

ABSTRACT

One of the environmental concerns associated with mining waste is the contamination of soil. This study addresses the decontamination of soil, particularly of Co and Ni using *Berkheya coddii* (*B. coddii*). *B. coddii* is a hyperaccumulator plant that is able to decontaminate Co and Ni from the contaminated land. The use of *B. coddii* to decontaminate soil or waste must be based on a cognizance of the complicated, integrated effects of pollutant sources and soil-plant variables.

Phytoextraction pot trials using *B. coddii* were carried out under green house condition, with controlled watering. A contaminated metallurgical waste residue known as Rustenburg Base Mine Refineries waste (RBMR waste soil) collected from Rustenburg while a serpentine (native) soil (N soil) where *B. coddii* grows naturally was collected from Mpumalanga. The experiment involved the addition of sulfur doses to both soils in order to test whether acidification and higher sulfur availability could enhance the uptake of both Co and Ni by *B. coddii*. The results indicate that the addition of sulfur from 2.0 to 8.0 g per kilogram decreased pH in both substrates. RBMR waste soil pH was found to have decreased from 7.8 to 7.4 while the N soil pH was found to have decreased from 6.4 to 4.7. The reduction oxidation potential (redox potential) in both substrates was observed to have decreased along with the increase in sulfur dosage. The mean redox potential for RBMR waste soil was found to be 350 mV and 506 mV for the N soil after the addition of sulfur. Conductivity increased along with the increase in sulfur dosage in both substrates. The mean conductivity for the N soil was found to be 961 $\mu\text{S}/\text{cm}$ while that of the RBMR waste soil was found to be 1453 $\mu\text{S}/\text{cm}$ after the addition of sulfur.

The decrease in soil pH was significant ($p = 0.00115$) in the N soil than RBMR waste soil. Despite the increase in sulfur dosage and decrease in soil pH in both substrates, *B. coddii* observed growing. Although it was evident that *B. coddii* is able to grow in the RBMR waste soil, it was observed that the RBMR waste soil limits the root depth of the *B. coddii*, reducing chances for the roots to penetrate into the ground especially when dry. The RBMR waste soil becomes more compacted than the N soil when dry. It is therefore

crucial to ensure that there is enough moisture to allow for the *B. coddii* being able to survive effectively in the RBMR waste soil. *B. coddii* plant height in the RBMR waste soil after four months was observed to be in the range of 190 to 200 mm tall. This was found to be less than the height observed for the *B. coddii* planted in the N soil, which was in the range of 350 to 400 mm.

Nonetheless, plants grown in both substrates were able to absorb Ni and Co into their tissues. More Co and Ni were found to have accumulated into the leaf tissues than in other parts of the plant. This could be an advantage since one would harvest only the leaf part or the canopy (shoots) and allow *B. coddii* to resprout in order to continue taking up more Co and Ni from the same waste substrate to remediation levels that could be stipulated by Government as desirable for the ecosystem and the protection of human health. Although the accumulated Ni and Co can be recovered from biomass, this alone might not provide sufficient economic justification for phytoextraction due to the low concentrations that could be recovered.

B. coddii was found to absorb higher concentrations of Co and Ni from the N soil than from the RBMR waste soil. However, the results found in this study may not be conclusive. This could be due to many variables that could control metal uptake which were not investigated. These include mycorrhizal fungi and metal forms in the soil. Moreover, this study was performed in a green house and not in the outdoor environment. Ni is generally toxic to most plants, hyperaccumulators (i.e. *B.coddii*) contain elements that nullify the toxic effect of nickel, and in this case the accumulated nickel is bound to malate to form a harmless nickel complex which could be absorbed by the plants as nutrients.