MAPK SIGNALING PATHWAY MEDIATING COPPER TOLERANCE IN THE GREEN MACROALGA ULVA COMPRESSA (CHLOROPHYTA)

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Abstract— Macroalgae are main primary producers and the base of trophic networks in coastal ecosystems, providing food, shelter and habitat for a wide variety of organisms. Thus, any environmental impacts on macroalgae will directly affect associated communities within these ecosystems. In this context, copper industry has been the main economic activity in Chile since decades; unfortunately, it had negatively influenced terrestrial and coastal ecosystems through pollution events. Copper is an essential metal that participates as an enzymatic cofactor of several metalloenzymes. However, at certain concentrations, copper can become highly toxic generating oxidative stress. In eukaryotes, several types of stress stimuli (e.g. copper stress) induce the release of intracellular calcium activating certain signal transduction pathways. In turn, reactive oxygen species (ROS) can activate signaling transduction pathway of the MAPKs kinases family, leading the induction of gene expression; although ROS excess and oxidative stress can induce important changes in these signaling pathways. To address for the contribution of MAPKs pathways to copper stress tolerance mechanisms, we analyzed the expression of five genes related with oxidative stress in the presence of inhibitors involved in the MAPKs signal transduction pathways. Additionally, photosynthetic efficiency parameters were also analyzed to determine physiological response. Samples of U. compressa were treated with sublethal concentrations of copper (10 µM) together with enzymes inhibitors of ERK MAPK, JNK MAPK and p38 MAPK. Then, samples were collected at 6 h, 24 h, 48 h and 6 days, and gene expression was determined by qRT-PCR. Results showed that in the presence of enzymatic inhibitors for all MAPKs there is a marked trend of inhibition of gene expression at 48 h, whereas there was a significant up-regulation of tested genes after 6 days of treatments. The results suggest that MAPKs pathways may be involved as signal pathway to induce a stress tolerance response in U. compressa under copper excess. Interestingly, significant up-regulation of ROS control genes at day 6 mediated by inhibitors of MAPKs pathways, could represent a novel rapid recuperation response; indeed, subject that could provide new insights on the mechanisms underlying metal-stress tolerance in marine macroalgae.

Index Terms—Macroalgae; Metal; Pollution; Tolerance Mechanisms.

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