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Distribution and speciation of chromium in *Gynura pseudochina* (L.) DC.

Bodin MONGKHONSIN[1], Woranan NAKBANPOTE*[1], Ponlakit JITTO[1], Izumi NAKAI**[2], Akiko HOKURA[3], Saori TAKADA[2], Yuuichi YOSHII[2], Wakiko YAMAOKA[2], Kriengkamol TANTRAKARN[2]

[1] Mahasarakham University, Kantarawichi, Mahasarakham, 44150, Thailand
[2] Department of Applied Chemistry, Tokyo University of Science, Shinjuku, Tokyo, 162-8601, Japan
[3] Department of Green and Sustainable Chemistry, Tokyo Denki University, Chiyoda,Tokyo, 101-8457 Japan

Introduction

Hexavalence chromium (Cr(VI)) used in many industries results to its bioavailability and biomobility [1]. Phytoremediation is the process through which contaminated land is ameliorated by growing plants [2]. Our preliminary study found that *G. pseudochina* (L) DC. was able to accumulate and reduce the toxicity of Cr(VI). Therefore, this research aims to study the chemical speciation and distribution of chromium accumulated in treated *G. pseudochina* (L.) DC., by XAFS and XRF imaging utilizing synchrotron radiation (SR).

Materials and Methods

One month old, healthy, *G. pseudochina* (L) DC. plants were treated with 100 mg l^{-1} of chromium solution (pH 5.5±0.5) prepared from $K_2Cr_2O_7$, in a hydroponic system for two weeks. Control plants were treated with deionised water. Plant samples were separated into leaves, stem and tuber (medullar and periderm). A thin sample for XRF imaging was prepared by slicer, to 200 µm and 1 mm thickness, before suddenly freeze dried. For bulk XAFS analysis, 100 mg of each plant's freeze dried parts were ground and pressed into a pellet and sealed in a mylar plastic bag. Reference materials for Cr(III) were $Cr(NO_3)_3$, $CrCl_3$, Cr_2O_3, $Cr_2(SO_4)_3$ and CrS; Cr(V) was $Na[Cr(O)(ehba)_2].H_2O$; Cr(VI) were CrO_3 and $K_2Cr_2O_7$.

µ-XRF imaging was performed at BL-4A. SR X-ray was monochromatized to 11 keV and focused to 32x32 μm^2 by a K-B mirror. The XRF intensities were measured for 2-4 sec at each point and normalized by the intensity of scattered X-rays. The Cr 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 was analyzed by Rigaku Rex2000 Version 2.3.2 software.

Results and Discussion

µ-XRF imaging showed chromium was translocated from the tuber to the stem and leaves through the vascular bundles and localized around the vascular tissue. The distribution of chromium in the tuber related to Fe, Zn and Ca, and tended to relate with Zn and S in the stem (Fig.1). The distributions of Cr, Fe, Zn, Ca, Cl, K and S were in the same areas of the leaves tissue. XANES indicated highly toxic Cr(VI) was reduced to the less toxic Cr(III) when it was translocated and accumulated in tissues (Fig.2). EXAFS spectra indicated to Cr(III) being bound to oxygen ligands. Their coordination number (*N*) were 3 to 4, and the interatomic distances (*R*) to the first shell were approximately 2 Å. Consequently, the chromium accumulated in all parts of the plant tissues were indicative of Cr(III) bound to oxygen ligands in the structure of cellulose, hemicelluloses and lignin [3].

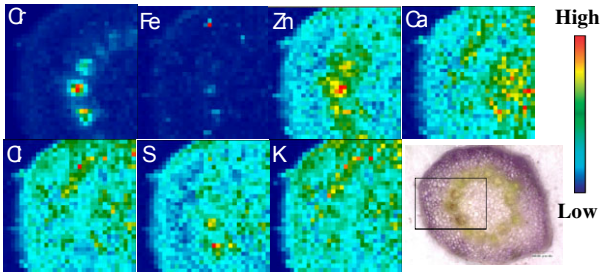

Fig. 1 µ-XRF imaging of the stem of *G. pseudochina* (L.) DC. treated with Cr(VI)

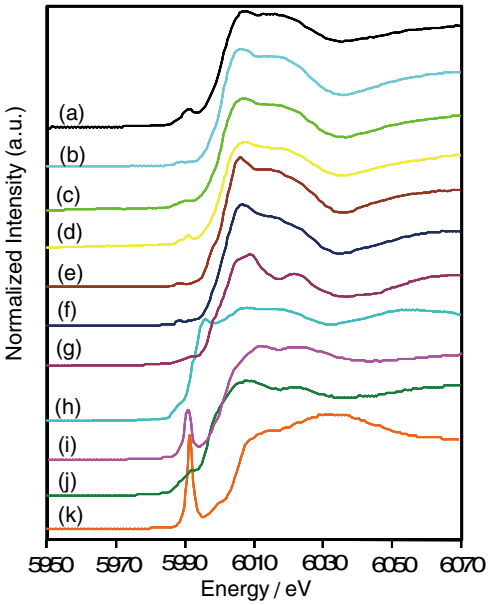

Fig. 2. Cr K-edge XAFS spectra of *G. pseudochina* (L) DC. treated with Cr(VI), and reference materials. (a) leaves, (b) stem, (c) medulla, (d) periderm, (e) $Cr(SO_4)_3$, (f) $Cr(NO_3)_3$, (g) Cr_2O_3, (h) CrS, (i) $Na[Cr(O)(ehba)_2].H_2O$, (j) CrO_3, (k) $K_2Cr_2O_7$

References

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* woranan.n@msu.ac.th, ** inakai@rs.kagu.tus.ac.jp