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DETERMINATION OF FLUORIDE CONCENTRATION IN GROUND WATER OF YERRAGUNTLA AND JAMMALAMADUGU AREAS OF YSR KADAPA DISTRICT OF ANDRAPRADESH (INDIA)

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ABSTRACT

A total of twenty groundwater samples were randomly collected from different parts of Yerraguntla and Jammalamadugu areas. The fluoride content in drinking water was determined by SPANDS method using UV-VIS spectrophotometer. The results showed that fluoride concentration in the ground water of Yerraguntla ranged from 0.90-2.11 mg/L with a mean of 1.704 mg/L where as in Jammalamadugu area fluoride ranged from 0.65-1.09 mg/L with a mean of 0.85 mg/L. In these two areas most of the people use groundwater for drinking and domestic purpose. In Yerraguntla area 70% of samples contained fluoride concentration above the permissible limits of WHO. The high fluoride content in drinking water leads to dental moiety and skeletal fluorosis. So, proper defluoridation methods should be followed for the treatment of water in this area. On the other hand, in Jammalamadugu area, fluoride level in all samples was found within the permissible limits of WHO. It is suggested to check other quality parameters of ground water of this area to make suitable for drinking.

Keywords: Fluoride, Drinking water, Spectrophotometric method, Dental moiety, Defluoridation

INTRODUCTION

Ground water is one of the Nation's most important natural resources. Groundwater is the most important source of water supply for drinking, irrigation and industrial purposes. It provides about 40 percent of the Nation's public water supply. The fluoride element is found in the environment and constitutes 0.06 – 0.09 % of the earth's crust. Fluoride occurs naturally in all types of water. Typically, surface waters and seawaters have low concentration of fluoride while groundwater may contain high levels of fluoride as it may be exposed to many inorganic fluoride-containing minerals (Table-1). Fluoride pollution in the environment occurs through natural and anthropogenic sources. Fluoride is frequently encountered in mineral deposits and generally released into groundwater by slow natural degradation of fluoride bearing rocks. Fluoride distribution in groundwater depends on solubility of CaF_2 in groundwater which may be controlled by various factors like lithology, rock weathering and other chemical parameters present in groundwater, hydro chemical facies and climate of the area[1-3].

Fluoride (F^-) occurs in almost all waters from trace to high concentration.[4] It has been shown to cause significant effects in humans through drinking water[5] (Table-2). Low concentrations of fluoride in drinking water is an essential component for normal mineralization of bone, teeth and formation of dental Enamel, but excessive exposure to fluoride in drinking water can give rise to a number of adverse effects[6-9].World health organization (WHO) has set a limit value of 1.5 mg/L for fluoride in drinking water.[10, 11] There is a narrow margin between the desired and harmful doses of fluoride in drinking water[12].

Table-1: Minerals of fluoride

S.No	Mineral	Chemical Composition	Rock Type
1.	Fluorapatite	$CaF_2.3Ca_3(PO4)_2$	Pegmatite Pneumatolitic deposits
2.	Fluorite	CaF_2	Pegmatite Metamorphosed limestone
3.	Lepidolite	$K(Li, Al)_3(Al, Si, Rb)_4O_{10}(F,OH)_2$	Gabbros, Dolerites
4.	Tremolite	$Ca_2(MgFe^{+2})_5(Si_8O_{22})(OHF)_2$	Clay
5.	Rock Phosphate	$NaCa_2(MgFe^{+2})_4(AlFe^{+3})(Si,Al)_8O_{22}(OHF)_2$	Limestone, Fossils

In Andhra Pradesh, the drinking water in some areas in Prakasam, Anantapur and Kadapa districts suffering from fluoride problem[13-16]. Some parts of YSR Kadapa district are highlighted in groundwater quality problem of fluoride contamination. The Groundwater is the primary source of drinking water in most parts of the district. Geologically limestone is the most predominant rocks of the whole Kadapa area and these rocks have fluoride bearing minerals which are leached out to the ground water and contribute high fluoride concentration in the groundwater. So periodical monitoring of fluoride levels in drinking water is very essential. For the study of fluoride level in ground water, Yerraguntla and Jammalamadugu areas in YSR Kadapa district are selected**.** A total of twenty samples i.e. ten samples each from Yerraguntla and Jammalamadugu areas were collected and analyzed by an accurate, simple, rapid and cost effective ultra violet-visible (UV-VIS) Spectrophotometric method using Sodium-2-(p-Sulfophenylazo)-1, 8-dihydroxynaphthalene -3, 6-disulfonate (SPANDS) reagent.

Table-2: Concentration of fluoride in drinking water and its effects on human health

S.No.	Fluoride (mg/L)	Effect on Human Health
1	Nil	Limited growth and fertility
2	Below 0.5	Dental caries
3	0.5-1.5	Promotes dental health, prevents tooth decay
4	1.5-4.0	Dental fluorosis (mottling and pitting of teeth)
5	4.0-10.0	Dental and Skeletal fluorosis
6	Above 10.0	Crippling fluorosis

EXPERIMENTAL

Study Area

Yerraguntla municipal town (Figure-1b) in YSR kadapa district of Andhra Pradesh (Fig-1a) is located at 14.63N and 78.53E coordinates with an elevation of 152meters. This is dominantly an arenaceous consisting of conglomerate quartzite, quartzite with shale formation of dolomitic lime stones. The main factors that control the quality of water are associated with lithology and soil. Water quality may vary depending upon variations in geological formations.

Jammalamadugu (Fig.-1c) is one of the big municipalities in YSR Kadapa district in Andhra Pradesh (Fig-1a), India, which lies between 14° 83' north and 78° 40'east with an elevation of 169 meters. The town had an area of 24.83 square kilometers with a population of 46,069.The population density of the town is 1900 per square kilometer.

Many methods are available to determine the amount of fluoride ion in ground water such as alizarin method, colorimetric method, ion selective electrode method and chromatographic method[17-20]. Recently Spectroscopic methods, which are widely used in the determination of fluoride, which are based on the reaction of fluoride with colored metal chelate complexes, producing either a mixed ligand ternary complex or replacement of the ligand by fluoride to give a colorless metal fluoride complex and the free ligand[21] . In the present study, fluoride was analyzed spectrophotometrically using SPANDS as fluoride reagent.

(a) Andhra Pradesh (b) Yerraguntla (c) Jammalamadugu

Fig.-1

Apparatus

A double beam UV-Vis spectrophotometer (Spectronics-2080) was used to quantify levels of fluoride for both safety and effectiveness

Reagents and Solutions

All the chemicals were of analytical reagent grade used for preparation of solutions. SPANDS (0.958 g) was dissolved in 100 mL of distilled water and diluted to 500 mL. Zirconyl chloride octa hydrate (0.133g) was dissolved in 25 mL of distilled water and 350 mL of conc. hydrochloric acid which was further diluted to 500 mL. Equal volumes of SPANDS solution and Zirconyl acid solution are mixed. Standard fluoride stock solution was prepared by dissolving 0.221 g of sodium fluoride in water and diluted up to one liter. The stock solution was further diluted to get a series of standard solutions.

Methodology

Fluoride was analyzed spectrophotometrically using SPANDS as fluoride reagent. This method depends upon the bleaching action of fluoride on the intensity of color of the complex / lake formed between dyestuff and metal. A colored complex is formed between zirconium and SPANDS reagent. Fluoride ion reacts with dye- lake dissociating a portion of it into a colorless complex anion [ZrF_6^{2-}] and dye. The rate of reaction between fluoride ion and Zirconium ion is influenced greatly by acidity of the reaction mixture and polyvalent metal ion present in the mixture.

Suitable aliquots of sodium fluoride stock solution were pipetted out into 50 mL standard flasks. 2 ml of zirconyl acid-SPANDS reagent was added to each of these solutions. These solutions were diluted up to the mark and mixed well. The absorbance of these solutions was measured against a reagent blank and a calibration plot was constructed by plotting absorbance against concentrations using UV-VIS spectrophotometer. Suitable aliquots of water sample were taken and repeated the above process. Using the calibration curve, the concentration of fluoride was calculated.

RESULTS AND DISCUSSION

For this study, ten samples each from Yerraguntla (S-1 to S-10) and Jammalamadugu (S-11 to S-20) areas are randomly selected for fluoride analysis of the groundwater by UV-Vis Spectrophotometric method. The results showed that the fluoride concentration in Yerraguntla area ranged from 0.90-2.11 mg/L (Table-3) with a mean of 1.704 mg/L. 70% of samples in this area exceed the maximum permissible limits of fluoride (1.5 mg/L) set by WHO(Figure-2). The maximum and minimum concentrations of fluoride are observed in S-9 and S-3 respectively. In Yerraguntla area, fluoride contamination is mainly a natural process, i.e. leaching of fluorine-bearing minerals, since no man-made pollution has been noticed. Since fluorite, apatite, mica and various other minerals take part during rock–water interaction and liberate fluoride into the groundwater. The fluoride concentration above 1.5 mg/L in drinking water leads to dental fluorosis which is very common in this area. Proper

defluoridation techniques should be followed and fluoride free drinking water should be supplied for healthy world.

Table -3 Fluoride level in Yerraguntla and Jammalamadugu

Yerraguntla		Jammalamadugu	
Sample	Fluoride (mg/L)	Sample	Fluoride (mg/L)
S-1	1.9	S-11	0.65
S-2	1.96	S-12	0.97
S-3	0.90	S-13	0.72
S-4	1-71	S-14	0.71
S-5	1-49	S-15	1.09
S-6	2.04	S-16	0.55
S-7	1.27	S-17	0.88
S-8	2.01	S-18	0.94
S-9	2-11	S-19	1.09
S-10	1.58	S-20	0.90

In Jammalamadugu area, fluoride concentration ranged from 0.65-1.09 mg/L with a mean of 0.85 mg/L. The maximum fluoride concentration was observed in sample number S-15 and S-19 and the minimum concentration was observed in sample S-16. The Fluoride concentration in all samples was found within the permissible limits of WHO.

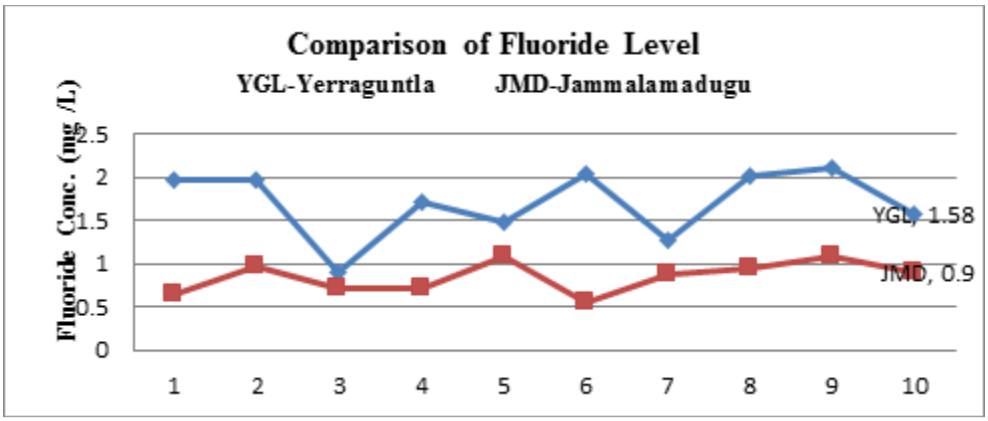

Fig.-2: Comparison of Fluoride in Yerraguntla and Jammalamadugu Area

CONCLUSION

For the determination of fluoride concentration in the study area, ten samples each from different locations of Yerraguntla and Jammalamadugu are collected and analyzed by UV-VIS Spectrophotometric method. From the data it was observed that the average fluoride concentration in Yerraguntla area was found 1.704mg/L which has exceeded the maximum permissible limit (1.5 mg/L) set by WHO. The fluoride concentration in 70% of samples was above WHO permissible limits. In the fluoride-affected areas, both children and adults suffer from health disorders like mottling of teeth, deformation ligaments, bending of spinal column and ageing problem. It is finally concluded that the Yerraguntla area need a sound fluoride management plan and proper defluorination methods should be adopted for supply of fluoride free drinking water to the public. On the other hand, in Jammalamadugu area, the average fluoride concentration was 0.85mg/L. In all samples the fluoride concentration was found within the permissible limits of WHO. It is suggested to check other water quality parameters of ground water of this area to make suitable for drinking.

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