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Role of Osmolytes Under Saline Stress in *Oscillatoria Willei*

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ABSTRACT
The present study was conducted to understand the role of osmolytes under saline stress. In order to determine the role of osmolytes the *Oscillatoria willei* was treated with different concentrations of NaCl viz., 0.2, 0.4, 0.6 and 0.8M, besides control over a period of 30 days. It was found that, β-carotene and glycine betaine was noticeably increased upto 0.6 M and thereafter declined, whereas proline content increased with increase in NaCl concentrations. The results exhibited that, adaptation of the alga to salinity was characterized by the accumulation of osmolytes like β carotene, glycine betaine and proline. It was attributed that proline accumulation may be one of the major mechanisms of salinity tolerance by the alga.

Keywords : - *Oscillatoria,* NaCl, Osmolytes, Proline, Glycine betaine, β-carotene

I. INTRODUCTION

Salinity is one of the important limiting factors for agricultural productivity. It not only reduces the yield but also makes land infertile. In response to different abiotic stresses such as high salinity, dehydration, cold, heat and excessive osmotic pressure cells develop many adaptive strategies. Cells adapt themselves by undergoing changes in morphological and developmental pattern as well as physiological and bio-chemical processes (Bohnert et al 1995). Accumulation of several organic solutes and osmolytes is one of the strategy associated with stress adaptation. Osmolytes protect the cellular enzymatic activities under salinity stress and are called compatible solutes. Algae inhabit a wide variety of habitats, both marine and freshwater. These habitats differ in various factors such as chemical composition, the organisms that live there, the light, the temperature etc. One factor that varies from environment to environment is the salinity. The ability of cells to survive and flourish in saline environment under the influence of osmotic stress has received considerable attention. Hence, the present work mainly concentrates on how the alga copes up with the changes in salinity and how they use different osmolytes to carry out this process.

Therefore, in the present investigation an attempt has also been made to understand the role of osmolytes under saline stress in *Oscillatoria willei.*

II. MATERIALS AND METHODS

The organism used in the present study i.e., *Oscillatoria willei* BDU 141621 was obtained from National Facility for Marine Cyanobacteria (NFMC) Tiruchirapalli. ASN III medium at pH 7.5 was best suitable for the growth of the alga in the laboratory. Axenic cultures were maintained at temperature of 26±20 C. Further to study the impact of NaCl the experiments were carried out in 250 ml conical flasks, contained 100 ml of ASN III medium. The cultures were treated with different concentrations of NaCl such as 0.2, 0.4, 0.6 and 0.8M besides control. The samples were drawn periodically during growth (10th , 20th and 30th day) from control and different concentrations of NaCl were subjected for the analysis of β- Carotene, Glycine betaine and Proline, contents of *Oscillatoria willei*. β-carotene was estimated according to the method of Jenson (1978). The proline contents in the samples were determined by the method of Bates (Bates *et al*., 1973). Estimation of Glycinebetaine was made according to the method of Grieve and Grattan (1983).

III. RESULTS

The alga *O. willei* treated with different concentrations of NaCl viz., 0.2, 0.4, 0.6 and 0.8 M over 10, 20 and 30 days revealed increase in β-carotene contents with maximum of 112, 125 and 137 µg/g at 0.6 M but it was found to be decreased with minimum of 41, 48 and 62 µg/g at 0.8 M for all the cultures(Table and Fig 1). The glycine betaine contents also increased with maximum of 157, 172 and 181 µg/g at 0.6 M but it was found to be decreased with minimum of 108, 120 and 131 µg/g at 0.8 M for all the cultures (Table and Fig 2). The most distinctive change noticed during the study was drastic increase in the proline contents with increase in NaCl concentrations with maximum of 121, 142 and 168 µg/g 0.8 M for all the cultures (Table and Fig 3).

IV. DISCUSSION

Our results on β carotene and glycinebetaine contents of *O. willei* exposed to different concentrations of NaCl exhibited gradual increase up to 0.6 M thereafter showed decrease in all the cultures over all the durations. whereas proline increased with increase in the concentration of NaCl.

Similarly, in *Nostoc* and *Hapalosiphon* Reddy *et al.* (2003) observed enhancement in the of β carotene with increase in the concentrations of NaCl. It has been suggested that β carotene is an important source of provitamin –A amongst cyanobacterial strains. Earlier investigators suggested that, yield of β carotene was maximum at an intermediate salinity (Borowitzka and Borowitzka, 1988). Rao *et al.* (2007) observed increase in the β carotene content in *Botryococcus brunii* at higher salt concentrations. Similarly increase in the glycinebetaine has been observed by Gabbay-Azaria *et al.* (1988) in *Spirulina subsala* and Surasak *et al.* (2010) in *Aphanothece halophytica.* According to Reed *et al.* (1984) glycinebetaine is characteristically found in most of the cyanobacteria under inhospitable conditions including *Aphanotheca halophytica* and *Synechocystis* DUN 52. Several previous studies indicated the accumulation of the amino acid proline in microalgae (Greenway and Setter, 1979; Ahmad and Hellebust, 1988; Kalinkina and Naumova, 1992; Bartels and Nelson, 1994; Singh *et al.,* 1996) and macroalgae (Edward *et al.,* 1987, 1988) in response to elevated salinity. It has been reported that proline increases the stress tolerance of the plants through osmoregulation, protection of enzymes against denaturation and the stabilization of protein synthesis.(Kuznetsov and Shevyakova, 1997). According to Levitt (1980) salt stress inhibits growth and protein synthesis preventing the utilization of proline and thus leading to its accumulation.

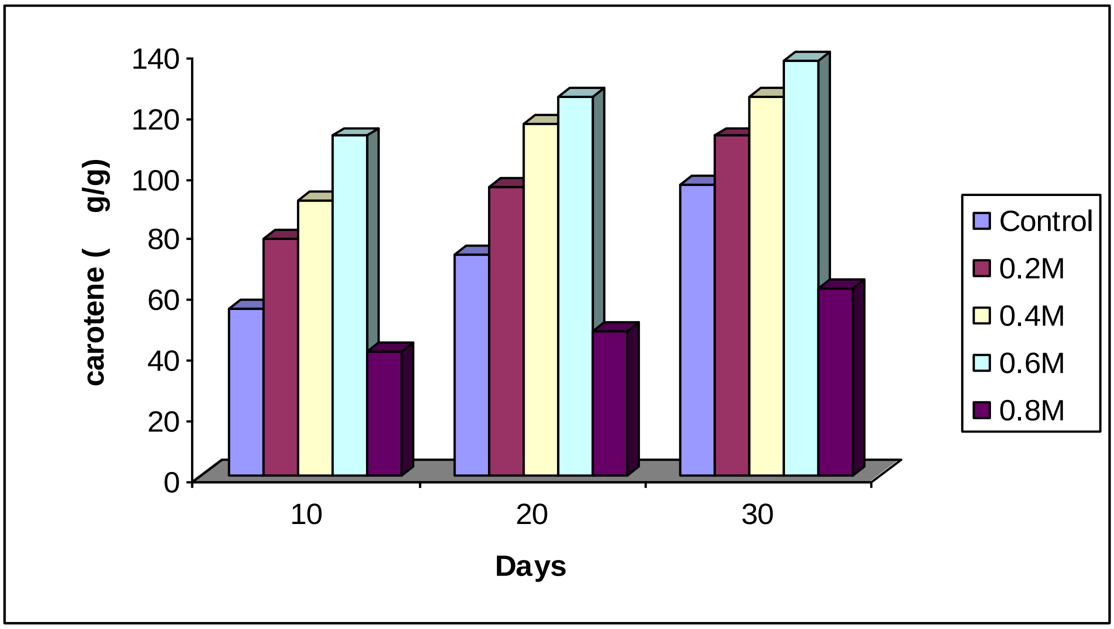
V. CONCLUSION

The present study exhibited that, adaptation of the alga to salinity was characterized by the accumulation of osmolytes like β carotene, glycine betaine and proline. It was attributed that proline accumulation may be one of the major mechanisms of salinity tolerance by the alga.

Table - 1: Effect of different concentrations of NaCl on β carotene contents of Oscillatoria willei.

NaCl con. (M)	β carotene (μg/g)		
	10 days	20 days	30 days
Control	**55.0 ± 0.03**	**73.0 ± 0.01**	**96.0 ± 0.04**
0.2	**78.0 ± 0.02**	**95.0 ± 0.06**	**112.0 ± 0.02**
0.4	**91.0 ± 0.04**	**116.0 ± 0.04**	**125.0 ± 0.03**
0.6	**112.0 ± 0.02**	**125.0 ± 0.02**	**137.0 ± 0.02**
0.8	**41.0 ± 0.04**	**48.0 ± 0.02**	**62.0 ± 0.04**

Fig-1 : Effect of different concentrations of NaCl on β carotene contents of *Oscillatoria willei*



Table–2 : Effect of different concentrations of NaCl on Glycinebetaine contents of *Oscillatoria willei*

NaCl con. (M)	Glycinebetaine (µg/g)		
	10 days	20 days	30 days
Control	**81.0 ± 0.02**	**95.0 ± 0.02**	**105.0 ± 0.01**
0.2	**120.0 ± 0.01**	**131.0 ± 0.03**	**145.0 ± 0.02**
0.4	**143.0 ± 0.03**	**154.0 ± 0.02**	**170.0 ± 0.01**
0.6	**157.0 ± 0.02**	**172.0 ± 0.01**	**181.0 ± 0.03**
0.8	**108.0 ± 0.01**	**120.0 ± 0.01**	**131.0 ± 0.01**

Fig-2**:** Effect of different concentrations of NaCl on Glycinebetaine contents of *Oscillatoria willei*

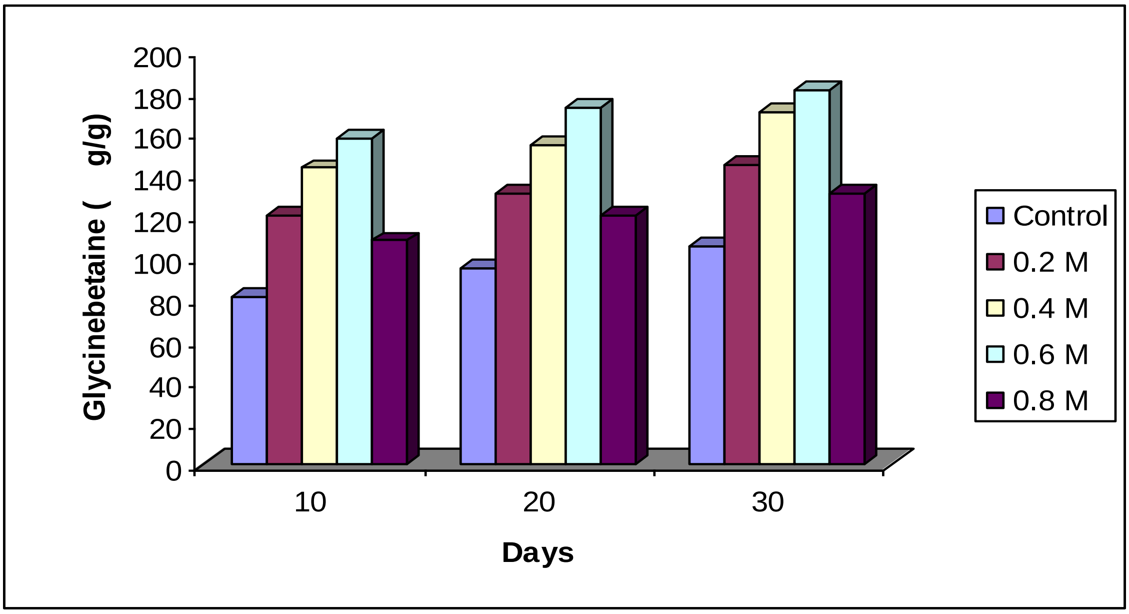
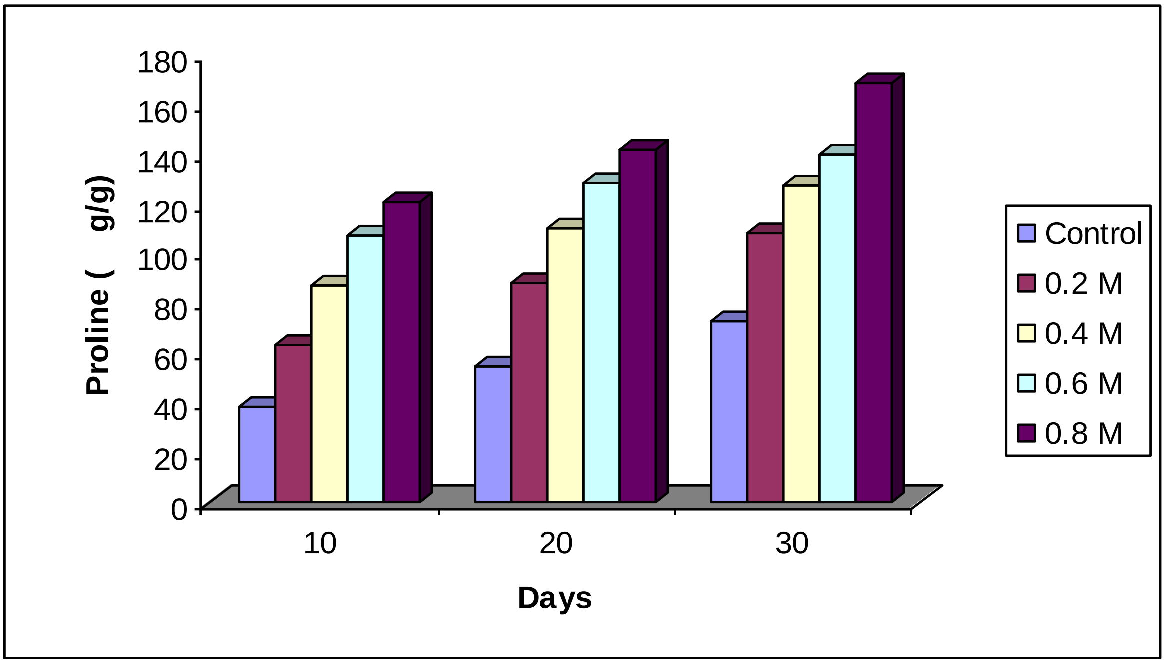


Table-3 : Effect of different concentrations of NaCl on proline contents of *Oscillatoria willei*

NaCl con. (M)	Proline (µg/g)		
	10 days	20 days	30 days
Control	**38.0 ± 0.02**	**55.0 ± 0.01**	**73.0 ± 0.01**
0.2	**63.0 ± 0.04**	**88.0 ± 0.02**	**108.0 ± 0.03**

0.4	**87.0 ± 0.01**	**110.0 ± 0.01**	**127.0 ± 0.04**
0.6	**107.0 ± 0.03**	**128.0 ± 0.02**	**140.0 ± 0.02**
0.8	**121.0 ± 0.01**	**142.0 ± 0.01**	**168.0 ± 0.03**

Fig-3 : Effect of different concentrations of NaCl on proline contents of *Oscillatoria willei*



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