloni *et al.* (2003) reported, fluoride level of groundwater assets in southeast of Argentina. Mean fluoride concentration was determined to be 3.8 mg/l and 97.1% of samples had fluoride content over the guideline worth of 1.5 mg/l. In certain areas of

Thailand, fluoride grouping of drinking water was higher than 10 mg/l (Prasertsom 1998). According to Narsimha and Sudarshan (2017) and Adimalla and Qian (2019), the centralization of fluoride in Medak groundwater went from 0.13 to 7.10 mg/l with a mean of 3.85 mg/l. The most extreme reasonable/safe restriction of fluoride for drinking water is 1 mg/l (BIS), which is profoundly dangerous for the purpose of drinking. In a study, Sujatha (2003) observed that Ranga Reddy region significantly comprises of stones and pegmatites of volcanic beginning of Archaean age (2,500 Ma), where groundwater sources have to a great extent polluted by fluoride and its gone concentration from 0.40 to 4.80 mg/l with a mean value of 3.98 mg/l.

There are four different methods such as Reverse Osmosis filtration (RO), Activated Aluminum, Distillation and Bone Char mentioned by World Water Reserve for removal of fluoride form water but out of these four systems RO is one of the best house hold method for this purpose. However, TDS needs to be maintained in safe limits.

Results in this study showed that groundwater samples were highly contaminated by fluoride. In view of these outcomes, it very well may be presumed that the rate of dental caries in the review region is high.

Conclusion

The present study uncovers level of fluoride in different ground water samples of Meerut (U.P.) India region. All sites showed higher values of fluoride content than the recommended limit (1 mg/l) given by BIS. The highest fluoride content (81.50%) was found at Ulakhpur site. It was seen that 100% of groundwater areas have advancement of fluoride concentrations above 1 mg/l; consequently this groundwater is unsuitable for drinking. Higher fluoride content in drinking water causes different types of diseases (Dental and skeleton fluorosis, low hemoglobin levels, skin rashes, neurological manifestations, muscle fiber degeneration etc.) to human beings and also enter in the food chain consequently disturb the ecosystem. The people of these areas employed for the survey may be advised to avoid the drinking of fluoride contaminated water without its purification. Only reverse osmosis filtration system can be used to overcome this problem. More studies are required to identify the fluoride content in different sites of Meerut region.

We will be published our next research article related to effect of fluoride on plant in the next of this journal.

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