Enzyme activity and aqueous removal of endocrine disrupting chemicals in phytoremediation.

A.R. Reis[1], K. Tabei[1], H. Watabe[1] and Y. Sakakibara[*1]

1. Introduction

Phytoremediation refers to a set of technologies that use plants to degrade or contain contaminants. The objective of this study was to investigate the possible effect of plant peroxidase and polyphenol oxidase activity on aqueous removal of endocrine disrupting chemicals (EDCs) in phytoremediation using aquatic plants.

2. Materials and methods

Two types of laboratory-scale experiments, batch and continuous experiments were conducted. The EDCs used were 2,4-Dichlorophenol (DCP), 4,t-Octylphenol (OP), Pentachlorophenol (PCP), Nonylphenol (NP), and Bisphenol-A (BPA). The initial and feed concentrations of all EDCs were set in the range of 1-100 μg/L. In addition, peroxidase (PO) and polyphenol oxidase (PPO) activities were measured and relations to removal rates of EDCs were investigated.

2.1. Batch and continuous experiments

Batch experiments with a period of 10 days were conducted to measure time-course changes in concentrations of EDCs. The continuous experiments were carried out during 70 days to investigate the stability of removal performance.

Aquatic plants used in this study were: *Fontinalis antipyreta* (FA), *Ceratophyllum demersum* (CD), *Taxiphulum barbieri* (TB), *Nasturtium officinale* (NO), *Ricciocarpos natans* (RN), *Limnobium laevigatum* (LL), *Riccia fluitans* (RF), *Hydrilla verticillata* (HV), and *Potamogeton oxyphyllus* (PO). These plants were divided into three groups. The LL, RN and RF were classified as floating plants, the CD, FA, HV and PO as submerged plants, and the NO as an emerged plant. These plants were used because of their wide distribution in aquatic environment. Enzyme (PO and PPO) activities were measured according to former studies (Pandolfini and Gabbrielli, 1992; Varda, 1976).

3. Results and discussion

In batch experiment, EDCs were removed effectively by plants such as, RN, RF, HV, PO and CD. Based on this result, continuous experiments were conducted using NO, CD and RN plants. Figure 1 shows time course changes of EDCs in the continuous experiments. As shown, after quick decrease at initial phase effluent EDCs concentration attained to steady-state values. On days 48, 58 and 67, influent concentration was changed from 10 to 1 μg/l, 1 to 100 μg/l, and 100 to 10 μg/l, respectively. Every EDC was removed continuously by every plant, while relatively smaller removal was observed for PCP. Among the aquatic plants, the RN plant showed good removal performance due to larger amount of biomass used in experiment.

Figure 2 shows an example of plant enzyme (PO and PPO) activities for different plants, demonstrating the enzyme activity differed significantly with species of plants and the CD and PO have relatively larger activities. Figure 3 shows relations between specific removal rates of BPA observed in batch and continuous experiments and enzyme activities for different aquatic plants. It is interesting to note that the removal rates tended to increase with increasing ion-binding PO activities (indicated as □ in Figure 3) regardless of the species of aquatic plants. In the cases of soluble and covalent binding PO as well as PPO activity, clear relations were not identified.

[1] Department of Civil and Environmental Engineering. Waseda University. Shinjuku Ku, 3-4-1 Okubo, Tokyo 169 8555, Japan.
*Corresponding author. Tel/Fax: + 03-5286-3902. E-mail address: sakaki@waseda.jp
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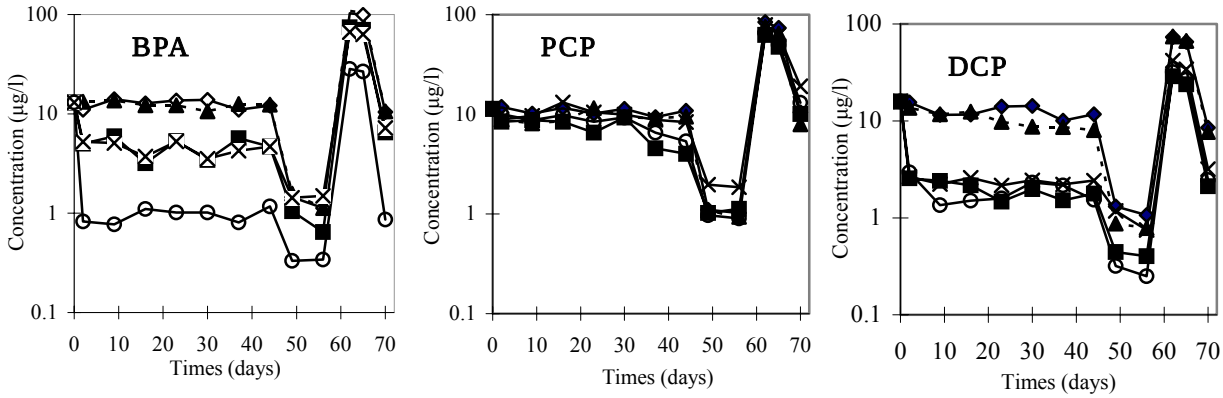

Figure 1. Time course changes of EDCs concentrations in continuous experiments, where ▲: control (no aquatic plant), ■: NO, ×: CD, ○: RN and ◇: influent concentration, respectively.

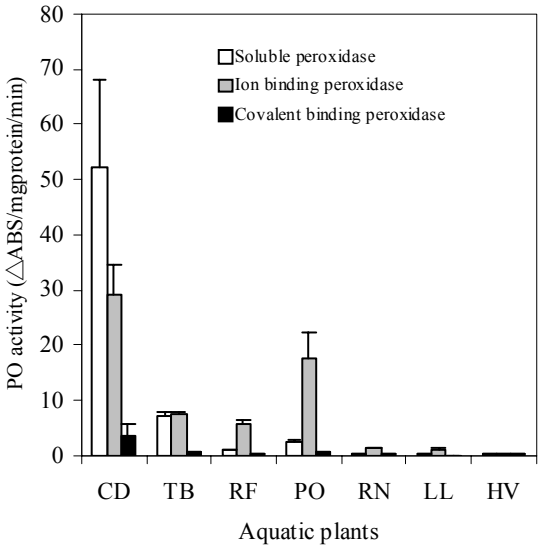

Figure 2. PO activity in aquatic plants

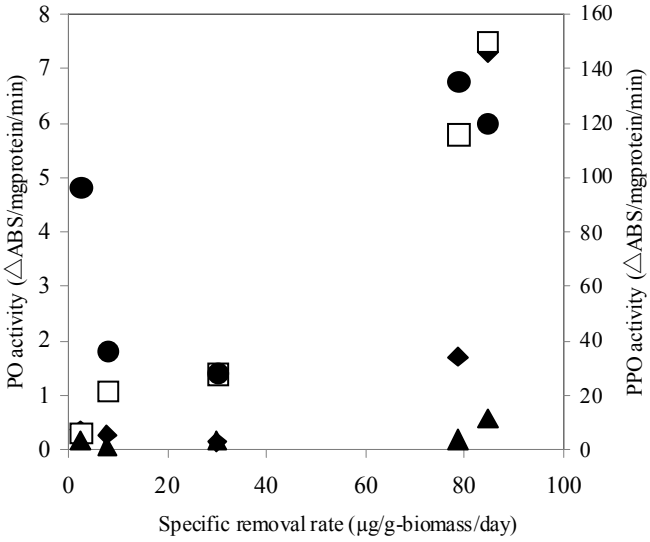

Figure 3. Relationship among removal rate and PO and PPO activities, where ♦: soluble peroxidase, □: ion-binding peroxidase, ▲: covalent-binding peroxidase and ●: PPO activity, respectively.

4. Conclusion

Experimental results demonstrated that most EDCs except PCP were effectively and stably removed by different types of aquatic plants. In addition, it was thought the specific removal rates were affected by enzyme activity, especially by ion-binding PO activity in aquatic plants.

References

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