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The effect of salinity on organic components of *Excoecaria agallocha* L.

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ABSTRACT: The present report is about the growth of the seedlings of *Excoecaria agallocha* in different concentration of NaCl. The observation shows that the accumulation of ions and organic components such as starch and protein increased with increasing salt concentration upto optimal level (200 mM NaCl) and decreased at higher concentration. Aminoacids and total sugar decreased with increasing concentrations of NaCl upto optimal level and increased at higher concentrations. NaCl promoted chlorophyll and carotenoid synthesis upto the optimal concentrations of 200 mM. The plant can able to tolerate upto 300 mM NaCl concentration but the optimal growth of the seedlings were observed in 200 mM NaCl concentrations.

Introduction

Mangrove forest forms an unique community in tropical coastal regions and tidal lowlands (Takemura *et al.,* 2000). They fall into two groups according to their habitats in nature: true mangroves and mangrove associates. True mangroves refer to the species that specially grow in intertidal zones while mangrove associates are capable of occurring in both littoral and terrestrial habitat, such as *Hibicus tilisaceus* and *Excoecaria agallocha* (Lin, 2001and Wang *et al.*,2003). *Excoecaria agallocha* L. is a latex bearing tree/shrub growing at fringes; landward hard soil. Latex was highly irritant to eyes, causing blisters on skin. Aerial root was not prominent. Leaves are simple, alternate, elliptical and leaf tip was acute and narrow at base. Flowers were unisexual and fragrant. Seed was subglobose belonging to the family Euphorbiaceae. The growth and physiological mechanism of mangroves differ in nature due to their complexity of structure and differences in flooding regime, tidal inundation, rapid influx of extra nutrients as well as type of soil (Clough, 1984; Naidoo, 1987).

Soil salinity directly affect plant growth through osmotic stress and ionic toxicity caused by Na^+, Cl^- and So_4 which may promote imbalance in plant nutrient metabolism (Rowell, 1994; Ghafoor, 2004). Salinity can damage the plant through its osmotic effect, which is equivalent to a decrease in water activity, through specific toxic effects to ions and by disturbing the uptake of essential nutrients (Lauchli and Epstein, 1990; Marschner 1995; Dorais *et al.*, 2001). In general, enzymes and metabolic activities in plants are highly influenced by both amount and type of salts (Flowers *et al.*, 1977).

Materials and Methods

About 200 Plants of uniform sized seedlings were collected from mangrove belt of Pichavaram, Tamilnadu. These seedling were washed thoroughly with tap water and planted in the polythene sleeves (9" × 7"). They were filled with homogenous mixture of garden soil consisting of red earth, sand and farmyard manure in the ratio of (1:2:1). The uniform sized seedlings were selected and kept in to plots and treated with various concentration of NaCl ranging from 0 (control) to 300 mM. The control plants were maintained without the addition of sodium chloride. After completion of salt treatment, the seedlings were irrigated with tap water samples were collected 60th day after salt treatment and (a) Total free amino acids - Moore and Stein (1948), (b) Total sugar – Nelson (1944), (c) Starch - Summner and Somers (1949), (d) Protein - Lowry *et al.*, (1951), (e) Proline - Bates *et al.*, (1973), (f) Glycinebetaine - Grieve and Grattan (1983), and (g) Chlorophyll – Arnon (1949) were analysed.

Result

The decreased aminoacid and sugar with -21.8% and -23.4% with increased concentration upto 200 mM NaCl and thereafter both the content increased gradually. The highest accumulation of starch and protein was 14.40% and 28.30%. The proline and glycinebetaine increased with increasing concentration upto extreme level of 300 mM and this was 147.52% and 36.31% higher when compared to control. NaCl treatment stimulated the chlorophyll synthesis in the leaves of *Excoearia agallocha* represented in the Table-1 and Fig-1. The total chlorophyll increased with increasing salinity upto 200 mM and at higher concentrations, there was a sharp decrease in chlorophyll. However, even at the extreme salinity (300 mM), the leaf chlorophyll was as much as that of control plants.

Discussion

Amino acid and Sugar of *Excoecaria agallocha* significantly decrease with increasing concentrations of NaCl upto 200 mM. Similar observation has been made in other halophytes such as *Salicornia europaea* (Shamsutdinov *et al.*, 1995), *Ipomoea pes- caprae* (Venkatesan and Chellappan, 1998) and *Helleochloa setulosa* (Joshi *et al.*, 2002). Rao and Rao (1981) have reported that certain halophytes under moderate salinity accumulate free amino acids and it is believed to be in response to changes in the osmotic adjustment of cellular content and the increase in the amino acid at higher salinity level may be due to degradation of protein. Under severe salinity stress, the decrease in sugar content can be either due to high respiration or a decrease in photosynthetic activity accompanied by reduction in growth rate. An increasing sugar content and corresponding decrease in the starch at higher salinities have been reported in several halophytes (Prado *et al.*, 2000; Joshi *et al.*, 2002; Ashraf and Hanis, 2004). Potassium ions may also play an important role in starch metabolism. Potassium has been reported to enhance photosynthesis (Peoples and Koch, 1979) and active starch metabolism (Hawker *et al.*, 1979). The increase in starch may due to increase in the nitrogen content, which plays as important role in photosynthesis. (Cook and Evens, 1983). Increase in protein is associated with the decrease in the amino acids content under moderate salinity and a reverse trend is noticed at higher salinity ranges. Protein synthesis responses dramatically to environmental stress such as heat stock (Key *et al.*, 1982) and anaerobiosis (Sachs, 1980) and salt stress (Ericson and Alfinito, 1984) have also been shown to increase the net synthesis of protein. A substantial increase in the proline content is noticed with increasing NaCl concentration upto 300 mM.

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Fig: 1 – Effect of NaCl on organic components of *Excoecaria agallocha*

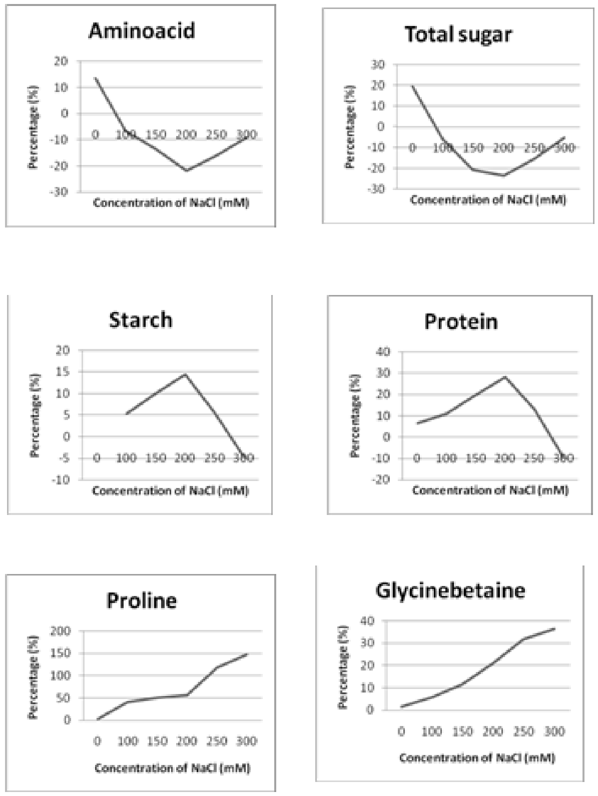

Table 1. Effect on NaCl on organic components of *Excoecaria agallocha* (whole plant mg g^{-1} fr.wt.)

Concentration of NaCl (mM)	**Aminoacid**	**Total sugar**	**Starch**	**Protein**	**Proline**	**Glycinebetaine**	**Total Chlorophyll**
Control (0)	13.64	19.5	18.46	6.43	3.43	1.366	0.555
100	12.74 (-6.59)	18.33 (-6.00)	19.46 (+5.41)	7.15 (+11.19)	4.82 (+40.52)	1.444 (+5.710)	0.784 (+41.26)
150	11.81 (-13.41)	16.69 (-20.81)	20.32 (+10.07)	7.71 (+19.91)	5.18 (+51.02)	1.521 (+11.34)	0.905 (+63.06)
200	10.67 (-21.77)	14.92 (-23.48)	21.12 (+14.40)	8.25 (+28.30)	5.36 (+56.26)	1.654 (+21.01)	0.961 (+73.15)
250	11.49 (-15.76)	16.49 (-15.43)	19.47 (+5.47)	7.27 (+13.06)	7.49 (+118.36)	1.791 (+31.55)	0.901 (+62.34)
300	12.4 (-9.09)	18.5 (-5.12)	17.61 (-4.60)	5.82 (-9.49)	8.49 (+147.52)	1.862 (+36.31)	0.523 (-5.76)

(+/-) Percent of increase or decrease over control are in parentheses

Plants accumulate proline and other soluble nitrogenous compounds under salinity stress, in order to maintain osmoregulation (Abbas *et al*., 1991). Salt tolerance has been associated with the capacity of a species to accumulate proline which acts as an intracellular osmoticum (Zidan, 1995). Besides functioning as osmoregulatory agent proline is reported to protect various enzymes in the cytoplasm (Wrench *et al*., 1977). It has been suggested that the proline accumulation is primarily due to the stimulation of proline biosynthesis (Bhul and Stewart, 1983) by an increase of pyrolin-5-carboxylate reductase activity and a decrease in the proline dehydrogenase activity (Delauney and Verma, 1993). The glycine betaine content shows a parallel increase with proline with increasing salt concentration. Glycinebetaine like proline is hypothesized to function in osmoregulation of the cytoplasmic compartment of cell as an osmoprotectant of protein and its accumulation in a well documented metalobic feature exhibited by many halophytes (Marcum, 1995; Bohnert and Jenson, 1996). The result suggest that a wide range of NaCl salinity does not inhibit the chlorophyll synthesis. Even at the extreme salinity 300 mM, Chlorophyll content is equal to that of control plants. A positive effect of NaCl salinity on the chlorophyll synthesis has been reported in the halophytes *Sesuvium portulacastrum* (Venkatesan *et al*., 1995); *Bruguiera cylindrical* (Oswin *et al*., 1994); *Rhizophora apiculata* (Das *et al*., 1995) and *Halopeplis perfoliate* (Al-Zaharani and Hajar, 1998). The present investigation indicates that optimal salinity neither affects protein pigment lipid complexes nor the chlorophyllase activity.

References

Abbas, M.A., M.E. Younis and W.M. Shukry,1991. Plant growth, metabolism and adaptation in relation to stress condition. XIV. Effect of salinity on the internal solute concentrations in *Phaseolus vulgaris, J Plant Physiol*., **138**: 722-727.

Al-Zaharani, H.S. and Hajar, 1998. Salt tolerance on the halophyte *Halopeplis perfoliata* (Forsk.). Bge. Ex. Schweint: Effect of NaCl salinity on growth and ion uptake. *Indian J. Plant Physiol*., **3**: 32-35.

Arnon, D.I., 1949. Copper enzymes in isolated chloroplast, polyphenol – oxidase in *Beta vulgaris*. *Plant Physiol*., **24**: 1- 15.

Ashraf. F. and P.J.C. Harris, 2004. Potential biochemical indicators of salinity tolerance in plants. *Plant Science*, **166**: 3-16.

Bates, L.S., R.P. Waldren and I.D. Teare, 1973. Rapid determination of the free proline in water stress studies. *Plant and soil*, **38**: 205 – 208.

Bhul, M. B. and C.R. Stewart, 1983. Effect of NaCl on proline synthesis and utilization in excised barley leaves. *Plant Physiol*., **72**: 664-667.

Bohnert, H.J., and R.J. Jenson, 1996. Metabolic engineering for increased salt tolerance. The next shap: Comment. *Aust. of Plant Physiol*., **23**: 661- 666.

Clough, B.F. 1984. Growth and salt balance of the mangroves *Avicennia marina* (Forssk.) Vierh and *Rhizophora stylosa* Griff. In relation to salinity. *J. Plant Physiol*.**11**: 419-430.

Cook, M. G. and L. T. Evans, 1983. Some physiological aspects of the domestication and improvement of rice (*Oryza sativa*). *Field Crop Res*., **6**: 219-238.

Das, N., M. Misra and A.N. Misra, 1995. Sodiun chloride salt stress induced metabolism cahangse of pearl millet (*Pennisetum americanum* L.) free solute accumulation. *J. Plant physiol*., **137**: 244-246.

Delauney, A. J. and D. P. S. Verma, 1993. Proline biosynthesis and osmoregulation in plants. *Plant J*., **4**: 215-223.

Dorais, M., Papadopoulos, A.P., Gosselin, A., 2001. Greenhouse tomato fruit quality. *Hortic. Rev.* **26**, 239 – 319.

Ericson, M.C. and S.H. Alfinito, 1984. Proteins produced during salt stress in tobacco cell culture. *Plant Physiol*., **74**: 506 – 509.

Flowers, T. J., Troke, P.F, and Yeo, A.R. 1977. The mechanism of salt tolerance in halophytes.Ann. Rev. *Plant Physiol*. **28**: 89-121.

Ghafoor, A., M. Qadir and G. Muartaza, 2004. Salt- affected Soils Principles of management.1st . Edn. Allied Centre Urdu Bazaar, Lahore, Pakistan.

Grieve, C.M. and S. R. Grattan, 1983. Rapid assay for determination of water soluble quaternary ammonium compounds. *Plant and soil*, **70**: 303-307.

Hawker, J. S., H. Marschner and A. Krawss, 1979. Starch synthesis in developing potato tubers. *Plant Physiol*., **46**: 25-30.

Joshi, A, J., A. Sagar Kumar and H. Heriglajia, 2002. Effects of sea water on accumulation of organic and inorganic metabolities in *Aeluropus lagopoides* Linn. *Physiol. Mol. Biol*., 149-152.

Key, J. L., C. Y. Lin and Y. M. Chen, 1982. Heat shock proteins of higher plants. *Proc. Nat. Acad. Sci*., USA, **78**: 3526-3530.

Lauchli, A., Epstein,E., 1990. Plant responses to saline and sodic conditions. In:Tanji, K.K. (Ed.), Agricultural Salinity Assessment and Management. American Society of Civil Engineers, New York, pp. 113 – 137.

Lin P. A Review on the Mangrove Research in China. J Xiamen Univ (Natural Sci. in Chinese), 2001, **40** (2): 592-603.

Lowry,O.H., N.J. Rosenbrough, A.L. Farr and R.J. Randall, 1951. Protein measurement with the Folin - phenol reagent. *J. Biol. Chem*., **193**: 265 – 275.

Marcum, K.B., 1995. Salt tolerance in the grass (Poaceae) sub-family Chloridoideae. In: Biology of salt tolerant plant (Khan, M.A. and I.A. UNgar, Eds.), Department of Botany, University of Karachi, Pakistan, ISBNO-9648260-1-1, pp.231-237.

Marschner, H., 1995. Mineral Nutrition of Higher Plants, second ed. Academic Press, London.

Moore, S. and W.H. Stein, 1948. Photometric method for use in the chromatography of aminoacid. *J. Biol. Chem*., **176**: 357-388.

Naidoo, G, 1987. Effects of salinity and nitrogen on growth and plant water relations in the mangrove *Avicennia marina* (Forssk.) Vierh. *New Phytol*. **107**: 317-326.

Nelson, N., 1944. A photometric adaptation of the Somogyi's methods for the determination of reducing sugar. *Anal. Chem*., **31**: 426-428.

Oswin, S.D., K. Kathiresan and S.Deivasoswin, 1994. Pigments in mangroves species of Pichavaram. *Indian J. Marine Sci*., **23**(1): 64 - 66

Peoples, T.R. and D. W. Koch, 1979. Role of potassium in carbondioxide assimilation in *Medicago sativa. Plant Physiol*., **63**: 878-881.

Prado, F.E., C. Bocern, M. Gallardo and J.A Gonzalez, 2000. Effect of NaCl on germination growth and soluble sugar content in *Chenopodium quinoa* Willd, Seeds. *Bot. Acad.* **41**: 27- 34.

Rao, G.G. and G.R. Rao, 1981. Pigment composition and chlorophyllase activity in pigeon pea (*Cajanus indicus* Spreng) and gingelly (*Sesamum indicum* L.) Under NaCl salinity. *Indian J.Exp. Biol*., **19**: 768 – 770.

Rowell, D. L., 1994. The Preparation of Saturation Extracts and the Analysis of Soil Salinity and Sodicity. In Soil Science Methods and Applications: Ed. Rowell, D. L. Longman Group, UK.

Sachs, M.M., M. Freeling and R. Okimoto, 1980. The anaerobic proteins of maize cell, **20**: 761 -767.

Shamsutdinov, Z.Sh., N.A. Myasoedov, L.G. Kalinkina, O.K Baburina, T.G. Navmova and V. Yu. Balnokin, 1995. Effect of soil salinity on contents and sets of amino acids in halophytes. Problems of Desert Development, **3**: 66 - 69.

Summner, J.B. and C.F. Somers, 1949. Laboratory Experiment in Biological Chemistry, 2nd Ed., Academic Press,New York, p. 173.

Takemura,T., Hanagata, N., sugihara, K., Baba, S., Karube, I., Dubinsky, Z., 2000. Physiological and biochemical responses to salt stress in the mangrove *Bruguiera gymnorrhiza*. *Aquat. Bot*., **68**: 15-28.

Venkatesalu, V. and K.P. Chellappan, 1993. Photochemical characteristics of *Sesuvium portulacastrum* L. under sodium chloride stress. *Photosynthetica*, **29**(1): 139 – 141.

Venkatesalu, V. and K.P. Chellappan, 1998. Accumulation of proline and glycinebetaine in *Ipomoea pes-caprae* induced by NaCl. *Biologia Plantarum,* **41**(2): 271 – 276.

Venkatesan, A.V. Venkatesalu, V. and K.P. Chellappan, 1995. Photosynthetic characteristics of *Ipomoea pes-caprae* under NaCl stress. *Photosynthetica*, **31**(4): 631 – 634.

Wang B S, Liang S C, Zhang W Y, *et al*. Mangrove Flora of the World. Acta Bot Sin, 2003, **45**(6): 644-653.

Wrench, P., L. Wright, C. J. Brady and R.W. Hinde, 1977. The sources of carbon for proline synthesis in osmotically stressed artichoke tuber slices. *Aust. J. Plant Physiol*., **4**: 703-711.

Zidan, M.A., 1995. Proline synthesis and degradation in salinized *Chlorella phrenoidosa*. *Indian J.Plant Physiol*., **38**(2): 118-120.