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Impact of Organic Matter on The Phytoaccumulation Technology of Copper in Soils by *Ipomea reptans*

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Abstract. Heavy metal contamination in soil is often a problem in living organisms. The efforts to control heavy metal contamination in soils can be done by using living organism. The phenomenon of the uptake, accumulation and storage of heavy metals in the plants' body is known as phytoaccumulation. Phytoaccumulation research of copper metal has been carried out with application of material waste i.e. sawdust, charcoal and compost used by *Ipomea reptans*. The analytical method used is atomic absorption spectrophotometry (AAS). The results showed that the impact of the application of organic waste material curbed the influx of copper into *Ipomea reptans* with the phytoaccumulation ability to control plants, sawdust, charcoal and compost of 231.1, 229.7, 196.1, and 152 mg/kg. The bioaccumulation factor value in each application is 0:33, 0:26, 0:34 and 0:19 respectively. There were significant differences between the phytoaccumulation ability of copper metals done by *Ipomea reptans*.

Keyword: *Phytoaccumulation; Ipomea reptans; Copper; Sawdust; Charcoal; Compost.*

1. Introduction

Soil contaminated by heavy metals is found to be unproductive and scarce or lack of cover vegetation [1]. The presence of cover vegetation on contaminated soil reduces the migration of contaminants to the water bodies. However, high concentrations of toxic metals are a major constraint of re-vegetation [2],[3]. Remediation of heavy metals contaminated soil may be carried out using psycho-chemical processes such as precipitation, reverse osmosis, ion exchange, chemical evaporation and reduction; however, the process is expensive. Phytoremediation is proposed as a viable low cost remediation approach to removing heavy metals from soil and groundwater [4].

Organic soil amendments, such as compost, sawdust and charcoal are alternative removal, cleansing and reducing risks associated with in situ low-cost and environmentally friendly heavy metals pollution [4] - [6]. The general benefits shown by experimental application of organic matter to soil include increasing water holding capacity, status C, N and P, increased availability of Ca, Mg and Zn and reduction of macronutrient leaching in solution [7]-[10]. In the context of pollution control, removal of heavy metals [4] and CO from soil and heavy metals from soil leachate [11] have also been reported as a consequence of addition of organic matter. In this study, the effect of organic matter



application for phytoremediation of soil contaminated with copper by *Ipomea reptans* has been investigated.

2. Methods

The organic matter used i.e. compost, sawdust and charcoal in this study come from Ternate Island (North Maluku, Indonesia).

2.1 Sample preparation

The experiment was carried out at a green house. Soil samplings of 0-50 cm depth were taken from the Ternate island, North Maluku, Indonesia. Soil samples were allowed to air dry in a green house at a temperature between 30°C and 32°C and were then ground to pass a 2-mm mesh sieve to be prepared as soil samples. *Ipomea reptans* plantlets were planted in pots containing 10 kg of these soils. The experiment consisted of 12 treatments including soil without organic matter (T1), soil contaminated (9 Kg) with 1 kg concentration of sawdust (T2), soil contaminated (9 Kg) with 1 kg of charcoal (T3), and soil contaminated (9 Kg) with 1 kg of compost (T4). Samples were taken for testing, after 30 days.

2.2 Laboratory experiments

Physical and chemical characteristics of soil such as soil texture, cation exchange capacity (CEC), soil reaction (pH), electrical conductivity (EC), organic matter (OM). Soil texture was determined by the hydrometer method. Soil pH and EC were measured on 1:1 extract (Soil:Water). Copper concentration was determined by atomic absorption spectrophotometry.

To determine the ability of bioaccumulation factor (BF), the formula 1. below was used;

$$BF = [Cu]_{shoot}/[Cu]_{soil} \text{ (mg/Kg)} \quad (1)$$

3. Result and discussions

On the first stage of the research, physics-chemistry soil test was done to assess the nutrients availability and the soil fertility level. The result of the physics-chemistry soil test was presented in Table 1.

Table 1. Soil quality parameters. Physical and chemical properties of soils.

pH	CEC (cmol/Kg)	N (%)	P (ppm)	Ca (%)	K (%)	Zn (%)
6.8	32.24	0.24	32.24	5.82	0.8	0.058

Table 1 shows the soil texture as clay. The pH was around 6,8 with the in-availability of Mg and Ca elements as much as 5.82 %. According to [4] Mg and Ca elements are available in soils with 7 to 8.5 pH level, and the availability of N is in soils with 6 to 8 pH. Apart from the factor of pH soil, the CEC value is essential in the relations of the nutrients supply and the media buffer. The limited amount of the essential K nutrient in the soil indicates the low fertility level of the soil used in this research.

The concentration of Cu was determined by spectrometry as soon as the soil sample was destructed with aquaregia solvent. The total of Cu metal in the lysimeter was determined to see the impact and Cu metal availability in the soil-plant system with and without organic material addition. The analysis result of the total level of Cu was presented in figure 1. Based on the graphic (figure 1), significant difference of total Cu level in the soil-plant system was seen in the lysimeter. Cu level in the lysimeter without organic material addition (soil only) is higher compared to Cu level in the lysimeter with organic material addition. Total level Cu resulted from the experiment of soil only lysimeter (T1), soil + sawdust (T2), soil + charcoal (T3), soil + compost (T4) were 939.6, 749.43, 668, and 792.76 mg/Kg, respectively. Based upon the analysis result, it is known that in the lysimeter with organic material addition, either sawdust, charcoal or compost, Cu metal migration occurs in the soil-plant and leachet.

This result is similar with Beesley reported[12], the addition of soil contaminated by organic waste can affect the mobility and the toxicity of the trace element.

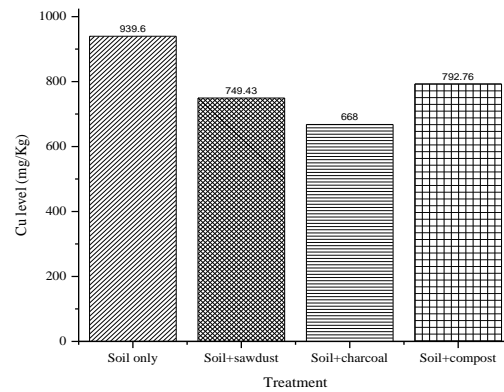


Figure 1. Copper total concentration in the lisimeter of soil-plant system. Cu concentration in controlled lisimeter (soil only) is significantly higher compared to lisimeter treated with organic material.

Ipomea reptans ability to absorb and accumulate Cu metal in the lisimeter is presented in figure 2. Based on figure 2, there is difference in Cu level in the plant's body that shows the different ability in absorbing and accumulating Cu by *Ipomea reptans*. Similar with the Cu level in the soil which is also significantly different according to the variatio of the organic material added. Cu concentration in the soil in each lisimeter is as follows; T1= 939.6, T2= 749.43, T3= 668, T4= 792.76 mg/Kg. Cu concentration in *ipomea reptans* plant is as much as 231.06, 196.13, 229.73, 156 mg/Kg in the lisimeter T1, T2, T3, and T3, respectively.

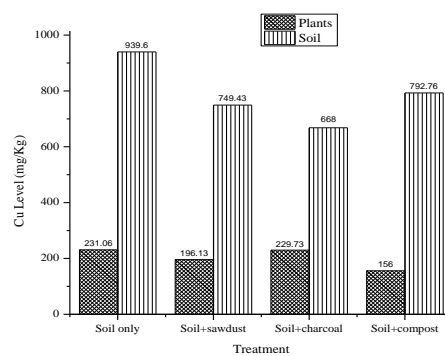


Figure 2. Copper level comparison in the soil and plant. The average of Cu distribution level in the soil-plant system within the lisimeter treated with sawdust, charcoal and compost is lower than controlled lisimeter (soil only).

The difference of Cu concentration within the plant's body and soil on lisimeter T2, T3 dan T4 compared to T1 shows some some impact of the organic material addition significantly. Generally, organic material increases Cu metal solubility in the soil which causes Cu to migrate from the soil to the plant and leachate. However, the amount of Cu concentration in the leachate was not acknowledged in this research. The value of bioaccumulation factor was determined to assess the ability of Cu bioaccumulation by *Ipomea reptans*, which is by calculating the total Cu concentration in the plant, then divided into the total Cu in the soil. Based on the calculation result using the formula 1, the value of bioaccumulation factor from each treatment is resulted as presented in figure 3.

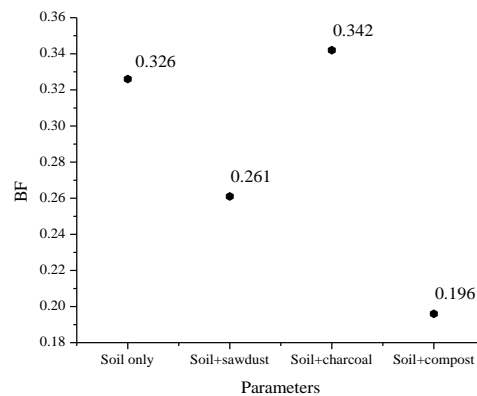


Figure 3. The value of bioaccumulation factor (BF) of each trial lisimeter.

The highest BF is the lisimeter with charcoal treatment and the lowest is the value of bioaccumulation factor varies according to the treatment in the lysimeter. Based on figure 3, beside T3, T2 and T4 both have lower BF value than the T1 (control). The low BF value of T2 and T4 indicates the ability to withhold Cu migration to the plant's body by the sawdust and compost organic material is higher than T1 and T3. On the other hand, the higher value of T3 bioaccumulation factor than the T1 indicates that charcoal can increase the ability of Cu accumulation from the soil to the plant's body.

4. Conclusion

Organic materials play a vital role in increasing solubility and mobility of Cu metal in lysimeter system (soil-water-plant). The mobility Cu metal to the plant's body is even higher with the addition of charcoal compared to sawdust and compost. There is no toxicity of Cu metal on *Ipomea reptans* when the Cu level is around 900 mg/Kg soil.

5. Acknowledgment

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