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# ESTIMATION OF FLUORIDE AND SOME ALKALINE EARTH METAL ION LEVELS IN THE DRINKING WATERS IN RURAL AREAS OF CHICKBALLAPUR TALUKE (KARNATAKA)

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## ABSTRACT

Fluorine is one of the most common elements in the Earth's crust. Fluoride is recognized to be the most effective caries-preventive agent. The main sources of fluoride for people are generally food and drinking water. For this reason, the fluoride and also the metal ion (Ca, K, Mg, Na,) concentrations in the drinking waters collected from the rural areas of chickballapur taluke and its counties were investigated. In the determination of fluoride and of Na and K, an ion-meter with a combination-fluoride electrode and a flame photometer were used, respectively. According to the results obtained, the metal ion concentrations in the drinking waters in the studied area are within the safe drinking water regulation limits (TS 266) and also the fluoride levels (as mean 0.17 mg $L^{-1}$) are lower than the permissible limit for fluoride (0.8-1.7 mg $L^{-1}$).

**KEYWORDS:** Fluoride, Metal Ions, Drinking Water, Pre Concentration

## INTRODUCTION

Fluoride (fluorine) is a trace element. Trace elements occur in tiny amounts or traces. They play a major role in health, for even minute portions of them can significantly affect health. Since some fluoride compounds in the Earth's upper crust are fairly soluble in water, fluoride exists in both surface- and ground waters. The fluoride concentrations in groundwater fluctuate within wide limits, e.g., from <1 to 25 mg or more per liter1. Fluoride, bromide and iodide ions except for chloride are found in low concentrations in natural waters. The main source of the fluoride in waters is CaF2, which can be soluble up to 16 mg per liter at 18_C and is found in the composition of volcanic rocks. Minerals such as fluorapatite $CaF_2.3Ca_3$ $(PO4)_2$, fluorspar ($CaF_2$), cryolite $3NaF.AlF_3$ and mica also contain fluoride. Fluoride exists in volcanic gases more than in rocks.

Fluoride also is frequently added to some consumer products, such as toothpaste, toothpowder, mouthwash and vitamin supplements for various reasons At present, different opinions exist toward the Fluoridation applications in drinking waters in the world. These opinions are based on the experimental data having uncertainty as to whether fluoride has carcinogenic properties for humans, and also it is more toxic than Pb and less than $As_3$. Approximately 90% of the fluoride in the body is contained in the bones and teeth. Fluoride increases the resistivity of tooth enamel against acids which cause the initiation of tooth decay. It reduces tooth decay about 40-50% in the case of a concentration approximately of 1.0mg $L^{-1}$ in drinking water without any additional influences. When the fluoride concentration in drinking water is greater than 2 mg $L^{-1}$, it may cause fluorsis related to the concentration, to the amount of water taken up and to the amount of additional fluoride from using toothpaste and gargle, etc. When the fluoride concentration exceeds 2.4 mg $L^{-1}$, children under the age of four years must drink from another water source having a known suitable fluoride level or from water

treated with reverse osmosis. In the determination of the fluoride levels in various samples, different techniques have been used, such as Potentiometry (with fluoride sensitive electrodes) or spectrophotometry.

In the present study, the levels of fluoride and the metal ions in the drinking waters taken from rural areas of chickballapur taluke were determined potentiometrically by using the fluoride ion electrode. Also, the determination of Ca, Mg was carried out directly by titration, and that of K and Na was carried out by flame photometry.

## MATERIALS AND METHODS

### Sampling

Rural areas of chickballapur taluke and the locations at which the water samples were collected are shown in Figure 1. After the water samples were transported to the laboratory, the fluoride analyses were performed immediately 6. After the determinations of fluoride were performed, the water samples were made acidic (pH - 2) with concentrated nitric acid (64%, w/w), in order to minimize chemisorption and hydrolysis of metal ions, and preserved at $+4^0$C in a refrigerator for the metal analyses.

### Instruments and Chemicals

A Perkin Elmer 3110 model atomic absorption spectrometer with an air-methane burner was used in the Determination of the metals (, Ca, Mg, K, Na) in the drinking water samples.

The instrumental parameters recommended by the manufacturer were used throughout the experimental measurements. All pH measurements were performed using a NEL digital pH-meter with a combination electrode. The fluoride analyses were performed by using a Cole-Parmer Combination Ion Selective Electrodes, Fluoride ($F^-$) fluoride electrode25. In the determination of sodium and potassium and also the other metal ions after the preconcentration onto Amberlite XAD-16 resin, a Jenway PFP 7 model flame photometer and, except for Ca, Mg which were determined directly by titration method.

Analytical-reagent grade chemicals (Merck,) were used without further purification.

Doubly distilled water was used throughout the experiments. The glassware was kept overnight in a 5% nitric acid solution prior to being used. Fluoride stock solution (1000 µg mL−1) was prepared from sodium fluoride. Total ionic strength adjustment buffer solution contains 58 g of sodium chloride, 57 mL of glacial acetic acid, 4 g of 1,2-cyclohexanediamine-N,N,N*0*,N*0*-tetraacetic acid (CDTA) and approximately 150 mL of 6 mol $L^{-1}$ NaOH in a volume of 1000 ml (pH 5.0-5.5). At a pH below 5.0, the measurement gives low biased concentrations because of the complexation of F− by $H^+$. A high bias in the measured concentration occurs at pH values above 7.0 because of the presence of high concentrations of OH− or HCO3 −. Stock solutions of the metals (1000 µg $mL^{-1}$) were prepared by dissolving appropriate amounts as nitrate salts and diluting to 1000 ml with 1% (w/w) HNO3. The working solutions were diluted to the appropriate volume prior to being used. Sodium tetraborate solution (0.01 mol $L^{-1}$) was prepared by dissolving the appropriate amount of sodium tetraborate (Na2B4O7.10H2O) in water and completing to the mark (pH 9.1).

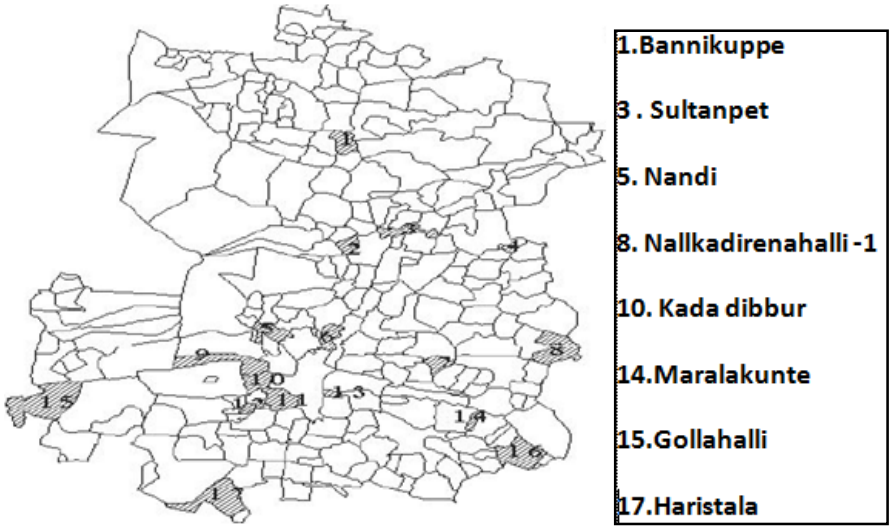


**Figure 1: Map of Rural Areas of Chickballapur Taluke and the Sampling Locations for the Drinking Water Samples**

**Determining of Fluoride in Drinking Waters**

A combination fluoride electrode was used to determine the fluoride concentrations in the drinking waters. The drinking water samples and the fluoride standard solutions were diluted 1:1 with a total ionic strength adjustment buffer solution. TISAB solution equals the ionic strength of sample and standard solutions and adjusts the pH, and also avoids interferences by polyvalent cations such as Al(III), Fe(III) and Si(IV), which are able to complex or precipitate with fluoride and reduce the free fluoride concentration in the solution. The mixed solutions were stirred with a magnetic stirrer for 5 minutes. The electrode potentials of the sample solutions were directly compared with the electrode potentials of fluoride standard solutions. A calibration curve for determining fluoride in the drinking waters, prepared by the least squares method, is given in Figure 2.

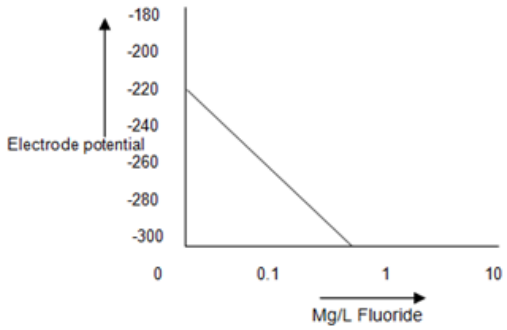


**Figure 2: A Calibration Curve for Determining Fluoride in the Drinking Waters**

## RESULTS AND DISCUSSIONS

The fluoride levels determined in the drinking water samples collected from Rural areas of chickballapur taluke villages, a total of 8 different locations, are given in Table 1. In the drinking waters in all the sampling locations, which are fed by snow originating from Nandi Hills regions, the fluoride contents were found to be lower than 0.80 mg $L^{-1}$, the minimum permissible value. As can be seen in Table 1, the highest fluoride level (2 mg $L^{-1}$,) was observed. The waters of this region probably pass through a soil or a rock layer which is a little richer in fluoride than the other regions; this may be

the reason for this high level. This region is close Nandi Hills regions (about 20 km), and the fluoride levels of the three water samples taken from this region are very close to each other. The concentrations were found to be less than or equal to 0.25 mg $L^{-1}$. In another study previously performed in the rural areas of chickballapur, the concentrations of fluoride in drinking waters were determined to be between 0.2 and 0.34 mg $L^{-1}$.

In most drinking waters in which the determination of fluoride was performed in India, the fluoride concentrations were observed to be below 2.0 mg $L^{-1.}$ According to the Indian National Standards for drinking waters, the recommended and the maximum permissible levels of fluoride are in the range of 1.0-1.5 mg $L^{-1}$. The levels of some metal ions determined in the same drinking waters are given in Table 2. In Table 2, one can see that there is no potential metal pollution for the drinking waters.

**Table 1: The Fluoride Concentrations Determined in the Drinking Water Samples (Mg L−1)**

| Sampling Location | Mean Conc. mg/ L | No of Samples | Range mg/ L |
|---|---|---|---|
| Bannikuppe | 0.39 ±0.13 | 2 | 0.35 – 0.46 |
| Sultanpet | 0.29±0.04 | 4 | 0.23 – 0.36 |
| Nandi | 0.19±0.03 | 4 | 0.17 -0.21 |
| Nallkadirenahalli | 0.56±0.02 | 2 | 0.50 -0.64 |
| Kada dibbur | 0.62±0.12 | 4 | 0.50 -0.65 |
| Maralakunte | 0.62±0.02 | 4 | 0.50 -0.65 |
| Gollahalli | 0.7±0.14 | 3 | 0.70 – 0.75 |
| Haristala | 0.73±0.10 | 2 | 0.71-0.75 |

**Table 2: The Concentration of Elements in Drinking Water Samples**

| Sample Location | Elements | No Samples | Conc. in ppm | Range in ppm |
|---|---|---|---|---|
| **Bannikuppe** | Mg | 2 | 500±60 | 600-1000 |
| | Ca | 2 | 600±55 | 600-1200 |
| | Na | 2 | 0.75±0.1 | 1-5 |
| | K | 2 | 0.62±0.13 | 1-6 |
| **Sultanpet** | Mg | 4 | 520±60 | 600-1000 |
| | Ca | 4 | 610±55 | 600-1200 |
| | Na | 4 | 0.78±0.1 | 1-5 |
| | K | 4 | 0.63±0.13 | 1-6 |
| **Nandi** | Mg | 4 | 525±60 | 600-1000 |
| | Ca | 4 | 610±55 | 600-1200 |
| | Na | 4 | 0.77±0.1 | 1-5 |
| | K | 4 | 0.65±0.13 | 1-6 |
| **Nallkadirenahalli** | Mg | 2 | 510±60 | 600-1000 |
| | Ca | 2 | 640±50 | 600-1200 |
| | Na | 2 | 0.78±0.1 | 1-5 |
| | K | 2 | 0.66±0.13 | 1-6 |
| **Kada dibbur** | Mg | 4 | 540±60 | 600-1000 |
| | Ca | 4 | 630±55 | 600-1200 |
| | Na | 4 | 0.78±0.1 | 1-5 |
| | K | 4 | 0.63±0.13 | 1-6 |
| **Maralakunte** | Mg | 4 | 560±60 | 600-1000 |
| | Ca | 4 | 650±55 | 600-1200 |
| | Na | 4 | 0.76±0.1 | 1-5 |
| | K | 4 | 0.63±0.13 | 1-6 |
| **Gollahalli** | Mg | 3 | 570±60 | 600-1000 |
| | Ca | 3 | 660±55 | 600-1200 |
| | Na | 3 | 0.74±0.1 | 1-5 |
| | K | 3 | 0.61±0.13 | 1-6 |

**Table 2: Contd.,**

| | | | | |
|---|---|---|---|---|
| **Haristala** | Mg | 2 | 580±60 | 600-1000 |
| | Ca | 2 | 650±55 | 600-1200 |
| | Na | 2 | 0.71±0.1 | 1-5 |
| | K | 2 | 0.61±0.13 | 1-6 |

## CONCLUSIONS

This study was performed at the request of the Zilla panchyath of chickballapur District. In addition to the determination of fluoride levels, the concentrations of elements such as Ca, K, Mg, and Na were measured in the same drinking waters. It was observed that the metal contents did not exceed the threshold values The results of this investigation indicate that the drinking waters in rural areas of chickballapur taluke contains sufficient fluoride content. The use of fluoride tablets for children at the age of 6 months or older (until 5 years) not required.

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