The Effectiveness of Filter Media and *Echinodorus palaefolius* on Phytoremediation of Leachate

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**Abstract:** This research aims to know the effectiveness of filter media and *Echinodorus palaefolius* on phytoremediation of leachate. This research was conducted at greenhouse Faculty of Agriculture, Lancang Kuning University. The method used was an experimental method by using a completely randomized design, which consists of 4 treatments with five replicates at each treatment. The parameters measured were turbidity, temperature, total suspended solids (TSS), pH, and dissolved oxygen (DO). Data were analyzed by using Analysis of Variance and a further test with Duncan's Multiple Range Test at a significant level (α) = 0.01. The results showed that there was a significant effect of filter media with *Echinodorus palaefolius* on phytoremediation of leachate, to reduce levels of pollutants found in leachate. Treatment P3 (PMK, zeolite, *Echinodorus palaefolius*) with a value of effectiveness were 95.18% for turbidity, 97.47% for TSS, 20.86% for pH and (-) 66.60% for DO.

**Keywords:** Zeolite, Echinodorus palaefolius, Phytoremediation, Leachate.

1. Introduction

Litter is a kind of solid waste which comes from human activity (domestic). Even though domestic litter is much dominated by organic, the type and the composition are varied (Hadiwiyoto in Sari & Martala, 2014). Goes along with it, Badrus and Sutrisno (2007) stated that litter might come from the human activity or industry, commercial activity, market, park, and garden, etc. Based on the material content, litter is divided into two types. They are organic and inorganic. Organic is the litter which comes from animal, plant, and human. Inorganic is the litter which comes from a mineral material such as metal, glass, plastic, and, etc. The mixed organic litter, organic litter, and other toxic substances will produce a liquid named Lindi (Leachate water). If it infiltrates into the soil or may go flow to the river so it will pollute the water. Finally, it is going to endanger the human life. Based on the observation done in the garbage dump (Tempat Pembuangan Akhir), Muara Fajar. It was found that the litter was decomposition naturally. Unfortunately, the result of that decomposition was held within the litter dump. So, it needs a media to bring the result of this decomposition. One of the media used was rainy. Because it could be a solvent media. Lindi as the result of the decomposition would flow to the leachate pool. If the pollutant material in leachate water did not manage well, it would surely infiltrate into the soil and made a water and soil pollution.

Muara Fajar Garbage Dump (TPA) applied a drainage system. It is an underground waterway. It aimed at controlling the rainy flow to reduce the water volume which goes to the litter dump. As it is known that rainy was the main factor of leachate debit. In conclusion, it would finally influence the need for management unit. Recently, Muara Fajar Garbage Dump (TPA) applied an open dumping system in managing the litter. It is caused by the overcapacity of litter. It was such kind of a wide opened area. It was used to accommodate the whole litter from around the city of Pekanbaru. An effort of Lindi purification was by using phytoremediation and specific water plants which cooperate with the microorganisms in media (soil, coral, and water). This fusion could change the contaminant substance (pollutant) to be less or nondangerous environment. The process which was done by the plants for decomposing contaminant substances become undangerous with the simple molecule. It is very useful for the water plants grow (Anam, 2011).
Water plants used in the bioremediation was growing in the garbage dump (TPA) area. It was jasmine (*Echinodorus palaefolius*). It had trunk cavities for supplying oxygen to the root. The root works to sips the nutrient from the waste for changing the pollution water to be an aesthetic value for environment (Sari, 2013).

2. **Review of Literature**

Leachate could infiltrate to the soil. This process causes a direct soil and water pollution. There was a treatment done for reducing this pollution. It was by putting a layer to filter the leachate water. It could be surely able to reduce the metal content of leachate water (Apria in Liliya & Suharto, 2011). Zeolite comes from the word "zeinlithos". It means a yeasty rock. Zeolite is an alumina silicate crystal with the empirical formula $Mx/n.(AlO_2)x. (SiO_2)y. xH_2O$. It was made from tetrahedral alumina densilika with the cavities which were full of a metal ion. Zeolite is a group of mineral which was made from the process of hydrothermal of batuan beku basa. This kind of mineral was found in the stones. Zeolite was also the sediment of vulcanic activity. It contains silica. Nowadays, the use of mineral zeolite was increased. Ferrolite was a filter media used for decreasing the metal and manganese substance content in the water. Ferrolite is a kind of mineral which contains metal ions, alkali and water molecule. Ferrolite can be used to lose the pollutant substance and bacterial E. Coli (Putra & Purnomo, 2012).

The soil is a medium for growing, and it is also used as the sources of hara for the plants. In Indonesia, There is an acid available large land for the farming area. It has specific characteristics such as low pH, Al for solubility, Mn, and Fe should be higher, Ca content, Mg, and Mo should be lower, and the content of N, P, and S should be less because the composition went so slow. By doing balance management, it is believed that the soil could be more productive (Murni, 2009). Phytoremediation is a system where both specific plants and microorganisms works in the soil. This collaboration can change the pollutant substance to be safety for the environment. The process done by the plants for decomposing pollutant substance which has a complex molecule chain to be less dangerous substance. It is very useful for growing the plants (Anam, 2011).

This jasmine was a part of clump *Echinodorus palaefolius*. It has the wide leaf; the flower is white, a bud of flower can produce some flowers, the flowers can stand as long as 6 to 7 hours. The root and the trunk supply the oxygen to the root in a big volume, and the root of the plant can be used to absorb harm from the waste for managing the pollutant substance of the water (Sari, 2013).

3. **Methodology**

It was a true experiment with the Complete Random Design. It has four treatments and five replicates. The comparison media composition can be seen as follows:

- **P1**: Leachate 20 liter
- **P2**: Leachate 20 liter + PMK 100% + 4 clumps *Echinodorus palaefolius*
- **P3**: Leachate 20 liter + Zeolit 50% + PMK 50% + 4 clumps *Echinodorus palaefolius*
- **P4**: Leachate 20 liter + Ferrolit 50% + PMK 50% + 4 clumps *Echinodorus palaefolius*

This research was done in greenhouse, Agriculture Faculty of University of Lancang Kuning, Pekanbaru. The procedure of this research was described in the following points:

1) Providing tools and material used
2) Providing media used such as zeolite and ferrolit, PMK Soil, *Echinodorus palaefolius*, 400 liters of leachate, soaked zeolit and ferrolit.
3) Planting.
4) Observing. In this phase, the researcher did a daily observation as long as 28 days.
5) Analyzing the data.
6) Made a conclusion.

Normality and homogeneity tests were done before analyzed the data. If the data distribute normally or having homogenous variance, it would be analyzed by using ANOVA. But, if there were abnormal distribution and having inhomogenous variance, it would be analyzed by using Kruskal/Wallis. Then, it was needed to the next test by using Duncan’s Multiple Range Test (DMRT).

4. Result and Discussion

The result of physical and chemical characteristics of leachate could be seen in the following table:

| Parameters  | Units  | Treatment | Value                  | Classification of Water Quality Standards |
|-------------|--------|-----------|------------------------|------------------------------------------|
|             |        | P1        | Day - 0                | I - II - III - IV                        |
| Turbidity   | NTU    |           | 39.8                  |                                          |
|             |        | P2        | 33.8                  |                                          |
|             |        | P3        | 33.4                  |                                          |
|             |        | P4        | 32.7                  |                                          |
| Temperature | °C     |           | 25.8                  |                                          |
|             |        | P2        | 23.8                  |                                          |
|             |        | P3        | 23.6                  |                                          |
|             |        | P4        | 23.5                  |                                          |
| TSS         | mg/l   |           | 232.2                 |                                          |
|             |        | P2        | 223.1                 |                                          |
|             |        | P3        | 221.0                 |                                          |
|             |        | P4        | 231.0                 |                                          |
| pH (at lab) |        |           | 8.44                  |                                          |
|             |        | P3        | 8.46                  |                                          |
|             |        | P4        | 8.46                  |                                          |
| DO          | mg/l   |           | 0.25                  |                                          |
|             |        | P2        | 0.88                  |                                          |
|             |        | P3        | 0.20                  |                                          |
|             |        | P4        | 0.78                  |                                          |

Note: Values with the same letter within a column for each parameter are not significantly different at 1% significance level

*PP No. 82 (2001)

4.1 Leachate Turbidity

Turbidity was caused by an organic and inorganic substance which was suspended and dissolved in the mud, sands, and microorganisms. Suspended solids, turbidity value, went so high. The example of Organic and inorganic substance such as ions are the high sodium, calcium, magnesium, bicarbonate, sulfate, chloride, iron, carbonate, nitrate, strontium, boron, and silica. They were floating in the leachate. Fiscally, these substances were the caused by turbidity of the water. The liquid waste which contained by the high suspended substance cannot be dumped into the water directly. It made the siltation and also prevent the sun ray came into the base of water so the process of phytoplankton photosynthesis cannot be done. But, the high suspended siltation is not always followed by the high turbidity (Syafrian, 2007).

In this research, the best result was found in the P3 treatment with the average leachate turbidity 2.08 NTU. In this P3 treatment, there was zeolite which was able to help the process of purification; it also can be used as catalyst (Semara et al., 2010). On day 28 of observation, the highest turbidity was found in P1 treatment; it was 14.6 NTU. The turbidity was caused by the numbers of suspended substances in the leachate water. The observation was done in 28 days. The
jasmines were able to adapt to the leachate water and absorb the pollutant substances. Zeolite could absorb organics so the pollutant content could be decreased (Liliya et al., 2011).

4.2 Leachate Temperature

The high leachate temperature was caused by the increasing of biochemical process within the leachate. It could produce a hot energy which made the decreasing the amount of suspended oxygen in the water and the increasing chemical reaction speed (Lufti et al., 2014). And then, Rosiana in Suharto et al. (2011), the plants meditate organic pollution through three ways. They were absorbed directly the contaminant, metabolism calculation nonphytotoxicity to the cell of the plants, and let the exudate and enzyme which could stimulate microbes activity go, and absorb the mineral in roster area. The plants evaporate the steam. The evaporation caused migration of chemical and change temperature the leachate.

4.3 TSS (Total Suspended Solid) of Leachate

The high TSS in leachate was caused by accumulation from the result of organic and inorganic dumped decomposition waste in a garbage dump. TSS shows the amount of suspended solid density which contains organic and inorganic substance of ions were sodium, calcium, magnesium, bicarbonate, sulfate, chloride, iron, potassium, carbonate, nitrate, strontium, boron, and silica which were floating in the leachate (Erni & Mukhlis, 2013).

4.4 pH

Acidity degree defines a balance between acid and bases in water. The value of water pH less than 5.0 or more than 9.0, so the waters were heavy polluted so the water biota would be interrupted and could not be used for daily activities. The result of this research shows pH value increased. The result of the research decreased from day 7 to 28. This decreasing point occurred because the jasmine as the water plants ability in absorption the pollutant substance was dissolved in the water (Syafrani, 2007).

4.5 DO (Dissolved Oxygen)

Dissolved Oxygen was needed by the alive body for respiration, metabolism and breeding process. The result of the research found an increasing until day 28th. In the day 0 the average score of dissolved oxygen of leachate water was not different because the purification media and the Echinodorus palafolius was not effective in leachate pollutant absorption so it was able to decrease the pollutant content of the leachate water.

The result of the research shows the highest dissolved oxygen found in the zeolite media. Zeolite was absorbed so it can absorb a big amount of smaller molecules (Anggraini, 2013). It was appropriate to the Emelda et al. statement, (2013). She said that zeolite had inside pores and the wide surface so can be used as adsorbent. Dissolved oxygen was used for measuring the quality of water purity. The bigger dissolved oxygen value shows, the better water quality (Prahutama, 2013).
4.6 The Effectiveness of Filters Media and Echinodorus palaefolius in Decreasing Pollutant Substance

The effectiveness of physical and chemical characteristics of leachate could be shown as in the following table:

Table 2. The Effectiveness of Physical and Chemical Characteristics of Leachate

| No | Parameter | Units   | Treatments | Effectiveness (%) |
|----|-----------|---------|------------|-------------------|
|    |           |         |            | Day-0 | Day-7 | Day-14 | Day-21 | Day-28 |
| 1  | Turbidity | NTU     | P1         | 7.80  | 34.21 | 50.54  | 61.66  | 66.18  |
|    |           |         | P2         | 21.70 | 50.66 | 69.35  | 82.25  | 88.18  |
|    |           |         | P3         | 29.94 | 72.20 | 87.28  | 91.03  | 95.18  |
|    |           |         | P4         | 21.93 | 63.40 | 73.05  | 83.55  | 88.74  |
| 2  | Tempertaure| ^oC     | P1         | 0     | 8     | 4      | 4      | 4      |
|    |           |         | P2         | 0     | 8     | 4      | 4      | 4      |
|    |           |         | P3         | 0     | 4     | 4      | 8      | 8      |
|    |           |         | P4         | 0     | 0     | 4      | 8      | 8      |
| 3  | TSS       | mg/L    | P1         | 52.74 | 68.6  | 73.52  | 82.19  | 83.50  |
|    |           |         | P2         | 52.95 | 64.96 | 82.85  | 85.29  | 87.78  |
|    |           |         | P3         | 52.95 | 83.50 | 89.85  | 94.21  | 97.47  |
|    |           |         | P4         | 52.95 | 86.19 | 89.73  | 92.42  | 95.19  |
| 4  | pH        | -       | P1         | 9.24  | 19.35 | 13.33  | 8.60   | 11.82  |
|    |           |         | P2         | 9.03  | 16.98 | 11.18  | 9.89   | 11.82  |
|    |           |         | P3         | 9.24  | 17.20 | 17.20  | 14.19  | 20.86  |
|    |           |         | P4         | 9.03  | 16.34 | 15.48  | 11.61  | 10.32  |
| 5  | DO        | mg/L    | P1         | (-)150| (-)800| (-)620 | (-)620 | (-)640 |
|    |           |         | P2         | (-)780| (-)580| (-)3100| (-)3620| (-)3940|
|    |           |         | P3         | (-)100| (-)1040| (-)4680| (-)5120| (-)6660|
|    |           |         | P4         | (-)680| (-)3100| (-)3100| (-)4680| (-)5100|

Based on Table 2, it can be known that the lowest effectiveness of turbidity was at treatment P1, it was about 7.8%, and the highest one was at treatment P3, it was about 29.94% NTU. In the day 0, the media had no activity. In the observation done on day 7th, the lowest turbidity of leachate was at treatment P1, it was about 34.21% and the increased effectiveness found at treatment P3, it was about 72.20% NTU. In day 14th, the effectiveness value at treatment P3 was about 87.28% NTU. In the day 21st, the highest effectiveness value was at treatment P3; it was about 91.03 & NTU. In the day 28th, the lowest turbidity was found at treatment P1, it was about 66.18%, and the effectiveness value decreased to the highest one at treatment P3, it was about 95.18 NTU.

The lowest effectiveness temperature parameter in day 7th, the effectiveness leachate temperature value increased at treatment P3; it was about 4%. In the day 14th, the temperature at treatment P3 was about 4%. In the day 21, the effectiveness temperature increased at treatment P3; it was about 8%. And in the day 28, the leachate effectiveness temperature was at treatment P3; it was about 8%. The effectiveness value for TSS parameter in the day 7th for treatment P3 was about
83.50% Mg/L. In the day 14th, the TSS effectiveness value at treatment P3 was 89.85 Mg/L. And in the day 21st, the effectiveness of treatment P3 was 94.21% Mg/L. And in the day 28, TSS increased the effectiveness value of treatment P3 was 97.47% Mg/L.

The effectiveness value of the pH in the day 7th for the treatment P3 was 17.20%. In the day 14th, the P3 pH effectiveness was 17.20%. In the day 21st, the P3 pH effectiveness was 14.19%. Then, in the day 28th, the P3 pH effectiveness was 20.86%. The effectiveness value of DO in the treatment P3 was -1040% Mg/L. In the day 14th, the P3 DO effectiveness was -4680%. In the day 21st, the P3 DO effectiveness was -5120 Mg/L. In the day 28th, the P3 DO effectiveness was -6660% Mg/L. Based on the discussion above, all of the best effectiveness parameter value was at treatment P3 with the time of observations took as long as 28 days. This *Echinodorus palaefolius* could absorb the solid and dissolved substances. Treatment P3 with MPK, zeolite and *Echinodorus palaefolius*, were able to produce the pure leachate water. It can be seen that zeolite could absorb the small molecule so that the pollutant decreased.

At the first time, leachate water had a black color. After doing phytoremediation, it changed. But, in control treatment of leachate, there was no change. In treatment P2, the pure pf water changed because treatment P2 was given PMK treatment + *Echinodorus palaefolius*, so that's a way the leachate changed. In treatment P3, the leachate water was given *Echinodorus palaefolius* + PMK + zeolite, so it was pure. Treatment P4, the leachate water was not too pure because it helped by *Echinodorus palaefolius* + water + PMK + ferrolit, so the leachate did change the color became yellow.

5. **Conclusion and Suggestion**

Based on the result of research, it can be concluded that there was a significant effect of using filters media and *Echinodorus palaefolius* toward the leachate water quality. Filters media and *Echinodorus palaefolius* could affect the turbidity parameter, TSS, pH, and DO on leachate, but it did not affect the temperature parameter. The effectiveness treatment could decrease the pollutant content at the treatment P3 which used filters media such as PMK + zeolite + *Echinodorus palaefolius*. It is known that the effectiveness of each parameter, turbidity was 95.18%, temperature 4%, TSS 97.47%, pH 20.86%, and DO (-)6660%.

Based on the research, *Echinodorus palaefolius* is better for leachate phytoremediation media with zeolite and PMK. But the choice of clayey PMK is not suggested because it can plug the waterways. It is also suggested to take the leachate water in rainy or dry season. Because in the rainy season the leachate was so fluid, but in the dry season the leachate was so loud and could make the purification process difficult. The greenhouse used as the research was better completed by air circulation, so the temperature is not too high.

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