Original Article

Study on Fluoride Contamination in Ground Water (Drinking water) of Deoghar, Jharkhand, India

Seema Singh[1]*, Anupriya Bharti[1], Archana[1], Veena Kumari[1], Basant Kumar Gupta[1] and Mohommad Arif [2]

[1]*Deoghar College, Deoghar under Sido Kanhu Murmu University, Jharkhand-814112, India*
[2]*Defence Institute of Bio-Energy Research (DIBER), HQ, Haldwani, Uttarakhand- 263139, India.*

*Correspondence E-mail : seemasinghania96@gmail.com

Abstract

Fluoride contamination in groundwater is one of the foremost natural mishaps for the different districts of Jharkhand. The present study was carried out to know the concentration of fluoride in the groundwater of Deoghar city. For this experiment, twelve samples were selected from each zone namely East, West, North and South. In each zone three places were selected to check the fluoride level in groundwater. Overall 36 water samples (36 samples used and the experiment was done in triplicate) from 12 different tube wells of Deoghar city were collected and investigated by using fluoride test kit. The lowest average value observed 0.343 ppm in civil lines (west zone). The highest average value 1.670 ppm observed in the Jaruadih (north part) of the Deoghar city respectively. In this study, it was observed that few locations showed fluoride contamination near the permissible limit or just above the limit (1.5 mg/L) but the remaining all areas are safe as they possess fluoride concentration within desirable limits (0.5-1 mg/L). Thus this study indicated that most of Deoghar city is free from Fluoride contamination and statistically insignificant difference of fluoride concentration was observed in Jhousagari and Jaruadih area when compared with WHO standards. The present study clearly showed that different areas of four zones are free from fluoride contamination but much more study is also needed for further more information.

Keywords: *Deoghar city; Fluoride contamination; desirable limit; permissible limit and safe zone.*

Introduction

Water is needed for all biological and physiological activities associated with humans, animals, and plants. Though the nature and the excellence of surface and groundwater are extensively variable and are determined by the local geological history, including the rocks and hidden ore deposits nearby the sites for the assembly of the water, and other issues, such as the effort of fundamental elements and contaminants by lentic and lotic waters and alternative aquifers (Davis and Deweist, 1966; Sankhla and Kumar, 2018). The quality of water is poorly understood due to the variety in the interactions between water and soluble minerals, sparingly soluble minerals, and salts, both natural and anthropogenic (Dutta et al, 2014). Fluoride comes to be toxic once it happens in drinking water away from the extreme permissible limit of 1.5 ppm. Chronic

exposure to the fluoridated ground or drinking water creates a health problem not only in human beings but also in diverse species of domestic animals in the form of osteo-dental fluorosis. In recent times, bio-indicators of common fluorotoxicosis due to fluoridated water. In India, several states are endemic for hydro fluorosis due to the high Fluoride content in drinking water (Choubisa et al, 2001; Choubisa, 2012). Various reports present conflicting data about the availability and quality of drinking water to the public in the country (Farooq et al, 2008). The permissible limit set by WHO as well as Bureau of Indian Standards (BIS) for fluoride in drinking water is 1.5 mg/L (WHO 2004 Guidelines for drinking-water quality recommendations; BIS (2012) Indian Standard Specification for drinking water. B.S.10500).

In India 17 states were affected by severe fluorosis (Choubisa, 2001; kumari and Pathak, 2014) and now the problem exists in 20 states indicating that endemic fluorosis. It is one of the most alarming public health problems of the country. In most parts of the country, the water is supplied through groundwater. World Bank on 7th January 2014 approved $500 Million to improve rural water supply and sanitation services in four Indian states which include Assam, Bihar, Jharkhand, and Uttar Pradesh. Dental fluorosis is endemic in 14 states and 150,000 villages in India. UNICEF estimates that fluorosis is endemic in at least 25 countries and around 200 million people from 25 nations have health risks because of high fluoride in groundwater (Ayoob and Gupta, 2006; kumari and Pathak, 2014) & in India, around 25 million people of 150 Districts are affected by fluorosis disease (Rajiv Gandhi National Drinking Water Mission, 1986 & 1993). In Jharkhand state Palamu, Garhwa, Giridih, Bokaro, Gumla, Godda, Ranchi are the districts where fluoride pollution in water is prevalent. The Daltonganj block in Palamu district is severely affected by this problem, is mainly geogenic in this area (Kumari and Pathak, 2014).

As per the Drinking Water Supply department groundwater in 203 districts has shown high fluoride out of 593 districts (Susheela, 2001). The cause of the presence of high fluoride in groundwater is the aridity of climate, dissolution of fluoride bearing minerals and rocks such as fluorspar, cryolite, fluorite, fluorapatite, and hydroxyapatite (Handa, 1975; Kumari and Pathak, 2014)

Deoghar is considered a religious place and well known for Lord Shiva temple. The landscape of Deoghar is characterized by mountainous tracts of granitic gneisses with isolated flat-topped hills. Ajay River passes through eastern parts of Deoghar district. During the rainy season these rivers often get flooded. During summer, a narrow strip of water flows through it. The water level depth in the district varies between 6.37 and 10.35 m during pre-monsoon and 2.55-5.47 m below ground level during the post-monsoon season (CGWB, 2009 & Singh et al, 2015). Water resources are considered as surface water sources and Groundwater sources.

In Deoghar mostly groundwater resources is used for drinking purposes. The groundwater has certain dissolved ions, among which the presence of fluoride has got attention as it is required by the human body for mineralization of bones under permissible limits not beyond a limit. As per the WHO standard prescribe maximum level for fluoride in drinking water is 1.5 mg/l but the required desirable limit of fluoride concentration in drinking water as 0.6-1.0 mg/L so above 1.5 mg/L is considered as fluoride contamination. When fluoride concentration increases from 1.5 mg/L to 3 mg/L than it causes dental Fluorosis (discolouration, mottling, and pitting of teeth) and between 3mg/L-4 mg/L causes stiffened and brittle bones and joints. When its limit increases more than 4 than it causes deformities in knee and hip bones, and finally paralysis, making the person unable to walk or stand in a straight posture, crippling fluorosis. In some parts of India, the fluoride levels are below 0.5 mg/l, while at certain other places, fluoride levels are as high as 30 mg/l have been reported (Handa, 1975). Deoghar is also severely affected by many mineral contaminations like arsenic and high TDS in groundwater. A few earlier study has been done on fluoride contamination in Deoghar city of Jharkhand. Groundwater is the main source of drinking water in different areas of this

Deoghar city. So this study was focussed on fluoride concentration of different areas of this city and to find out whether the fluoride concentration is under its permissible limit or beyond limit.

Materials and Methods

Firstly the Deoghar city was divided into four zones i.e. East, West, North and South respectively. In each part of the town three areas were selected for sampling of underground water for fluoride analysis. The water samples were collected in 500 ml. volume of polypropylene bottles which were cleaned and pretreated with HCl. Overall 36 water samples were collected from tube wells of different selected areas of the city. Collected water samples were precisely analysed by fluoride testing kit method. Experiment was carried out in triplicate.

Statistical analysis

The treatments and controls of the experiments were replicated thrice. Crop Stat for Windows, developed by the Biometrics Unit, IRRI Philippines was used for analysis of variance (ANOVA) for the experiments laid out in Completely Randomized Design (CRD). The treatment means were compared by Least Significant Difference (LSD) Test at a significance level of $P \geqslant 0.05$.

Results

In the present study fluoride contamination in ground water of different areas of Deoghar city was studied .The above results indicated that the fluoride concentration in ground water is ranges between 0.343 ppm to 1.670 ppm in Deoghar city. The maximum and minimum fluoride level was observed 1.670 ppm in Jaruadih area and 0.343 ppm in civil lines area respectively. In east and west zone maximum fluoride concentration was observed 1.431 ppm in Baijnathpur area and 0.839 ppm in Barmasia correspondingly. Further maximum fluoride concentration in north zone was 1.670 ppm in Jaruadih and south zone was 0.846 ppm in Bompas town area observed respectively. From this study it was concluded that in some areas fluoride level increases its permissible limit but maximum places are

under safe limit as per WHO standards. Out of twelve area selected only two namely Jauradih and Jhousaghari showed fluoride level above its permissible limit i.e. 1.5 ppm. Remaining all ten places are under permissible limit. It was also observed that north and east zone possess more fluoride level than west and south zone. Fluoride under desirable level are actually needed by our body for mineralization and development of bones and teeth. Mminimum fluoride level were observed in Civil lines (0.343 ppm) and Castairs town (0.370 ppm) respectively. This study clearly indicated that fluoride concentration in different area of Deoghar city is not life threatening. A graphical representation showed in figure 1 which clearly explained that Deoghar city is not effected by fluoride contamination. Long term exposure of inorganic fluoride beyond permissible limit through drinking water and food may lead so many hazardous diseases to the mankind. This study is based on fluoride kit testing method so further more study is also needed like atomic absorption method, UV spectrophotometer method for much more quantitative and qualitative analysis.

Discussion

Deoghar district is largely covered by Chotanagpur granites and gneissic complex associated with some metasediments and metabasic rocks. The Gondwanas have been developed in tectonic basin fill deposits and are resting on Archaean basements. The Gondwanas mainly consist of sandstones, shales, coal seams and are exposed in Karon and Madhupur blocks of the district. Alluvium occurring along the river channels and adjoining areas and are mainly composed of fine to coarse sand and clays. Laterites occur in isolated patches. About 70% of the district area is underlain by hard and compact granitic rocks, known as Chotanagpur granite gneiss. Weathering, fracturing and jointing have introduced secondary porosities in these hard rocks and these govern the occurrence and movement of groundwater in these rocks. In these formations groundwater occurs under unconfined condition in the weathered mantle and under semi-confined to confined conditions in the fractures underneath. Groundwater also occurs under unconfined

condition in the narrow stretches of alluvium along stream courses; however, groundwater potentiality in the alluvium is not promising (Reddy, 2013).

Ground water in the phreatic aquifers in Deoghar district has been found to be slightly alkaline in nature. The specific electrical conductance of ground water in phreatic zone during May 2011 was in the range of 480 to 1130 µS/cm at 25⁰C. The suitability of ground water for drinking purpose has been evaluated on the basis of pH, Total hardness (T.H), Ca, Cl, F and NO3. The chemical concentration of these constituents, when compared with the drinking water specification recommended by IS: 10500, 1991 which indicated that none of the samples exceed the permissible limit set for drinking use. (Reddy, 2013).

Some researchers reported about fluoride contamination in drinking water in other districts of Jharkhand but not in Deoghar city (Singh et al, 2008; Sankhla and Kumar 2018). Singh et al, 2008 reported that 0.1–6 ppm of fluoride level in Damodar River basin of Jharkhand. Kumari and Pathak 2014 also reported fluoride concentration above permissible limits in different districts of Jharkhand except Deoghar. Jharkhand has Bokaro, Giridih, Godda, Gumla, Palamu, Ranchi districts where fluoride in groundwater was found beyond permissible limit. Studies pertaining to fluoride concentration in groundwater of Jharkhand have been conducted by various researcher (Pandey *et al*, 2012; Shrikant 2008; Avishek et al, 2010; Shekhar *et al.,* 2012). All have suggested fluoride pollution in the area is due to rock-water interaction & more exploitation of groundwater resources. Defluoridation is also suggested by eating some herbs which have medicinal value (Priyadarshi, 2012,). Srikanth (2008) have also reported that Ganke, Mukhiya Tola, Satyari Tola, Chukru, and Bakhari villages in Palamu district showed severe fluoride problem in groundwater which is the only source of drinking water. In this study the highest fluoride concentration found was 12 mg/L in Chukru and Andharbagh villages. Sadhu *et.al.* (2013) have collected data on seasonal basis of three seasons (rainy, winter, and summer) of the year July

2011 to June 2012 of Hazaribag district and calculated the percentage of children affected with dental fluorosis. Pandey et al, (2012) and Shekhar, et.al, (2012) analysed a set of data of Palamu and Garhwa district to show the severity fluoride contamination. According to Priyadarshi (2012) Bakhari village in Daltonganj where most of the people have problems like deformed limbs, cataract, or premature ageing, if people continuous consume significant amount of Chakwad (ring worm plant) plant then they get less affected of fluoride toxicity. The presence of high calcium in this plant which binds fluorine –helps in safe excretion of fluorine, and also helping replenish body calcium depleted by fluorine.

Due to excess withdrawal of groundwater, there is urgent need for recharging deeper aquifers in those areas where number of apartments are more. (Thakur, 2013). For the fluoride management in the groundwater Food items rich in Ca and P should be consumed because it reduces fluoride retention capacity of human body.

In India many regions ground water and river water are contaminated with the high amount of fluoride pollutants. Their quantities are far above the permissible levels according to national guidelines of drinking water and WHO, USEPA standards. The contamination of water with fluoride is going to develop a serious health problem in coming years. In Indian perspective, highly contamination of fluoride in water is commonly observed in areas with high water salinity. Human health is directly affected by the intake of polluted fluoride water, fish etc. It is recommended that awareness should be spread among the people regarding the hazards on consumption of polluted water and related eatables (Kumari and Pathak, 2014).

On the basis of above findings it was essential to know the fluoride concentration in different areas of Deoghar city as no earlier reports available for fluoride contamination in city. In this study it was observed that this city is free from fluoride contamination but in few places fluoride level reached the permissible level. It mean awareness is needed otherwise fluoride level will slowly increase in city. These findings

also needed specific instrumentation for more precise work on fluoride contamination.

Conclusion

The lowest concentration of fluoride was observed 0.343 ppm in civil lines of west zone and the highest concentration was 1.670 ppm in the Jaruadih of north zone of the Deoghar city respectively. In this study, it was observed that few locations showed fluoride contamination near the permissible limit or just above the limit (1.5 mg/L) but the remaining all areas are safe as they possess fluoride

concentration within desirable limits (0.5-1 mg/L). Thus it was concluded that deoghar city is almost free from fluoride contamination but in few places fluoride level reached the permissible level.

Conflicts of Interest:

The authors declare no conflict of interest.

References

Avishek K et.al. (2010) Water quality assessment of Majhiaon block of Garhwa District in Jharkhand with special focus on fluoride analysis, *Environmental Monitoring assessment*, 167: 617-623.

Ayoob S and Gupta A K (2006) Fluoride in drinking water: A review on the status and stress effects. *Critical Reviews in Environmental Science and Technology*. 36, 433–487.

Choubisa SL (2001) Endemic fluorosis in Southern Rajasthan, India. 34, 61-70.

Choubisa SL (2012) Status of fluorosis in animals. *Proc Natl Acad Sci India Sect B. Biol Sci* 82(3): 331-9.

Choubisa SL, Choubisa L, Choubisa DK (2001) Endemic fluorosis in Rajasthan. *Indian J Environ Health*. 43(4):177-89.

Datta AS, Chakrabortty A, Dalal De S S, Lahiri S C (2014) Fluoride contamination of underground water in Kolkata, West Bengal, India. Research Report, International Society for fluoride contamination Inc. 47(3), 241-8.

Davis SN, Deweist RJM (1996) Hydrogeology. New York, NY, USA: John Wiley and Sons; 1966. 96-128.

Farooq S, Hashmi I, Qazi IA, Qaiser S, Rasheed S (2008) Monitoring of coliforms and chlorine residual in water distribution network of Rawalpindi, Pakistan. *Environ Monit Assess*. 140:339–47.

Handa BK (1975) Geochemistry and genesis of fluoride-containing ground waters in India. Research Article for National Ground Water Association, USA. 13, 275–281.

Kumari N and Pathak G (2014) A Review of Groundwater Quality Issue in Jharkhand Due to Fluoride. *Journal of Engineering Research and Applications*. 4, 3 (Version 2) 65-77.

Pandey AC et.al (2012) Evaluation of Fluoride in Groundwater sources in Palamu district of Jharkhand. *Journal of Applied Sciences* 12(9). 882-887.

Priyadarshi N (2012) Fluoride toxicity in Jharkhand state of India http://fluoridealert.org/news, fluoride action network.

Sadhu & Kumar (2013) Assessment of Drinking water quality in tribal dominated villages of Barkagaon, Hazaribag, Jharkhand, India". *European Scintific Journal*. 9(35), 331-338.

Sankhla M S, Kumar R (2018) Fluoride Contamination of Water in India and its Impact on Public Health. *ARC Journal of Forensic Science*. 3 (2)10-15.

Shekhar S.et.al., (2012) Evaluation of fluoride contamination in groundwater sources in hard rock terrain in Garhwa district, Jharkhand, India. *International Journal of Environmental Sciences*. 3(3), 1022-1030.

Singh A K, Mondal GC, Mahato MK and T.B. Singh (2015) Hydro-geochemistry and Water Quality Assessment of Surface and Groundwater Resources of Deogarh District, Jharkhand, India. *Asian Journal of Water, Environment and Pollution*.12,2, 43–58.

Singh AK, Mondal GC, Kumar S, Singh TB, Tewary BK, Sinha A (2008) Major ion chemistry, weathering processes and water quality assessment in upper catchment of Damodar River basin, India. *Environ Geol* 54(4):745–758.

Srikanth R, Chandra T R and Kumar B R (2008) Endemic fluorosis in five villages of the Palamau district, Jharkhand, India. Research report (copyright 2008, International Society for Fluoride Research) 41(3), 206–211.

Susheela AK (2001) Fluorosis: Indian scienario: A treatise on fluorosis. Fluorosis Research and Rural Development Foundation; New Delhi, India.

Thakur BS (2013) Urgent need for Sustainable management of Ground water in fractured Aquifers in hard rock terrains of Ranchi urban area, Jharkhand. Proceeding of National Conference on Earth Sciences in India: Challenges and Emerging trends (ESICET-2013) 7-9 November, 2013. www.mapsofindia.com Census-2001 & Census – 2011.

WHO (2004) Guidelines for drinking-water quality: recommendations, 1. World Health Organization, Geneva.