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Use of Leachate and Compost for Phytoremediation of Divalent Mercury Polluted Soil by Jatropha

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Abstract: This research was conducted to investigate the potential use of leachate and compost for phytoremediation of divalent mercury polluted soil by Jatropha. Greenhouse experiment was carried out for two months and replicated twice. Mercury concentration in soil was in the range of 1 to 20 mg Hg/kg soil. It was found that the mercury concentration in soil without significant negatif effect towards Jatropha was no more than 6 mg Hg/kg soil. The levels of leachate and compost, which were added to the soil, were no effect on phytoremediation efficiency. However, both of materials were significantly effective to be used for phytoremediation using Jatropha.

Key words: Jatropha · Phytoremediation · Leachate · Compost · Mercury

INTRODUCTION

Mercury in solid waste disposal soil has been found in West Java [1-2]. Dissolved mercury has a strong affinity for organic matter and suspended sediment [3-5] and therefore it can be expected to be bound to these particles in the leachate. In rainy season, the mercury polluted leachate could be dispersed in soil and water bodies. Mercury in soils has a long retention time and that may have a negative impact towards living organisms [6-8]. Thus the polluted soil should be treated to attenuate pollution load. Physicochemical and bioremediation could be applied to treat the mercury polluted soil. However, phytoremediation would be an easy one locally, efficient, low cost and environmental friendly [9].

This current research continued the previous research on Phytoremediation of Hexavalent Chromium Polluted Soil Using *Pterocarpus indicus* and *Jatropha curcas* L. [10] and *Jatropha curcas* L. for Phytoremediation of Lead and Cadmium Polluted Soil [11]. Additional polluted soil treatment was used by adding a mixture of leachate and compost that is not toxic as reported in Mangkoedihardjo *et al.* [12]. The main objective of this research was to obtain the limit of mercury concentration in the treated soil that could be remediated by Jatropha.

MATERIALS AND METHODS

Plants: Jatropha curcas plants were collected from local agriculture agency. The plants were adapted under glasshouse conditions. Healthy plant with a height of 20-25cm of each was selected for the test plant.

Mercury Polluted Soil: Mercuric chloride ($HgCl_2$) solution was used a source of divalent mercury. Mercury solution was uniformly mixed with air-dried soil and leave for 24 hours. Range finding test was performed that consisted of 1, 3, 6, 10, 20 mg divalent mercury for each kg of soil. The range finding test was run for one week. The result of the range finding test was used for the definitive test to assess the effectiveness of phytoremediation.

Treatments: The test media were organized for two compositions. The first media, M1 contained 50% mercury polluted soil with addition 40% leachate and 10% compost. The second media, M2 contained 50% mercury polluted soil with addition 25% leacahte and 25% compost. Percent compositions were based in wight (kg). A control test medium was provided for each composition.

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Experiments: Greenhouse experiments were carried out to each of the test plant that was grown in the test media. Experiments were carried out with two replicates. Random sampling was applied for the test medium and plant. Samples of the test media and plants were taken every week. Ten grams of sample was digested in acidic mixture of HNO and HCl and the divalent mercury was analysed using Atomic Absorption Spectrophotometer. Plant parameters consisting of plant height and plant diameter were measured every week at the same time as the polluted media. Plant dry matter was measured before and after the plant was applied in the polluted media. The dry matter was measured using oven dried at 105 °C for three days or constant weight. Supporting parameters such as temperature and pH were measured using electronic probes weekly. Standard Methods [13] was used as a source of standard laboratory analyses.

RESULTS AND DISCUSSION

During two months exposure, water extractable soil parameters were observed for pH, temperature and oxygen content. The pH was in the range of 6-7, temperature was ranging from 25 to 33 °C and dissolved oxygen content was 3.4 – 5.6 mg/L. All parameters were not limiting for the current phytoremediation process. In addition, Jatropha plant parameters were observed for height, diameter, dry matter. There were no significant effect of the maximum mercury polluted soil towards the plant parameters.

The results of range finding test of 1 – 20 mg Hg/kg soil showed that the maximum concentration of mercury without negative effect towards Jatropha was 6 mgHg/kg soil. The maximum concentration of mercury was decided to be used in investigation of using leachate and compost. The different compositions of leachate and compost (M1 and M2) were not significant in removing mercury from soil (Fig. 1). However, significant effect of leachate and compost was found in phytoremediation of mercury polluted soil by Jatropa.

Mercury measurements in plants were carried out at the end of two months exposure. Table 1 showed that plants could accumulate mercury significantly ($p < 0.05$). However, there was no significant different of leachate and compost compositions. The results could be used for phytoremediation of post closure of solid waste disposal on-site that support composting the waste [1-2].

CONCLUSION

The primary findings of this current research were as follows. The use of leachate and compost has a significant performance for phytoremediation using Jatropha. Composition of leachate and compost did not affect phytoremediation efficiency. The maximum mercury concentration in soil without negative effect towards Jatropha was 6 mg Hg/kg soil.

Table 1: Mercury in Jatropha plants under the maximum concentration in soil for two months exposure

Media	Mercury remaining in soil (mg Hg/kg soil)	Mercury in plants (mg Hg/kg DW)
Control: without leachate and compost	4.738	0.764
M1: 50% soil + 40% leachate + 10% compost	4.872	1.147
M2: 50% soil + 25% leachate + 25% compost	4.872	1.232

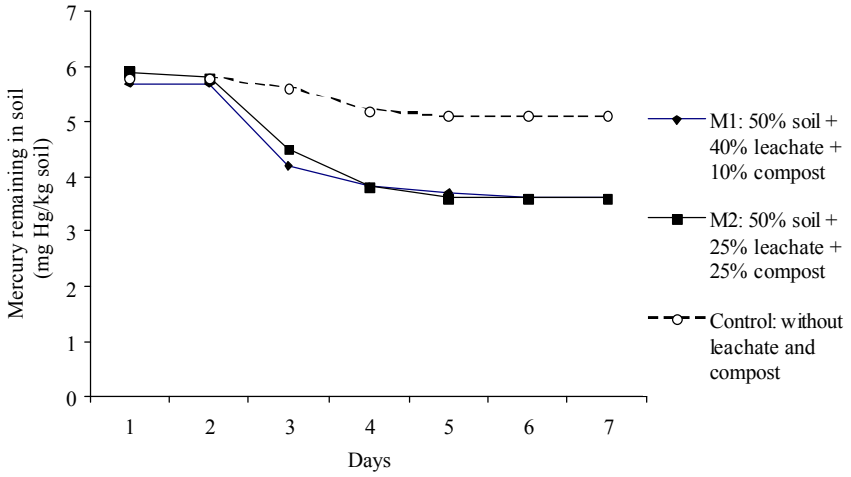

Fig. 1: Effect of leachate and compost addition in phytoremedition of mercury polluted soil by Jatropha

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