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Extraction Potential of Nickel from Native Hyperaccumulator Plants from Ginigalpelessa Serpentinite Deposit

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Abstract

Serpentine soils are low-grade Ni resources that have been utilized widely to extract Ni to meet its burgeoning demand in the renewable energy sector. However, the economic impracticability of Ni recovery by conventional mining techniques has been directed towards Ni phytomining, in which native hyperaccumulators grown in serpentine soils are used for commercial Ni recovery. In this context, the Ginigalpelessa serpentinite deposit in Sri Lanka harbors a wide variety of plants that can accumulate high Ni concentrations from the soil. Despite the promising Ni potential (0.4-1.7%) in the Ginigalpelessa serpentinite deposit, the lack of detailed studies on the hyperaccumulation ability of native plant species and proper extraction methods retards the commercial application of Ni phytomining in this deposit. Therefore, the present study carried out ex-situ phytomining trials using two native hyperaccumulator species namely, *Crotalaria verrucosa* and *Apluda mutica*. The harvested biomasses were then incinerated to produce Ni-rich bio-ores, which were analyzed for Ni concentration using Inductively Coupled Plasma Mass Spectrometer (ICP-MS). The bio-ore of *C. verrucosa* contained 7,279 ± 106 mg/kg of Ni whereas the bio-ore of *A. mutica* showed 3,867 ± 39 mg/kg of Ni. The bio-ore of *A. mutica* was used for the leaching experiments due to its highest abundance in the deposit. The leaching assays were carried out with *A. mutica* bio-ore under different pulp densities (100 g/L and 200 g/L) and H_2SO_4 concentrations (1 mol/L and 5 mol/L). The bio-ores used in leaching experiments were produced from an open flame and muffle furnace (at 550 ºC). The highest leaching efficiency was observed as 59% in open burnt samples (leachate Ni concentration = 649 mg/kg and total Ni concentration = 1,098 mg/kg) under 100 g/L pulp density and 5 mol/L H_2SO_4 concentration. The overall low leaching efficiency of bio-ore can be attributed to the formation of an aluminum silicate matrix ($Al_2O_3.2SiO_2$) during leaching experiments which inhibits the Ni leaching. Therefore, the present study requires further investigations to optimize the leaching efficiency to implement a sustainable Ni extraction method for the local serpentinite bodies.

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Keywords: Leaching efficiency; incineration; Ni hyperaccumulators; phytomining; serpentine soil