Uptake of Mercury Ion in a Wetland Plant, Canna Sp.

[1*]Suhendrayatna, [1]Henny Marlina, [1]Muhammad Zaki, [2]Elvitriana

[1]Department of Chemical Engineering, Faculty of Engineering, Syiah Kuala University, Darussalam, Banda Aceh, 23111, Indonesia
[2]Department of Environmental Engineering, Faculty of Engineering, University of Serambi Mekkah, Banda Aceh, 23246, Indonesia

*Coorresponding Author: suhendrayatna@unsyiah.ac.id

Abstract
Canna Sp. is one of the plants that can live in conditions of wetland cultivated in freshwater courses, which often serve as recipients for domestic and other sorts of wastewater. In the context of its life ability, this study deals to investigate the capacity of Canna Sp. in uptake toxic heavy metal mercury from a wetland system. Canna Sp. was cultivated in a polybag contained wastewater for a couple months to reach acclimatization. The wastewater contained mercury ions in different concentrations of 1.2; 0.96 and 0.36 mg-Hg/L. Each polybags contained five stems of Canna Sp. Control media (contain no mercury in media) were also prepared for these treatments. During 14 days of the experiment, the atmospheric air and water temperature (30$\pm$3 ^{o}C is optimum) were maintained and every five days, length of stems, concentration of mercury ion in water phase, and its tissue were analyzed. The concentration of mercury in shoots, leaves, and roots were analyzed by Atomic Absorption Spectrophotometer, Shimadzu AA 6300 after destructed using TCLP method. Results showed that Canna Sp. has resistant a survival on water phase containing mercury and it inhibits the growth of Canna Sp. in the log phase. The highest mercury ion uptake by Canna Sp. occurred in the root (1.16 – 1.34 mg-Hg/kg) compared to the leaves (0.05 – 0.33 mg-Hg/kg) and the shoots (0.29-0.69 mg-Hg/kg). These results reached to the conclusion that Canna Sp. has a potential for mercury phytoremediation application in a wetland system.

Key words: Wetland, Canna Sp., uptake, and mercury.

Introduction

A number of aquatic plants species, cultivated in urban areas show interesting characters of accumulation and degradation of pollutants. Most of these plants have already been extensively utilised for aesthetic reasons or for landscaping purposes in urban environments and in a wetland system. Recently it has been shown that these plants can uptake heavy metals from the soil or water through roots as well as from air via leaves and either incorporates and stably immobilise them in plant tissues or transform and degrade them by enzymatic functions (Göthberg, et.al., 2003). Since aquatic plants can accumulate large amounts of these substances in their shoots, they may be used to decrease heavy metal concentrations in stormwater. Usually, to improve the production of a metal removal high biomass of plants may increase this accumulation.

In the Southeast Asia the aquatic plant (Canna Sp.) is one of the plants that can live in conditions of wetland that is cultivated in freshwater courses, which often serve as recipients for domestic and other sorts of wastewater. This plant lives in groups in areas of

stagnant water and has a high resistance to changes in weather and other environmental conditions. It is accumulating heavy metals and due to its fast growth it might be used in phytofiltration of water and so far is the use and effectiveness of aquatic plants not yet fully understood.

The aim was therefore to find out the capacity of Canna Sp. to accumulate the toxic heavy metals mercury. In this study, aquatic plant species, Canna Sp., was used to investigate mercury uptake from the wetland system and the effect of mercury on the growth of plant within the system.

Materials and Methods

Preparation of Wetland Plant

Canna Sp. collected from the area in Banda Aceh City with 10 – 20 cm length was cultivated in polybag for a couple months to reach acclimatization phase. The study was conducted at an outdoor laboratory as a quality control step to control the factors of water supply, temperature, diseases, and pest.

Experiment

Canna Sp. was exposed to water containing mercury in different concentrations (1.2; 0.96 and 0.36 mg-Hg/L) of mercury ion for 14 days in polybags. Each polybags contained five stems of Canna Sp. Media without mercury ion were used as control. During 14 days of cultivation, the atmospheric air and water temperature ($30 \pm 3^{o}C$ is optimum) were maintained in the outdoor laboratory. Water phase, shoots, roots, and leaves samples from every polybags were taken for every fix treatment period. Mercury concentration in water phase were measured by using Atomic Absorption Spectrophotometer under standard procedure (Eaton, and Epps, 1995) and the shoots, roots, and leaves samples were measured after digested under Toxicity Characteristic Leaching Procedure (US-EPA, 1998).

Results and Discussion

Effect of Mercury Ion on the Wetland Plants Growth

After wetland plants (Canna Sp) were exposed to water containing mercury ion at 1.2; 0.96 and 0.36 mg-Hg/L, the growths of Canna Sp were observed by measuring the increase of leaves at specified interval times and the results are illustrated in Figure 1.

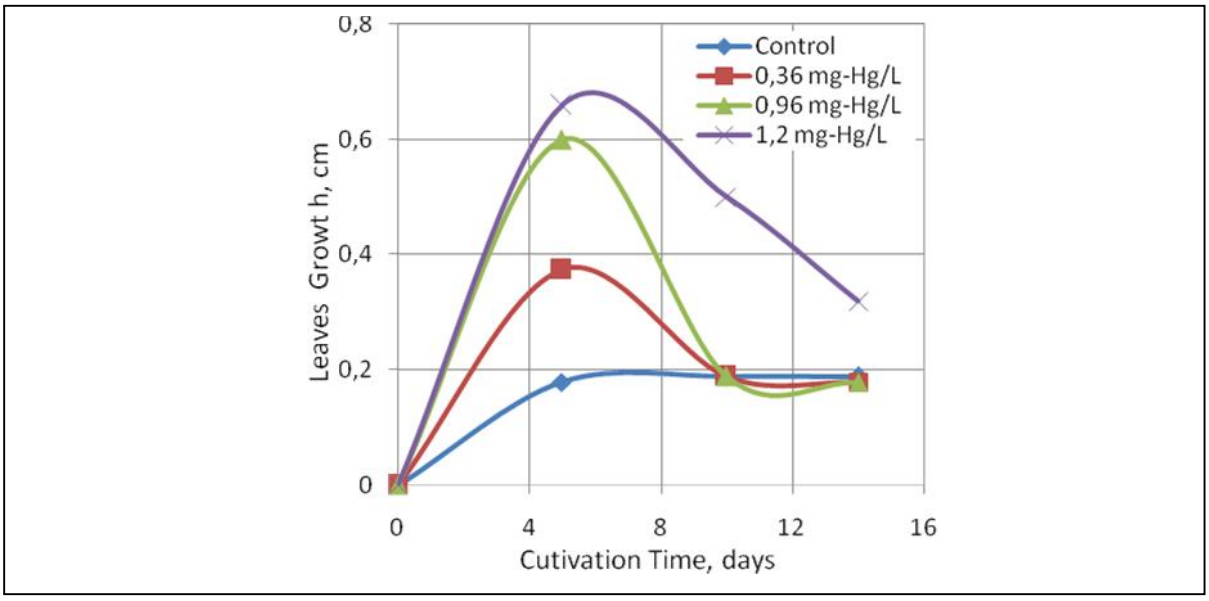

Figure 1. Growths of Canna Sp. in water containing mercury ion

Results showed that growth of Canna Sp. better and grew well at the lag phase in the media containing mercury ion compared with control media (without mercury). It was characterized by the longer growth of leaves and shoots in the growth phase. Furthermore, higher concentration of mercury in the media occurred higher growth of Canna leaves the in lag phase. Maximum length of Canna leaves found on the 5th day of growth to 0.67; 0.6; and 0.34 cm for each initial concentration of 1.2; 0.96 and 0.36 mg-Hg/L, respectivelly, while, the growth of Canna Sp. leaves for control media was only 0.17 cm. However, growth rate of Canna Sp. in medium containing mercury decreased in log phase. It was not occured in the control plants, where the growth of Canna Sp. stable since log to stationary phase. It was indicated that mercury inhibits the growth of Canna Sp. in the log phase. The same results as reported by (Suhendrayatna, et.al., 2012; Sasmaz, et.al., 2008), that plants have ability to grow and survive in the extreme environmental conditions.

Mercury uptake in Wetland Plant

The uptake of mercury ion from water phase by Canna Sp. was investigated after exposed to different concentration of mercury ion at 1.2; 0.96 dan 0.36 mg-Hg/L for 14 days in polybag. Each polybags contained five stems of Canna Sp. with 50 cm in height. After 14 days exposured, accumulation of mercury in each roots, shoots, and leaves were analyzed and results are summarized in Table 1. The results showed that the highest accumulation of mercury ion occurred in the root compared to the leaves and also to the shoots. These results perform the same results to the others vegetable and aquatic plant that have been also reported by Faeiza, et.al. (2007).

Table 1. Mercury uptake in Canna Sp. after exposured to water containing mercury

Hg Concentration in Water Phase (mg-Hg/L)	Hg Uptake in Wetland Plant (mg-Hg/kg DW)		
	Roots	Shoots	Leaves
0.36	1.30	0.69	0.05
0.96	1.16	0.29	0.33
1.20	1.34	0.51	0.14

HRT: 14 days; plant height: 50 cm; cultivation volume media: 10 L; 5 plants in each cultivation.

Conclusions

These results reached to conclusion that Canna Sp. has resistant a survival on water phase containing mercury and mercury inhibits the growth of Canna Sp. in the log phase. After exposed to water containing mercury ion, the highest mercury uptake by Canna Sp. occurred in the root (1.16 – 1.34 mg-Hg/kg) compared to the leaves (0.05 – 0.33 mg-Hg/kg) and the shoots (0.29-0.69 mg-Hg/kg). These results indicated that this plant has a potential for the mercury phytoremediation application.

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References

Eaton, A.D, and Epps, A.A. (1995). Standard Methods for the Examination of Water and Wastewater, 19th Ed, APHA, AWWA, and WEF, Baltimore, MD.

Faeiza, B., Kasmawati, M., Zuraimi, O., and Darus, F. (2007). The Used Of Aquatic Wetland Plant Phylidrum lanuginosum To Remove Lead From Aqueous Solution, Faculty of Applied Science, University Technology MARA Shah Alam, Selangor, Malaysia.

Göthberg A., Greger, M., Holm, K., and Bengtsso, B.E. (2003). Uptake of Heavy Metals in A Tropical Aquatic Macrophyte, Proceeding Workshop on Phytoremediation of toxic metals, Stockholm, Sweden, June, 12-15, 2003.

Suhendrayatna, Marwan, Andriani, R., Fajriana, Y., and Elvitriana. (2012). Removal of municipal wastewater BOD, COD, and TSS by phyto-reduction: A laboratory–scale comparison of aquatic plants at different species Typha latifolia and Saccharum spontaneum, International Journal of Engineering and Innovative Technology, Volume 2, Issue 6.

Sasmaza, A., Obekb, E., Halil Hasarb, H. (2008). The accumulation of heavy metals in Typha latifolia L. grown in a stream carrying secondary effluent, Ecological Engineering, Volume 33, Issues 3–4, Pages 278–284

US-EPA. (1989). EPA Superfund Record of Decision: Picatinny Arsenal (US Army). Rockaway Township, NJ, U.S. Environmental Protection Agency Superfund. http://www.epa.gov/superfund/sites/rods/fulltext/r0289093.pdf.