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STUDY OF SEASONAL VARIATION IN PHYSICO-CHEMICAL PROPERTIES OF
BRINE SAMPLES FROM SAMBHAR LAKE, RAJASTHAN

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ABSTRACT

Sambhar Lake is one of largest inland salt water lakes situated in Rajasthan, India. Brine samples were collected from one of the crystallization ponds of the Sambhar Lake during summer, rainy and winter seasons from May 2013 to January 2014. A total of 12 physico-chemical parameters were analyzed for the brine samples. Minor seasonal variations in pH and sodium concentration were observed, however considerable differences were observed in total dissolved and suspended solids, specific conductance, organic solids, nitrogen, magnesium, potassium, chloride and bicarbonates concentration. It was interesting to find variations among all the parameters in samples collected during summer, winter and rainy season. Most of the parameters showed highest concentration in summer, while the parameters like pH, total suspended solids, organic solids and bicarbonates were maximum in rainy season. This study of physical conditions and chemical composition of the brine in the crystalline ponds can help in the understanding of the existence of the phylogenetic variations and occurrence of the halophilic organisms in the crystallization ponds of the Sambhar Lake.

Keywords- *Crystallization pond, halophiles, physico-chemical, Sambhar Lake, seasonal variation.*

I. INTRODUCTION

Rajasthan is the abode for the largest inland saline lake of India, Sambhar Lake. It is of glacial origin and is also a wetland of international importance (Kumar, 2008). The main rivers that feed the water to the lake are Mendha (from south), Rupangarh (from north), Kharian and Khandel (Gaur and Mohan, 2014). Most of the salt production of Rajasthan comes from Sambhar Lake, with nearly 196,000 tonnes per year (about 9% of total salt production in India). It is an important bird area, being a key wintering destination for thousands of flamingoes and other migratory birds from Northern Asia, which feed on the specialized algae and bacteria growing in the lake. These microorganisms also impart striking colors to the brine and support the lake ecology. The lake has a unique diversity of flora and fauna including the brine shrimp *Artemia salina*, *Sevellestheria sambharensis*, alga *Dunaliella salina* and bacteria like *Serratia sambhariana* (Kumar, 2008). The present study was undertaken to assess seasonal variations in the physicochemical characteristics of water samples from the lake, which would give an insight into the reasons influencing the quality of the salt and microbial diversity of the lake. They will also influence the biotechnological potentials of the microorganisms inhabiting the lake (Ventosa *et al.*, 1998). The objective of this study was to understand the seasonal variations of the brine samples collected from one crystallization pond of Sambhar Lake considering different physico-chemical parameters that might affect the diversity of the halophilic microorganisms in this lake.

II. METHODOLOGY

a. Collection of brine samples

The brine samples were collected from one of the solar crystallization ponds of Sambhar Lake, Rajasthan. These samples were collected from surface at a distance of 10 feet from the shore in containers pre-sterilized with 70% ethanol. Sampling was done from May 2013 to January 2014, in summer, rainy and winter seasons respectively.

b. Analysis of physical parameters

Samples were analyzed for various physical parameters including different environmental and abiotic factors. pH and specific conductance of the brine samples were measured at the time of sampling using Combo pH/ Conductivity/ TDS Tester (Hanna Instruments, HI 98130) but total dissolved solids (TDS) and total suspended solids were determined as per *protocols* of the bureau of Indian Standards (BIS) for water and waste-water: IS:3025 part 16 (1984, Reaffirmed 2006) and 17(1984, Reaffirmed 1996) respectively. Estimation of organic matter was carried out by standard method (Maiti, 2001).

c. Analysis of chemical parameters

Samples were analyzed for various chemical parameters using standard protocols of Bureau of Indian Standards as shown below:

S. No.	Parameters	Protocols
1	Total nitrogen	BIS:3025 part 34, 1988 reaffirmed in 2009
2	Sodium and potassium	BIS:3025 part 45, 1993 reaffirmed in 2003
3	Chloride	BIS:3025 part 32, 1988 reaffirmed in 2007
4	Organic solids	BIS:3025 part 18, 1984 reaffirmed in 2002
5	Bicarbonate	BIS:3025 part 51, 2001 reaffirmed in 2006

Magnesium was measured using inductively coupled plasma-mass spectrometer (ICP-MS). In the present study, brine samples were randomly sampled from the crystallization pond from Sambhar Lake. While sampling, special attention was taken to procure samples in triplicate from the same sampling site of the same pond. Samples (0.5 g) of each type of brine were digested in Teflon tubes with nitric acid and hydrogen peroxide in the ratio 5:1. All samples underwent pressurized digestion in a microwave-heated system (SINEO microwave, China). The heating programme was conducted in three steps of different timescales [130°C for 10 min., 150°C for 5 min. and 180°C for 25 min. at a pressure of 0.2 MPa; total time 40 min] and at constant power supply of 400 W. The final extract was filtered in 50 ml volumetric flasks and diluted to the mark with Milli Q water. The samples were digested along with the reagent blank in duplicates. The content of magnesium obtained from ICP-MS analysis (mg/l) was converted into mg/kg using Temminghoff and Houba’s formula:

$$\frac{\{(a-b) \times v\}}{w}$$

where “a” is the concentration of the magnesium in the sample digest (mg/kg), “b” the concentration of the magnesium in the blank digest (mg/l), “v” the total volume of the digest at the end of the digestion process (ml) and “w” is the weight of the samples (g). Counts were recorded and analyte concentration was calculated with Plasma lab software (Debnath *et al.*, 2015).

d. Statistical analysis of the results

The data from the season wise brine samples were analyzed in triplicate and evaluated for equality of their mean values± standard deviation.

III. RESULTS AND DISCUSSION

a. Physical parameters of brine samples

The pH was alkaline, ranging between 8.83 and 9.11 for the brine samples during all the seasons. However, pH was more alkaline in rainy season with a mean value of 9.11 as compared to 8.83 and 9.04 in summer and winter seasons respectively. Total dissolved solids (TDS) were lowest in winter season and highest in summer season. Total suspended solids were highest in rainy season and lowest in winter season for all the samples. Specific conductance for all the samples was lowest in rainy season and highest in summer. The amount of organic solids was found to be lowest in winter season in all the samples. The results of physical analysis of brine samples have been summarized in Table 1.

b. Chemical parameters of brine samples

The results of chemical parameters of the brine for summer, rainy and winter seasons from Sambhar Lake have been summarized in Table 1. Sodium and potassium were found to occur in small concentrations in all the seasons (Table 1), and are mainly responsible for the salinity of the lake (Meena, 2017). These cations contribute to conductivity in brine samples (Hollister *et al.*, 2010). High concentrations of magnesium have been found in summer and rainy season but were lower in winters. Presence of magnesium salts from waters of Sambhar Lake has also been reported by Meena, 2017. Divalent cations including magnesium and calcium are reported in most hypersaline environments studied (Oren, 2006). There was no variation in chloride content in different seasons. It has been quoted as one the dominant ions in hypersaline ecosystems and also to play a role in production of bacteriorhodopsin (Kerker, 2004). Concentration of bicarbonates was highest in summer season as compared to winter and rainy seasons. Alkalinity has been attributed to the presence of bicarbonates (Joshi, 2008). This gives a clear correlation of the high alkalinity with high bicarbonate content in the rainy season in the crystallization pond. This explains the occurrence of extreme haloalkaliphilic archaea in Sambhar Lake as reported by Upasani (2008).

Most of the parameters showed a higher value in summer, while lowest values in rainy season. However, pH was slightly more alkaline in rainy season while it was least alkaline in summer season. This may be due to excessive evaporation leading to concentration of the brine during summers while dilution during rainy season.

Table 1: Seasonal variations for the physical parameters of the brine samples from Sambhar Lake, Rajasthan

S.No.	Parameter	Summer season	Rainy season	Winter season
1	pH	8.83 ± 0.06	9.11 ± 0.18	9.04 ± 0.16
2	Total dissolved solids, (g/L)	5.4 ± 0.14	1.54 ± 0.07	0.357 ± 0.18
3	Total suspended solids, (mg/L)	32.87 ± 1.20	137.0 ± 1.86	6.9 ± 1.44
4	Specific conductance (mS/cm)	187472 ± 31.16	101300 ± 51.58	135000 ± 46.14
5	Organic solids (mg/L)	15760.44 ± 54.98	22260 ± 68.62	1320 ± 41.24
6	Total nitrogen (mg/L)	5.28 ± 2.54	3.49 ± 1.46	2.07 ± 1.48
7	Sodium (%)	1.97 ± 0.74	0.72 ± 0.18	1.02 ± 0.41
8	Potassium (%)	0.78 ± 0.02	0.35 ± 0.07	0.39 ± 0.04
9	Magnesium (mg/L)	4687.9 ± 3.96	2034.7 ± 2.68	155.84 ± 2.34
10	Chloride (mg/L)	165.99 ± 5.92	60.50 ± 37.00	98.64 ± 28.08
11	Organic matter (%)	4.53 ± 1.16	1.86 ± 0.08	2.96 ± 0.05
12	Bicarbonate (mg/L)	12.61 ± 0.98	31.3 ± 1.78	11.09 ± 0.66

Data represented as mean values± standard deviation

IV. CONCLUSION

The composition of the brine and sediments of the crystallization ponds gives a clear indication of the halophilic population in this saltern, Sambhar Lake. Looking to the geographic location of Sambhar Lake, where summer is too hot and winters are comparatively colder, it was interesting to study the seasonal variations of the brine samples from the same crystallization pond to understand the phylogenetic diversity and variable occurrence of the halophilic microorganisms in the lake. During our study, a maximum total dissolved solid, specific conductance, organic matter, nitrogen content and sodium, potassium, magnesium, chloride concentrations were observed in brine solution in summer season. Moderate concentration of all these parameters were noted in the winter season while pH, total suspended solids, organic solids and bicarbonates were highest in the rainy season. Further study on sampling from different crystalline ponds of brine and sediments can give a deeper understanding of the halophilic population and ecology of Sambhar Lake.

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