Investigating the Use of Ceratopteris richardii as a Model Plant for Phytoremediation of Cadmium

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Cadmium (Cd) is a widely used environmental pollutant. High levels of cadmium in plants can inhibit chlorophyll production, increase lipid peroxidation and reduce the activity of antioxidant systems. This study investigates if pretreatment of prothallial cells of Ceratopteris richardii with melatonin, an antioxidant, can mitigate the phytotoxic effect of cadmium. Moreover, this study compares the tolerance to Cd between wild type RNW1 and a double mutant that is resistant to herbicide paraquat and glyphosate (pq45/glt1). To determine the effect of Cd, 10-day-old gametophytes were treated with various concentration of CdCl2. At 50 uM, Cd inhibited gametophyte development. It also reduced photosynthetic pigments, and increased cell death in prothallial cell. Treatment of cells with 100 uM melatonin before exposure to 50 uM CdCl2 significantly increased cell division, chlorophyll production and reduced lipid peroxidation and cell death, supporting the role of melatonin as a potent antioxidant. Comparison between RNW1 and the pq45/glt1 double mutant showed the double mutant can tolerate Cd level as high as 100 uM. Using PCR, a partial fragment of N-acetylserotonin methytransferase or ASMT, was isolated. ASMT is the last enzyme in the melatonin synthesis pathway. Cd increased the expression of ASMT expression in wild type (RNW1) as measured RT-PCR. The double mutant pq45/glt1 showed constitutive higher level of ASMT expression. The results of this experiment showed that higher level of intracellular melatonin can increase tolerance and mitigate the phytotoxic effect of cadmium. Moreover, the double mutant pq45/glt1 of Ceratopteris is a good candidate for phytoremediation for cadmium.

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