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Role of fulvic acid on the bioaccumulation of copper and lead by a unicellular green algae Chlamydomonas reinhardtii

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PURPOSE OF THE ABSTRACT

Of the unicellular algae species, Chlamydomonas reinhardtii has only recently gained greater attention for the treatment of heavy metal contamination in aqueous solutions. Because of its wide range of heavy metal tolerance, this species can sequester an array of trace metals. In addition, C. reinhardtii was used in the literature to predict the toxicity and the bioavalability of trace metals to aquatic environments [1-2]. According to free ion activity model (FIAM), the complexation of a metal is predicted to reduce bioaccumulation in direct proportion to the concentration of free ions [3]. In contrast, Pb uptake by Chlorella Kesslerii was shown to decrease in the presence of Suwannee River fulvic acid (SRFA) [4]. On the other hand, there is no consensus in the literature as to whether the role of humic and fulvic substances is limited to trace metal complexation in the bulk solution [5]. To better understand the relationship between trace metal speciation and bioavailability in natural freshwaters, the interaction of copper and lead with algal cells Chlamydomonas reinhardtii was studied in the presence of SRFA.

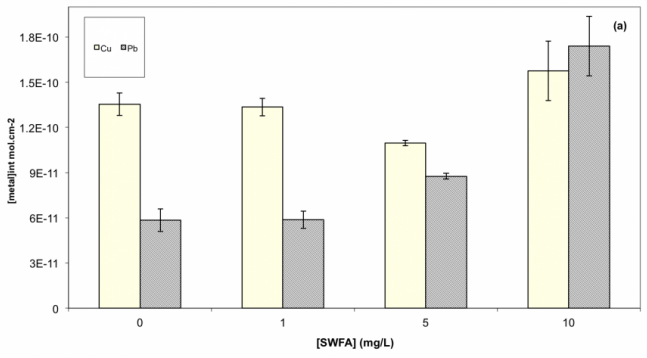
Short term bioaccumulation experiments of 40 minutes were performed in solutions containing 5x10-7M of free metal at 30oC and pH 6 in the presence of variable concentrations of SRFA (1-10mg/L). Algal cells were used in the concentration of 0.2g.L-1. The effect of SRFA on the bioaccumulation of Cu (II) and Pb (II) was studied in single and binary metal systems.

Algal cells showed high removal efficiency for both metal ions in the absence and in the presence of SRFA. Cu and Pb biouptake was shown to decrease in the presence of low concentrations of SRFA (?5mg/L). However, high concentrations of SRFA (?10mg/L) increase bioaccumulation of algal cells for both metal ions (Figure 1a). In addition, bioaccumulation of Pb (II) is affected by Cu (II), whereas, Cu (II) has no competitive effect on Pb (II) bioaccumulation in the presence of SRFA (Figure 1b). It seems thus, that the affinity of fulvic acid for Pb is greater than for Cu metal ions. The obtained results can be attributed to the contribution of labile hydrophylic Pb-SRFA complexes and lipophylic Cu-SRFA complexes to the uptake. On the other hand, changes in the algal surface charge due to SRFA adsorption seemed to account for the observed increase in Cu and Pb biouptake by C. reinhardtii in the presence of SRFA.

Figure 1. Effect of SRFA on bioaccumulation of Cu and Pb in (a) single and (b) binary metal systems.

The results clearly demonstrate that C. reinhardtii is capable of removing Pb and Cu from complex aqueous solutions. Although development and further investigations are needed, the obtained results are very promising as a starting point for a potential application of these microorganisms as an efficient and economic biomaterial for the removal of heavy metals from natural freshwaters.

FIGURES



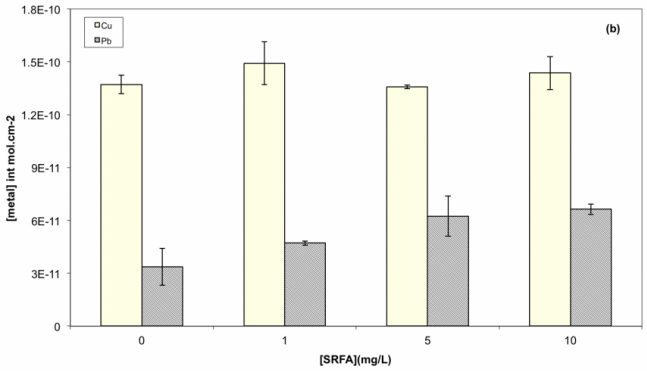


FIGURE 1

Figure 1 a

Effect of SRFA on bioaccumulation of Cu and Pb in single monometallic systems.

FIGURE 2

Figure 1 b

Effect of SRFA on bioaccumulation of Cu and Pb in binary metal systems.

KEYWORDS

Bioaccumulation | Heavy metals | Chlamydomonas reinhardtii | Fulvic acid

BIBLIOGRAPHY

[1] z. chen, l. Zhu, k.j. Wilkinson, environ. sci. technol. 2010, 44, 3580-3586

[2] r. flouty, g. estephane, j. environ. Manage. 2012, 111, 106-114.

[3] c. lamelas, j.p. pinheiro, v. slaveykova, environ. sci. technol. 2009, 43, 730-735.

[4] v. slaveykova, k.j. Wilkinson, a. Ceresa, e. kretchzmar, environ. sci. technol. 2003, 37, 1114-1121.

[5] i. christl, a. metsger, i, heidmann, r. kretschmar, environ. sci. technol. 2005, 39, 5319-5326.