Fluoride Content in Brine Samples, Salt, and Pan Soil of Ramanathapuram, Ramanathapuram District, Tamil Nadu, India

R. Sundarakumar[1], S. Ponnusamy[2]

[1]Research Scholar, Sri Paramakalyani College, Alwarkurichi, Tirunelveli District, India

[2]Associate Professor, PG & Research Department of Chemistry, Sri Paramakalyani College, Alwarkurichi, Tirunelveli District, India

Abstract: ***This article reports the presence of fluoride in the brine samples obtained from the salt pan. Previous researches have proved that water is the main source for fluoride and suggested various defluoridation techniques. The availability of fluoride beyond a limit causes a severe disease called fluorosis. On the other hand if the level is less than the required amount then it leads to dental caries. As per the recommendations of WHO, the permissible limit is 1.5 mg/l. Here we have analyzed brine, salt and pan soil samples collected from Vandikaratheru salt pan, Ramanathapuram District. Investigation revealed that the maximum fluoride level in the brine samples was 1.6 mg/l and the minimum level in the brine samples was 1.0 mg/l. The fluoride level in salt was also studied and it was recorded to be 1.0 mg/l. During the formation of salt, there was a reduction in the amount of fluoride. Maximum fluoride got settled into the pan soil which was found to be 1.2 mg/l.***

Keywords: Salt, Pan Soil, Fluorosis. Brine. Concentration. Electrical conductivity

1.Introduction

Fluorine is the most electronegative and reactive of all elements and thus, in nature, is rarely found in its elemental state. Fluorine combines directly at ordinary or elevated temperatures with all elements other than oxygen and nitrogen [1]. Earth crust is being extremely rich in fluoride bearing minerals. Hence water is naturally fluoridated. The chief sources of fluoride in natural waters are fluoride – bearing minerals like fluorite, fluorapatite, cryolite, and apophyllite as well as fluoride ion replacing hydroxyl ion in the ferromagnesium silicates (amphiboles and micas), and soil consisting of clay minerals [2,3,4,5,6]. The optimum recommended fluoride levels vary with climate, because the average consumption of water increases in warmer climates. In cold climates, the recommended fluoride levels may be as high as 1.2 ppm while in extremely hot climates a level of about 0.7 ppm is recommended [7]. But the maximum tolerance limits of fluoride in drinking water are specified by WHO should range from 0.5 mg/l to 1.5 mg/1 [8].

The adsorption - leaching process directly affects the fluoride migration and exchange from soil to water. Water draining from fluoride containing rocks and soils can contain fluoride, at various concentrations (<0.1 to 8.0 ppm) [9,10]. The effectiveness of low fluoride intake in reducing dental caries in animals, rats, and hamsters is well documented [11]. In human populations, 1 ppm fluoride in the municipal water supply has resulted in well over a 50% reduction in the incidence of dental caries in individuals who consume it from infancy [11]. There are two types of endemic fluorosis in men and animals, which are essentially dependent on the fluoride ingested. Dental fluorosis or mottled teeth is related to the ingestion of excess of fluoride during the formative years of teeth and may or may not be later accompanied by skeletal fluorosis, depending on the amount of daily fluoride ingestion as shown in Fig.1. Most of the work on skeletal fluorosis in man has appeared since 1937 [12].

Figure 1: Bones affected by fluorosis

The mortality of the zebra mussels or mollusks rose with the increase of both fluoride concentration and exposure time. No mortality occurred in the first 24 hour at fluoride concentrations upto 360 mg/l; in the same period, 60 % of animals exposed to the 720 mg F^{-}/l died [13]. In a study at Poland which concentrates fluoride content of selected infant foods containing poultry or fish proved the presence of fluoride. Fluoride concentrations in the samples, of chicken, turkey and fish ranged from 0.12 to 1.06 mg/kg, 0.15 to 0.74 mg/kg and 1.6 to 1.44 mg/kg respectively [14]. Salt occupies an important role in our daily food material. This prompted as to investigate the presence of fluoride content in the salt.

2.Materials and Methods

The study area is located at Vandikaratheru, Ramanathapuram District in South India. The salt pan receives water form bore wells. The salt pans cover an area of 81 hectares. The brine samples were collected from the salt pan daily for a period of 7 days during the summer season (May, 2011) (Table 1). The brine samples were collected in 1 litre capacity polythene bottles. The sample bottles were initially washed with water many a time, then rinsed with de-ionized water and then with the brine samples for two to three times before collecting it for analysis. The concentration of the brine samples collected from the salt pan gradually increases due to evaporation, and finally it becomes the salt. The saline water that was released from the reservoir pond got crystallized into salt by the seventh day. The crystallized salt and pan soil were also collected for analysis. These samples were collected in a clean polythene container. For analyzing the salt, the salt was converted into a saturated solution by dissolving 390 g salt in 1 litre of the de-ionized water. Pan soil was collected by inserting a PVC pipe of 2 feet length into the soil. For analyzing the pan soil, 470 g of the same soil was dissolved in 1 litre of the de-ionized water.

2.1 Preparation of the reagent

70 mg of alizarin red S was dissolved in 50 ml of distilled water. 300 mg of zirconyl chloride octahydrate was dissolved in 50 ml of distilled water. The alizarin red S solution was poured slowly into zirconyl chloride octahydrate solution. After few minutes the solution became clear. This was called as the first solution. To a little amount of distilled water 101 ml of concentrated hydrochloric acid was added and the volume was made upto 400 ml. To this 33.3 ml of the concentrated sulphuric acid was added. The solution was cooled. The first solution was mixed with the second solution. This mixture was made upto 1000 ml in a standard measuring flask.

2.2 Analysis of Fluoride

100 ml of sample or a portion of sample was taken and diluted to 100 ml in a Nesslers tube. 5 ml of acid – zirconyl alizarin reagent was added and kept in dark. The colour standards were compared after one hour. The volume of standard fluoride which was used for comparing the colours were noted [15] and the fluoride content calculated using the formula,

$$\text{Fluoride (ppm)} = \frac{\text{Standard fluoride in ml x 50 x 100}}{\text{Sample in ml}}$$

2.3 Determination of Electrical Conductance

Electrical conductance of the water samples were carried out using conductivity meter (Systronics). The conductivity meter was calibrated using 0.01 N KCl solutions at 25°C. The conductivity cell was washed free of KCl solution by distilled water and finally with the respective samples. The electrical conductance of the different saline water samples were measured at 25°C and the result was tabulated.

3.Results and Discussion

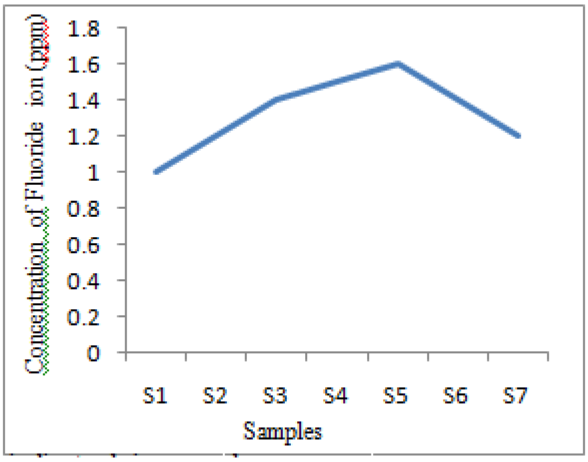
Fluoride is present in particular quantities in brine solutions, salt and pan soil. The fluoride ion concentration and electrical conductivity of the above samples were estimated / measured and are tabulated in Table 1.

Table 1: Concentration (mg/l) and electrical conductivity of fluoride ion (dS/m) in brine samples, salt and pan soil.

Sample No.	*Date of collection*	*Concentration of Fluoride (ppm)*	*Electrical conductance(dS/m)*
S1	22-05-2011	1.0	147
S2	23-05-2011	1.2	164
S3	24-05-2011	1.4	171
S4	25-05-2011	1.5	177
S5	26-05-2011	1.6	181
S6	27-05-2011	1.4	172
S7	28-05-2011	1.2	163
S8	31-05-2011	1.0	187
S9	31-05-2011	1.2	161

S_1-S_7 indicates brine samples
S_8 indicates salt sample
S_9 indicates pan soil sample

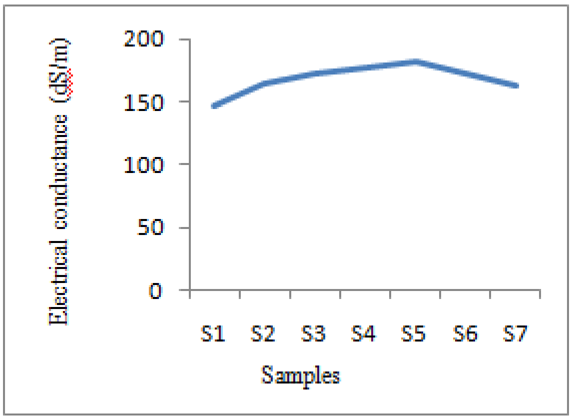
The amount of fluoride ion present in the saline water samples from Ramanathapuram salt pan were analyzed till the crystallization stage and are presented in Fig 2. From the Fig 2, in the initial stage, the concentrations of fluoride ion was low and with the progression of time of sample collection from salt pan it increased gradually and reached the maximum value (1.0 mg F/l to 1.6 mg F/l). The higher value of fluoride content gradually declined with the formation of salt during the crystallization process (1.6 mg F/l to 1.0 mg F/l).



S_1-S_7 indicates brine samples
Figure 2: Fluoride ion concentration in brine samples during crystallization stages.

During the crystallization process considerable amount of fluoride got settled in the pan soil, which was detected to be 1.2 mg F/l. In a study at Karnataka State, Basavaraddi et al proved the amount of fluoride in ground water was within the permissible limit which was found to be between 1.22 mg/l and 1.48 mg/l [16]. The levels of fluoride ion concentration in the various samples collected were also supported exactly by electrical conductivity studies which are portrayed in Fig.3.

The electrical conductivity of the brine samples measured candidly reflected a gradual increase reaching the highest value of 181 dS/m which later decreased subsequently (163 dS/m). However, on testing the pan soil, an E.C. value of 161 dS/m was recorded which could be attributed to the existence of other ions that include both cations and anions.



S_1-S_7 indicates brine samples

Figure 3: Electrical conductance of brine samples during the stages of crystallization.

4.Conclusion

It is extrapolated from the foregoing works that salt has fluoride ion content under permissible limits [8]. It is also construed that the saline waters of Ramanathapuram have high levels of fluoride initially but on crystallization the salt proceeds to possess only a limited content of fluoride making it conducive for human consumption and also from health view point, so as to avoid fluorosis.

5.Acknowledgement

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Author Profile

R. Sundarakumar has completed his M. Sc. Chemistry degree from Annamalai University, Annamalai Nagar and has completed his B. Ed. in Madras University, Madras. He has also finished his M. Phil. Chemistry in Manonmaniam Sundaranar University, Tirunelveli. He is a Research Scholar in Sri Paramakalyani College, Alwarkurichi, Tirunelveli District, Tamil Nadu, India.

Dr. S. Ponnusamy did his M. Sc. Degree in Chemistry and proceeded to get his M.Ed. and Ph.D. Degrees subsequently from Madurai Kamaraj University, Madurai. He worked for his PGDCA obtaining it from Manonmaniam Sundaranar University, Tirunelveli. He was awarded DST-SERC visiting fellowship in the year 2000. He has been visiting scientist I.I.Sc., Bangalore. His research arena includes Environmental Chemistry, Green Chemistry, and Computational Chemistry. He served as an Associate Professor at the PG and Research Centre, Department of Chemistry, Sri Paramakalyani College, Alwarkurichi, Tirunelveli District, Tamil Nadu, India.