ASSESSING THE POTENTIAL OF PHYTOMINING TO EXTRACT GOLD FROM THE TAILINGS OF CASTROMIL MINE, PORTUGAL

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ABSTRACT: In recent years, the ever-rising price of gold (Au), the incapacity of conventional mining to extract the totality of Au from mineral ores, and the buildup of billions of tons of mine waste with residual Au around the world, have prompted the development of phytomining, a plant-based technology to extract valuable metals from tailings and mineralized soils.In its state of the art, gold phytomining relies on induced gold hyperaccumulation, i.e. the use of chelating agents to increase Au solubility in soil, allowing plants to accumulate Au in levels that are 1-3 orders of magnitude greater than those normally found without chelation. Upon harvesting, the incineration of plant biomass yields a “bio-ore”, from which Au can be recovered through conventional methods. The aim of this study was to assess the potential of phytomining to recover Au from selected tailings of the defunct Castromil mine in northern Portugal.Seeds of *Brassica juncea*, were sown on a 2:1 perlite:sand mixture (v/v), allowed to germinate and grow till two fully expanded leaves, and transferred to pots at the rate of 1 per pot. The pots were filled with equal volume of tailings from Castromil mine (41°9'18.88"N, 8°23'25.27"W), previously sieved (<2 mm) and vigorously mixed to enhance homogeneity. One week before harvesting, the pots were treated with ammonium thiocyanate (NH_4SCN), at the rates of 0 (control) and 1 g kg^{-1}. Plants, 3 replicates per treatment, were harvested 60 days after sowing and their dry weights were measured. Metal contents in plant tissue and tailings were assessed by inductively coupled plasma mass spectrometry (ICP-MS). Paired samples T-test was carried out to determine significant differences ($p<0.05$) between treatments.The biomass yield and metal levels of the shoots are critical for phytomining because they control the quantity of metal to be harvested from each plant. Unlike the dry weight of shoots, Au concentrations in the aboveground parts were significantly different between control and NH_4SCN-treated plants. The latter presented average Au levels of 43.58^{a} mg kg^{-1}, while the former displayed 0.72^{b} mg kg^{-1} (different letters indicate significant differences between treatments). Given the concentration of Au in the tailings (4.38 mg kg^{-1}), the bioconcentration factor (ratio of metal concentration in shoot to substrate) of plants treated with NH_4SCN was approximately 1, denoting the plant’s ability to efficiently uptake Au.The results of this study are aligned with previous experiments conducted in Brazil, Australia, Mexico, and New Zealand, and constitute a step further towards demonstrating the viability of Au phytomining. Future research encompasses the replacement of NH_4SCN by more biodegradable and less-hazardous chelants, the inoculation with cyanogenic bacteria, and testing under field conditions.

KEYWORDS: PHYTOMINING; GOLD; TAILINGS

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