

Determination of mercury biosorption by *Microcystis novacekii* (Cyanobacteria) biomass

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Bio-sorption is the process of removal of heavy metals by the passive binding to non-living biomass from an aqueous solution (Davis et al., 2003). The adsorption of toxic metals in biomass of various organisms has been studied in order to develop inexpensive and efficient processes for the removal of metals from wastewater. Production and cost of biomass for metal removal systems have been tested utilizing diverse sources of biomass (Bailey et al., 1999). Microorganisms are target in bio-sorption studies for their high surface-to-volume ratio, providing important surface area where the bio-sorption processes take place. *Microcystis novacekii* (Cyanobacteria) was isolated from lake Dom Helvécio (Rio Doce Park, southeast Brazil) and has been maintained under culture conditions in the Laboratory of Limnology, Ecotoxicology and Aquatic Ecology (LIMNEA). This strain has been used in studies of toxic elements bioaccumulation such as lead and arsenic. The aim of this study was to determine the capacity of *M. novacekii* biomass to remove mercury ions (Hg^{+2}) in distinct physical and chemical conditions.

M. novacekii cultures (4L) were cultivated in BG-11 medium in Erlenmeyer flasks under constant light ($27\mu mol.cm^{-2}$), temperature ($20\pm 1^{\circ}C$) and aeration with filtered air ($45\mu m$). After 30 days the biomass was collected by centrifugation (7700 rpm), lyophilized and stored ($-20^{\circ}C$).

For bio-sorption experiments some variables were standardized in previous tests: adsorption equilibrium time (10 h), proportion of lyophilized biomass used (1 mg/ml) and pH of aqueous solution maintained at 6 using MES buffer [2-(N-morpholino) ethanesulfonic acid]. After

exposure to Hg concentrations of 2 to 200 mg/L (Figure 1). The maximum bio-sorption was determined according to the models of Langmuir and Freundlich isotherms (Figure 2).

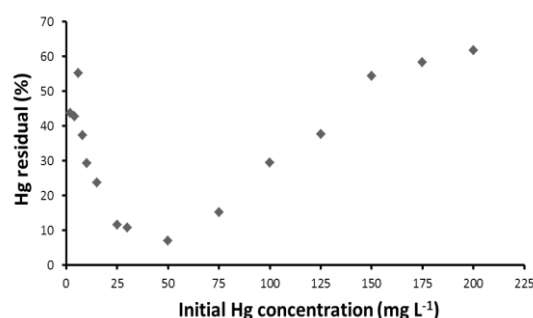


Figure 1. Hg adsorbed ($mg\ g^{-1}$) as function of Hg concentration ($mg\ L^{-1}$).

To evaluate the influence of the solution pH on the mercury adsorption process biomass samples were exposed to Hg solutions of 50 mg/L at pH values from 3 to 8. To evaluate the influence of co-ions in the adsorption solutions of Hg^{2+} (0.25 mM) were prepared with the addition of Fe^{+2} , Fe^{+3} or Mn^{+2} at concentrations of 0.125; 0.25 and 0.5 mM.

The maximum quantity of Hg adsorbed (Q_e) according to the isotherms of Langmuir (44.84 mg/g, Figure 1A) and Freundlich (39.28 mg/g, Figure 1B) was comparable to *Spirogyra hyaline* (Zygnematophyceae) that presented a maximum bio-sorption capacity of 35.71 mg/g Hg (Kumar and Oommen, 2012). The maximum efficiency of bio-sorption was $93.0 \pm 4.4\%$ in the concentration of 50 mg/L (Figure 1), was used in the subsequent experiments.

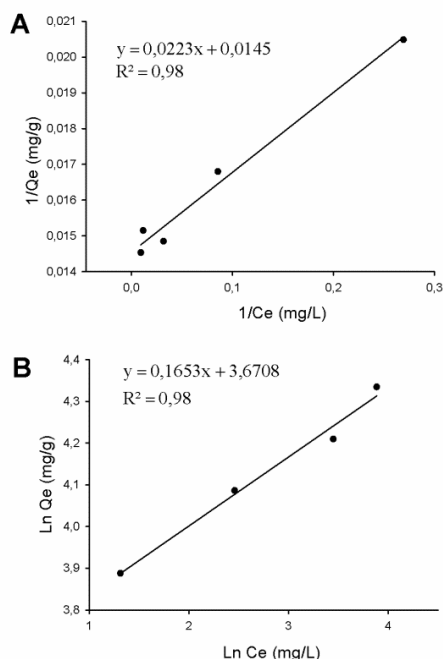


Figure 2. Freundlich (A) and Langmuir (B) isotherms. Qe: Hg adsorbed in the biomass. Ce: Hg concentration in the aqueous phase.

As a function of the pH in solution the maximum removal efficiency was found in pH 7 (97.2%). Phosphate and hydroxyl groups in cell wall are deprotonated in neutral conditions favoring chemical interactions (Sujoy et al., 2007). Spherical amorphous extracellular deposits of Hg⁺² were found as the main process of bio-sorption in bacteria lyophilized biomass exposed to HgCl₂ (François et al., 2012).

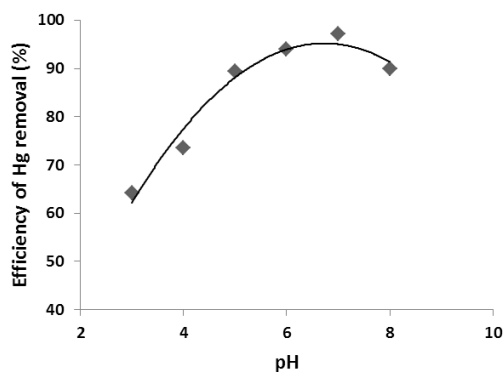


Figure 3. Hg⁺² removed (%) by the biomass from aqueous solution as function of the pH in the concentration of 50 mg/L.

The Hg removal efficiency was greater than 94.71% for all concentrations of co-ions tested) in constant concentration of Hg (Figure 4).

The presence of co-ions in solution is not considered an issue for using *M. novacekii* biomass in processes of water decontamination with Hg ions.

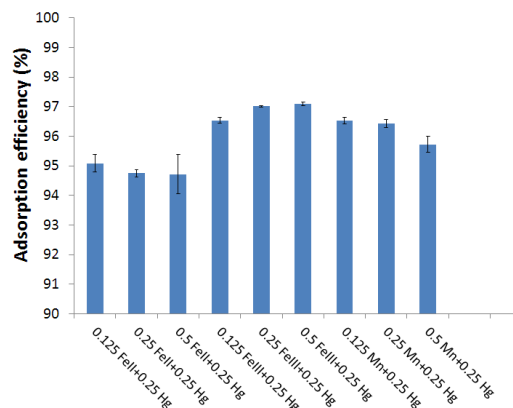


Figure 4. Hg⁺² removed by the biomass from aqueous solution (%) as function of co-ions (Fe⁺³, Fe⁺² and Mn⁺²). Concentrations in mM

All the properties of *M. novacekii* biomass analyzed here are favorable to the application of this cyanobacteria strain in processes of waste water decontamination in distinct conditions, mostly when Hg is present in high concentration. For this reason, the use of *M. novacekii* biomass is indicated for the development of techniques used in wastewater treatment.

References

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