https://scilett-fsg.uitm.edu.my/
Vol. 13(2) DECEMEBR 2019

ISSN: 1675-7785
eISSN: 2682-8626
DOI: 10.1234/jmpc.v13i2.7529

Removal of Lead and Cadmium from Wastewater Sludge Using *Bougainvillea* sp. Through Phytoremediation Technique

Ahmad Na'im Abdul Rahman, Nurul Nadiah Mohd Firdaus Hum*, Zitty Sarah Ismail

Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

Corresponding author: nurulnadiah@uitm.edu.my

Received: 6 August 2019; Accepted: 17 September 2019; Published: 31 December 2019

ABSTRACT

Phytoremediation uses plants to remove, extract and absorb heavy or toxic matters from soil and water. This study explores *Bougainvillea* sp. heavy metals uptake capacity under different ratio of wastewater sludge condition. This study used 24 plants of *Bougainvillea* sp. and involves a duration of 2 months (61 days). The plants were divided and labelled according to six different treatments with four replications; A - Control (100% soil), B (20% sludge), C (40% sludge), D (60% sludge), E (80% sludge) and F (100% sludge). Accumulation of considered metals of lead and cadmium for leaf, stem and roots were analyzed using Inductive Coupled Plasma-Optical Emission Spectrophotometer (ICP-OES). The highest removal was found to be at 60% sludge mixture for both metals. The highest lead and cadmium accumulation were found in the root with the concentration of 0.1 mg kg^{-1} and 0.06 mg kg^{-1} respectively. Thus, the optimum lead and cadmium removal using *Bougainvillea* sp. was at the 60% sludge mixture (Treatment D).

Keywords: *Phytoremediation; Wastewater sludge; Lead; Cadmium; Bougainvillea* sp.

INTRODUCTION

Phytoremediation is an effective, environmentally friendly, long lasting and serves more than one type of environmental treatment other than mitigating air pollution (greenhouse gases) and soil remediation. Example of soil remediation was remediation on heavy metals by using *Bougainvillea* sp. [3]. In Malaysia, *Bougainvillea* sp. has been one of the most planted ornamental plants in rural, resident and city area like Kuala Lumpur [1], or Ipoh city which is also known as 'The Bougainvillea city (referring as the symbol flower of the city) [2]. This plant has been recommended by the Metropolitan Manila Development as an ornamental plant at the main roads because of its abundance and colorful flower [3], as well as can withstand heavily polluted urbanized area. In addition, *Bougainvillea* sp. best characteristics are tolerant in hot dry locations, can grow in acidic pH, salt tolerant and wind resistant [4].

Despite of its ornamental value in landscaping, *Bougainvillea* sp. is one of the plants that has been used for phytoremediation [5]. Researchers discovered that *Bougainvillea* sp. has the ability to absorb metal from soil while no morphological symptoms or contamination damage on the examined plant parts was

https://scilett-fsg.uitm.edu.my/
Vol. 13(2) DECEMEBR 2019

ISSN: 1675-7785
eISSN: 2682-8626
DOI: 10.1234/jmpc.v13i2.7529

found [6]. Besides, *Bougainvillea* sp. was mostly used by researchers as phytoremediator for urban soils in removing heavy metals particularly like lead and cadmium [3, 6, 11].

However, studies in treating heavy metals using *Bougainvillea* sp. as wastewater sludge phytoremediator is scarce. Hence, this indicates that *Bougainvillea* sp. is suitable to be a tested subject to treat wastewater sludge in removing the heavy metals [7]. The objective of this research is to determine the ability and performance of *Bougainvillea* sp.in removing lead and cadmium from the wastewater sludge.

EXPERIMENTAL

In order to evaluate the plant growth and the heavy metal uptake capacity of the *Bougainvillea* sp., experimental analysis and laboratory work were carried at the Faculty of Applied Science, Universiti Teknologi MARA (UiTM) Shah Alam. Wastewater sludge was obtained from Mawar Wastewater Treatment Plant, UiTM Shah Alam. A total of 24 seedlings of approximately same size were planted in black polyester bags.

These samples were divided and labelled according to six different treatments with four replicates; A - Control (100 % soil), B - (80 % soil + 20 % sewage sludge), C - (60 % soil + 40 % sewage sludge), D - (40 % soil + 60 % sewage sludge), E - (20 % soil+ 80 % sewage sludge) and F - (100 % sewage sludge). Plants were planted in a duration of two months (61 days) and were harvested and cut into leaf, stem and root parts for further analysis.

Plant analysis was performed using rapid wet digestion. All of soil sludge samples were sieved with 2 mm sieve and digested using wet digestion method in accordance to the APHA standard methods for examination of water and wastewater [8, 9, 12]. Then, metals analysis was conducted using Inductive Coupled Plasma-Optical Emission Spectrophotometer (ICP-OES) (Perkin Elmer) [10]. The percent of removal efficiency of each heavy metal in soil was calculated using Equation 1 as follows:

$$\text{Removal Efficiency (\%)} = \left(\frac{C_i - C_f}{C_i}\right) \times 100 \qquad (1)$$

Where C_i is the initial concentration of heavy metal (mg/L) and C_f is the final concentration of heavy metal (mg/L).

RESULTS AND DISCUSSION

The concentration of lead and cadmium that were found in the parts of plants namely; roots, stem and leaf were presented in Figure1, Figure 2 and Figure 3 respectively. The maximum concentrations of lead and cadmium in the *Bougainvillea* sp. plant roots were 0.1 mg kg^{-1} and 0.06 mg kg^{-1} respectively under the treatment D. Similarly, for the *Bougainvillea* sp. stem and leaf, the maximum concentration obtained were 0.009 mg kg^{-1} and 0.006 mg kg^{-1} respectively for lead and cadmium in stem, and 0.049 mg kg^{-1} and 0.04 mg kg^{-1} respectively in the *Bougainvillea* sp. leaves. Highest accumulated plant parts would be in the roots of *Bougainvillea* sp. as evidenced in Figure 1, Figure 2 and Figure 3 respectively.

https://scilett-fsg.uitm.edu.my/
Vol. 13(2) DECEMEBR 2019

ISSN: 1675-7785
eISSN: 2682-8626
DOI: 10.1234/jmpc.v13i2.7529

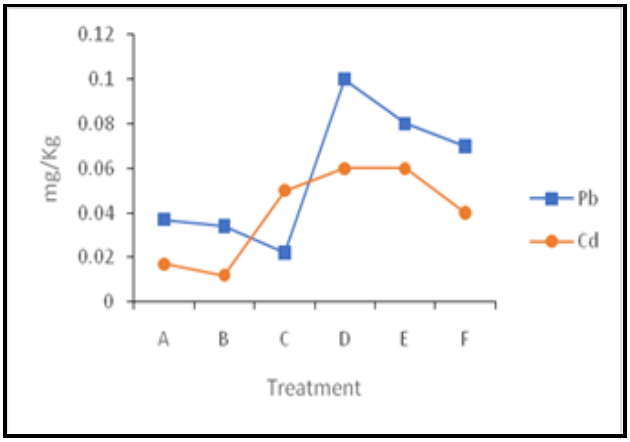

Figure 1: Metal concentration in plant roots

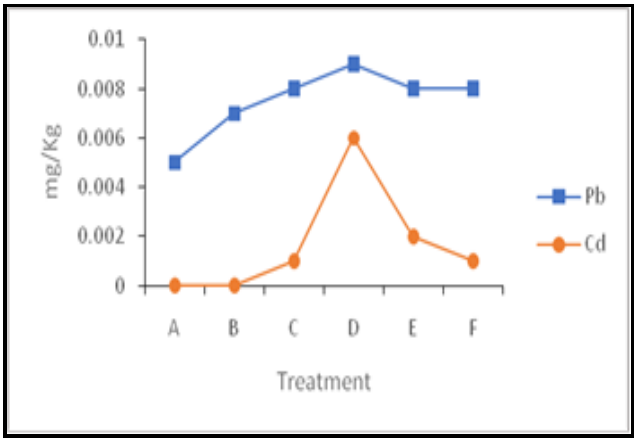

Figure 2: Metal concentration in plant stem

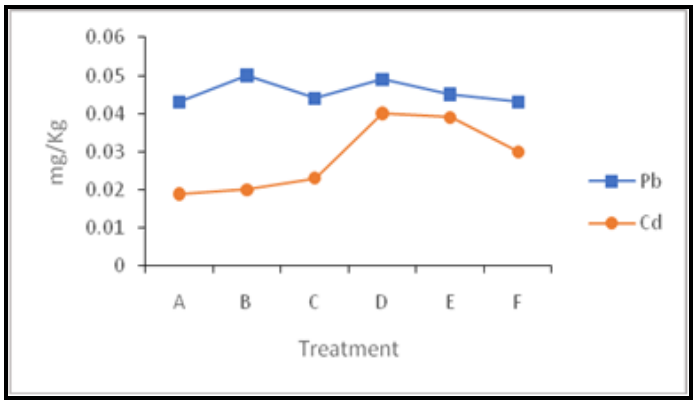

Figure 3: Metal concentration in plant leaf

In accordance to [13], metal accumulation would be more obvious in roots compared to other parts of the plants. One study suggested that the plant roots may acts as a barrier against heavy metal translocation and may be a potential tolerance mechanism operating in the roots [14]. Thus, resulting in high metal concentration in the roots and not the other plant parts.

Figure 4 and Figure 5 shows the lead and cadmium percentage removal efficiency in soil for the *Bougainvillea* sp. plant. For the first month, the highest percentage removal efficiency was found in treatment D for both lead and cadmium with the precentage removal efficiency of 68.26% and 62.37% respectively. Similarly, treatment D for the second month also shows the highest percentage removal for both metals with the percentage removal efficiency of 80.22% and 74.11% respectively.

https://scilett-fsg.uitm.edu.my/
Vol. 13(2) DECEMEBR 2019

ISSN: 1675-7785
eISSN: 2682-8626
DOI: 10.1234/jmpc.v13i2.7529

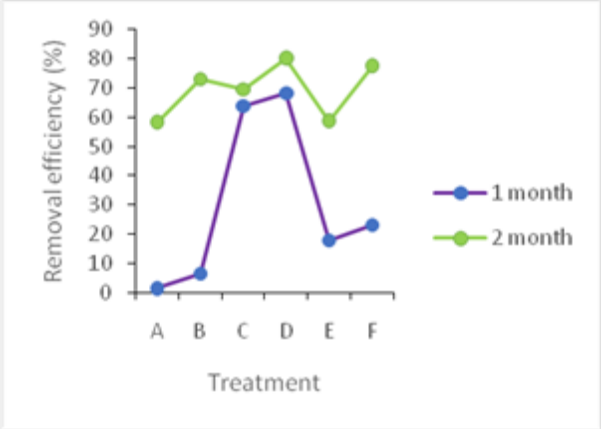

Figure 4: Percentage removal efficiency for lead

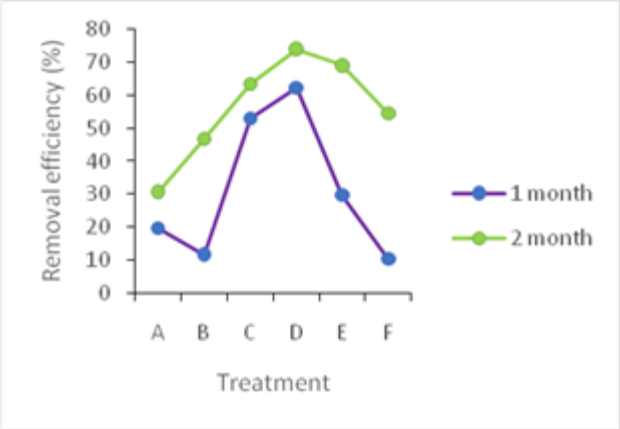

Figure 5: Percentage removal efficiency for cadmium

Overall, the removal of heavy metals is higher in second month compared to the first month as the metals can also form complex to the components of the soil inhibiting the plants ability to absorbed the metals from the soil. As agreed by Subhashini *et al.*[14], at the end of the two months experimental period using *Acalypha indica* and *Abutilon indicum* plants, the percentage removal was at its highest for both metals; lead and cadmium. Thus, it can be concluded that a longer period of time is needed for the removal of heavy metals.

CONCLUSIONS

In this research and from the obtained results, it can be concluded that *Bougainvillea* sp. effective in removing the lead and cadmium from the wastewater sludge through a mixture of 60% sludge mixture (Treatment D). Accumulation of metals in the *Bougainvillea* sp. plant were then in the order of root>leaf> stem and the removal efficiency of the *Bougainvillea* sp.is higher in the second month as compared to the first month.

ACKNOWLEDGMENTS

The authors would like to thank all personnel involve in the research, particularly the staffs from Faculty of Applied Sciences, Universiti Teknologi MARA (UiTM) Shah Alam and Environmental Technology Programme (AS229) for providing unlimited help in carrying the research work.

REFERENCES

[1] Ismail, N. A., Landscape Alteration in Urban Residential Areas of Selangor, Malaysia, Lincoln University, (2010).

[2] Ipoh-City. Welcome to Ipoh City, 'Your real Malaysia Truly Asia'. Retrieved October 11, 2018, from http://www.ipoh-city.com, (2013).

https://scilett-fsg.uitm.edu.my/
Vol. 13(2) DECEMEBR 2019

ISSN: 1675-7785
eISSN: 2682-8626
DOI: 10.1234/jmpc.v13i2.7529

[3] Dela Cruz, K. M., Burgos, S. D., Gloria, M. A., Ventura, K. M., Solidum, J., Comparison of Lead Absorption Ability of Bougainvillea (*Bougainvillea Spectabilis L.*) Leaves in Two Cities in Metro Manila, Philippines, *International Journal of Bioscience, Biochemistry and Bioinformatics*, **3**(3):192-195 (2013).

[4] Gupta, A., Maurya, B., Latare, A., Effect of Sewage Sludge and Cadmium on Growth and Quality Features of Marigold (*Tagetes erecta L.*) Grown in Three Soils, *International Journal of Current Microbiology and Applied Sciences*, **6**(8):2350-2359 (2017).

[5] Paz-Alberto, A. M., & Sigua. G. C., Phytoremediation: A green technology to remove environmental pollutants, *American Journal of Climate Change*, **2013**(2):71-86 (2012).

[6] Juson, A. D., Martinez, M. K., Ching, J. A., Accumulation and Distribution of Heavy Metals in *Leucaena Leucocephala Lam.* and *Bougainvillea Spectabilis* Wild Plant Systems, *Journal of Experimental Biology and Agricultural Sciences*, **4(**1): (2016).

[7] Mani, D., Kumar, C., Biotechnological advances in bioremediation of heavy metals contaminated ecosystems: An overview with special reference to phytoremediation, *International Journal of Environmental Science and Technology*, **11**(3):843-872 (2013).

[8] Patek Mohd, N., Abdu, A., Jusop, S., Karim, M. R., Nazrin, M., Akbar, M. H., Abdul Hamid, H., Potentiality of *Melastoma malabathricum* as Phytoremediators of soil decontaminated with sewage sludge, *Scientia Agrocola*, **75**(1):27-35 (2017).

[9] Radziemska, M., Vaverková, M. D., Baryła, A., Phytostabilization Management Strategy for Stabilizing Trace Elements in Contaminated Soils, *International Journal of Environmental Research and Public Health*, **14**(9):958 (2017).

[10] Al-Anbari R., Al-Obaidy A.H., Al-Khafaji M., Al-Imari T., Removing Chromium and Lead Metals Using Phytoremediation Technique, *MATEC Web of Conferences*, **162:**05004 (2018).

[11] Einstein D S Juson, Albert & Kariza M Martinez, Maria & Ching, Johnny., Accumulation and distribution of heavy metals in *Leucaena leucocephala Lam*. and *Bougainvillea spectabilis Wild*. plant systems, *Journal of Experimental Biology and Agricultural Sciences*, **4**:1-6 (2016).

[12] Rice, E.W., Baird, R.B, Eaton, A.D., *Standard Methods for The Examination of Water and Wastewater, 23rd Edition.* American Public Health Association, American Water Works Association, Water Environment Federation (2017).

[13] Yuanqing, Z., Shuying, L., Yundong, S., Wei, Lv., Taibo, S., Qilin, H., Yinke, L., Zhaolu, W., Phytoremediation of Chromium and Lead Using Water Lettuce (*Pistia stratiotes L.*), *Applied Mechanics and Materials*, 401-403, 2071-2075 (2013).

[14] Subhashini, V and Swamy, A.V.V.S, Harika, D., Venkateswararao, K., Phytoremediation of Heavy Metals Contaminated Soils, *International Journal of Current Microbiology and Applied Sciences*, **5:**19-30 (2017).