

Fluoride Ion Concentration in Brine Solutions, Salt and Pan Soil of Veppalodai, Thoothukudi District, Tamil Nadu, India

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Abstract: The fluoride ion concentration in water samples, salt and pan soil present in the salt pans of Veppalodai, Thoothukudi District were evaluated. The variation of fluoride ion concentration in the samples were supported by electrical conductance studies. The samples were drawn in the summer season for eight days during May 2011. The fluoride content was determined using a standard procedure. The concentration of fluoride ranged between 1.0 ppm and 1.7 ppm was well within the permissible limits. The concentration of fluoride ion increased in the saline water till the start of crystallization and subsequently decreased with an increase in salt formation. During the crystallization process considerable amount of fluoride got settled into the pan soil. The electrical conductivity measurement during this investigation supported the fluoride level in the brine solution.

Keywords: Brine, Conductivity, Crystallization, Fluorosis, Saline water, Salt pan.

I. Introduction

The fluoride concentration in unpolluted sea waters generally ranges from 1.2 to 1.5 mg F/l [1],[2]. Assessments made on a F⁻ exposed group, in Arak with a non F⁻ exposed group suggest that occupational F has harmful effects on the functions of the central nervous system and can negatively affect both cognitive and psychomotor functions [3]. In a study at Iran, it was found that the mean IQ score of 91.37 of 7-9 year old children in a high F water (2.38 mg F/l) city was lower than the mean IQ score of 97.80 in a low F water (0.41 mg F/l) city [4].

According to safe drinking water quality standards, the concentration of fluoride has to be between 0.6 and 1.0 ppm in potable waters which protects the tooth decay and enhances bone developments [5]. Above 1.5 ppm, the severity of fluorosis increases [6]. In recent items the caries increase has been attributed speculatively to changes in fluid intake, including increased consumption of sweet drinks and bottled waters [7]. Excessive intake of fluoride (F⁻) causes fluorosis, which is a progressive degenerative disorder that predominantly affects the skeletal system (Fig.1), teeth and also the structure and function of skeletal muscle[8].



Fig. 1: Bones affected by skeletal fluorosis

Fluorosis originating from F⁻ in drinking water is of great concern in India. In Rajasthan, more than 50 percent of the districts are affected by high F⁻ in ground and drinking water sources [9]. Fluoride affects animals more. Oral administration of NaF for 30 days causing significant reduction in the body weight of mice has been attributed to lower food consumption resulting in decreased protein synthesis and lower energy metabolism [10]. The activities of superoxide dismutase, catalase and glutathione peroxidase on broilers were significantly lower in high F⁻ groups than those in control group [11]. In another

study, a group of rats received silymarin followed by NaF, in which silymarin has a potent ameliorative effect on NaF- induced oxidative stress in rat erythrocytes [12].

II. Materials and Methods

The study area is located at Veppalodai, Thoothukudi District in the Southern part of India (Fig. 2).

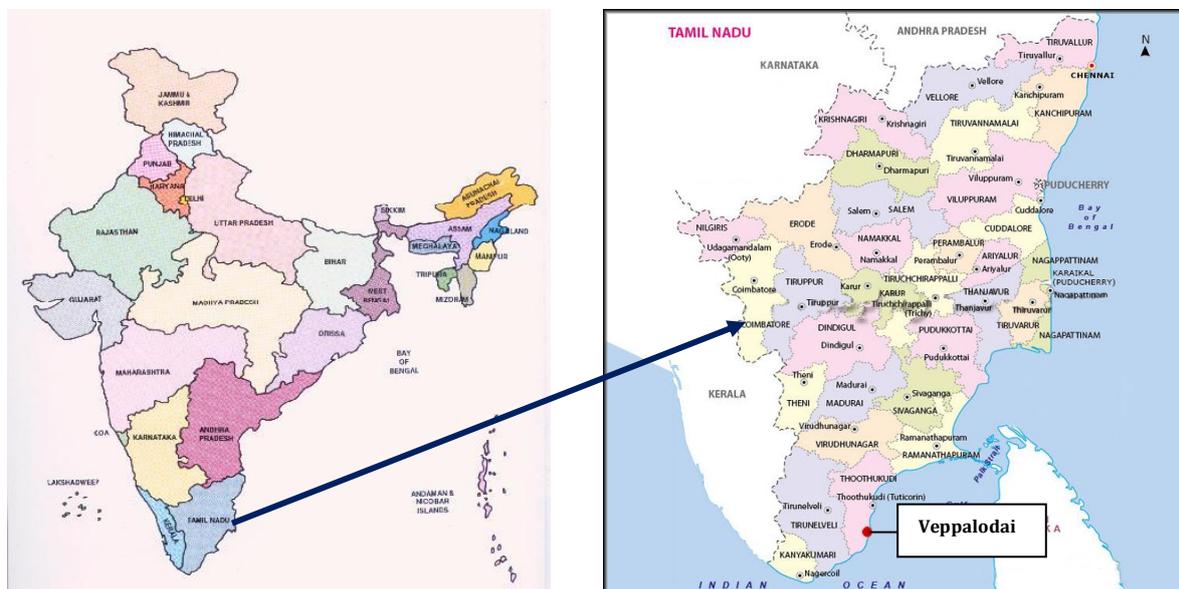


Fig. 2: Location of Veppalodai in South India

Here, the sea water salt pans cover an area of 1011.74 hectares. The brine samples were collected from the salt pan daily for a period of 7 days everyday during the summer season (May, 2011) (Table 1). The sample bottles of 1 litre capacity were first rinsed with de-ionized water and then for two to three times with the brine samples before collecting it for analysis. The concentration of the saline water in a pan gradually increases due to evaporation, and finally it becomes the salt. After the saline water was released from the reservoir pond, the salt got crystallized on the seventh day. The complete crystallized salt and pan soil were collected after its formation. The crystallized, solid salt sample was also 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-ionised 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 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 Nessler's 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 [13], and the fluoride content calculated using the formula,

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

2.3 Determination of electrical conductance

Electrical conductance of the water samples were carried out using a conductivity meter (Systronics). The conductivity meter was calibrated using 0.01 N KCl solution 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.

III. Results

Fluoride is an important component 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: Analysis of fluoride ion concentration (ppm) and electrical conductivity (dS/m) in brine samples, salt and pan soil.

Sample No.	Date of collection	Concentration of Fluoride (ppm)	Electrical conductance (dS/m)
S1	02-05-2011	1.2	149
S2	03-05-2011	1.3	156
S3	04-05-2011	1.4	166
S4	05-05-2011	1.6	173
S5	06-05-2011	1.7	179
S6	07-05-2011	1.4	159
S7	08-05-2011	1.2	146
S8	13-05-2011	1.0	188
S9	13-05-2011	1.0	197

S1-S7 indicates brine samples
 S8 indicates salt sample
 S9 indicates pan soil sample

The amount of fluoride ion present in the saline water samples available in salt pan were analyzed till the crystallization stage and are presented in Fig. 3. As seen in Fig 3, in the initial stage, the concentration of fluoride ion was low and with the progression of sample collection from salt pan daily it increased gradually and attained the maximum value (1.2 ppm to 1.7 ppm). The higher value of fluoride content gradually declined with the formation of salt during the crystallization process (1.7 ppm to 1.0 ppm).

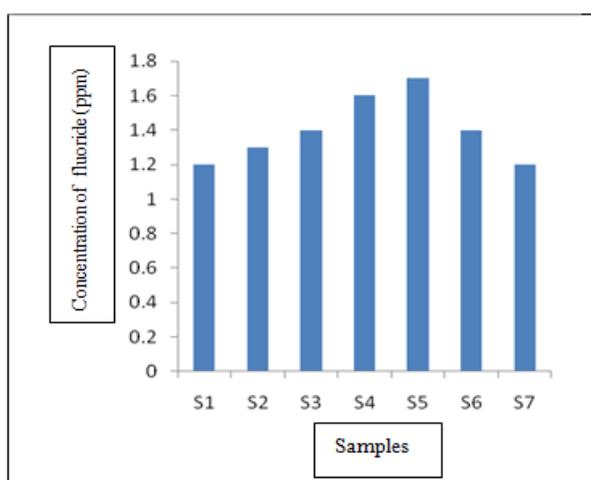


Fig. 3: Fluoride ion concentration in brine samples during crystallization stages.

During the crystallization process considerable amount of fluoride got settled in the pan soil, which was detected to be 1.0 ppm. The level of fluoride ion concentration in the various samples collected were also supported aptly by electrical conductivity studies which is portrayed in Fig. 4.

The electrical conductivity of the brine samples measured candidly reflected a gradual increase reaching the highest value of 179 dS/m which later decreased subsequently (146 dS/m). However, on testing the pan soil, the higher E.C. value (197 dS/m) recorded which could be attributed to the existence of other ions that include both cations and anions.

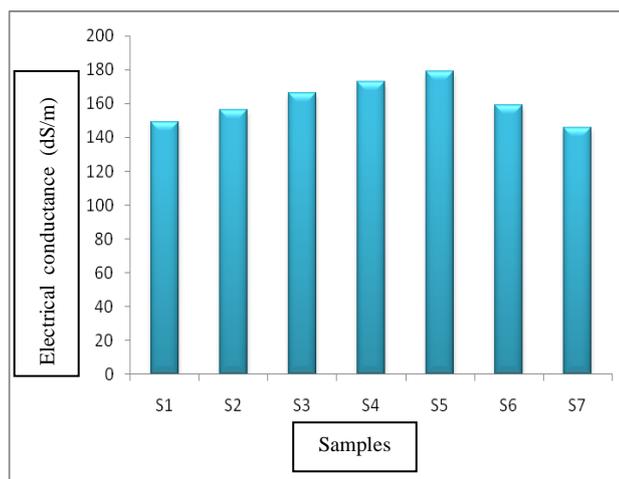


Fig. 4: Electrical conductivity of brine samples during the stages of crystallization

IV. Discussion

From the results of an analysis on ground water of Arsikere Taluk, Karnataka reported that the fluoride concentration ranged from 1.1 mg/l to 2.23 mg/l in post monsoon season [14]. In a study, they have proved the amount of fluoride in ground water was within the permissible limits, which was found to be between 1.22 mg/l and 1.48 mg/l [15].

In an analysis they have concentrated about physico-chemical characteristics of ground water and they found out the electrical conductance values in nine of their samples at pre monsoon season which was ranged between 1380 to 2400 $\mu\text{S}/\text{cm}$ at 25^oC [16]. In our samples it was found to be in the range of 1490 to 1970 $\mu\text{S}/\text{cm}$.

It is extrapolated from the foregoing works that salt has fluoride ion content under permissible limits (I.S.I. standards). It is also construed that the saline waters of Veppalodai have high level of fluoride initially but on crystallization the salt proceeds to possess only limited content of fluoride (1.0 ppm) making it conducive for human consumption and avoidance fluorosis from health view point.

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