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Potential toxicity assessment of anthropogenic pressure by heavy metals in semi-enclosed artificial lagoon ecosystems in the Gulf of Aqaba, Red Sea

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Several environmental hazards are due to the spreading of high levels of potentially harmful substances (PHS) such as oil, plastic and heavy metals in marine ecosystems. Marine related activities such as manufacturing, constructions and industry may lead to elevated levels of PHS, increasing the potential environmental risk worldwide. PHS are able to increase heavy metal concentrations to higher levels than the background baselines and become harmful to the aquatic environment and its living organisms. However, most of the insoluble portion of the wastes in the aquatic ecosystems settle on the bottom in close association with sediment particles, keep suspended or enter with the food chain. PHS can be transported as either dissolve species in water or in association with suspended sediments and are subsequently deposited and in some cases trapped by the sediment particles.

The Gulf of Aqaba represents the most northern tip of the Red Sea. It is a semi-enclosed sea with low wave action and mixing with the open sea. In Jordan, the Gulf of Aqaba is the only access to marine and therefore it is subjected to high loads of stress on its seagrass ecosystems as a result of anthropogenic pressure.

The aims of this study were i) to determine the levels of heavy metals (Cd, Cr, Cu and Fe) in different semi-enclosed marine lagoons ecosystems in the Gulf of Aqaba and their bioaccumulation and biotransfer to the most dominant species of seagrasses (*Halophila stipulacea*) and ii) to evaluate the phytotoxicity of heavy metals using lipid peroxidation oxidative stress biomarker assay on seedlings growing in the same area.

Our results indicated that the total concentrations of most of the investigated metals in the sediment samples were significantly higher (ANOVA $p < 0.05$) than those of control. Moreover, *Halophila stipulacea* bio-accumulated significant quantities of heavy metals in both leaves and roots (ANOVA $p < 0.05$). The effect of heavy metals is extremely harmful and causes oxidative stress to seagrasses; it alters the metabolism equilibrium, as it increases dramatically the generation of reactive oxygen species and accordingly the lipid peroxidation (LPO). The levels of LPO seem to be significantly correlated (ANOVA $p < 0.05$) to the levels of heavy metals in sediments.

Our findings of PHS levels in sediments and seagrasses together with the bioaccumulation factor, translocation coefficients and the phytotoxicity assay indicate that the seagrass *Halophila stipulacea* appear rather highly tolerant towards environmental pressure since their metabolic equilibrium is not altered by increased metal uptake. Therefore, the above mentioned native marine plant species growing on stressed ecosystem may have the potential for restoration and reclamation of anthropogenic stressed marine ecosystems.

Keywords: Heavy metals, Gulf of Aqaba, Lipid peroxidation, Phytotoxicity.