International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org Volume 2 Issue 12 ǁ December. 2013 ǁ PP.04-07

Analysis of Fluoride in Brine, Salt, and Pan Soil of Parangipettai, Tamil Nadu, India.

Ponnusamy, S.[1], Sundarakumar, R.[2]
[1]*PG & Research Department of Chemistry, Sri Paramakalyani College, Alwarkurichi- India*
[2]*Department of Chemistry, Vivekananda Kendra Vidyalaya, Kanyakumari- India*

ABSTRACT: *In India, Tamil Nadu is one of the important states which contains large area of salt pans and large production of salt. The amount of fluoride ion concentrations in saline water samples, salt and pan soil present in the salt pans of Parangipettai, Cuddalore District were evaluated. The distribution of fluoride ion concentration in the samples were supported by electrical conductance values. The sample collections were made in summer for eight days during April 2011. The quantity of fluoride present in the samples were determined by Zirconyl – alizarin method. The concentration of fluoride in the collected samples varied from 0.8 ppm to 1.2 ppm which was generally good because the amount of fluoride in the samples were within the limit suggested by WHO, that is to be between 0.5 and 1.5 ppm. The concentration of fluoride ion increased in the samples with the earlier set of crystallization, but subsequently decreased during salt formation. During the process of crystallization a particular amount of fluoride get naturally deposited into the pan soil.*

KEYWORDS: *Concentration of fluoride, Brine solution, Salt pan, Fluorosis,, Electrical conductivity, Zirconyl-alizarin method*

I. INTRODUCTION

In sea water, the fluoride concentration generally ranges from 1.2 to 1.5 mg F/l [1,2] Fluoride is an essential micronutrient, and helps in prevention of dental caries and in the mineralization of hard tissues. The optimum fluoride level in drinking water for general good health set by WHO is considered to be between 0.5 and 1.5 mg/l [3]. Concentrations higher than this can lead to fluorosis, thereby causes a serious health problem for the population [4]. Fluorosis induced by excessive consumption of fluoride anions is a progressive degenerative disease in mammals, including humans, known to adversely affect the teeth and skeletal system [5] (Fig. 1).

Fig 1. Skeletal fluorosis in humans

Many studies have indicated that excessive fluoride can induce free radical toxicity and oxidative damage to the brain, muscle, thyroid, ovary, liver, and kidney in mice [6-10]. Communities in rural areas use water from natural sources without treatment and water monitoring is not possible because many rural areas are relatively inaccessible. Thus, especially in recent studies, it has been proposed that mere fluoride surveys should be conducted to establish the risk posed by increasing F exposure in certain communities [11]. The severity of fluoride contamination of borehole water increased with proximity to the lakes and the depth of the borehole[12].

II. DESCRIPTION OF THE STUDY AREA

The study area of Parangipettai salt pan which is in Cuddalore District, Tamil Nadu, India is named as Manambadi Parangipettai allam and located at 20 km away from Chidambaram town and 32 km from Cuddalore (Fig 2).

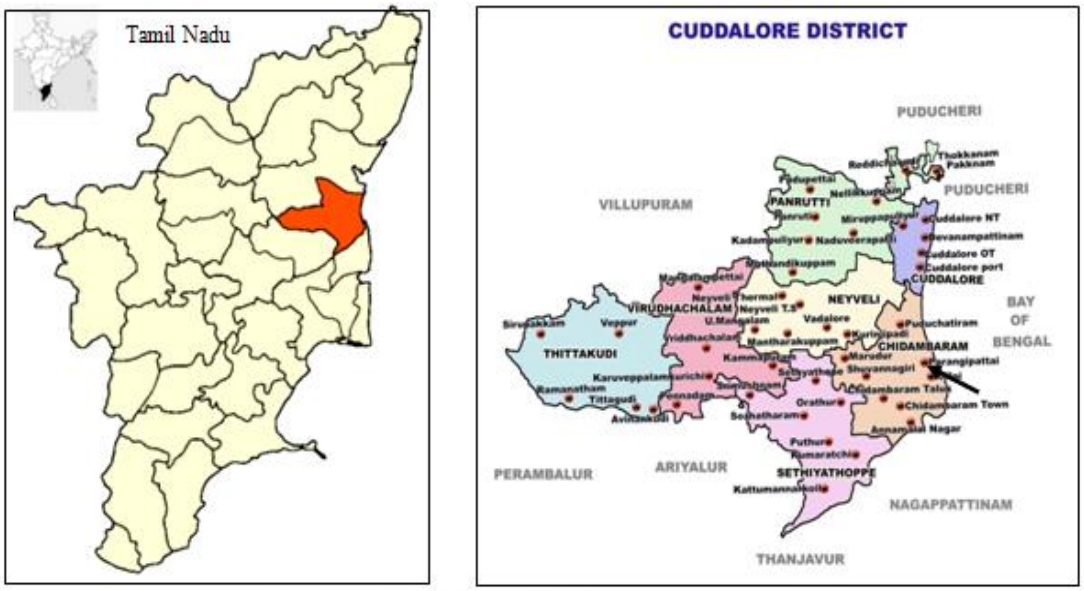


Fig 2. Location map of study area, Cuddalore District (TN)

The total area of the salt pan was 52 acres. The Parangipettai salt pan receives saline water from Bay of Bengal. The water flows through the estuary called Vellar. The length of the estuary is 4 km. From the estuary, the sea water is pumped into the reservoir. Then the saline water crosses the condenser and after crystallizer ponds and finally the salt is produced.

III. MATERIALS AND METHODS

The brine samples were collected from the salt pan daily for a period of seven (7) days during the summer season (April, 2011). The collection of samples were made in 1 litre capacity sampling polythene bottles. The sample bottles were initially washed with water, rinsed with de-ionized water and for two to three times before collecting the brine solution for analysis. Due to evaporation the concentration of the saline water in the salt pan gradually increases, and finally salt is formed. After allowing the saline water to pass into the condenser and crystallizer ponds, the salt water got crystallized on the seventh day. The perfect crystallized salt and pan soil were also collected for analysis. For the analysis of the salt, the salt was made into a saturated solution by dissolving 390 g salt in 1 litre of the de-ionized water. The pan soil was collected by a suitable technique by inserting a PVC pipe of 2 feet length into the soil. Analysis of pan soil was made by dissolving 470g of the pan soil in 1litre of the de-ionized water.

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 become 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.

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 [13] and the fluoride content calculated using the formula,

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

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.

IV RESULT & DISCUSSION

In brine solutions, crystallized salt and pan soil, fluoride ion is an important component. The fluoride ion concentration and electrical conductivity of the collected samples, were estimated/ measured and are tabulated in Table 1

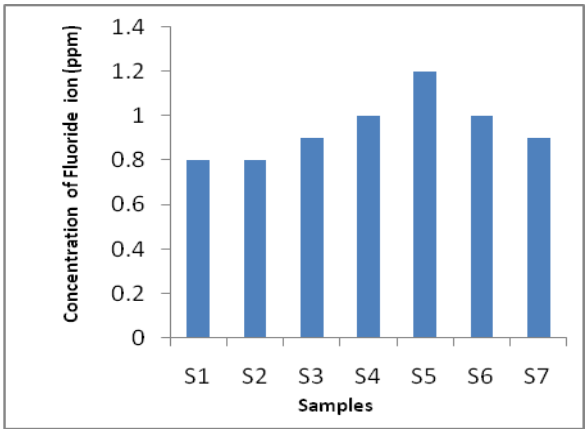
Table 1. Fluoride ion concentration (ppm) and electrical conductivity (ds/m) in brine samples, salt and pan soil.

Sample No.	Date of Collection	Concentration of Fluoride ion in ppm	Electrical Conductance (ds/m)
S1	21-04-2011	0.8	149
S2	22-04-2011	0.8	155
S3	23-04-2011	0.9	164
S4	24-04-2011	1.0	169
S5	25-04-2011	1.2	173
S6	26-04-2011	1.0	161
S7	27-04-2011	0.9	158
S8	30-04-2011	0.9	179
S9	30-04-2011	0.9	184

LEGEND

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

The amount of fluoride ion present in the saline water samples of salt pan were analysed till the crystallization stage and are presented in Fig.3. It is seen from Fig.3, that 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 (0.8 ppm to 1.2 ppm). The higher value of fluoride content gradually declined with the formation of salt during the crystallization process (1.2 ppm to 0.9 ppm).

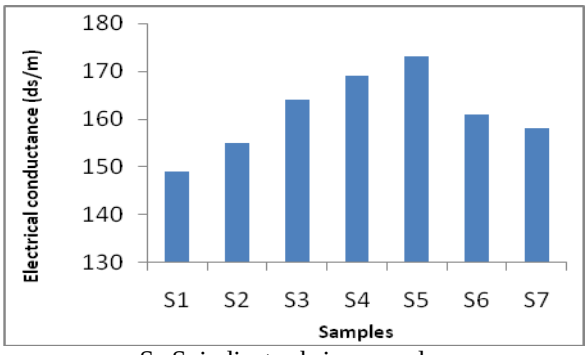


S_1-S_7 indicates brine samples

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

During the formation of salt, fixed amount of fluoride get settled in the pan soil and it was estimated to be 0.9 ppm. The level of fluoride ion concentration in the various samples collected were also supported aptly by electrical conductivity studies which is displayed in Fig 4.

The electrical conductivity of the brine samples measured candidly reflected a gradual increase reaching the highest value of 173 ds/m which later decreased ensuingly (158 ds/m). However, on testing the pan soil, the higher E.C.value (184 ds/m) recorded which could be attributed to the existence of other ions that included both cations and anions.



S_1-S_7 indicates brine samples

Fig 4. Fluoride ion concentration in brine samples during the crystallization stages

IV. CONCLUSION AND RECOMMENDATION

It is vivid from the foregoing works that the crystallized salt has fluoride ion content under permissible limits [3]. It was also seen that the brine solutions of Parangipettai have high levels of fluoride initially, but after crystallization they come to possess only permitted level of fluoride making it conducive for human consumption and thereby the avoidance of fluorosis from health view point.

V. ACKNOWLEDGEMENT

The authors are thankful to Mr. Ramamoorthy, Chief of the Manambadi Parangipettai allam, Cuddalore District, Tamil Nadu, Southern part of India.

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