

A COMPARATIVE STUDY OF THE FLUORIDE ION CONCENTRATION OF THE VARIOUS STAGES OF SALT PRODUCTION PROCESS OF SELECTED SALTPANS OF TAMILNADU, INDIA.

Leema Rose G., Anitha Malbi, M and Y. Christabel Shaji, Department of Chemistry, Holy Cross College (Autonomous), Nagercoil

ABSTRACT

An investigation was made on the fluoride concentration of the brine and the salt samples of the four saltpans - two from Kanyakumari district, SP1 and SP2 and two from Tuticorin district, SP3 and SP4-, Tamil Nadu. A gradual increase in concentration was noticed in the first two stages and then decreased. Further evaporation leads to an increase in fluoride concentration. The salt harvested has low values of fluoride concentration than that recommended by WHO.

Keywords: Saltpan, Fluoride, Salt

1. Introduction

Common salt (Sodium Chloride) is one of the best known minerals and the first substance after water to have attracted human attention¹. While salt is not made but harvested, seawater the inexhaustible substance constitutes the raw material for the production of salt in the solar saltpans. In solar saltpans a series of shallow, concentrating and crystallizer ponds of 20-30 cm depth are used for the evaporation of brine. As evaporation proceeds different salts present in the brine get separated depending upon their solubility. After the separation of sodium chloride, the supernatant liquid called bittern is drained off. Thus the technique of solar salt production involves the fractional crystallization of salts, a process based on the varying solubility in different ponds to obtain sodium chloride in the purest form possible.²

Salt is produced from sea water and sea water is found to contain almost all elements including fluorine. Common salt is an edible commodity needed by the living realm of the biosphere and contamination of the salt with fluoride, ion above the permissible limit leads to dangerous consequences. That is an optimum level up to 1ppm, it is an essential ingredient for development of teeth and bones.³ High intake of fluoride concentration results in excessive calcification which in turn leads to brittleness of bones, stiffness of joints and soft tissues.⁴ Though voluminous literature is available on fluoride contamination in water, there is limited scientific work carried out with regard to fluoride ion in brine and salt samples in salt production process. Hence it is proposed to assess the fluoride ion concentration in the different stages and the salt samples harvested from

the four saltpans; two from Kanyakumari district and two from Tuticorin district, Tamil Nadu, India.

2. Materials and Methods

The present study was carried out over a period of one year from July 2011 to June 2012. Brine samples were collected monthly from the different stages of the salt production process such as source, reservoir, condenser, crystallizer and bittern and salt samples from all the four salt pans, Kovalam (SP1), Puthalam (SP2) from Kanyakumari district and Vepalodai (SP3), Sahupuram (SP4) from Tuticorin district. Analysis of brine and salt samples for fluoride concentration was carried out using Fluoride ion selective electrode, ORION Fluoride electrode in combination with the direct combination readout specific ion meter (Model : ORION 720 A)⁵.

3. Results

The mean concentration of fluoride ion at the different stages of salt production like source, reservoir, condenser, crystallizer, bittern and the salt samples from the four saltpans SP1, SP2, SP3, and SP4 is tabulated in Table I and graphically represented in Fig 1.

It was observed that among the four salt pans, maximum fluoride content was noticed in SP2 (0.081 ± 0.1 mg/L) where the water is estuarine (Puthalam).

Minimum fluoride concentration 0.44 ± 0.002 mg/L was recorded in SP4 Sahupuram.

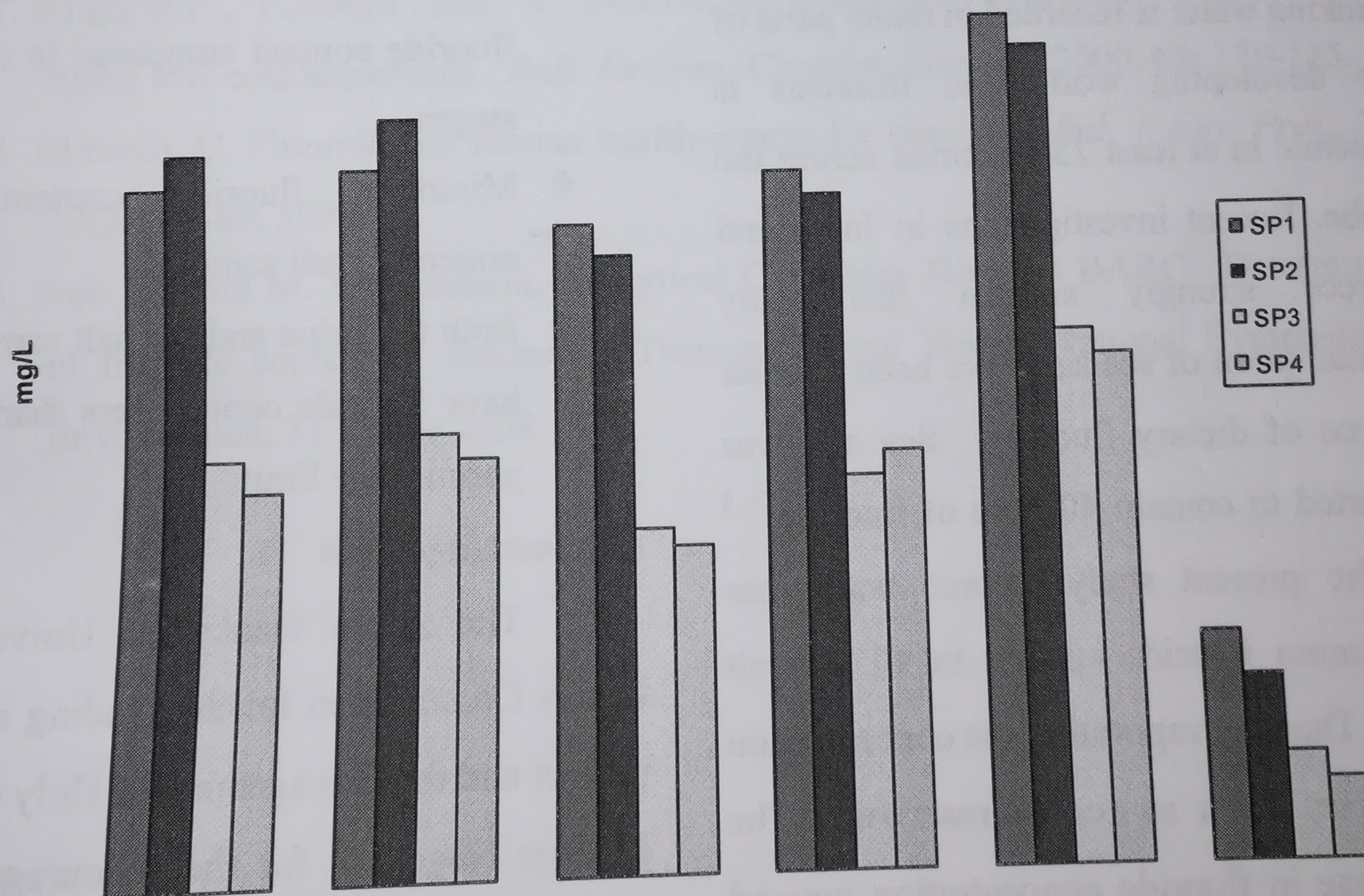
In the case of reservoir all the saltpans show an increase in fluoride concentration and SP2 recorded the maximum mean value 0.89 ± 0.03 mg/L. Minimum mean value 0.48 ± 0.01 mg/L was recorded in SP4. The brine in the condenser pond registered lesser fluoride content compared to reservoir and the minimum mean value 0.37 ± 0.01 mg/L is noticed in SP4.

In the case of condenser all the saltpans show a decrease in fluoride concentration and SP2 recorded the maximum mean value 0.76 ± 0.01 mg/L. Minimum mean value 0.37 ± 0.01 was registered by SP3. The brine in the condenser ponds registered lesser fluoride content compared to source and reservoir. In the crystallizer ponds all the four saltpans recorded higher fluoride content than the condensers. The maximum mean value 0.82 ± 0.01 was recorded in SP1 and the minimum mean value (0.45 ± 0.02 mg/L) in SP3. Bittern samples recorded higher mean fluoride concentration than the crystallizers. Among the bittern samples, SP1 sample recorded the maximum mean value of 1.01 ± 0.01 mg/L and the minimum mean value 0.59 ± 0.02 mg/L was registered in SP4.

Table 1-Variation of Fluoride concentration (mg/L) at different stages of salt production process

Stages	SP1	SP2	SP3	SP4
Source	0.81 ± 0.1	0.85 ± 0.2	0.48 ± 0.2	0.44 ± 0.02
Reservoir	0.83 ± 0.3	0.89 ± 0.3	0.51 ± 0.3	0.48 ± 0.01
Condenser	0.76 ± 0.1	0.72 ± 0.3	0.39 ± 0.01	0.37 ± 0.01
Crystallizer	0.82 ± 0.1	0.79 ± 0.02	0.45 ± 0.02	0.48 ± 0.03
Bittern	1.01 ± 0.1	0.97 ± 0.02	0.62 ± 0.02	0.59 ± 0.02
Salt	0.26 ± 0.01	0.21 ± 0	0.12 ± 0.01	0.09 ± 0.1

Fig-1 Variation of Fluoride concentration at different stages of salt production process



Surprisingly low values of fluoride content were noticed in salt samples harvested from the four saltpans. The salt sample from SP4 recorded the minimum mean value of 0.09 ± 0.1 mg/L and the sample from SP1 recorded the maximum mean value 0.26 ± 0.01 mg/L.

4. Discussion

Fluoride is a binary compound found in water, air and soil. At an optimum level it is needed for the development of teeth and bones. Fluoride has a direct effect in phosphate and calcium metabolism.⁶ According to WHO, the maximum allowed concentration (MAC) of fluoride in drinking water is 1.5 mg/L which is universally accepted. In warm climatic regions the value should be < 1 mg/L and in colder regions it may go up to 1.2 mg/L. High fluoride content in drinking water is recorded in many parts of the developing world and fluorosis is endemic in at least 25 countries across the globe. Recent investigations in India and Greece strongly suggest that daily consumption of sea salt have been another source of dietary fluoride. Sea salt was reported to contain 40 ppm of fluoride.^{7, 8} In the present study, source water has maximum fluoride content in all the salt pans. During evaporation the concentration increases from source to reservoir⁹. The decrease in fluoride concentration noticed

in the condenser ponds was due to the deposition of CaF_2 , a less soluble salt along with Gypsum¹⁰ $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. The subsequent increase in the concentration of fluoride in the crystallizer and bittern is due to further evaporation which leads to much reduction in volume and not due to any other precipitation¹¹. The salt samples harvested have very low values of fluoride content, which may be due to the deposition of fluoride in the condenser and crystallize ponds too. Celtic sea salt has a fluoride content of 19 ppm¹². Sea salt from other regions is reported to have fluoride content of 40 ppm¹³ which is higher than that reported in the present study.

Conclusion

- ❖ All the stages of salt production process carry fluoride ion.
- ❖ Source samples carry maximum fluoride content compared to other stages.
- ❖ Minimum fluoride content is noticed in salt samples.
- ❖ Both the brine and the salt samples have fluoride content less than the permissible limit

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