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Ectopic Expression of a *Thellungiella salsuginea* Aquaporin Gene, *TsPIP1;1*, Increased the Salt Tolerance of Rice

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Abstract: Aquaporins play important regulatory roles in the transport of water and small molecules in plants. In this study, a *Thellungiella salsuginea TsPIP1;1* aquaporin was transformed into Kitaake rice, and three transgenic lines were evaluated by profiling the changes of the physiological metabolism, osmotic potential, and differentially expressed genes under salt stress. The TsPIP1;1 protein contains six transmembrane domains and is localized in the cytoplasm membrane. Overexpression of the *TsPIP1;1* gene not only increased the accumulation of prolines, soluble sugars and chlorophyll, but also lowered the osmotic potential and malondialdehyde content in rice under salt stress, and alleviated the amount of salt damage done to rice organs by regulating the distribution of Na/K ions, thereby promoting photosynthetic rates. Transcriptome sequencing confirmed that the differentially expressed genes that are up-regulated in rice positively respond to salt stimulus, the photosynthetic metabolic process, and the accumulation profiles of small molecules and Na/K ions. The co-expressed *Rubisco* and *LHCA4* genes in rice were remarkably up-regulated under salt stress. This data suggests that overexpression of the *TsPIP1;1* gene is involved in the regulation of water transport, the accumulation of Na/K ions, and the translocation of photosynthetic metabolites, thus conferring enhanced salt tolerance to rice.

Keywords: *TsPIP1;1* gene; aquaporin; differentially expressed genes; salt stress; transgenic rice

1. Introduction

High soil salinity is a serious ecological obstacle factor limiting agricultural production and crop yield [1]. Usually, salt stress triggers physiological damage in plants and leads to a series of alterations in photosynthesis, ion flux, and water transport [2]. Plant aquaporins (AQPs) play important regulatory roles in the adaptive acclimation to physiological changes in plants in response to salt stress and are widely present in living organisms [3]. AQPs have been confirmed to be involved in the symplast pathway that efficiently dominates the transmembrane transport of water in plants