Nickel and zinc isotope fractionation in hyperaccumulating and non-hyperaccumulating plants

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Isotope fractionation of micronutrients, e.g. zinc (Zn), copper, iron, could be used to trace the uptake and transport mechanisms of these elements in plants. In this work, nickel (Ni) and Zn hyperaccumulator (HA) and non-hyperaccumulator (NHA) were investigated to explore the correlation between ion absorption strageties and isotope fractionation.

A hydroponic culture experiment was conducted and three species, namely NHA *Thlaspi arvense*, Ni HA *Alyssum murale* and Ni/Zn HA *Noccaea caerulescens*, were cultivated in different Ni and Zn treatments. Ni and Zn isotope compositions in solutions and plant parts were analyzed.

Results showed that plants were inclined to take up light isotopes for both elements, for instance, $\Delta^{60}Ni_{plant\text{-}solution}$ could reach -0.63 to -0.90‰ in low Zn treatments. Ni concentration in HAs decreased 33-61% in high Zn treatment, which could be ascribed to Ni/Zn competition in the uptake process. Meanwhile, the Ni isotope fractionation also decreased drastically ($\Delta^{60}Ni_{plant\text{-}solution}$ -0.07 to -0.11‰).

For all species, the shoots showed a similar extent of light Zn enrichment relative to the roots ($\Delta^{66}Zn_{shoot\text{-}root}$ around -0.7‰), indicative of a similar xylem loading mechanism functioning in both NHAs and HA. By contrast, heavy isotopes of Ni enriched in the shoot of NHA ($\Delta^{60}Ni_{shoot\text{-}root}$ 0.25‰) while HAs favored light isotopes (-0.14 to -0.47‰), probably reflecting different translocation strategies in these plants.

We concluded that the isotope fractionation of certain element could be well-correlated with its uptake and transport mechanisms. Moreover, according to the data of this work and previous publications, we hypothesize that isotope fractionation in plants is controlled by not only transmembrane transport in root cells but also ion diffusion in rhizospheric solution.