The good and the bad side of microalgae: *biosorbents* and *vehicles* of copper in polluted marine environments

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Abstract

Heavy metals (HMs) can induce chronic and acute harmful effects on aquatic organisms. Among HMs, Copper (Cu) is largely widespread in marine environments, since it can be released by natural and anthropogenic sources. Cu is an essential metal for microalgal growth, metabolism and enzyme activities, but it can cause several negative effects at high doses such as reduction of growth rates, impairments in cell and organelle morphology and even death. Microalgae showing high tolerance toward Cu can be employed to reduce its concentration in seawater through mechanisms of adsorption onto cell wall that can be followed by compartmentalisation inside cells, acting as natural *biosorbents* of the metal. On the other hand, Cu-polluted algae can be also ingested by marine organisms, such as filter feeders, transferring the metals in their tissues increasing the risk of biomagnification, and posing serious threats to human health in case of contamination of edible organisms. The present project has the dual purpose of: i) exploring algal potential in Cu removal, to lay the foundation for future applications in the bioremediation of marine environment (biotechnological aim); ii) to assess the impact of contaminated microalgae on mussels, which are among the most widespread edible organisms (ecotoxicological aim). Indeed, whilst microalgae can contribute to Cu removal, they can also be considered as *vectors* to transfer the metal up the food chain, posing serious risks for both mussel fitness and human health in case of contaminated seafood. The present project aims to evaluate these risks, by detecting alarming levels of Cu in mussels by coupling X-ray fluorescence spectroscopy (XRF) analyses (to assess metal content within mussel soft tissues) to morphological, histological and biochemical analyses on mussel gonads (to evaluate eventual impairments in the reproductive cycle of the animals).

Intellectual merit of the proposed activity: This PhD proposal demonstrates strong intellectual merit through its innovative approach and potential contributions to advancing knowledge in the fields of bioremediation, ecotoxicology, and interdisciplinary research. Indeed, the project will address a critical knowledge gap in the interactions between Cu and microalgal cell walls thorough the use of X-ray photoelectron spectroscopy (XPS), that has never been applied to marine microalgal samples. The identification and characterization of microalgal species with high tolerance to Cu, along with the development of an interdisciplinary framework for analysis, represents a significant intellectual contribution to the field of environmental biotechnology.

Broader impacts resulting from the proposed activity: The proposed project could hold significant broad impacts in both biotechnological and ecotoxicological fields. It may result in advancements in eco-friendly bioremediation techniques in marine environments, since it aims to discover sustainable solutions for mitigating metal pollution. Moreover, this research proposal may shed light on the biomagnification potential within marine ecosystems, which could be pivotal in identifying vulnerable points in the food web and understanding the implications of metal pollution on higher trophic levels.