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From contaminated water to new products: the dual role of cyanobacterial exopolysaccharides in copper remediation and catalysis

Matilde Ciani[1], Giorgio Facchetti[2], Giovanni Orazio Lepore[3], Giulia Daly[1], Raffaella Gandolfi[2], Isabella Rimoldi[2], Roberto de Philippis[1], Alessandra Adessi[1]

[1] Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence. Florence (FI)
[2] Department of Pharmaceutical Sciences (DISFARM), University of Milan. Milan (MI)
[3] Department of Earth Sciences (DST), University of Florence. Florence (FI)

The exploitation of cyanobacteria for environmental remediation and subsequent valorization represents a double-win strategy to address sustainability and circularity challenges. In this context, the anionic charge in cyanobacterial exopolysaccharides (EPS), provided by uronic acids and other negatively charged groups, enables the biosorption of positively charged heavy metals, promoting clean water. The chemical-biological properties of EPS make them promising candidates for converting resulting metallic-organic materials into added-value products.
We explored the dual role of soluble EPS (released in the growth medium) and cellular EPS from two halophilic cyanobacteria in Cu uptake and catalytic reactions, investigating the binding mechanisms and the structure of the obtained materials.
The binding of Cu to cellular and released EPS was confirmed by SEM-EDX and ICP-OES analysis. The removal was positively correlated to released EPS concentration. In this fraction, Cu content was three times higher than in cellular fraction. X-ray absorption spectra revealed that Cu(II) is bonded Cl/S and O/N at different ratios and geometries, influenced by the strain, fraction, and simultaneous exposure to multiple metals. The interpretation of FT-IR absorption spectra suggested the presence of carbohydrates and proteins in both fractions due to the amide, carboxylic acids, and glycosidic bond bands. Cu-enriched materials, applied as catalysts for $B_2(Pin)_2$ addition on a chalcone, demonstrated a conversion efficiency of up to 83%.
In conclusion, our results show that cyanobacterial EPS can be involved in water remediation and may find a novel purpose as catalysts in reactions of pharmaceutical interest, enhancing process feasibility.

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