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Distribution and accumulation of zinc in *Gynura pseudochina* (L.) DC.

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Introduction

Phytoremediation is the process through which contaminated land is ameliorated by growing plants [1]. *Gynura pseudochina* (L.) DC., a large tuber plant found in the zinc mine, has potential in phytoremediation of zinc contaminated soil [2]. However, the mechanisms of hyperaccumulation and tolerance are unknown. Therefore, this research aims to study the distribution and speciation of zinc accumulated in the metals treated *G. pseudochina* (L) DC. by XAFS and XRF imaging utilizing synchrotron radiation (SR).

Materials and Methods

One month healthy plants, *G. pseudochina* (L) DC., were treated with zinc solutions (100 mg l^{-1}, pH 5.5 ± 0.5) for two weeks. Plant samples were separated into leaves, stem and tuber (medullar and sheet). A thin sample suitable for XRF imaging was prepared by slicer to 200 μm thickness before suddenly freeze dried. For bulk XAFS analysis, 25-100 mg of each plant's freeze dried parts were ground and pressed into a pellet and sealed in a mylar plastic bag. Analytical chemicals of $Zn(NO_3)_2$, ZnS, $ZnSO_4$, and ZnO were measured as reference materials.

μ-XRF imaging was performed at BL-4A. SR X-ray was monochromatized to 14.2 keV and focused to 4x6 μm^2 by K-B mirror for two-dimensional XRF imaging. The XRF intensities were measured for 2 s at each point and normalized by the intensity of scattered X-ray. The Zn K-edge XAFS spectra were obtained at BL-12C utilizing a Si(111) double-crystal monochromator and measured in a fluorescence mode using a 19-elements SSD. The XAFS data were analyzed by Rigaku Rex2000 Version 2.3.2 software.

Results and Discussion

XRF imaging of each plant parts of tuber, stem and leaves indicated that zinc was transported from vascular ring of tuber to stem and leaves, respectively (data not shown). However, the distributions of elements in plant's parts were not uniform. Fig. 1 shows that Zn, Mn and K in the cross-section of stem were mainly distribution in the cortex. Zn and K were also spread in vascular tissue and pith, whereas Mn might be restricted in up-translocation by phloem and limited transported to pith.

Zn K-edge XANES spectra are shown in Fig. 2. The results indicated that zinc in the stem and leaves were bound to S, whereas zinc in sheet and medulla of tuber possibly formed Zn-O bond. Curve fitting of EXAFS oscillation yielded coordination number (N) and interatomic distance (R). The results obtained for first Zn-S coordination shell of stem and leaves were both 3.2(N) and 2.25A°(R), respectively. On the other hand, those for first Zn-O shell of sheet and medulla were 3.1(N), 2.05A°(R) and 2.5(N), 2.07A°(R), respectively.

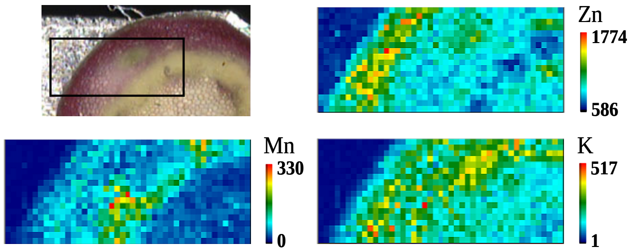

Fig. 1 Photograph of cross-section of stem and XRF imaging of Zn, Mn and K (900 x 2250 μm^2)

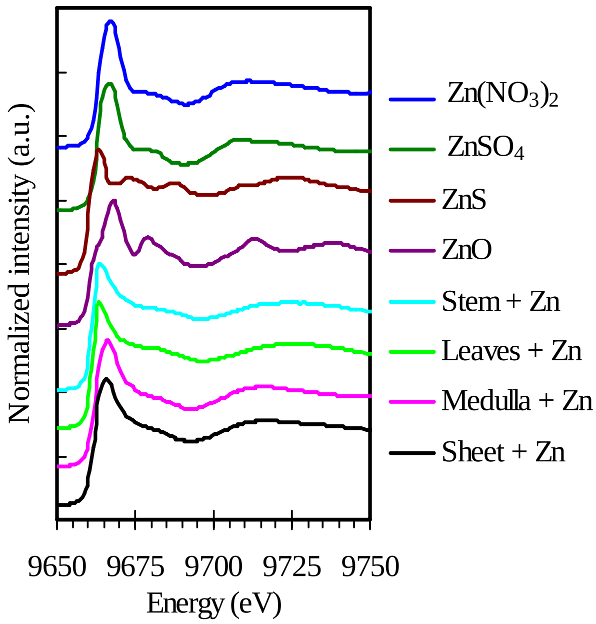

Fig. 2 Normalized Zn K-edge XANES spectra of references material; $Zn(NO_3)_2$, ZnS, $ZnSO_4$, and ZnO, and plant samples accumulated zinc in stem, leaves, and tuber (medulla and sheet)

References

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