Chemical interactions between plants and soil - metals in acidic and alkaline conditions

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The chemical interactions between plants and soil - metals have attracted special attention in the phytoremediation processes implementation. There are known plants which acquire an extraordinary ability to survive and tolerate high amounts of metals in toxic environments above the limits considered to the living organisms. Thus, some species developed strategies to exclude these metals preventing its absorption, while others may bioaccumulate these metals in their tissues. Sometimes, these plants are considered hyperaccumulators for a given element.

In this study a set of plants (native and emergent aquatic plants) were collected from the mine areas (tailings, soils/sediments, streams, lagoons with acid waters) with high heavy metal (Cu, Zn and Pb) concentrations. The samples were collected from the Iberian Pyrite Belt (Lousal, Aljustrel and S. Domingos), which is characterized by dominated acidic conditions in a semi-arid environment, and from Morocco (Tighza and Zeida) that is characterized by alkaline regime and arid region. Each plant was separated into different organs (roots, stems and leafs) and then, submitted to chemical analyses (ICP-MS) and infrared spectroscopy (FTIR).

The plants from Iberian Pyrite Belt mines contain important bioaccumulation of Cu (8 – 1113 $mg.kg^{-1}$) and Zn (29 – 912 $mg.kg^{-1}$). The amount of Pb is lower (5 – 468 mg.kg-1) but in some cases can be relevant. The translocation factor (TF) shows that roots accumulated both Cu and Pb, while Zn is more easily translocated to the aerial parts of the plant. Land plants had lower levels of bivalent metals than aquatic plants, but they are more efficient in the translocation of these metals. Aquatic plants retained metals in roots, which probably results from the release of oxygen by the roots that allows the Fe-oxyhydroxides precipitation, where metals are subsequent adsorbed. FTIR spectra shows vibration bands attributed to organic complexes or to inorganic phases (i.e., kaolinite) responsible for metals complexation, preventing plants against toxicological effects.

Chemical analyses of plants collected in Morocco mines show a higher enrichment of Pb instead of Cu and Zn. The range of metal contents were: Cu (2 – 240 $mg.kg^{-1}$), Zn (13 – 386 $mg.kg^{-1}$), and Pb (40 – 1252 $mg.kg^{-1}$). Generally, the amounts of metals were higher in roots than in aerial parts, but some exceptions were observed both for land and aquatic plants. The alkaline conditions did not favour a high mobility of metals, so Pb-uptake by these plants is due to organic chelates.

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