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Bacterial ACC Deaminase Activity in Promoting Plant Growth on Areas Contaminated with Heavy Metals

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ABSTRACT

The objective of this study was to explore the possible improvement of plant growth using the activity of the bacterial enzyme ACC (1-aminocyclopropane-1-carboxylate) deaminase (endophytes and rhizobacteria). The beneficial effect of ACC deaminase activity was tested on the plants growing under stress conditions (high concentrations of heavy metals: cadmium, lead, zinc in the soil). The bacteria were isolated from three plants species: *Festuca rubra* L., *Agrostis capillaris* L., *Arabidopsis thaliana* L. Heynh, acquired from the area contaminated with heavy metals. The strains with the highest ACC deaminase activity were used to prepare a bacterial consortium and inoculate the plants. It has been shown that inoculation of plants with ACC producing bacteria has a positive effect on their growth under stress conditions. The bacterial entophytes strains showed a higher activity of ACC deaminase, which resulted in a higher biomass growth of inoculated plants. The PGPB bacteria may limit the toxicity of harmful ions and thus the increase the adaptive properties of plants. Moreover, it was discovered that the bacteria mainly belonging to genus *Bacillus* and *Pseudomonas* had the highest ACC deaminase activity in the environment contaminated with multiple heavy metals. The use of selected microorganisms and plants will provide results in an increasing efficiency of phytoremediation.

Keywords: ACC deaminase, endophytes, heavy metals, plant growth promoting bacteria (PGPB)

INTRODUCTION

Heavy metals are natural components of the Earth's crust. Beside their natural occurrence, most environmental contamination and human exposure result from the anthropogenic activities. Migration of these contaminants into non-contaminated areas as dust or leachates through the soil and spreading of heavy metals containing sewage sludge are a few examples of events contributing towards the contamination of the environment (Kacprzak *et al.* 2014, Kanclerz *et al*. 2016).

Some trace elements, including heavy metals, such as Zn, Cu, Co, Ni and Mn are necessary micronutrients for plant growth, while others have an unknown biological function, such as Cd, Pb, and Hg (Wong-Villareal *et al.* 2016). Excessive level of heavy metal pollution in soil has a harmful effect on biological systems (Salihaj *et al*. 2016). All metals are toxic at higher concentrations, because they cause oxidative stress by formation of free radicals. Another reason why metals may be toxic is that they can replace essential metals in pigments or enzymes, thereby disrupting their function. The hazardous trace elements, especially highly bioavailable ones (Grobelak and Napora, 2015) create unsuitable land for plant growth and destroy the biodiversity (Hadi *et al.* 2014). As a consequence of heavy metal stress, the plant growth is significantly lower than it would be in their absence. Moreover, during its life, a plant is also subjected to a number of non-lethal stresses that limit the plant growth. Certain soil bacteria