DETERMINATION OF FLUORIDE CONTENT IN GROUND WATER AT VINUKONDA AREA

M.YANADI RAO
Department of Chemistry, Government Degree College, Vinukonda
Corresponding author: Email id: macherlayani@gmail.com

ABSTRACT

Groundwater is the major source of freshwater on the earth which contains dissolved ions in different concentrations. These dissolved ions are helpful for human health at desirable concentrations. Beyond the permissible limit is harmful and not suitable for domestic use. Fluoride is one such dissolved ion which causes dental and skeletal fluorosis to humans at high concentration. Some parts of Guntur district in Andhra Pradesh are such regions where people from several generations suffered from fluoride water because of lack of alternatives. The people from these regions use this fluoride water for drinking purpose face many problems such as skeletal fluorosis, formation of stones in the kidney, gastrointestinal disorders and enamel fluorosis. The main objectives of the present study are determination of the present status of fluoride content in groundwater from different areas in Guntur district and assessment of the possible causes for high concentration of fluoride.

KEYWORDS: Fluoride, Ground water, causes of concentration

INTRODUCTION

Fluorine is the 13th most abundant element on earth's crust. Fluoride is important for bones and tooth formation. The main source of fluoride for the human body is usually drinking water. The concentration of fluoride in groundwater is principally governed by the climate, the composition of the host rock, and the hydrogeology. Bureau of Indian Standard / Specification for Drinking Water (BIS:105001991) classified the permissible limit of fluoride in water as 1.50 ppm which is 1.5 mg/l. Fluoride beyond desirable amounts in groundwater is a major problem in many parts of the world. Fluoride is a common geo-genic contaminant of drinking water, and its effects on human beings have been recognized in both the industrialized and developing countries of the world. Areas with semiarid climate, crystalline rocks and alkaline soils are mainly affected (Kundu et al 2001). Fluoride is released to the soil and groundwater by the process of weathering of the primary rocks. Fluoride is released to the soil and groundwater by the process of weathering of the primary rocks.

The major sources of fluoride in ground water are fluoride-bearing rocks such as fluorspar, cryolite, fluorspatite and hydroxyl apatite etc. It is mainly industrial operations, atmospheric deposition during coal burning or mining or the natural sources that causes the dissolution of fluoride- bearing minerals that are responsible for occurrence of fluoride in drinking water. During weathering and circulation of water in rocks and soil, fluorine is leached out and dissolved in ground water.

Ingestion of excess fluoride, most commonly in drinking-water, can cause fluorosis which affects the teeth (Dental Fluorosis) and bones (Skeletal Fluorosis) especially for children and pregnant woman. This is a result of the destruction of metabolic calcium and phosphorus, inhibition of active enzymatic process in the human body. Thus the function of the endocrine system gets interrupted, leading to fluorosis (Khandare et al 2005).

Dental fluorosis: Low levels of fluoride intake help to prevent dental caries. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems. The dental effects of fluorosis develop much earlier than the skeletal effects in people exposed to large amounts of fluoride. Clinical dental fluorosis is characterized by staining and pitting of the teeth. In more severe cases all the enamel may be damaged.

Skeletal fluorosis: Chronic high-level exposure to fluoride can lead to skeletal fluorosis (Sushela, 2001). In skeletal fluorosis, fluoride accumulates in the bone progressively over many years. The early symptoms of skeletal fluorosis include stiffness and pain in the joints. In severe cases, the bone structure may change and ligaments may calcify, with resulting impairment of muscles and pain.

Acute high-level exposure to fluoride causes immediate effects of abdominal pain, excessive saliva, nausea and vomiting. Seizures and muscle spasms may also occur. The Guntur district with a geographical area of 11,328 sq. kms falling between Latitudes $15^{o}44'$ & $16^{o}47'$ North and Longitudes $79^{o}10'$ & $80^{o}55'$ East and is one of the Central coastal districts of Andhra Pradesh. It comprises 57 mandals under administrative control of 3 divisions namely Narasaraopet, Guntur and Tenali. The district has 729 villages and 1036 hamlets. Vinukonda have high fluoride. These villages in Vinukonda mainly contain rocks of cryolite which is the main cause of fluoride.

Vinukonda is a "mandal" which consists of 42 villages out of which 26 villages in the Guntur district of Andhra Pradesh suffers from a major problem of very high fluoride levels in the water, making it undrinkable. The underground drinking water is highly affected by concentrations of fluoride causing a bone disease called Fluorosis among the local people. These villages in Vinukonda mainly contain rocks of cryolite which is the main cause of fluoride. Ground water forms the main source for drinking water in these villages. The ground water in parts of Vinukonda, Sattenapalle, Palanadu and Narsaraopet taluks is charged with high fluoride content, exceeding 1.5ppm. People from several generations suffered from fluoride water because of lack of alternatives.

After the year 2003, there are no major studies on fluoride in groundwater of Guntur district, Andhra Pradesh. Considering this factor and keeping an account of the importance of public health, this study was designed to understand the present status of fluoride in groundwater of a part of Guntur district, Andhra Pradesh, India.

METHODOLOGY

Water Samples from drinking and irrigation wells (open, dug wells and hand pumps) is collected from all the affected villages of Vinukonda district. Groundwater level in the wells is recorded and pH of groundwater samples is measured in the field using a portable pH meter. Water samples are collected in clean polyethylene bottles of 600-ml capacity. The sampling bottles are soaked in 1:1 diluted HCl solution for 24 h, washed with distilled water, and are washed again prior to each

sampling with the filtrates of the sample. In the case of bore wells, water samples are collected after pumping the water for 10 min. In the case of open wells, water samples are collected 30 cm below the water level using a depth sampler. Samples collected are transported to the laboratory and filtered using 0.45-µm Millipore filter paper. The fluoride concentration of groundwater samples is determined using Specific Ion Electrode method (APHA, 1998).

Specific Ion Electrode method (Direct potentiometry): Direct potentiometry is the measurement of electrical potential (voltage) between two dissimilar chemical electrodes under the condition of zero external current flow to give the concentration of a particular ionic analyte (the "sensed ion") in solution. The most important and common example of direct potentiometry is the pH meter where [H+] (hydrogen ion concentration) is measured. Using sophisticated design, electrodes can be created that display selectivity for a particular ion to the exclusion of others to a certain and quantifiable degree. Through the combination of such an Ion Selective Electrode (ISE), a suitable reference electrode and a sensitive voltmeter (a millivoltmeter) a very sensitive, direct, non-destructive method can be devised.

Evaluation: The problem of high fluoride increased up within the last few decades, its origin involved prevalence of a more arid climate and recent exploitation of groundwater recharged during the past arid climatic phases. High fluoride in drinking water has resulted in dental fluorosis and skeletal fluorosis in the local residents. It is significant that a positive correlation between fluoride level and morbidity of dental fluorosis and skeletal fluorosis among people mostly in children exists. Many of the villages in Vinukonda are found below the potable level. Kothaluru, Kummaripalem, Upparapalem and many villages nearby are in the fluoride zone. People from several generations suffered from fluoride water because of lack of alternatives. People who use this water for drinking purpose face many problems related to their health and environment. We have also come across complaints of the male infertility with an abnormality in sperm morphology and low testosterone levels are said to involve fluoride toxicity. It will also cause an early development of cataract in human eyes due to excess consumption of fluoride. Apart from the health aspect, the villagers are facing some aesthetic and social problems. No one is ready to make matrimonial relationship with the females of this area. Mostly villagers suffer from enamel fluorosis and bow legs and deformity in muscle and bones. Around 30% of the people in these villages were disabled because of the high intakes of fluoride, causing symptoms similar to polio.

RESULTS AND DISCUSSION

The results of various parameters for the determination of fluoride in various samples are presented in the above table

Variation of fluoride in different months at different stations

Sample no	Covered area	Feb – fluoride %	March - fluoride%	April-fluoride
S1	Nugendla	0.92	1.2	1.15
S2	Epuru	1.02	1.42	1.64
S3	Vinukonda	1.22	1.38	1.79
S4	Bollapalli	0.95	1.25	1.2
S5	Nadendla	1.08	1.47	2.12
S6	Naguleru	0.85	1.05	1.42

The major sources of fluoride in groundwater are fluoride bearing rocks such as fluorspar cryolite , fluorspatite etc excess fluoride consumption affects plants and animals. Out of six sampling stations studied in all most three samples fluoride concentration remained within the permissible limits for drinking water (S1, S4, S6). On the other hand in three samples the fluoride content is (exceeded 1.5 mg/ liter) above the permissible limits prescribed by ICMR standards.

CONCLUSION

The present status of groundwater in parts of Vinukonda, Guntur district was assessed in this study. The use of groundwater for drinking purpose from these wells has to be restricted. The rocks of this area possess fluoride content higher than the world average. Weathering of rocks and leaching of fluoride bearing minerals are the major reasons which contribute to elevated concentration of fluoride in groundwater. The other important natural phenomenon that contributes to high fluoride is evaporation. Suitable measures such as defluorinating the groundwater before use and recharging the groundwater by rainwater harvesting need to be practiced to improve the groundwater quality in this area.

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