

PILOT SCALE ASSAY FOR ARBUSCULAR MYCORRHIZAL FUNGI-ASSISTED PHYTOMINING

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ABSTRACT

The increasing demand for critical raw materials (CMR), essential for renewable energy and emerging technologies, has intensified the search for sustainable extraction methods. Phytomining, an emerging green technology, uses hyperaccumulator plants to recover metals from mining soils, tailings, or contaminated sites, offering an environmentally friendly alternative to conventional mining. More recently, microbial-assisted phytomining has been proposed, where microbial inoculants enhance the process by improving nutrient uptake and increasing plant tolerance to heavy metals (HMs). Among them, arbuscular mycorrhizal fungi (AMF) play a key role by promoting plant growth and mitigating HM toxicity through mechanisms such as intracellular accumulation on their structures and even translocation to aerial parts. Our study focuses on the Pb-Zn Montevecchio-Levante mining site, located in the municipality of Guspini, western Sardinia, Italy. With 143 years of mining activity over 25 ha, concentrations of As, Cd, Co, Cu, Hg, Pb, Sb, Sn, and Zn exceed regulatory limits. In this context, we tested a novel AMF inoculation system in bioreactors (br), using sunflower as a model plant. Reactors were filled with Montevecchio (Mvc) substrate or commercial soil (C, control). Treatments included: Mvc and C (without inoculation), and Mvc+amf and C+amf, with n = 8 (plants per br). After 3 months, biomass was harvested, and the shoot and root growth values and mycorrhizal colonization were assessed. Inoculation was successful in Mvc+amf, with increased frequency and intensity of colonization compared to Mvc. No differences in biomass were observed between Mvc and Mvc+amf, although there were, when compared to their controls. This work represents the first step in defining optimal plant–substrate–inoculum conditions and provides insights for optimizing phytomining/phytoextraction strategies. Future developments will aim at scaling up the process for application in post-mining restoration and sustainable CRM recovery.

Palabras Clave: Phytomining, Phytoextraction, Circular Economy, Mychorriza