Studies of metal homeostasis in plants from organ to molecular level using X-ray based techniques for the purpose of phytoremediation

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Biosphere pollution by metals has accelerated dramatically during the last few decades; hence there is an urgent need for the development of cheaper and environmentally friendlier technologies for cleaning and remediation of metal-contaminated sites, such as phytoremediation. Since plant biological processes are ultimately solar driven, phytoremediation is on average ten times cheaper than engineering remediation methods. However, to increase the efficiency of phytoremediation technologies, more should be known about the specific plant physiological processes involved, including metal uptake, translocation and tolerance.

Our studies were mainly focused on the mechanisms of Cd accumulation and tolerance in pennycress *Thlaspi praecox,* a Cd hyperaccumulator from a metal polluted site in Mežica valley, Slovenia, able to accumulate up to 6000 mg Cd kg^{-1} of dry weight in leaves (Vogel-Mikuš et al. 2005). Cd contents in plant tissues were determined using Energy –dispersive X-ray spectrometry. Modern physical techniques as micro-proton induced X-ray emission (micro-PIXE) (Vogel-Mikuš et al. 2008) and synchrotron radiation based micro-X-ray fluorescence (micro-XRF) were employed to study Cd localization and distribution in leaf tissues of hydroponically grown plants fed with 100µM Cd and naturally grown plants. In addition X-ray absorption spectroscopy techniques, X-ray absorption near-edge structure (micro-XANES) and extended X-ray absorption fine structure (EXAFS) were used to study Cd coordination in *T. praecox* tissues (Vogel-Mikuš et al. 2010). Micro-PIXE was performed at Jozef Stefan nuclear microprobe, micro-XRF and micro-XANES was performed at the European synchrotron facility (ESRF) in Grenoble, France at the ID21 beamline and EXAFS was performed at the European synchrotron facility (ESRF) in Grenoble, France at the BM29 beamline and on C beamline of HASYLAB, Hamburg, Germany.

The results showed that in leaf tissues of the Cd hyperaccumulator *Thlaspi praecox* Cd accumulated in epidermal, so as photosinthetically active mesophyll tissues. In epidermal cells oxygen Cd ligands prevailed, while in mesophyll cells Cd was bound to oxygen and sulphur ligands. This indicates that extensive vacuolar sequestration plays the main role in Cd detoxification in leaf tissues (Vogel-Mikuš et al. 2010), preventing toxic Cd ions to interfere with metabolic pathways in cytoplasm.

References

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