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Making Salt-Tolerant Plants by using Genes from a Seagrass

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Summary

The majority of higher plants are sensitive to a high-salt environment. In particular, almost all crops are unable to tolerate saline conditions. Nevertheless, some unusual angiosperms, such as seagrasses, are able to thrive in saline environment. Seagrasses, which are monocotyledonous angiosperms, are peculiar in their ability to thrive in seawater. Terrestrial plants have almost entirely lost their tolerance to high salinity during the curse of their evolution. However, tolerance mechanisms have evolved anew in seagrasses and allow these plants to thrive in seawater. Therefore, these marine angiosperms should have salt-tolerance mechanisms controlled by specific genes.

In order to make salt-tolerant plants (crops) by using genes from a seagrass (*Zostera marina*), we have screened candidate genes by using *E. coli*. A cDNA library was constructed from total RNAs purified from seagrass leaves, and transformed *E. coli* cells containing a seagrass gene were screened on a medium containing 6% NaCl. Twelve candidate genes involving salt-tolerance were obtained by this screening. Four of them (C2, C21, C81B and C107) were introduced into a model plant *Arabidopsis thaliana*, and then transgenic *Arabidopsis* plants have been characterized for their sensitivity against various stresses, such as salt, drought and cold (4°C). Transgenic plants with over-expressing a C21 gene, which encodes an unknown protein, exhibited to be tolerant against both drought and salt (150 mM NaCl) stresses. Transgenic plants with over-expressing a C107 gene, which is supposed to encode a homologous protein with ethylene response factor, exhibited to be tolerant against cold stress. Furthermore, we have made transgenic rice plants with over-expressing a putative plasma membrane H^+-ATPase gene (*ZHA1*), which is likely to be involved in salt tolerance in a seagrass. However, since these transgenic rice plants exhibit a severe dwarf phenotype, further characterization to these rice plants for stress tolerance have not been carried out yet.

Introduction of the seagrass C21 gene confers both drought and salt tolerance to *Arabidopsis* plants, and do not affect negatively, such as dwarfism and growth retardation, to *Arabidopsis* plants on normal growth conditions. Therefore, C21 may be a potential gene for conferring drought and salt tolerance to crop plants.