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The Use of Lumbricus Rubellus as Bioremidiation Agent of Vermicomposting of City Organic Waste Polluted by Lead Metal (Pb)

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Abstrack: Landfill (TPA) is a place where waste reaches the last stage in its management since the nascent in its source, collection, transfer / conveyance, treatment and disposal. TPA is a place where trash is isolated safely so as not to cause disturbance to the surrounding environment. Therefore required the provision of facilities and the correct treatment so that security can be achieved well. The aim of this research is to investigate the use of Lumbricus rubellus as bioremidiation agent of vermicomposting of city organic waste polluted by lead metal (Pb). This research was compiled using a completely randomized design (RAL), with four treatments and replications of three (3) times. Treatment (1) in the form of organic waste + Pb metal as a control (S), treatment (2) organic waste + Pb metal is added by manure (SK), treatment (3) organic waste + Pb metal is added bio-activator (SA), treatment (4) organic waste + Pb metal is added by manure and bio-activator (SKA). Observations were made on days 3, 10, 20 and 30 days after inoculation of earthworms. that the provision of metallic lead (Pb) in an organic medium which has been provided treatment gives effect as follows: (1) Treatment by the addition of amendments material and activators in organic media will provide an increase in the percentage of the death of earthworms, over time the observations were conducted. SKA provides the highest mortality percentage. (2) earthworm Lumbricus rubellus have the ability to accumulate Pb metal. Ability to accumulate the lowest Pb metal in the control treatment (29.73 mg kg^{-1}) and the highest contained in the treatment of SKA (33.13 mg kg^{-1}). (3) The results of the analysis of C-organic, N-total and P-available on kascing in all treatments do not provide a real difference. While on the Pb metal content contained real differences in treatment SA the lowest content (20.43 mg kg^{-1}) and highest in the treatment of S (32.05 mg kg^{-1}).

Key words: Organic Waste · Lead Metal (Pb) · Lumbricus rubellus

INTRODUCTION

Landfill (TPA) is a place where waste reaches the last stage in its management since the nascent in its source, collection, transfer / conveyance, treatment and disposal. TPA is a place where trash is isolated safely so as not to cause disturbance to the surrounding environment. Therefore required the provision of facilities and the correct treatment so that security can be achieved well. Generally the garbage landfills, waste processing methods such as landfill, but this method still has an impact on environmental pollution in the form of leachate out of the landfill. The presence of high rainfall increases the amount of leachate formed in the region [1]. Environment that has been contaminated with harmful chemicals, will lead to pollution of soil, water and air in the environment. This will cause environmental damage and disruption. Contaminants that pollute the environment is an environmental hazard to all forms of living organisms. Recovery of environment which has become polluted to be the sort of environment that is free from pollution material is called as a remediation. In the present era remediation technique available is not entirely to eliminate waste polluting the environment, but only lowering the concentration and content of environmental pollutants [2].

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In many countries, municipal solid waste has been composted for use as an organic fertilizer on farmland because the content of the organic matter and nutrients contained [3], but the toxicity of certain urban waste, organic fertilizer derived from municipal solid waste can be threatening yields, long-term soil quality and human health [4]. Some developed countries, packaging waste contributes significantly to urban waste. In 2003, packaging waste accounted for 78.81 million tons, or 31.6 percent of the total municipal solid waste in the United States, in Europe in 2005 it was amounted to 56.3 million tons, or 25 percent and in 2004 in Australia by 3, 3 million tons, or 10 percent of the total municipal solid waste. The waste in the composting process of organic solid waste [5]. It is possible that the results of the process of composting of municipal waste are particularly at risk for non-organic ingredients in the process, that it will give effect toxin on the outcome of compost that will be used for organic fertilizers. Biodiversity is an indicator parameter in the provision of ecosystem services in the environment, thus ensuring the sustainability of living organisms in the environment ecosystem based on the high or low biodiversity in the environment. The higher the biodiversity in the environment, the environment is getting better. Earthworms are the largest animal biomass components of the organism's life and has provided services in a form of major contribution to biodiversity environment, so earthworms can be considered as a parameter of biodiversity in an environment. The earthworm contribution to biodiversity can be seen in the process of pedogenesis, the development of soil structure, water regulation, nutrient cycling, primary production and a reduction in pollutant solids [6].

Earthworms as organisms decomposing organic matter, generally its presence can be beneficial for plant growth. Earthworms can serve to improve plant growth through a number of mechanisms as follows: (1) earthworms can increase the activity of other beneficial microorganisms in the degradation of organic matter; (2) earthworms can control parasitic pests; (3) Earthworms can degrade organic matter and produce plant growth regulators such as hormones; (4) Earthworms can improve the structure, porosity and aeration of the soil; and (5) earthworms can increase nutrient availability to plants by increasing the level of mineralization [7].

Some earthworms can survive and be sensitive to contaminated media. This is due to earthworms are able to accumulate chemicals as contaminants in higher concentrations in the environment. Therefore, earthworms can play an important role in the assessment of ecological damage [8]. Provision of earthworms in soil contaminated as the oil mill waste and composting plant waste outcomes, wherein the waste contains high levels of organic resistant and poison the surrounding environment. Land, which has been given earthworms, then carried out cultivation of wheat. After 3 months, showed good growth of wheat plants and give high production yields. While on earthworms also experienced an increase in the amount. The provision of the chemically earthworms could significantly reduce the organic content of the soil resistant, while biologically (due to the dehydrogenase enzyme activity) it can increase the humic acids, lowering phenolic compounds in compost waste. Utilization of earthworms, particularly on lands that have been degraded, perhaps is a technology which is environmentally friendly and economical to obtain non-toxic production, high value and are useful for agricultural purposes [9]. The provision of earthworms in pulp processing residue on the coffee beans may remidiate solid and liquid waste that comes from the coffee waste. Addition of earthworms on coffee waste treatment can accelerate the decomposition process (77.9 percent) and the results of vermicompost which is significant than ordinary composting process [10]. The aim of this research is to investigate the use of Lumbricus rubellus as bioremidiation agent of vermicomposting of city organic waste polluted by lead metal (Pb).

MATERIALS AND METHODS

Research Sites: The study was conducted in a business incubator house of earthworms UPN "Veteran" East Java. Chemical analysis of soil and vermicompost yields were conducted in the laboratory of Soil Chemistry, Faculty of Agriculture, UPN. The needs of organic material obtained from the garbage contained in the landfill of Sutorejo.

Implementation of Research: The organic waste is used for media of research obtained from municipal solid waste sorting area of the city of Surabaya. The garbage were sorted out between organic and inorganic waste. The organic waste will be composted for one month. After one month of organic compost the garbage are to be sifted to qualify filter of 2 mm in size in order to obtain a uniform size. After measuring homogeneous organic compost there performed addition of Pb 400 ppm (mg Kg^{-1}) from the compound of Pb ($C_2H_3O_2$) 4 $_2H_2O$. Organic waste containing Pb are to be added by appropriate materials accordingly to the treatment in the draft, then performed incubation for 2 days. After incubation, placed in a glass pot of 1 kg and applied 25 earthworms of Lumbricus rubellus as bioindicator.

This research was compiled using a completely randomized design (RAL), with four treatments and replications of three (3) times. Treatment (1) in the form of organic waste + Pb metal as a control (S), treatment (2) organic waste + Pb metal is added by manure (SK), treatment (3) organic waste + Pb metal is added bio-activator (SA), treatment (4) organic waste + Pb metal is added by manure and bio-activator (SKA). Observations were made on days 3, 10, 20 and 30 days after inoculation of earthworms. Observations in the percentage of dead worm were carried out in accordance with the day of the observations. Whereas observation of Pb content in the worms and vermicompost were carried out on the last day. For the purposes of analysis of organic media there performed a measurement chemically in the form of organic matter (C-organic) by using Walkey-Black method, N-total by the Kjeldahl method, P-available method of Bray-I with spectrofotometri (solvent NH_4OAc). While for heavy metal analysis of Pb it was using wet destruction method (solvent HNO_3 and $HClO_4$).

Statistical Analysis: Statistical analysis was conducted to determine differences in metal content of Pb contained in each treatment, using LSD (Least Significant Different0 test at 5% confidence level. Statistical test results are expected to know the impact of the toxicity of these metals in earthworms.

RESULTS AND DISCUSSION

The Death Percentage of Worm Lumbricus Rubellus: The death percentage of worm Lumbricus rubellus is equal to the magnitude of the death of earthworms Lumbricus rubellus than the number of earthworms applied to the treatment in terms of percent. In general, the increasing time of observation, the percentage of deaths of earthworms keeps on increased as shown in Table 1.

The provisions of treatment in organic media which has been added by metal of Pb amounting to 400 mg kg^{-1}, has given significant effect ($p < 0, 05$) on the observation of 3, 10, 20 and 30 days after the aplicaiton of earthworms (Table 1). The percentage of dead earthworms caused by toxicity of Pb metal on the 3rd day with the lowest treatment of SA (9, 54 %) and the highest treatment of SKA (36, 05 %). On the observation of the 10th day, the dead percetage of the lowest on S (20, 04 %) and the highest on SKA (50 %). On the 20th day, the lowest dead percentage of SA (31, 19 %) and the highest on SKA (65, 75 %). On the 30th day, the lowest dead percentage of S (55, 31 %) and the highest on SKA (81, 73 %).

Table 1: Percentage of dead earthworms Lumbricus rubellus on several days of observation

	The percentage of deaths earthworm (%) on days-			
Treatment	3	10	20	30
S	9.54 a	20.04 a	46.10 b	55.31 a
SK	10.59 a	26.66 a	59.48 c	67.63 ab
SA	4.18 a	22.91 a	31.19 a	61.24 a
SKA	36.05 b	50.75 b	65.75 c	81.73 b
LSD 5%	21.79	19.89	10.32	20.04

Explanation: Average number of treatment followed by the same letter are conveying not significantly different realistically in LSD 5%.

In general with the increase of observation time, the percentage of deaths of earthworms experienced an increase in all treatments and the addition of amendments and activators gives different results ($p < 0.5$). This indicates that the administration of metallic lead (Pb) in an organic medium that has been treated as such above has toxic effects that can cause death in earthworms Lumbricus rubellus. According to Rosenberg and Resh [11] that in order to determine the impact of the toxicity of a metal may on organism can be seen from the negative effects of such metals on the organism. In the study of metal toxicity, impact can be seen from the percentage of deaths. Further said Dhahiyat and Djuangsih [12] that the results of toxicity tests in the form of the death of organism can be useful to determine toxicity levels of pollutants.

Lead Metal (Pb) which has been consumed by earthworms Lumbricus rubellus will cause the occurance of metal accumulation in the inerd organs. Pb metal which has been accumulated in the body of the worm will cause tissue damage that can cause death in the worm. This is in accordance with the opinion of Booth, et al. [13] which states that the metallic lead (Pb) will be accumulated in the body of earthworms consuming such matters. Pb metal in the body of earthworms will lead to poisoning that may interfere with the growth and death of the earthworms.

Lead Metal Content (Pb) of Worms Body: Lead Metal (Pb) which has been added to the organic medium of 400 ppm before the experiment. During the process of vermicompost earthworms, Lumbricus rubellus have consumed contaminated organic media by the metals. Pb metal that has been consumed by earthworms then accumulated in the body tissues of earthworms. Results of analysis of Pb metal contained in the earthworm's body at the end of the study are presented in the following Table 2.

Table 2: Results of analysis of Pb metal (ppm) in the body of earthworm Lumbricus rubellus

Treatment	Metals in the body of the worm Mg kg^{-1}
S	29.73 a
SK	32.77 b
SA	33.03 b
SKA	33.13 b
LSD 5%	1.14

Explanation: Average number of treatment followed by the same letter are conveying not significantly different realistically in LSD 5%.

Table 3: Results of kascin chemical analysis

	The content of the element in kascing			
Treatment	C- organic (%)	N-total (%)	P- available (%)	P Mg kg^{-1}
S	7.22a	1.27a	4.36a	32.05c
SK	6.89a	1.20a	3.10a	25.90b
SA	6.97a	1.11a	4.26a	20.43a
SKA	7.25a	1.22a	5.10a	21.17a
LSD	1.41	0.28	3.24	4.00

Explanation: Average number of treatment followed by the same letter are conveying not significantly different realistically in LSD 5%

Results of measurement of Pb metal content in the body of the earthworm in the various media of feeds that have been treated providing significant differences ($p < 0.05$). Feed media of worms coming from urban waste compost (control) gives the lowest metal content (S) and significantly different with other treatments. Pb metal content in the body of earthworm showed that earthworm Lumbricus rubellus can accumulate Pb metal coming through the consumption of the worm. Pb metal, which has been consumed by earthworm Lumbricus rubellus, then those metals is to be accumulated in the body tissues of worms. The content of Pb in the body of earthworms showed that earthworms are able to accumulate heavy metals and can be used as a biological indicator in an environment [14]. The presence of these metals in the body can cause death of earthworms. According to Tang, *et al*. [15] Heavy metals can pose a serious threat to biota environment, this is due to acute toxicity, in nature of not able to degrade and high concentrations, that the metal can cause death in a living organism. Furthermore said Chua [16] that the Pb metal is accumulated by organism mainly in the internal organs that can lead to many serious disorders and even death.

In the treatment of giving activator materials, soil amendments and the combination of both has shown metal contents in the body of the worm which is higher than those without the provision of these materials ($p < 0.05$). The addition of an activator material or amendment material would lead to an increase in biological microorganism activity in the decomposition of organic matter and the solubility of Pb metal will be high, it can cause an increase in the availability of Pb metal in the media. The addition of amendment and synergic activator with earthworms in decomposing organic material. If the media is consumed by earthworms, the metal will be absorbed and cause an increase in metal contents in the body of the earthworm. According to Andre *et al*. [17] argued that earthworms can live in contaminated areas and able to accumulate heavy metals thus heavy metals, that the toxicity of contaminants area will experience a decrease of toxicity. Further proposed by Fernandez *et al*. [18] An increase in biological activity will be synergizing with the earthworm in the process of vermicomposting, but the concentration of metal contained in the organic media remained causing toxicity to earthworms.

Chemical Analysis of Kascing Content: Analysis of nutrient content contained in vermicompost because of vermicompost of earthworm Lubricus rubellus applied to the treatment. Results of chemical analysis of C-organic, N-total, P-available and Pb contained in kascing are presented in the following table.

Decomposition of organic media in the process of vermicompost by using earthworm Lumbricus rubellus on all treatments provide C-organic, N-total and P- available in kascing which is not significant ($p < 0.05$). This suggests that the ability of earthworms in decomposing organic material, the provision of synergic activator or manure as a soil amendment material does not provide real influence on the process of vermicompost. The lowest C-organic kascing contained in treatment SA (6.89%) and highest in treatment SKA (7.25%), the value of N-total kascing contained in SK treatment (1.11%) and highest in treatment SKA (1, 27%) and availability of P in the lowest kascing on SK (3.10%) and highest in treatment SKA (5.10%).

While in the metallic lead (Pb) which was awarded in organic media consumed by earthworm Lumbricus rubellus, has undergone a process of vermicompost and resulting kascing (former worm). Pb metal in kascing was found that all treatments of organic medium by adding activators and amendments material provide different results with a single organic media ($p < 0.05$). This shows that the earthworm is able to remediate contaminated organic media of Pb metal. According to Suthar and Singh [19] that earthworms are able to reduce heavy metal waste contained in the compost and compost with manure in the process of vermicompost. The metals contained in the organic compost are reduced by earthworms through the metal accumulation in body tissues of the worm.

CONCLUSION

Based on the results, it can be concluded that the provision of metallic lead (Pb) in an organic medium which has been provided treatment gives effect as follows: (1) Treatment by the addition of amendments material and activators in organic media will provide an increase in the percentage of the death of earthworms, over time the observations were conducted. SKA provides the highest mortality percentage. (2) earthworm Lumbricus rubellus have the ability to accumulate Pb metal. Ability to accumulate the lowest Pb metal in the control treatment (29.73 mg kg^{-1}) and the highest contained in the treatment of SKA (33.13 mg kg^{-1}). (3) The results of the analysis of C-organic, N-total and P-available on kascing in all treatments do not provide a real difference. While on the Pb metal content contained real differences in treatment SA the lowest content (20.43 mg kg^{-1}) and highest in the treatment of S (32.05 mg kg^{-1}).

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