The Effects of Chelating Agents and Metal Speciation in Phytoremediation

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1. Introduction

Phytoremediation can be suggested as a cost effective, esthetically pleasing remediation method. As it depends on the ability of plant to absorb contaminants into the roots, it may take long time compared with other traditional remediation methods. The goal of metal phytoremediation is to reduce the levels of toxic metals in the contaminated soils within a reasonable time frame (1-3 years). Therefore, the focus of phytoremediation should be the efficiency to shorten the required time to extract.

The efficiency of metal phytoremediation is a function of a number of factors; major factors are plant species and bioavailability of metals. The purpose of this study is to increase the bioavailability of heavy metals (Cd and Pb) by various chelating agents and to evaluate the uptake potential of these metals by the lettuce (*Lactuca sativa L.*) in pot experiments.

2. Experimental Design

The basic soils were collected from Shiheung Cu-Pb-Zn abandoned mine sites. Almost all the soils were composed of tailings. In order to check whether the mobile metals were dispersed into non-polluted soil or not, non-polluted soils were put at the bottom of the each pot. Lettuce (*Lactuca sativa L.*) was selected as the main plant in this experiment. For control, the plant leaves and soils were collected around mine sites. In this experiments, four chelating agents were used: EDTA (Ethylenediaminetetraacetic aicd) and NTA (Nitrilotriacetic acid) as synthetic chelating agents and citric acid and malic acid as natural chelating agents.

The composition of batch was like this: (1) Pot A; control pot without chelating agent, (2) pot AA; EDTA treated, (3) pot AB; NTA treated, (4) pot AC; citric acid treated, and (5) pot AD; malic acid added pot. Seedlings were grown in a greenhouse equipped with supplementary lighting (14-h photoperiod; 24-28℃). Because of the typical conditions of the rhizosphere, the soil was divided into rhizosphere and non-rhizosphere soil. There were 3 duplicates of each pot; 5, 10 and 15 days after, the plants and soils were harvested and analyzed.

Key words: phytoremediation, chelating agent and metal (Cd and Pb) speciation

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3. Results and Discussion

The chelating agent was effective to make metal speciation into mobile form. The metal speciation was affected by various chelating agents and Cd and Pb also had the different affinities to the chelating agent. Extraction of Cd and Pb from the soil was effective in the order of EDTA > Citric acid > NTA > Malic acid, and EDTA > NTA > Citric acid > Malic acid, respectively (Fig.1).

The mobile fraction of Cd was higher than that of Pb. The rhizosphere soil had more mobile fractions of Cd and Pb than non-rhizosphere soil. The differences of mobile fraction from various chelating agent decreased in the rhizosphere soil. The same trend was observed in other elements, such as Cu, Mn and Zn. The ratio of mobile fraction in rhizosphere soils to that in non-rhizosphere soils increased in the pots, which had low mobile fraction in non-rhizosphere soil (Fig.2). This may imply the mobile fractions in rhizosphere soil are nearly constant regardless of various chelating agents. Cd and Pb can be changed into mobile fraction in rhizosphere soil without chelating agents. However, the area of rhizosphere is very narrow, chelating agents are necessary to transport metal into the root zone.

The mobile form of heavy metals could be dispersed to the non-contaminated sub-soil as well as to the plant roots. In this experiment, the concentration of metal in the base soil exceeded the tolerance level in case of chelating agent treated soils. The selection of proper chelating agent and their appropriate amount must be considered before applying chelating agent to the contaminated fields. This consideration can increase the efficiency of phytoremediation and prohibit the secondary pollution during the remediation process.

The heavy metal uptake by lettuce depended on the mobile fraction of metal in the pot experiments. However, the control plants collected from the mining area had low concentrations of metals in spite of the high mobile fraction. For the effective phytoremediation, the selection of the proper plant species is the first step to be solved.

4. Conclusion

Phytoremediation can be used as a metal extraction method in contaminated soils with Cd and Pb. Considering the efficiency of remediation, chelating agents can help metal changing into mobile fraction and good accumulating plants (hyperaccumulators) must be selected.

5. References

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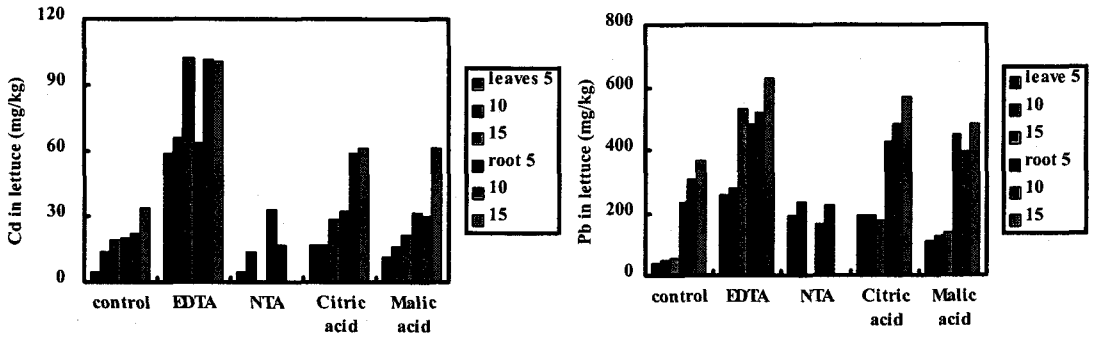
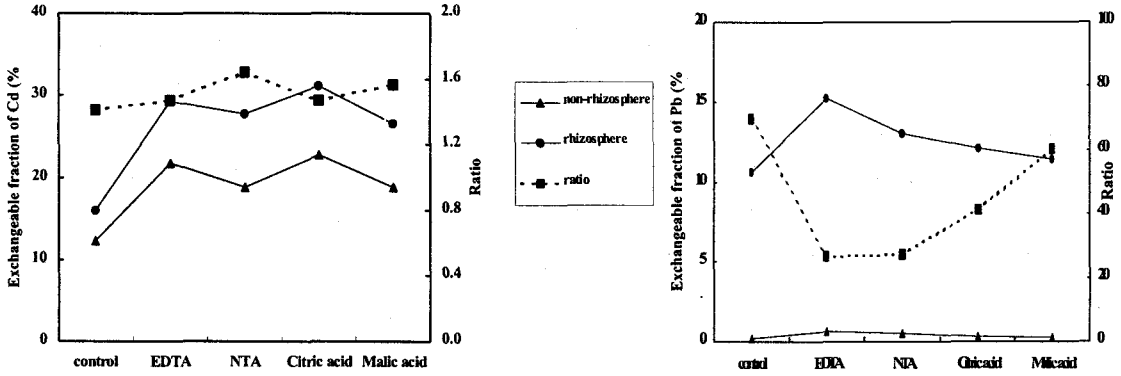


a) Cd b) Pb

Fig. 1 Concentration of (a) Cd and (b) Pb in lettuce leaves and roots.



a) Cd b) Pb

Fig. 2 Exchangeable fraction of (a) Cd and (b) Pb in non-rhizosphere soil and rhizosphere soil and their ratio.