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Assessment of Bioavailable Concentrations of Germanium and Rare Earth Elements in the Rhizosphere of White Lupin (Lupinus albus L.)

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Concentrations of Germanium (Ge) and Rare Earth Elements in soils are estimated at 1.5 mg kg -1 (Ge), 25 mg kg -1 (La) and 20 mg kg -1 (Nd), which are only roughly smaller than concentrations of Pb and Zn. Germanium and rare earth elements are thus not rare but widely dispersed in soils and therefore up to date, only a few minable deposits are available. An environmental friendly and cost-effective way for Ge and rare earth element production could be phytomining. However, the most challenging part of a phytomining of these elements is to increase bioavailable concentrations of the elements in soils. Recent studies show, that mixed cultures with white lupine or other species with a high potential to mobilize trace metals in their rhizosphere due to an acidification of the soil and release of organic acids in the root zone could be a promising tool for phytomining. Complexation of Ge and rare earth elements by organic acids might play a key role in controlling bioavailability to plants as re-adsorption on soil particles and precipitation is prevented and thus, concentrations in the root zone of white lupine increase. This may also allow the complexes to diffuse along a concentration gradient to the roots of mixed culture growing species leading to enhanced plant uptake. However, to optimize mixed cultures it would be interesting to know to which extend mobilization of trace metals is dependent from chemical speciation of elements in soil due to the interspecific interaction of roots. A method for the identification of complexes of germanium and rare earth elements with organic acids, predominantly citric acid in the rhizosphere of white lupine was developed and successfully tested. The method is based on coupling of liquid chromatography with ICP-MS using a zic-philic column (SeQuant). As a preliminary result, we were able to show that complexes of germanium with citric acid exist in the rhizosphere of white lupin, what may contribute to the bioavailability of this element.
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