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Redox changes in microalga *Chlorella sorokiniana* exposed to high concentrations of Mn(II)

Snežana Vojvodić[1*], Milena Dimitrijević[1], Tanja Dučić[2], Dalibor Stanković[3], Miloš Opačić[1], Marina Stanić[1], Milan Žižić[1], Ivan Spasojević[1]

[1]*Life Sciences Department, Institute for Multidisciplinary Research, University of Belgrade, Belgrade; Serbia*
[2]*CELLS-ALBA, Barcelona; Spain*
[3]*Department of Analytical Chemistry, Faculty of Chemistry, University of Belgrade*

[*]*e-mail: snezana@imsi.bg.ac.rs*

Microalgae can be implemented in the remediation of mining and other metal-rich wastewaters as pioneer species. On the other hand, metals affect aquatic ecosystems through the negative impact on microalgae which are the primary producers of O_2 and biomass. Redox processes represent an important component of the mechanisms of interaction of microalgae with transition metals. We analyzed the redox changes in *Chlorella sorokiniana* culture that are induced by high levels of Mn(II). Mn is the key metal pollutant, with five main oxidation forms that can bind to a variety of different ligands. Mn (1 mM) induced a significant increase in the intracellular production of reactive oxygen species. The boost appears to show two phases – the first is very fast (observed after 15 min), whereas the second starts after 1 h reaching a plateau at 24 h. The concentration of reduced thiols, which represent important targets of oxidation, appears to parallel this trend. Total glutathione concentration shows a drop at 1 h and recovery at 24 h. This implicates that either a glutathionylation of proteins or a synthesis of phytochelatins - sulfur-rich short-chain peptides that sequester metals, takes place early in the response to Mn. Further, FTIR analysis showed that Mn induced a decrease of C=C levels and CH_2/CH_3 ratio implicating increased lipid peroxidation. Finally, Mn ions that were accumulated in the cells were extracted with nitric oxide and analyzed by cyclic voltammetry. Two redox forms were detected - Mn(II) and Mn(IV). The latter appears to prevail at higher manganese concentrations and longer periods of incubation. These results demonstrate that redox response of *C. sorokiniana* to high Mn levels involves at least two phases. Initially, Mn(II) enters the cells and induces pro-oxidative changes that are mitigated by glutathione-based antioxidative defense. Later on, redox homeostasis is reestablished with concomitant inactivation of Mn in the more stable redox form.

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