Bioresource Technology 118 (2012) 455–459

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

Tolerant mechanisms of *Rorippa globosa* (Turcz.) Thell. hyperaccumulating Cd explored from root morphology

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HIGHLIGHTS

- ▶ Hyperaccumulative properties of *R. globosa* to Cd was further affirmed.
- ▶ *Rorippa palustris* (Leyss.) Bess. was a Cd non-hyperaccumulator.
- ▶ Cd tolerant mechanism of plant was relative with root morphology.

ARTICLE INFO

Article history:
Received 13 March 2012
Received in revised form 8 May 2012
Accepted 11 May 2012
Available online 18 May 2012

Keywords:
Cd
Hyperaccumulator
Rorippa globosa (Turcz.) Thell.
Root morphology

ABSTRACT

Hoagland solution was used to determine the root morphology properties of *Rorippa globosa* (Turcz.) Thell. and *Rorippa palustris* (Leyss.) Bess. Under the conditions of Cd spiked at 2.5 and 5 mg kg^{-1}, *R. globosa* showed all hyperaccumulative characteristics and was a Cd-hyperaccumulator. In contrast, *R. palustris* was a non-hyperaccumulator. The total root lengths, total root surface areas and total root volumes of *R. globosa* were not significantly decreased ($p < 0.05$) compared to the control when 2.5 and 5 mg kg^{-1} of Cd added. However, these 3 indexes of *R. palustris* were all significantly decreased ($p < 0.05$) when 2.5, 5, 10, 20 and 40 mg kg^{-1} Cd added compared its control. The average root diameters of *R. palustris* and *R. globosa* were not affected by Cd. These results showed that root morphology might be a factor of plant with strong tolerance to Cd.

1. Introduction

Cd is one of heavy metals which are toxic not only to soil microflora, fauna and vegetation but also to human being through food chain. In environmental science, the remediation of soil contaminated with Cd is a challenging and difficult problem. Phytoextraction mainly using hyperaccumulator or accumulator is a newly developing and promising phytoremediation technology besides of some traditional physical and chemical remediation methods. Till now, some hyperaccumulators have been comprehensively researched such as the Cd and Zn hyperaccumulator *Thlaspi caerulescens* (Xiao et al., 2010), the arsenic hyperaccumulator *Pteris vittata* (Ma et al., 2001; Mathews et al., 2010; Wan et al., 2010), Zn and Cd hyperaccumulator *Sedum alfredii* (Li et al., 2011), and Cd hyperaccumulator *Solanum nigrum* (Wei et al., 2010). However, phytoremediation technology using these hyperaccumulators has not been applied in a large scale to remove excessive heavy metals from contaminated soil partly due to limited remediation efficiencies. Thus, hyperaccumulator identification and relative hyperaccumulative mechanism exploration are still the key step of phytoextraction.

Usually, hyperaccumulator refers to some plants that can accumulate exceptionally high quantities of heavy metals in their stems or leaves. The main characteristics of hyperaccumulative plants can be summarized as follows: (1) accumulation property, i.e. the minimum concentration in the shoots of a hyperaccumulator for As, Pb, Cu, Ni, and Co should be greater than 1000 mg kg^{-1} dry mass, and Zn and Mn 10,000 mg kg^{-1}, Au is 1 mg kg^{-1}, and Cd is 100 mg kg^{-1}, respectively (Baker and Brooks, 1989); (2) translocation property, elemental concentrations in the shoots of a plant should be higher than those in roots, i.e., TF > 1 (translocation factor, concentration ratio of shoots to roots) (Chaney et al., 1997; Ma et al., 2001); (3) enrichment property (enrichment factor-EF, concentration ratio of plant to media), EF value in shoots of plants should be higher than 1 (Wei et al., 2005); and (4) tolerance

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http://dx.doi.org/10.1016/j.biortech.2012.05.049