THE EFFECTIVENESS OF FILTER MEDIA AND *LIMNOCHARIS FLAVA* ON PHYTOREMEDIATION OF LEACHATE

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ABSTRACT

This research aims to know the effectiveness of filter media and *Limnocharis flava* on the phytoremediation of leachate. This research was conducted in the greenhouse of Faculty Agriculture, University of Lancang Kuning on January-February 2015. The method used was experimental method by using a completely randomized design, which consists of 4 treatments with 5 replicates at each treatment. The parameters measured were turbidity, temperature, Total Suspended Solid, pH, and Dissolved Oxygen of leachate. Data were analyzed by using Analysis of Variance One-Way with significance level (α) = 0.01 and further tested by Duncan's Multi Range Test. The results showed that there was a significant effect of filter media and *Limnocharis flava* on phytoremediation of leachate. Effective treatment to reduce levels of pollutants contained in the treatment 2 (Podzolik Merah Kuning, zeolites, *Limnocharis flava*) with effectiveness value were 87.09%, 4.8%, 91.81%, 21.93%, and (-)4680% for turbidity, temperature, Total Suspended Solid, pH, and Dissolved Oxygen respectively.

Keywords: filter media, Limnocharis flava, phytoremediation, leachate

1. INTRODUCTION

Population growth is very rapid, it effects on human needs. One of the negative impacts of using such product that human need will produce side material in the form of solid waste or garbage. Along with the passage of time and the increasing number of residents resulted increasing the amount of waste generated. This problem begins to interfere, either to human health or to the environment such as contamination of soil, water, and air. Based on the foregoing, the garbage problem began to attract attention and require handling or management of good order not to disrupt human life and the environment (Esmiralda & Oktarina, 2012).

The existence of landfill has a very important function, namely as a final waste treatment either to be recycled as compost or simply dumped after sorting by scavengers. The high amount of garbage in landfill will lead to a large scale of natural decomposition process as well. The decomposition process will convert the waste into organic fertilizer and generate side products namely leachate (Darnoto & Astuti, 2009).

Leachate may have a negative impact on the environment around the landfill as leachate contains contaminants that can bother the human's health, polluting the environment and aquatic biota. Based on these problems, the leachate treatment which aims to reduce and prevent the negative impacts on the environment is needed. One of the treatments that can be done to reduce the levels of pollutants leachate that is by phytoremediation.

Phytoremediation is a system where certain plants are working with microorganisms in the media (soil, coral and water). This blend can change the contaminants become less or not harmful to the environment (Anam et al., 2011). An aquatic plant used in this research was *Limnocharis flava*. This is because *Limnocharis flava* can be found numerously around Rumbai and this plant also able to effectively reduce the pollutants in the palm oil mill effluents as TSS, TDS, turbidity, sulfate and chloride (Syafrani, 2007).

Based on the above background, this study was carried out to determine the effectiveness of the filter media and *Limnocharis flava* on phytoremediation of leachate.

2. LITERATURE REVIEW

2.1 Leachate

Leachate is the liquid waste that arises as a result of the entry of external water into the landfill waste (in particular TPA). Leachate if not managed properly, can contaminate drinking water sources in the population around a pile of garbage (Herison, 2011). Leachate is formed in water which dissolves the trash heap of existing compounds that have a particular pollutant content of organic substances. Leachate is a potential cause of water pollution, both ground and surface water that need to be handled properly (Hardyanti & Huboyo, 2009).

Leachate at ground level can pollute the ground water and surface water; it was stated by Ehrig in Ali (2011), as follows:

1. The water surface polluted by leachate with high organic matter content, the process of biological decomposition will spend the oxygen content in the water and eventually all life in the water depends on the presence of dissolved oxygen will die.
2. Ground water polluted by leachate with high concentrations of these pollutants will be and remain in the ground water in the long term, due to limited dissolved oxygen so that the source of water comes from groundwater unsuitable for consumption.

2.2 Characteristics of Leachate

Characteristics of leachate are varying depending on the processes that occur in landfills, which include the process of physical, chemical and biological. While the factors that affect the processes occurring in landfills include: the type of waste, the location of the landfill, hydrogeological and the operating system, these factors vary greatly on a landfill with each other, as well as biological activity as well as the processes that occur in the midden both aerobic and anaerobic. Given these conditions, it will influence the leachate produced as a result of the decomposition process such as the quality and quantity of leachate and gas, for example when a landfill contains a lot of organic waste, and then characters of leachate generated will contain high organic substances with odors (Ali, 2011).

2.3 Phytoremediation

Phytoremediation is the use of plants to remove pollutants from contaminated soil or water. Lately, phytoremediation reclamation techniques have evolved considerably since proved to be cheaper than other methods, for example, the addition of the surface layer of soil. Phytoremediator can include herbs, shrubs and even trees (Juhaiti et al., 2005). Phytoremediation is a system where certain plants are working with microorganisms in the media (soil, coral and water). This blend can change the contaminants/pollutants to be less harmful to the environment or not. Process which plants to decompose contaminants that have complex molecular chains into a harmless substance with a simpler arrangement of molecules can be useful for plant growth itself (Anam et al., 2011).

3. METHODOLOGY

3.1 Research Design

Research design used was completely randomized design (CRD), which consisted of 4 treatments and 5 repetitions.

P0: Leachate 20 liters
P1: Leachate 20 liters + PMK 100% + 3 clump *Limnocharis flava*
P2: Leachate 20 liters + PMK 50% + zeolite 50% + 3 clump *Limnocharis flava*
P3: Leachate 20 liters + PMK 50% + ferrolit 50% + 3 clump *Limnocharis flava*

This study was conducted in January-February 2015 in Greenhouse of Faculty of Agriculture, University of Lancang Kuning - Pekanbaru. Parameters measured were turbidity, temperature, Total Suspended Solid, pH, and Dissolved Oxygen.

3.2 Research Procedure

First, set up a bucket underneath the container that had been hollowed out and given as many as 20 pieces of pipe, 400 liters of leachate and *Limnocharis flava* 45 clumps that already acclimatized for 3 days. Then filter media was prepared namely zeolite, ferrolit and PMK. This research procedure used each of 4 treatments with 5 repetitions. This study was planned to last for 14 days. Parameters observed were turbidity, temperature, TSS, pH, and DO every 7 days.

3.3 Data Analysis Techniques

Data were analyzed by analysis of variance (ANOVA) at significant level of 0.01%. Data were then conducted a further test with DMRT (Duncan's Multiple Range Test).

4. FINDINGS

4.1 General Conditions of Muara Fajar Landfill

Muara Fajar Landfill is located in Gondo road, near to Muara Fajar village which is located in the district Rumbai, Pekanbaru. At the beginning, Muara Fajar landfill implemented systems landfill with soil, made like a row of layered regularly (controlled landfill) in waste processing. It is characterized by the presence of drains in the underground (drainage) for controlling rainwater, collecting leachate, ponds, control facilities methane and others, but an increasing amount of waste that exceeds the capacity of landfill makes TPA apply open systems (open dumping).

Muara Fajar Landfill accommodates all the trash in Pekanbaru. Every year the waste received at the Muara Fajar landfill was increasing. Muara Fajar Landfill received waste as such as 53.485 tonnes in 2010, 78.773 tonnes in 2011, 79.579 tonnes in 2012, 133.500 tonnes in 2013 and 164.338 tonnes in 2014, which came from 12 districts in the city of Pekanbaru (Dinas Kebersihan dan Pertamanan Pekanbaru, 2015).

Composition of waste generated in Pekanbaru can be seen in table below:

Table 1: Composition of Waste Generated in Pekanbaru

No	Type of Waste	Ammount (%)
1	Wood	3,01
2	Paper	5,02
3	Organic	59,34
4	Textile	1,00
5	Plastic	11,05
6	Glass	1,00
7	Others	11,55

Source: Dinas Kebersihan dan Pertamanan Kota Pekanbaru (2015)

Waste sources can come from various activities. Table 2 shows the percentage of waste origin contained in Pekanbaru.

Table 2: Waste Source in Pekanbaru

No	Source	Amount (%)
1	Domestic (house hold)	86,07
2	Market	7,64
3	Commercial trash	3,59
4	Office	2,58
5	Street trash	0,11

Source: Dinas Kebersihan dan Pertamanan Kota Pekanbaru (2015)

4.2 Physical and Chemical Characteristics of Leachate during Phytoremediation

The physical and chemical characteristics of leachate during 14 days of phytoremediation can be seen in Table 3. Parameter observed were turbidity, temperature, Total Suspended Solid, pH, and Dissolved Oxygen of leachate.

Table 3: Physical and Chemical Characteristics of Leachate

Parameters	Units	Treatments	Test Results			Classification of Water Quality Standard*			
			Day - 0	Day - 7	Day - 14	I	II	III	IV
Turbidity	NTU	P0	39,80[b]	35,26[c]	32,21[d]	5**	-	-	-
		P1	33,60[a]	15,05[b]	11,26[c]				
		P2	32,05[a]	10,58[a]	5,57[a]				
		P3	33,33[a]	11,06[a]	8,22[b]				
Temperature	°C	P0	24,6[a]	24,2[a]	24,6[a]	Normal ±3	Normal ±3	Normal ±3	Normal ±5
		P1	24,6[a]	24,2[a]	24,2[a]				
		P2	24,2[a]	24,0[a]	23,8[a]				
		P3	24,4[a]	24,2[a]	24,0[a]				
TSS	mg/l	P0	427,80[d]	374,60[d]	275,60[d]	50	50	400	400
		P1	246,00[c]	142,80[c]	87,20[c]				
		P2	108,80[a]	62,60[a]	40,20[a]				
		P3	133,00[b]	88,20[b]	61,00[b]				
pH (at lab)	-	P0	9,06[c]	8,48[d]	8,48[c]	6-9	6-9	6-9	5-9
		P1	8,66[b]	7,90[b]	7,76[b]				
		P2	8,50[a]	7,56[a]	7,26[a]				
		P3	8,56[ab]	8,08[c]	7,88[b]				
DO	mg/l	P0	0,14[a]	0,38[a]	0,58[a]	6	4	3	0
		P1	0,20[ab]	1,38[b]	3,20[b]				
		P2	0,34[c]	2,44[c]	4,78[c]				
		P3	0,30[bc]	2,16[c]	3,72[b]				

Note: Values with the same letter within a column for each parameter are not significantly different at 1% significance level
*PP No. 82 (2001)
**Peraturan Menteri Kesehatan No. 492/Menkes/Per/IV/2010

The results of the analysis of physical and chemical parameters of leachate in each treatment for fourteen days compared with the classification of water quality standards under Government Regulation 82 in 2001. The final results showed that the treatments were effective in lowering the levels of pollutants contained in the P2 media using PMK (Podzolik Red Yellow) with zeolite and *Limnocharis flava*. The final results of the study compared to the classification of water quality standards in accordance with Government Regulation No. 82 of 2001 which showed that the parameters of turbidity was above 5 NTU is 5.57 NTU. As for the normal temperature is 23,8°C. TSS (Total Suspended Solid) capable of reaching to below 50 mg / L is 40.20 mg / L. pH of leachate reached 7.26 was alkaline. Parameter Dissolved Oxygen (DO) reached 4.78 mg / L, so it belongs to the second class on the classification of water quality standards in accordance with Regulation No. 82 in 2001.

Decrease in turbidity of leachate was due to the increase in observation time for fourteen days periodically during 0, 7 and 14 days. Increasing time also showed that *Limnocharis flava* have the ability to absorb dissolved solids and suspended solids in leachate longer so as to decrease the turbidity. This is consistent with a research by Syafrani (2007) which stated that the increase in observation time able to reduce turbidity in wastewater and *Limnocharis flava* give significant effect in reducing the turbidity of wastewater. Turbidity can be caused by organic materials and inorganic suspended and dissolved, such as mud, silt, plankton and microorganisms. Suspended solids correlated with turbidity, suspended solids the higher the value, the higher the turbidity value (Syafrani, 2007).

Based on research that was conducted, decrease in turbidity of the most effective leachate contained in P2 by using media PMK (Podzolik Red Yellow) with zeolite and *Limnocharis flava* with average turbidity day 14 reached 5.57 NTU. This is consistent with research Semara et al. (2010) which proved that the zeolite has the ability to purify water from heavy metal impurities. This statement is also supported by Hartati (2007), which proved that zeolites able to reduce turbidity of leachate.

Based on the data, it can be seen that the temperature of leachate was not different; it ranged between 23.8ºC-24.6ºC. This is due to the temperature calculation is done in the laboratory. Temperatures in the laboratory ranged between 23ºC-25ºC. The temperature is influenced by the season, time of day, air circulation, and cloud cover. Changes in temperature can affect the physics, chemistry and biology in water (Effendi, 2003).

Decrease in TSS (Total Suspended Solid) value of leachate was due to the increase in observation time for fourteen days; periodically during 0, 7 and 14 days. Increasing time genjer also showed that plants have the ability to absorb dissolved solids and suspended solids in leachate longer so as to decrease the TSS (Total Suspended Solid). This is consistent with a research by Syafrani (2007) which stated that the increase in observation time able to reduce TSS (Total Suspended Solid) in wastewater and *Limnocharis flava* significant effect in reducing the TSS (Total Suspended Solid) liquid waste. This statement is also supported by research Yulvizar (2011) which stated that the duration of observation is also leading to decreased levels of TSS (Total Suspended Solid) due to the deposition process.

Based on research that has been conducted, the most effective in reducing TSS (Total Suspended Solid) value of leachate contained in P2 was by using media PMK (Podzolik Red Yellow) with zeolite and *Limnocharis flava* with a mean TSS (Total Suspended Solid) day 14 reached 40.20 mg/L. This is similar to a research by Suyata and Irmanto (2009), which proved that zeolites could reduce levels of TSS (Total Suspended Solid). This statement is also supported by Rosyida (2011), which proved that zeolites could reduce levels of TSS (Total Suspended Solid).

A decrease in the pH of the leachate was due to the increase in observation time for fourteen days periodically during 0, 7 and 14 days. Increasing time also showed that *Limnocharis flava* have the ability to absorb dissolved solids and suspended solids in leachate longer so as to lower the pH. This is in accordance with the relevant research Hermawati et al., (2005) which proved that *Limnocharis flava* able to lower pH detergent waste. A decrease in pH also occurred because *Limnocharis flava* rotting vegetation in the leachate. This is in accordance with the opinion of Sastrawijaya in Yulvizar (2011) who stated that the less organic matter is broken down by microorganisms then produced more alkaline pH and an increasing number of organic substances described pH, the more acid is produced.

Raising DO (Dissolved Oxygen) in leachate was due to the increase in observation time for fourteen days, periodically at 0, 7 and 14 days. Increasing time also shown that *Limnocharis flava* have the ability to absorb dissolved solids and suspended solids in leachate longer so as to raise the DO (Dissolved Oxygen). This is in accordance with the relevant research Hermawati et al., (2005) which proved that *Limnocharis flava* able to raise the DO (Dissolved Oxygen) detergent waste.

4.3 Effectiveness of Media Filters and Genjer Reduce Pollutants Levels

Based on the research results of all parameter values with the highest effectiveness, the second treatment (P2), which uses media PMK (Podzolik Red Yellow) with zeolite and *Limnocharis flava*. This is because the increase in observation time for fourteen days, periodically at 0, 7 and 14 days. Increasing time genjer also showed that plants have the ability to absorb dissolved solids and suspended solids in leachate longer so as to lower and raise the physical and chemical parameters in the leachate.

Table 4: Effectiveness Value of Physical and Chemical Characteristics of Leachate

No	Parameter	Units	Treatments	C_{in}	Effectiveness (%)		
					Day 0	Day 7	Day 14
1	Turbidity	NTU	P0	43,17	7,80	18,32	25,38
			P1	43,17	22,16	65,13	73,91
			P2	43,17	25,75	75,49	87,09
			P3	43,17	22,79	74,38	80,95
2	Temperatur e	^oC	P0	25	1,6	3,2	1,6
			P1	25	1,6	3,2	3,2
			P2	25	3,2	4	4,8
			P3	25	2,4	3,2	4
3	TSS	mg/L	P0	491	12,87	23,70	43,86
			P1	491	49,89	70,91	82,24
			P2	491	77,84	87,25	91,81
			P3	491	72,91	82,03	87,57
4	pH	-	P0	9,3	2,58	8,81	8,81
			P1	9,3	6,88	15,05	16,55
			P2	9,3	8,60	18,70	21,93
			P3	9,3	7,95	13,11	15,26
5	DO	mg/L	P0	0,1	(-)40	(-)280	(-)480
			P1	0,1	(-)100	(-)1280	(-)3100
			P2	0,1	(-)240	(-)2340	(-)4680
			P3	0,1	(-)200	(-)2060	(-)3620

Effectiveness value of turbidity was up to 87.09% on day 14. The highest effectiveness value of temperature was 4.8%, while the highest effectiveness value of the TSS (Total Suspended Solid) was at treatment P2 (91.81%) on day 14. The highest effectiveness value of pH was given by treatment P2 (up to 21.93%) on day 14. The Effectiveness of DO (Dissolved Oxygen) had a negative value because the value Dissolved Oxygen (DO) was inversely proportional to that of other parameters. The lower the value of DO (Dissolved Oxygen) the lower the quality of the water, which was more polluted. The results showed the value of DO (Dissolved Oxygen) was higher so that the value of effectiveness becomes negative. The effectiveness value of DO (Dissolved Oxygen) was given by treatment P2 (-) 4680% on day 14.

5. CONCLUSION

Based on the research that has been done can be concluded that there was a significant effect of the type of filter media and *Limnocharis flava* to quality of leachate. Filter media and *Limnocharis flava* affect turbidity, TSS (Total Suspended Solid), pH and Dissolved Oxygen (DO) in leachate.

Effective treatment to reduce levels of pollutants contained in the treatment P2, which was using PMK (Podzolik Red Yellow) with zeolite and *Limnocharis flava*. Effectiveness value of turbidity was 87.09%, temperature was 4.8%, TSS (Total Suspended Solid) was 91.81%, pH was 21.93% pH, and Dissolved Oxygen (DO) was (-) 4680%.

6. RECOMMENDATION

Media filter PMK (Podzolik Red Yellow) with zeolite and *Limnocharis flava* was effective to reduce levels of pollutants in the leachate so harmless when discharged into the environment. For further research is recommended selection of PMK (Podzolik Red Yellow) are not too tough so that leachate can flow into the underground and after acclimatization recommended for selection of *Limnocharis flava* fresh herbs and green leaves that the plant not die quickly when the phytoremediation process.

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