Thesis Title	Treatment of Nitrogen and Phosphorus from Domestic Wastewater by *Echinodorus cordifolius* with *Pseudomonas putida* and *Flavobacterium oryzihabitans*
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Abstract

The problem of major pollutant contaminating domestic wastewater is nitrogen and phosphorus, which cause eutrophication. Using phytoremediation is an alternative method in treating these nutrients. Therefore, the objective of this study is to find the most efficient plant for domestic wastewater treatment. The 8 types of plant screened for treatment of phosphorus from domestic wastewater were *Crinum asiaticum*, *Echinodorus cordifolius*, *Spathiphyllum clevelandii*, *Rhizophora apiculata*, *Thalia dealbata* J. *Fraser*, *Heliconia psittacorum*, *Sonnertia ovata*, and *Sagittaria montevidensis*. The result showed that *E. cordifolius* was the best plant in treatment of domestic wastewater. The reason was that *E. cordifolius* has numerous roots, high ability of water uptake, rapid growth and the roots of this plant contain acid-producing bacteria. These bacteria produce organic acids such as acetic acid, propionic acid, butyric acid, etc., which might contribute to phosphorus solubilization in organic phosphorus to turn it into available phosphorus, so that plants can uptake more phosphorus. *E. cordifolius* can also apply for nitrogen treatment. It can remove ammonia-nitrogen from an initial 6.17 mg L^{-1} to 0.74 mg L^{-1} and nitrate-nitrogen from an initial 1.7 mg L^{-1} to 0.4 mg L^{-1} within 20 hrs. In addition, the plant can remove COD from domestic wastewater continuously.

From the sustainability of phosphorus treatment for 20 cycles by *E. cordifolius*, it was found that there was plant prolongation, and that roots, shoots, and leaves were increased. This result associated with the increase of plant biomass, from an initial plant weight before treatment of 110.16±1.08 g dry weight $plant^{-1}$ to 142.74±3.89 g dry weight $plant^{-1}$ after phosphorus treatment for 20 cycles (26 days). In addition, the study of the relation between plant biomass and photosynthesis found that plant biomass increase associated with the increase of photosynthesis. This was due to the plant receiving nutrients from wastewater that caused more growth of plant and photosynthesis to increase, compared to the control set or plant grown in tap water, which had lower photosynthesis.

The result of this study showed the efficiency of *E. cordifolius* in pollutant treatment from domestic wastewater. The relationship among plant, microorganisms, and soil in phosphorus treatment found that when soil was saturated with phosphorus, the plant plays the major role in treatment of phosphorus (about 81%), and the least contributed

was from microorganisms in soil and wastewater. Moreover, the result showed that phosphorus was accumulated in the plant tissues about 1.29±0.06% in treatment compared with the control set, which was about 0.71±0.04%.

Domestic wastewater contained mainly *Pseudomonas putida* and *Flavobacterium oryzihabitans*. Therefore, in order to increase the efficiency of domestic wastewater treatment by *E. cordifolius*, *P. putida* augmented with plant, *F. oryzihabitans* augmented with plant, and mixed microorganisms (*P. putida* and *F. oryzihabitans*) augmented with plant were investigated. The result showed that only the plant system (no microorganisms) had 70% phosphorus removal and still did not pass the standard criterion of U.S.EPA, while the system of bioaugmentation had 90% phosphorus removal and passed standard criterion of U.S.EPA within 14 hrs. Moreover, after phosphorus treatment for 3 weeks, plant flowering appeared, plant shoots and leaves were extended and the plant growth rate increased in the bioaugmentation system, which was associated with increased plant biomass after phosphorus treatment for a month. The initial plant biomass in the system before treatment was 37.20±1.36 g dry weight plant^{-1}, the weight of the system augmented with *P. putida*, the system augmented with *F. oryzihabitans*, and the system augmented with mixed microorganisms increased to 46.17±4.74, 42.88±2.81, and 41.46±0.80 g dry weight plant^{-1}, respectively, whereas, in the system without bioaugmentation, the weight of plant increased to 39.30±0.67 g dry weight plant^{-1}. This result indicates that both *P. putida* and *F. oryzihabitans* are plant growth supporting microorganisms and phosphorus solubilizing microorganisms that solubilized organic phosphorus to become available phosphorus induced to increase phosphorus uptake by plant. This study showed that *E. cordifolius* was a suitable plant for removal of nitrogen and phosphorus from domestic wastewater because this plant has the ability to treat nutrients continuously and grow well in domestic wastewater. For enhancing the efficiency in treatment of domestic wastewater, *E. cordifolius* augmented with *P. putida* and *F. oryzihabitans* was obtained for sustainability.

Keywords : Bioaugmentation / *Echinodorus cordifolius* / *Flavobacterium oryzihabitans* / Nitrogen / Phosphorus / Phytoremediation / *Pseudomonas putida*