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Harnessing Hyper-Accumulator Plants for an Innovative Green Technology to Recover Nickle from Serpentine Soils in Sri Lanka

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Abstract

Phyto-mining is an environmentally sound green technique that has been employed for metal recovery from low-grade sources using hyperaccumulator plants. Due to its economic viability and wide social acceptance, this technology has been favoured over many conventional mining applications. Nickel (Ni) phyto-mining was introduced to the world with the identification of many Ni hyperaccumulator species grown in Ni-enriched metalliferous soils like serpentine, where they accumulate more than 1,000 mg/kg of Ni. Along the boundary of Highland and Vijayan Complexes in Sri Lanka, Ginigalpelessa, Indikolapelessa, and Ussangoda serpentinite deposits are closely located by showing similar geographical features. According to previous studies, these deposits contain a high concentration of Ni in the soil causing the evolution of serpentinite flora unique to these areas. This study aimed to identify the diversity and the presence of hyperaccumulator species that can be employed in Ni phyto-mining. More importantly, the study focused on identifying annual or biannual crop species with short lifespans that can be used in phyto-mining. The plant diversity and abundance analysis were carried out using a grid sampling method (3×3 m), and the highly abundant species were harvested and subjected to aqua regia digestion to determine hyperaccumulator levels using Inductively Coupled Plasma Mass Spectrometer (ICP-MS). Ginigalpelessa and Indikolapelessa showed similar diversity, abundant with grass and small herb species, such as *Apluda mutica*, *Imperata cylindrica*, *Eupatorium odoratum*, and *Tephrosia villosa*, where the *A. mutica* was dominant. In addition, plants like *Morinda tinctoria*, *Vitex pinnata*, and *Azadirachta indica* were dispersed throughout the deposit. Ussangoda deposit exhibited few herb species, including *Hybanthus enneaspermus*, *Evolvulus alsinoides*, and *Desmodium triflorum*, and localized thick vegetation patches. Diversity analysis of all the deposits showed very low plant diversity, ranging from 0.1 to 1.3. Moreover, the areas containing high Ni concentrations (6,000-10,000 mg/kg) were abundant with stunted trees and grass species. The present study identified the *Apluda* grass species as a potential Ni hyperaccumulator for phytomining since it accumulates a high concentration of Ni (900-2,800 mg/kg) and can be grown biannually. Even though the grass species was dominant in both Ginigalpelessa and Indikolapelessa deposits, it was not observed in Ussangoda deposit, probably due to the arid climate and the deposition of salt spray from the coast. The findings of this study would be promising to establish phytomining in serpentine soils to support the increasing demand for Ni in the global market, especially for clean energy transition.

Keywords: Low-grade soils, Clean energy transition, Ni phyto-mining, Serpentinite deposits

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