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Copper biosorption and ions release by *Stenotrophomonas maltophilia* in the presence of benzo[a]pyrene

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HIGHLIGHTS

- Effect of BaP on Cu(II) biosorption by *Stenotrophomonas maltophilia* was studied.
- Cu(II) and NO_3^- were reduced to Cu(I) and NO_2^- by *S. maltophilia*.
- *S. maltophilia* released K^+, and exchanged Mg^{2+} and Ca^{2+} for Cu(II) accumulation.
- Macromolecules were excreted to chelate Cu(II).
- Macromolecules could protect *S. maltophilia* from destruction by BaP.

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ABSTRACT

To investigate metal biosorption in polluted environments where organic and inorganic pollutants coexisted, this study has focused on the removal of $Cu(NO_3)_2$ by *Stenotrophomonas maltophilia* in the presence of benzo[a]pyrene (BaP). Initial pH, biosorbent dosage, contact time and BaP concentration were the significant factors for Cu biosorption. The uptake capacities of 2 and 10 mg L^{-1} Cu(II) by 0.25 g L^{-1} *S. maltophilia* were 7 and 26 mg g^{-1} at 0.5 h, respectively. Cu(II) biosorption included bioaccumulation, ions and macromolecules release, Ca^{2+} and Mg^{2+} exchange, functional groups attraction, and Cu(II) and NO_3^- bioreduction. During the biosorption process, *S. maltophilia* metabolically released K^+, and metabolically independently exchanged Mg^{2+} and Ca^{2+} for Cu(II) bioaccumulation. When the initial concentration of Cu(II) was 2 or 10 mg L^{-1}, the coexisted 1 mg L^{-1} BaP showed no significant influence on Cu(II) biosorption, ions release and cellular morphology.

1. Introduction

Organisms and environments are frequently exposed simultaneously or sequentially to a variety of pollutants by multiple exposure routes. Among these pollutants, heavy metals (HMs) and polycyclic aromatic hydrocarbons (PAHs) are two of the most abundant and harmful ones found in polluted environments [1–3]. The sources, accumulation, transformation and toxicity of HMs and PAHs in environment are increasingly concerned because of their impacts on environmental safety and potential health risks [4–7]. The biosorption of HMs and biodegradation of PAHs are the most promising ways to remove these pollutants from the polluted environments [8–10]. However, information regarding the joint effects of these two types of contaminants on their bio-treatment is limited.

Biosorbents can attract and bind HMs by complex processes that comprise of ion exchange, surface precipitation, surface adsorption, metal detoxification and transformation [11]. During biosorption process, biomass can release some light metals to balance the uptake of HMs. So far, the most concerned and discussed ions were cations. However, to further explain the behavior of ion exchange regarding biosorption, attention needs also to be paid to the release of anions.

It has been revealed that dead microorganisms can passively bind HMs by various physicochemical mechanisms, while living strain is able to transport sorbate to the inside of cell by metabolic processes [11]. Yet part of the mechanism involved in various chemical and physical interactions among the functional groups present in cell wall and HMs is still unknown. Hence, it is of

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