Environmental Science and Pollution Research (2020) 27:31793–31811
https://doi.org/10.1007/s11356-020-09447-z

RESEARCH ARTICLE

Spirulina platensis as renewable accumulator for heavy metals accumulation from multi-element synthetic effluents

Liliana Cepoi[1,2] · Inga Zinicovscaia[3,4,5] · Ludmila Rudi[1] · Tatiana Chiriac[1] · Vera Miscu[1] · Svetlana Djur[1] · Ludmila Strelkova[3] · Dmitrii Grozdov[3]

Received: 12 March 2020 / Accepted: 25 May 2020 / Published online: 5 June 2020

Abstract

Metal accumulation by *Spirulina platensis* from synthetic effluents with the following chemical composition: Cr/Fe, Cr/Fe/Ni, Cr/Fe/Ni/Zn, and Cr/Fe/Ni/Zn/Cu during repeated cultivation cycle was investigated. Metal ions in different concentrations were added to the culture medium at the exponential and stationary phases of biomass growth and their uptake by biomass was traced using neutron activation analysis. The effect of metal ions on biomass and main biochemical components (proteins, carbohydrates, lipids, phycobilins, and β-carotene) was monitored. *S. platensis* keeps high metal accumulation capacity during 2–3 cultivation cycles, while the metal ions were added in the stationary phase of its growth. By adding metals in the exponential phase of growth in the following concentrations: 10 mg/L of chromium (VI), 5 mg/L of iron, 2 mg/L of zinc, nickel, and copper, *Spirulina platensis* acted as renewable accumulator only in Cr/Fe system. It maintained the accumulation capacity during three cultivation cycles when exposed to lower concentrations of metal ions. Its ability to accumulate metal ions during several cultivation cycles was ensured by the maintenance of the optimal level of proteins and lipid in biomass.

Keywords *Spirulina platensis* · Metal bioaccumulation · Biochemical components · Renewable accumulator · Neutron activation analysis

Introduction

Environmental pollution with heavy metal poses a serious threat to all life forms due to their toxicity, high reactivity even at low concentrations, and accumulation in the food chain (Ayangbenro and Babalola 2017). Metal toxicity for humans depends on several factors including dose, route of exposure, and chemical species, as well as the age, gender, genetics, and nutritional status of exposed individuals (Tchounwou et al. 2012).

Today, industrial operations such as mining, iron sheet cleaning, plating, metal processing, automobile parts manufacturing, dyeing, textile, fertilizer, chemicals, and petroleum production release heavy metals such as copper, nickel, chromium, zinc, and iron into the environment (Mishra and Malik 2013; Mutongo et al. 2014; Shahnaz et al. 2020; Dotto et al. 2012; Ajmani et al. 2019). While so-called microelements like copper, cobalt, iron, nickel, magnesium, molybdenum, chromium, selenium, manganese, and zinc are essential for various physiological and biochemical activities in living organisms in small amounts, others elements like cadmium, mercury, lead, chromium, silver, and arsenic can cause acute and chronic toxicities in organisms even in minute quantities (Azeh Engwa et al. 2019). Some heavy metals act as a pseudo-element in the living body and affect various metabolic pathways (Shahnaz et al. 2020). Thus, it is necessary to treat metal-contaminated effluents prior to their discharge into the natural water.

Responsible editor: Tito Roberto Cadaval Jr

✉ Inga Zinicovscaia
zinikovskaia@mail.ru

1 The Institute of Microbiology and Biotechnology, 1 Academiei Str., 2028 Chisinau, Moldova

2 State University "Dmitrie Cantemir", 3/2 Academiei Str, 2028 Chisinau, Moldova

3 Joint Institute for Nuclear Research, 6 Joliot-Curie Str, 1419890 Dubna, Russia

4 Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering, 30 Reactorului Str. MG-6, Bucharest -, Magurele, Romania

5 The Institute of Chemistry, 3 Academiei Str., 2028 Chisinau, Moldova