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ASSESSMENT OF EXPOSURE, INTAKE AND TOXICITY OF FLUORIDE FROM GROUND WATER SOURCES

Anurag Tewari[1*], Ashutosh Dubey[1] and M.K.Chaturvedi[2]
[1]Department of Chemistry, Pranveer Singh Academy of Technology, Kanpur
[2]Scientist, Department of Science and Technology, Govt. of India, New Delhi, India
*E-mail: at7071@rediffmail.com

ABSTRACT

High concentration of fluoride in groundwater causes a disease called "Fluorosis"**.** It varies considerably; fluoride in the environment is of public health and scientific interest because of their ill effects on human health. Present study was designed to assess fluoride exposure through drinking water consumption and to elucidate fluoride endemic areas through mapping. Total number of 52 (fifty Two) ground water samples were collected from the study area dividing into five clusters of Unnao district of Uttar Pradesh, India. Ground water samples were collected using simple random sampling technique and analyzed by Ion Selective Electrode Method (APHA). Majority of population were found to be exposed to the risk of skeleton fluorosis. Based upon the findings of the study regional hydrogeology, physiographic and climatic conditions are other possible sources of fluoride influence in ground water there is need to mapping of fluoride endemic clusters/areas so that effective fluoride mitigation plans can be executed.

Keywords: Fluoride, Fluorosis, Ground water, Fluoride Exposure, Fluoride intake and Toxicity.

INTRODUCTION

Fluoride ion in drinking water is known for both beneficial and detrimental effects on health. The World Health Organization and Indian Council of Medical Research described the drinking water quality guideline values for fluoride is 1.5 mg/L[1-2].

In India, around 20 million people were severely affected by fluorosis and around 40 millions are exposed to its risk.[3]The number of people getting affected, the number of villages, blocks, districts and states endemic for fluorosis have been steadily increasing ever since the disease was discovered in India during 1930s. The reason for the increase in the disease incidence and the sizeable number of locations being identified as endemic zones for fluorosis is due to overgrowth of population, necessitating more and more water, indiscriminate digging of tube wells, resorting to the use of hand pump water, unawareness regarding the importance of checking water quality, specially for fluoride and due to water shortage. Agencies responsible for water supply resort to pumping water from open wells and tube wells to overhead tanks and supply ground water to residents; and invariably such sources are not tested for fluoride [4].

Endemic fluorosis is present in at least 20 states of India, affecting more than 65 million people including 6 million children. Fluoride (F^-) concentration in ground water varies widely, ranging from 0.01 mg/L to 48 mg/L. The amount of Fluoride (F) occurring naturally in groundwater is governed principally by climate, composition of the host rock, and hydrogeology. Areas with a semi-arid climate, crystalline rocks, and alkaline soils are mainly affected.

So, concentration of fluoride in drinking water is a primary factor for the cause of fluorosis (teeth and Skeletal). Fluorosis is a slow, progressive, crippling malady, which affects every organ, tissue and cell in the body and results in health complaints having overlapping manifestations with several other diseases. The primary adverse effects associated with chronic, excess fluoride intake are dental and skeletal fluorosis[4]. It also adversely affects the foetal cerebral function and neurotransmitters[5-8].

In view of the above and increased interest in recent years in fluoride concentration in natural waters and various adverse impacts on human health, an extensive study was undertaken in the study area of Unnao,

UP by estimating fluoride level in drinking water, identification of exact geographical locations which are having high concentration of fluoride in drinking water, intake and toxicity of fluoride due to consumption of drinking water. This study may be useful to perform remedial measures and can be helpful to give awareness about fluorosis to the villagers residing in the particular area. Hence there is an instant need to take mitigation steps in Unnao region to prevent the population from further risk of fluorosis.

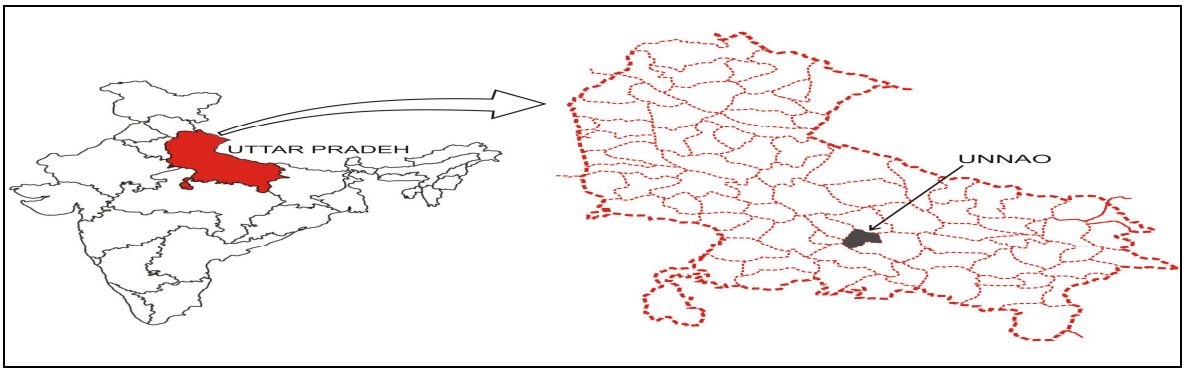

Fig.-1: Study Area

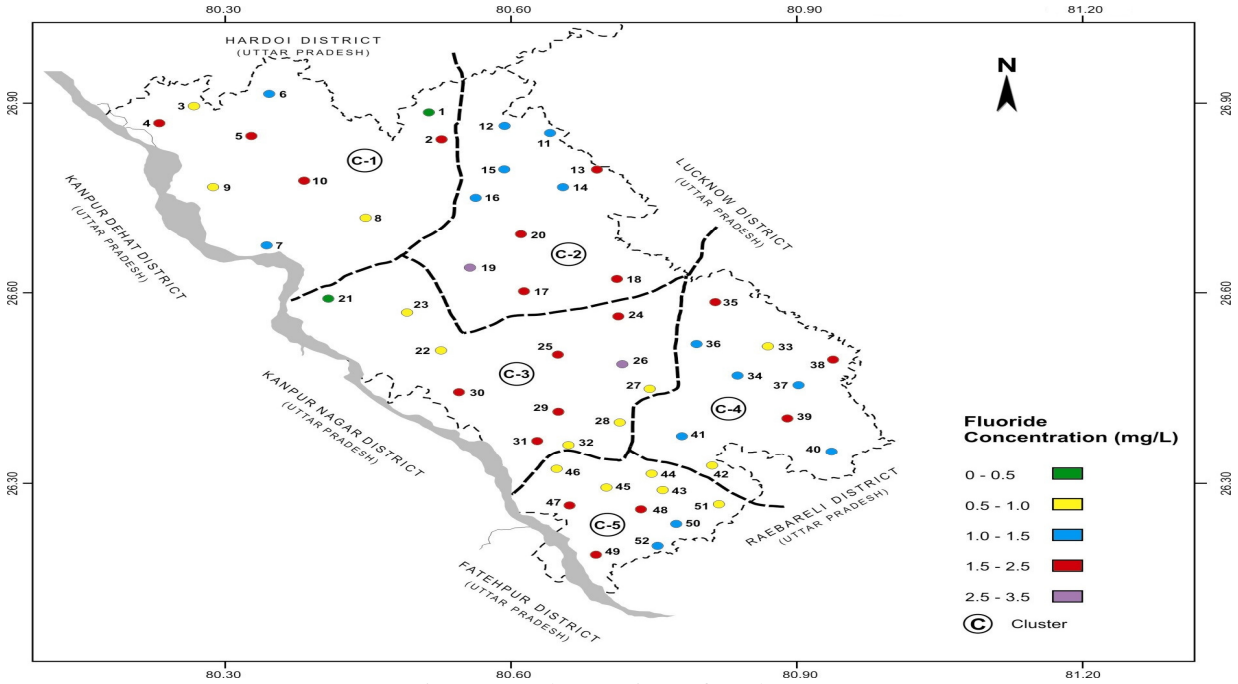

Fig.-2: Sample Locations of Study area

EXPERIMENTAL

Cross sectional study was carried out in the study area dividing into five clusters of district Unnao of UP during 10th May 2010 to 28th Feb 2011. The area of the present study was parallelogram in shape and lies between latitude 26^0 8' N and longitude 80^0 3' E & 81^0 3' E at 121 Meter or 396 feet above from sea level. It has a sub tropical wet and dry climate region with an average annual temperature varying between 25^0C - 27.5^0C, the average annual rain fall is between 50-100 centimeter, the area extends about 4589 sq. km. with a population of about 144,917 (Approx.). A total number of 52 ground water samples from all the clusters (10 each from C-1 to C-4 and 12 from C-5) were collected(Fig-2), stored at 25^0C and analyzed by using a fluoride selective electrode (Orion 9609BNWP using 900061 Orion electrode filling

solution) Eutech Cyber Scan pH 6500 pH/Ion meter, method for fluoride estimation as described in standard methods for the examination of water and waste water [9].

Preparing two standards that bracket the expected samples range and differ in concentration by a factor of ten, when a stable reading is displayed, record the mV value and corresponding standard concentration, using the same temperature range as the sample. Ffluoride (F^-) concentration in the collected ground water samples (Table-1), these values were further compared with the drinking water standard of Bureau of Indian Standards (BIS) and World Health Organization (WHO) for evaluation of fluoride concentration in the study area.

Table-1: Cluster wise concentration of fluoride distribution

S. No.	Cluster No.	Standard Limit (mg/L)	Observed value (mg/L)	Mean ± SD	Percentage of affected population
1	C-1	0.5-1.5	0.49-1.82	1.23±0.45	23.30
2	C-2	0.5-1.5	1.03-2.86	1.54±0.53	25.51
3	C-3	0.5-1.5	0.32-2.90	1.34±0.84	22.25
4	C-4	0.5-1.5	0.62-1.84	1.25±0.37	17.30
5	C-5	0.5-1.5	0.59-1.64	1.08±0.38	11.60
SD= Standard Deviation					

RESULTS AND DISCUSSION

The analysis results indicate prevalence of dental and skeleton fluorosis (Table-1). The fluoride (F^-) concentration range in the study area was found between 0.32 mg/L - 2.90 mg/L. It is clear from the above mentioned study that the downward percolating water is not inactive, and it is enriched in CO_2. It also acts as a weathering agent apart from general solution effect. Consequently, the chemical composition of ground water vary and depending upon several factors i.e. frequency of rain, which will leach out the salts, time of stay of rain water in the root-zone, intermediate zone and presence of organic matter etc.[10].

It seems that the water front does not move in a uniform manner as the soil strata are generally quite heterogeneous. The movement of percolating water through larger pores is more rapid than through the finer pores. Thus the overall effect on the variation of fluoride concentration among all the clusters are due to composition of ground water varies from time to time and from place to place.

Chemical composition of ground water is affected by concurrence of several factors like regional hydrogeology, physiographic and climatic conditions; these show their positive influence on fluoride distribution in the study area. Ground water with high fluoride contents are generally HCO_3-Na-type waters, particularly poor in Ca^{2+}. It seems more appropriate that rocks which are rich in fluoride minerals have contributed to the enriched fluoride contents of ground water during the course of weathering of rock types. It also appears more reasonable that dissolution activity of fluoride minerals are more important for excessive fluoride concentration in ground water rather than fluoride bearing minerals present in rocks.

The content of fluoride is related to the depth of the wells/source. In these areas, there is no industry or any human activity that can cause anthropogenic contamination of the ground water with fluoride and the high levels of fluoride are due to geogenic sources. Elevated fluoride concentrations were also found in some water supply of the study area.

It has been also observed that study area shows variation in fluoride (F^-) concentration this may be presence of fluoride bearing minerals in the host rocks and their interaction with water is considered to be the main cause for fluoride enrichment in the ground water and regular intake of fluoride rich waters seems to be the main cause for fluorosis (dental and skeleton) in the study area. These results will be helpful to prepare fluorosis mitigation plan for the affected population of the study area. Fluoride has widely been in the focus of public and scientific interest because of their important physiological role in the health of a man. It is high time that an affordable solution should be found to minimize the fluoride

contamination for maintaining the good health of the large population of the study area of Unnao district. There is urgent need to carry out studies on hydro-chemical and hydro-geological aspect of occurrence of fluoride which can be useful to mitigate fluorosis in the study area. Defluoridation tanks should also be installed in the villages which are having high exposure of fluoride concentration in drinking water; the possibilities of bringing safe water from nearby villages can also be planned with village people and local authorities through community participation.

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