

Cadmium Accumulation Involves Synthesis of Glutathione and Phytochelatins, and Activation of CDPK, CaMK, CBLPK, and MAPK Signaling Pathways in *Ulva compressa*

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Abstract

In order to analyze the effect of cadmium in *Ulva compressa* (Chlorophyta), the alga was cultivated with 10, 25, and 50 μM of cadmium for 7 days, and the level of intracellular cadmium was determined. Intracellular cadmium showed an increase on day 1, no change until day 5, and an increase on day 7. Then, the alga was cultivated with 10 μM for 7 days, and the level of hydrogen peroxide, superoxide anions, and lipoperoxides; activities of antioxidant enzymes ascorbate peroxidase (AP), dehydroascorbate reductase (DHAR), and glutathione reductase (GR); the level of glutathione (GSH) and ascorbate (ASC); and the level of phytochelatins (PCs) and transcripts encoding metallothioneins (UcMTs) levels were determined. The level of hydrogen peroxide increased at 2 and 12 h, superoxide anions on day 1, and lipoperoxides on days 3 to 5. The activities of AP and GR were increased, but not the DHAR activity. The level of GSH increased on day 1, decreased on day 3, and increased again on day 5, whereas ASC slightly increased on days 3 and 7, and activities of enzymes involved in GSH and ASC synthesis were increased on days 3 to 7. The level of PC2 and PC4 decreased on day 3 but increased again on day 5. The level of transcripts encoding UcMT1 and UcMT2 increased on days 3 to 5, mainly that of UcMT2. Thus, cadmium accumulation induced an oxidative stress condition that was mitigated by the activation of antioxidant enzymes and synthesis of GSH and ASC. Then, the alga cultivated with inhibitors of calcium-dependent protein kinases (CDPKs), calmodulin-dependent protein kinases (CaMKs), calcineurin B-like protein kinases (CBLPKs), and MAPKs and 10 μM of cadmium for 5 days showed a decrease in intracellular cadmium and in the level of GSH and PCs, with the four inhibitors, and in the level of transcripts encoding UcMTs, with two inhibitors. Thus, CDPKs, CaMK, CBLPKs, and MAPKs are involved in cadmium accumulation and GSH and PC synthesis, and GSH and PCs and/or UcMTs may participate in cadmium accumulation. © Copyright © 2021 González, Laporte and Moenne.

Author keywords

antioxidant enzymes; ascorbate; cadmium; glutathione; marine alga; metallothioneins; phytochelatins