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Isolation of metal-tolerant bacteria from metallophytes for bioaugmentation purposes in mine tailings

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Abstract

Mining is one of the most pollutant anthropogenic activities, generating a large amount of rejected waste materials from ore processing, known as tailings. Unvegetated tailings are a source of contamination, namely metals and metalloids, for the surrounding environment, including to the nearby communities. Tailings' low nutrient and organic matter content, as well as the low pH, limit the establishment of a plant cover, although some metallophytes can be sparsely found inhabiting these areas. Metallophytes can harbor metal-tolerant bacterial strains that may be used to produce bioinoculants to help tailings revegetation along with metal stabilization.\

The Borralha mine (northern Portugal) is a former tungsten producer with several tailings exposed to atmospheric conditions, where some metallophytic plants can be found. In this work, we aimed to characterize the culturable rhizosphere bacterial community of metallophytes in the tailings area for bioaugmentation purposes under remediation approaches. To attain this goal, composite soil samples from the rhizosphere of metallophytic plants such as *Agrostis capillari*s, *Cytisus striatus*, *Erica arborea*, *Pinus pinaster*, *Rubus ulmifolius,* and *Salix caprea* were collected. The culturable bacterial community of the samples was isolated, and 65 different morphotypes were characterized genotypically (BOX-PCR, 16S rDNA sequencing) and for Cu, Cd, and Zn tolerance. The most tolerant strains were screened for growth-promoting traits, namely the productions of siderophores, organic acids, NH_3 and indoleacetic acid production, ACC-deaminase activity, and phosphate solubilization capacity. The best-performing strains, especially those with higher ACC deaminase activity and IAA production, were selected and used to prepare two different bacterial consortia. The effects of these consortia in parameters such as plants' growth and soil metal stabilization were tested in a greenhouse experiment using *Agrostis capillaris* as a model plant, grown in tailings material. Microbial parameters were also assessed, showing an overall increase in microbial activity. Results indicate that revegetation and metal stabilization of some tailings can be improved by using bioaugmentation approaches.