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RESEARCH ARTICLE

Effect of zinc-containing systems on *Spirulina platensis* bioaccumulation capacity and biochemical composition

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Abstract

Cyanobacteria *Spirulina platensis* due to its high biosorption and bioaccumulation capacity toward metal ions can be considered as an excellent candidate for environmental bioremediation. The effect of Zn and in different combinations on the accumulation capacity of *Spirulina platensis* biomass and its biochemical composition was investigated. Four Zn-containing systems with a different combination of metal ions (Zn; Zn/Cu/Sr; Zn/Cu/Ni; Zn/Cu/Sr/Ba) and different metal concentrations were modeled. Studied systems were introduced in the cultivation medium on the fifth day of biomass grow and experiments were performed in three variants, which differed by metal ions concentrations. Metal uptake by biomass was traced using neutron activation analysis. *Spirulina platensis* showed a high accumulation capacity for all metal ions present in the analyzed system. Because the metals were added at the beginning of the stationary growth phase, the contact with the biomass was only 24 h, even at the highest metal concentration in the systems, the accumulation of *Spirulina platensis* biomass was reduced by no more than 11.2%. *Spirulina platensis* biomass grown in a mono-metallic system expressed two biochemical indicators of stress: decrease of phycobiliprotein content and increase of malondialdehyde content. In biomass grown in the presence of Zn-containing multi-metallic systems, three indicators of stress were expressed: decrease of protein content, reduction of phycobiliprotein content, and increase of malondialdehyde content. *Spirulina platensis* biomass can be considered as an effective accumulator for the treatment of zinc-containing industrial effluents.

Keywords *Spirulina platensis* · Zinc · Biochemical composition · Neutron activation analysis · Water treatment

Introduction

Nowadays, rapid industrialization and urbanization have greatly increased the quantity of various pollutants including heavy metals in the environment (Goswami et al. 2015). Various industrial processes, modern agricultural practices, acid mine drainage, and human wastes are recognized as the most important source of heavy metals (Fiore et al. 1998). The indiscriminate discharge of metals into the environment results in the pollution of natural water bodies, thereby affecting the quality of the water and aquatic inhabitants. In spite of the fact that some metals are required for microorganisms development and growth when present in excess, they become toxic for living organisms.

Zinc is a constituent of all six classes of enzymes; plays important roles in gene regulation; is involved in protein, nucleic acid, carbohydrate, and lipid metabolism; and is considered an essential microelement for almost all classes of organisms (Blindauer 2008; Ishimaru et al. 2011). At the same time, zinc compounds are extensively used in different industrial processes mainly in galvanization, electroplating, production of brass and other alloys, lead and cadmium refining, steel production, catalysis, ceramics, textiles, fertilizers, pigments, and batteries production (Leyva Ramos et al. 2002; Zinicovscaia et al. 2015). The high cost of some conventional techniques, their lower removal efficiency at a metal concentration less than 100 mg/L, and the complex nature of

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