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The Impact of NaCl on the Uptake of Minerals in *Chlorella vulgaris*

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ABSTRACT

In the present study, the impact of NaCl on the uptake of mineral uptake in *Chlorella vulgaris* was investigated. The study examined how different NaCl concentrations influence the absorption of key minerals such as sodium, potassium and calcium in *Chlorella vulgaris*. In order to evaluate the effect of NaCl, the alga was treated with different concentrations (0.1-0.4M) of NaCl, besides control. The study revealed that Chlorella vulgaris exposed over 30 days to different concentrations indicated that NaCl significantly alters the uptake of these minerals. The results indicated increase in the uptake of minerals such as Na+ and K+ in all the concentrations of NaCl over all the durations while uptake of Ca+2 was found to be inhibited at all the concentrations of NaCl. These findings helps in understanding the role of salt stress on uptake of minerals and provide insights into the ability of *Chlorella vulgaris* to take up potassium even under high salinity levels suggests a potential strategy for osmoregulation in the presence of excess sodium ions. The significant reduction in calcium uptake may be due to alterations in membrane permeability and enzyme activities essential for mineral transport.

Keywords : *Chlorella,* Na+ , K + and Ca+2 , NaCl

INTRODUCTION

Algal species have the capability to survive in extreme salinities by developing resistance against osmotic pressure in saline water. Due to their capacity to tolerate osmotic pressure-algae grow naturally at various salinities. Both halotolerant freshwater algae and marine algae can survive at high salinities. The soil is the main pool of essential mineral nutrients. These nutrients are building blocks of plant biomolecules and play fundamental roles in cell processes and involved in various enzymatic reactions. High concentrations of NaCl apparently inhibits the growth more by ionic (Na^+) stress than by osmotic stress (Brownell and Nicolas, 1967). Hence the present study was conducted to understand the impact of NaCl on uptake of minerals in *Chlorela vulgaris*

MATERIAL AND METHODS

The *Chlorella vulgaris* Beijerinck was isolated from the garden soil of Gulbarga University, Gulbarga. De's modified Beneck's medium was best suited for the growth of *C. vulgaris* in the laboratory. Axenic cultures were maintained at temperature of 26 ± 2oC. Further to investigate the effect of NaCl, the experiments were carried out in 250 ml conical flasks, contained 100 ml of De's modified Beneck's basal medium. The exponentially growing algal suspension was centrifuged and inoculated in the flasks containing different

concentrations of NaCl such as 0.1, 0.2, 0.3 and 0.4 M besides control and kept for observation to 30 days. The samples were drawn periodically during growth (10th, 20th and 30th day) from control and different concentrations of NaCl and were subjected for the analysis of the impact of NaCl on uptake of minerals in *Chlorella vulgaris.* Estimation of mineral uptake by the alga was done by Atomic Absorption Spectrophotometer (AAS) method (Sawhney and Singh, 2002).

RESULTS

The results shown that the alga *C. vulgaris* when treated with different concentrations of NaCl viz., 0.1, 0.2, 0.3 and 0.4M over 10, 20 and 30 days exhibited increase in sodium with 8.24, 9.92 and 11.17 µg/mg at 0.4M for all the cultures (Table 1 & Fig.1).. Similarly the study exhibited increase in potassium with 11.01, 11.54 and 12.64 µg/mg at 0.4M for all the cultures (Table 2 & Fig.2). However it is curious to note that *C. vulgaris* exhibited decrease in the calcium with minimum of 0.24, 0.36 and 0.45 µg/mg at 0.4M for all the cultures (Table 3 & Fig.3).

DISCUSSION

The present results demonstrated that, NaCl-induced differential effect on the uptake of minerals in *Chlorella vulgaris*. The uptake of sodium and potassium appeared to increase at all the concentrations of NaCl, whereas calcium uptake was declined at all the concentrations of NaCl. These effects likely result from osmotic stress, ion competition, and changes in the physiological state of the algal cells.

Similarly earlier studies also reported that, under salinity algae usually accumulate several ions including Na^+ K^+ and Cl^- and organic metabolites to maintain constant turgor pressure. In general, it is considered that the significant accumulation of these ions is an efficient way for marine algae to counteract osmotic changes when suffering changed salinity (Lee and Liu, 1999). According to Krist (1990) when the algae exposed to salinity changes, the movement of water occurs first followed by ion flexes for the maintenance of constant cell turgor by regulating osmotic potential; monovalent ions including Na^+, K^+ and Cl^- are the main ionic osmolytes contributing to the osmotic adjustment. As reported earlier, high intracellular sodium concentrations was toxic to most biological system (Wyn Jones and Gorham, 1983). Patel *et al.* (2011) found significant increase in the Sodium content in tissues in response to salinity. Strizh *et al.* (2004) found increase in the concentrations of K^+ at higher concentrations of NaCl *Tetraselmis viridis.* It has been suggested that the increased NaCl concentration in the growth medium increases the intracellular K^+ concentration. This indicates that K^+ accumulation is a mechanism for osmoregulation in the adaptation of the alga to salt (Blumwald *et al*., 1983). Shieh and Barber (1971) have reported preferential accumulation of K^+ over sodium in *Chlorella.* Lee and Lue (1999) have reported that Na^+ might replace the cell wall associated Ca^{+2} or in turn decreases the availability of Ca^{+2} in *U. fasciata* exposed to high NaCl conditions.

CONCLUSION

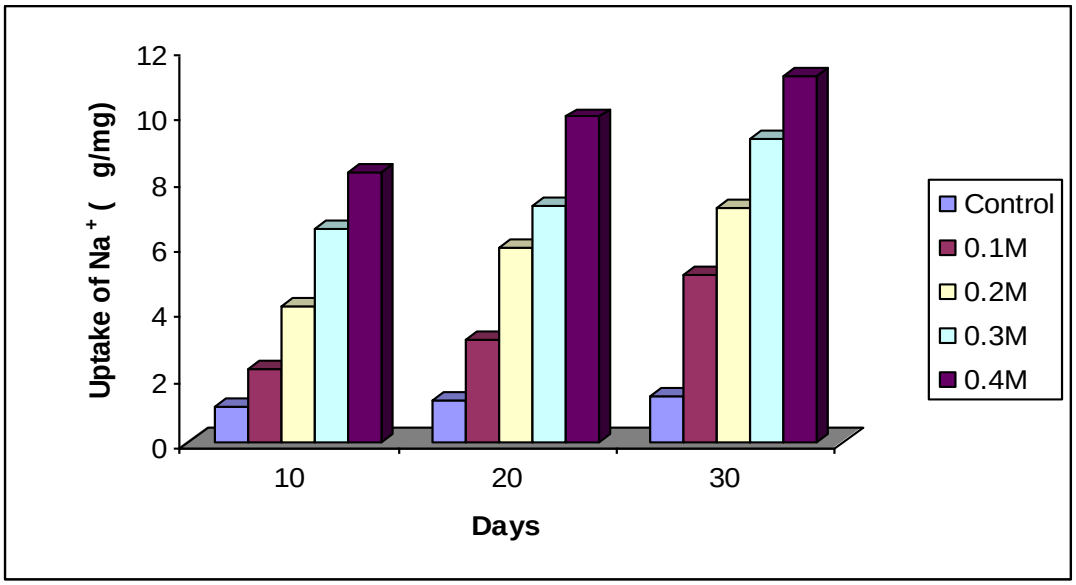
The present study speculated that the ability of *Chlorella vulgaris* to take up potassium even under high salinity levels suggests a potential strategy for osmoregulation, as potassium is essential for maintaining cell

turgor and osmotic balance in the presence of excess sodium ions. The significant reduction in calcium uptake may be due to alterations in membrane permeability and enzyme activities essential for mineral transport.

Table–1: Effect of different concentrations of NaCl on uptake of Na^+ by Chlorella *vulgaris*

NaCl con. (M)	Uptake of Na^+ (µg/mg)		
	10 days	20 days	30 days
Control	**1.111± 0.37**	**1.287 ± 0.60**	**1.427 ± 0.21**
0.1	**2.247 ± 0.27**	**3.143 ± 1.36**	**5.127 ± 1.02**
0.2	**4.157 ± 0.56**	**5.927 ± 1.65**	**7.157 ± 1.42**
0.3	**6.533 ± 1.36**	**7.231± 1.63**	**9.243 ± 1.96**
0.4	**8.241 ± 1.65**	**9.920 ± 2.62**	**11.17 ± 2.08**

Fig–1: Effect of different concentrations of NaCl on uptake of Na^+ by Chlorella *vulgaris*

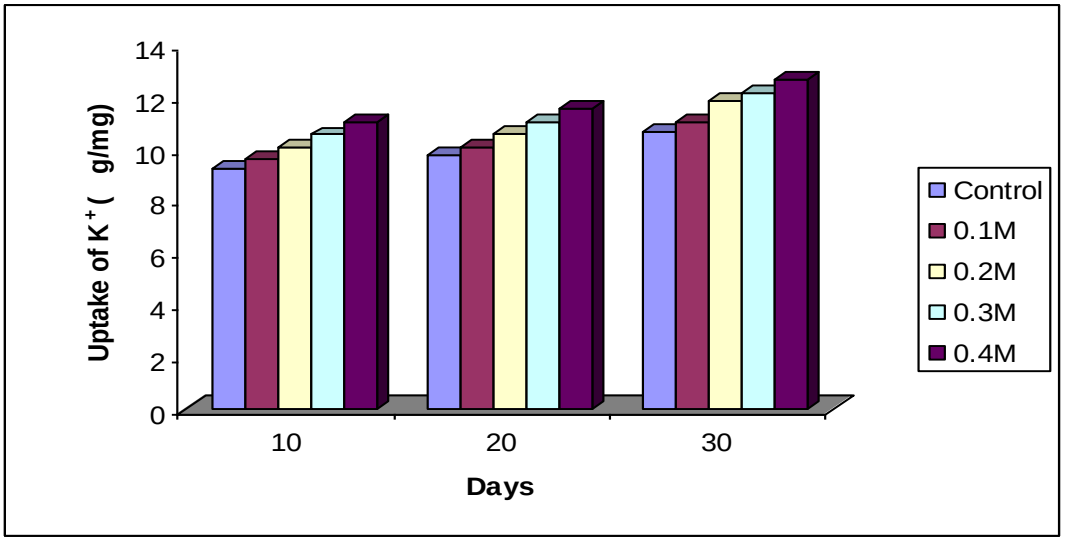


Chlorella vulgaris

Table–2: Effect of different concentrations of NaCl on uptake K^+ by *Chlorella vulgaris*

NaCl con. (M)	Uptake of K^+ (µg/mg)		
	10 days	20 days	30 days
Control	**9.23 ± 2.40**	**9.78 ± 2.71**	**10.64 ± 2.89**
0.1	**9.57 ± 2.74**	**10.02 ± 2.80**	**11.01 ± 2.62**
0.2	**10.07± 2.33**	**10.57 ± 2.81**	**11.83 ± 2.36**
0.3	**10.53 ± 2.80**	**11.02 ± 1.68**	**12.14 ± 2.09**
0.4	**11.01 ± 2.62**	**11.54 ± 2.62**	**12.64 ± 1.59**

Fig–2: Effect of different concentrations of NaCl on uptake K^+ by *Chlorella vulgaris*

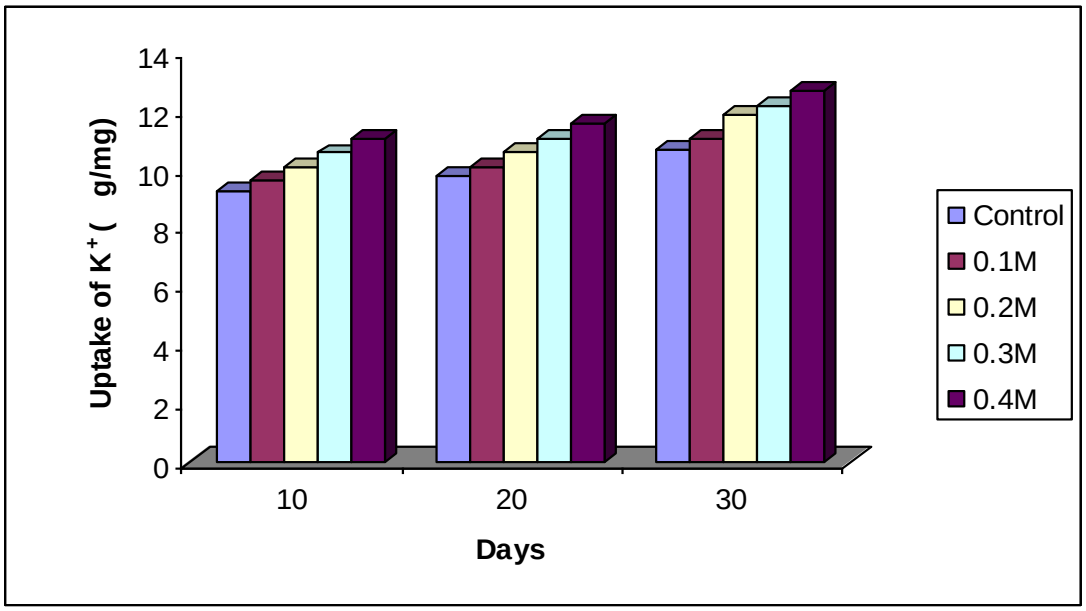


Chlorella vulgaris

Table–3: Effect of different concentrations of NaCl on uptake of Ca^{+2} contents of *Chlorella vulgaris*

NaCl con. (M)	Uptake of Ca^{+2} (µg/mg)		
	10 days	20 days	30 days
Control	**2.04 ± 0.98**	**2.40 ± 0.92**	**2.83 ± 1.08**
0.1	**1.35 ± 0.85**	**1.49 ± 0.90**	**1.56 ± 0.89**
0.2	**1.04 ± 0.65**	**1.24± 0.72**	**1.41 ± 0.82**
0.3	**0.53 ± 0.32**	**0.74 ± 0.29**	**0.82 ± 0.25**
0.4	**0.24± 0.76**	**0.36 ± 0.27**	**0.45 ± 0.03**

Table–3:Effect of different concentrations of NaCl on uptake of Ca^{+2} contents of *Chlorella vulgaris*



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