Characterization of the Mangrove Metabolism Related to the Salt Tolerance

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Naturally grown seedlings of *Avicennia marina* contain high concentrations of Na^+ and Cl^-. Our NMR studies revealed an accumulation of glycinebetaine, asparagine and starcyose in *A. marina.* The highest concentration of glycinebetaine was observed in young leaves, while the distribution of starcyose was restricted in stems and roots. Asparagine comprised more than 96% of total free amino acids in roots and 84% in leaves. Little or no accumulation of proline or polyols, which are proposed as compatible solutes in other plants, could be detected in *A. marina.* The cellular levels of glycinebetaine increased by the salt stress. The results from tracer experiments indicate the operation of an ethanolamine→phosphorylethanolamine→phosphorylmonomethylethanolamine→ phosphoryldimethylethanolamine → phosphorylcholine → choline → betaine aldehyde → glycinebetaine pathway in young leaves of *A. marina.* The rates of the biosynthesis of glycinebetaine from both [methyl-^{14}C]choline and [1,2-^{14}C]ethanolamine were stimulated by the salt stress. Salt also markedly increased the degradation of [methyl-^{14}C]choline to $^{14}CO_2$.

The activities of phosphofructokinase, pyrophosphate:fructose-6-phosphate 1-phosphotransferase, glucose-6-phosphate dehydrogenase, 6-phosphogluconate dehydrogenase (decarboxylating), phosphoenolpyruvate carboxylase and NAD:malate dehydrogenase from *A. marina* were inhibited by NaCl, while the activity of fructose-1,6-bisphosphate aldolase was activated by 50-200 mM NaCl. There was little or no effect of high concentrations (up to 500 mM) of glycinebetaine on the activities of any of these enzymes. No significant protection by glycinebetaine was detected against NaCl inhibition of these enzymatic activities. Based on these results, possible mechanisms for the salt-resistance of *A. marina* cells are discussed.