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The comparison of organic waste compost quality between aerated static pile and open windrow method in Cahaya kencana landfill south Kalimantan Indonesia

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Key words: Aerated Static pile, Aeration rate, Carbon-to-nitrogen ratio, Composting, Open windrow

Abstract

This research is intended to analyzed composting condition of leaf organic waste (temperature and pH fluctuation), and analyzed the compost quality comparison between aerated static piles (ASP) and open windrow method. Composition of ingredients for one composting pile namely: 20 kg of leaf waste, 0.8 kg lime, chicken manure 0.6 kg, EM-4 20 ml, 20 grams of sugar and 200 ml of water. Variation of aeration rate in this ASP method is 0.4 L/min.kg; 0.5 L/min.kg and 0.6 L/min.kg, open windrow method is using as control. During each aeration, parameters such as carbon-to-nitrogen ratio, temperature and pH were measured. The results of this research showed that the colour of compost is brown to black, odorless and similar the smell of soil, the compost texture similar as soil, particle size between 0.55-25 mm, and the temperature of the mature compost is30°C which is according to SNI: 19-7030 2004. Based on the temperature fluctuation, aeration rate of 0.5 L/min.kg is the most ideal aeration rate because resulting the highest temperature fluctuation than the other aeration rate. pH parameter of all aeration rate did not showed significant differences, it has the same range between 8,17-8,27. The optimum aeration rate based on carbon-to-nitrogen ratio is 0.6 L/min.kg, it has the lowest carbon-to-nitrogen ratio (11.50). The results of statistical tests can be concluded that there is no significant differences between aeration rate of 0.4, 0.5 and 0.6 L / min.kg in carbon-to-nitrogen ratio of compost.

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Introduction

The importance of this research is to analyzed the excellence of aerated static pile than open windrow method to improving best composting practice management in Cahaya Kencana Landfill South Kalimantan Indonesia.

Composting in Cahaya Kencana Landfill Banjar Regency South Kalimantan Indonesia using leaf organic waste from PLN Banjar Regency, Banjar Regency service and the surrounding community. The method of composting is using open windrow method. However, open windrow method has several weaknesses, namely: the need for extensive land, need a lot of equipment and workers.

Nema (2009) stated that aerated static pile (ASP) composting an improvement method of open windrow. Aeration in the ASP method is done by placing a pipe at the base of the pile to drain air into the pile to prevent the formation of anaerobic conditions. The air blown in the pile by using the blower and the rate of aeration can be adjusted. Composting using ASP method did not requiring large land and a lot of workers. Processing compost with this method can be a good solution for composting in Cahaya Kencana Landfill.

Guo (2012) stated that aeration rate (aeration rate) is the most important factor in ASP method. Aeration deficiency can caused anaerobic condition, while excessive aeration can decrease temperature, eliminate moisture content and ammonia and finally increasing the cost and slow down the composting process. Nugroho and Istiqomah (2010) research results show that the optimal aeration rate for waste composting is 1.0 L/min.kg. The composting temperature reaches a maximum temperature of 62.4°C at 1.0 L/min.kg aeration of dry Weight. Agastirani (2011) stated that the ideal aeration rate is 2.0 L/min.kg (based on the total mass of the starting material in dry basis).

The composting principle is to decrease the carbon-to-nitrogen ratio of organic matter, equal to soil carbon-to-nitrogen ratio(<20).

The higher value of carbon-to-nitrogen ratioin organic matter make the compost mature longer. The time required varies from one month to several years depending on the basic ingredients (Setyorini *et al.*, 2006).The materials needed in composting are organic substances. The material can be leaves, grass cuts, vegetable waste, and other materials that come from living things. These materials must have a carbon and nitrogen ratio that is eligible for perfect composting. The formulation of research problem namely: How is the composting condition of organic waste (temperature change and pH change); How does the compost quality comparison of aerated static piles and open windrow method based on physical structure and carbon-to-nitrogen ratio?

Material and methods

Research Design and Material

The experiments were carried out at Cahaya Kencana Landfill Banjar Regency South Kalimantan Indonesia. The first step to do in this research is assembling tool for aeration process for ASP method, first: connecting PVC pipe on blower and pairing the faucet and pressure gauge. Preparing 3 series of PVC pipe due to variation of aeration rate. The next stage is sorting out organic waste to be composted. If the size of the composted waste is smaller it will make better contact between bacteria and organic matter, and make the process of decomposition faster, according to Cooper band (2002) best size for composting is 25-75 mm. Ingredients for one composting pile namely: 20 kg of leaf waste mixed with 0.8 kg lime, 10 kg of chicken manure, 10 kg of rice husk, 10 ml EM-4, and 6 liters of water. The amount of material composition for one pile is 40.8 kg. The pile is made with a height of 60 cm and a width of 100 cm.

Method

The composting process done by 28 days (1 month). The aeration rate were given 0.4; 0.5; 0.6 L/min.kg for 1 hour per day and stirring every 5 days. The control pilestirred manually every 3 days. Twelve composting pile with 1 m high piles were built. For a better air distribution, perforated polyvinyl chloride (PVC) pipes of 90 mm diameter were made.

In this treatment, daily temperature measurements will be checked in different locations each pile (Harmoko, 2008). The temperature measurement range is based on Rasa poor (2008). Thermometers were used for temperature monitoring at different locations in the piles, including top center (i.e., about 11.25 cm from the top), and bottom center (i.e., about 30 cm from the bottom). The measurement at each point is repeated 3 times at a time. Both ambient temperature and composting piles temperature were recorded daily. Temperature and pH measurements will be performed every day before aeration using a soil survey instrument. The composting piles will be checked for moisture if it is too dry it will be watered. Homogeneous replicate samples were collected by picking up material from different pile locations.

Observation of compost quality variable were determine in laboratory, the parameters tested were total organic carbon and total nitrogen. Temperature measurement data and pH were presented in graph and compared with graph of ideal temperature condition in composting process. A carbon-to-nitrogen ratioof mature compost compared with the results by Rasa poor *et al* (2009) and SNI of Compost Quality: 19-7030-2004.

Analysis of Data

Differences analysis of carbon-to-nitrogen ratio in ASP and open windrow method of this research data using 95% confidence level so that the probability value used to be 5% (sig. A = 0.05).

Data analysis used statistic in the form of single complete random design with linear additive model using software in the form of SPSS (Statistical Product and Service Solution) Version 16. First, normality test was performed to find out whether the data has been normal distributed (sig> 0,05).

If the data is normally distributed, the next step was performed homogeneity test, homogeneity test is performed to find out whether the data has a homogeneous variant (sig> 0,05). If the data was normally distributed and had homogeneous variant, the next test is ANOVA test to see if the treatment has significant effect (sig <0,05), if it proved significant then continued with the median value of test using LSD test (Least Significance Different).

Results and discussions

Composting Conditions: Temperature Profile

The composting process will successful if the temperature of the composting process is appropriate for the growth of the microorganisms.

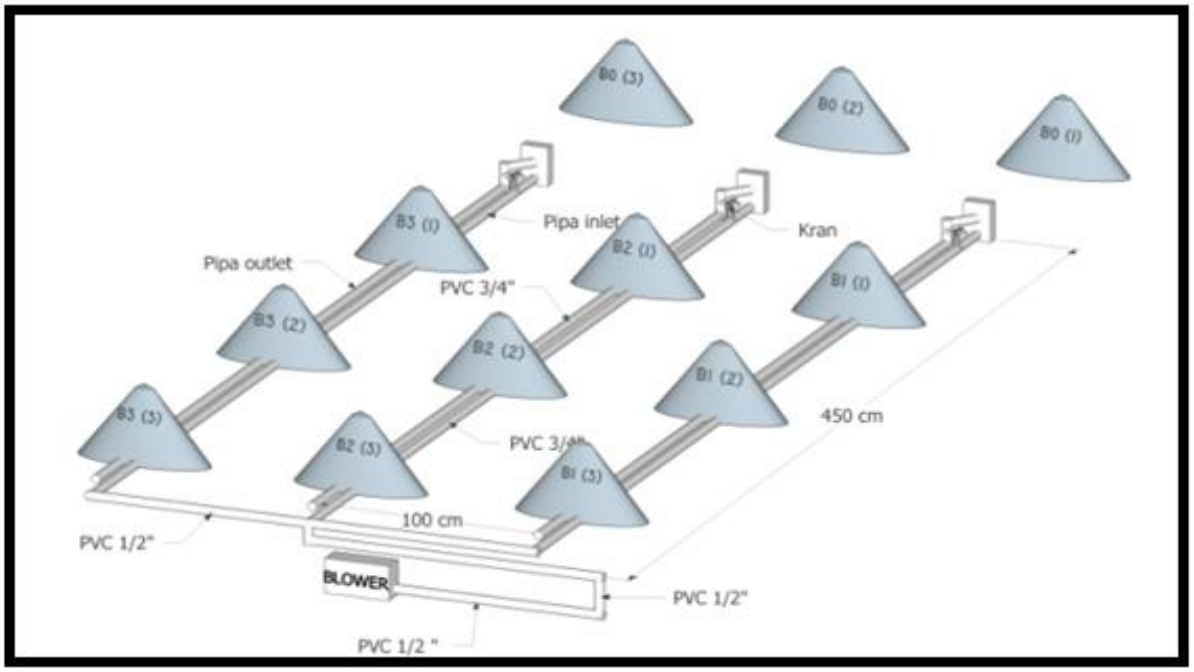

Fig. 1. Aerated static piles design.

Therefore, in this study carried out daily temperature measurements on the first day to day 30. Graph of temperature change of compost with aeration treatment 0,4; 0.5; 0.6 L/min.kg can be seen in Figure 3.

The figure showed that the composting process with the ASP method has the most optimum temperature increase. On the first day of the composting process, the compost temperature with ASP method showed an average temperature value of more than 45°C, it is estimated that the bacteria working at this stage are thermophilic bacteria because the temperature for thermophilic bacteria works in the range of 45-50 ° C. Thermophilic bacteria are in charge of consuming carbohydrates and proteins to make compost material can be rapidly dissociated.

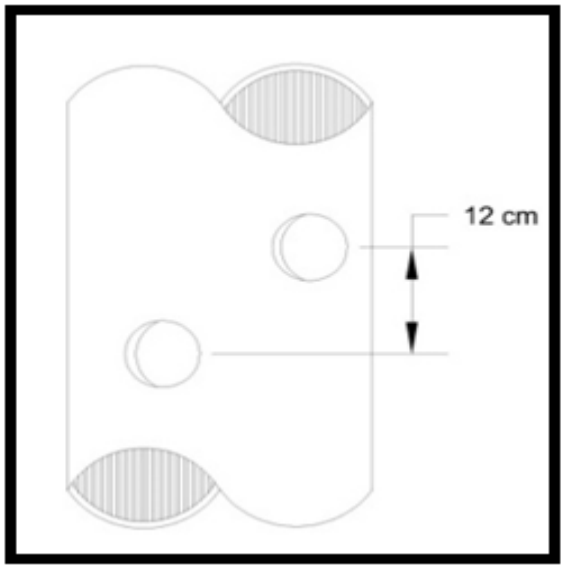

Fig. 2. Perforated Polyvinyl Chloride (PVC) pipes.

Entering the 2nd to 4th week either ASP method or open windrow there is a decrease in average temperature composting temperature is in the range 31.67-40.67°C. The composting process has entered the cooling phase, the number of microorganisms thermophilic reduced due to reduced food, this is causes the mesophilic microorganisms began to re-activity. The results showed that ASP method with aeration rate of 0.5 L/min.kg has a higher temperature increase. This is in accordance with previous research by Rasapooor (2009).

Height of the pile is also one of the factors that affect the composting process, in this study the pile is made with a height of 60 cm and a width of 100 cm while the recommended minimum piles is 100-160 cm, the dimension of the piles is too small to make the heat generated from the degradation process is not restrained in materials and carried along with air (Indrasti and Wimbanu, 2006).

pH Profile

The degree of acidity (pH) is a factor that plays an important role in the composting process. Graph of pH change in ASP 0.4; 0.5; 0.6 L/ min.kg and open windrow method can be seen in Figure 4. The final value of pH on each compost pile of ASP and open windrow method is 8.17. This value is according to Hadiwijaya (1999) and acceptable pH range that is between 5-12.

Carbon-to-Nitrogen Ratio

Graph of carbon-to-nitrogen ratio of compost with aeration treatment 0.4; 0.5; 0.6 L/min.Kg can be seen in Figure 5.Providing active aeration will accelerate the process of decomposition of organic materials because many microorganisms consume oxygen and increase its activity to produce energy, humus, and nutrients desired. 0.6 L/min.kg aeration rate have a lowest carbon-to-nitrogen ratio value. According to Indrasti and Elia (2004), aeration process helps degradation that requires oxygen to decompose organic matter, so that the decomposition rate of organic matter is more optimum.

Compared to the compost quality standard, the value of carbon-to-nitrogen ratio either control or ASP method of 0.4; 0.5; 0.6 L/min.Kgwas appropriate(10-20) with SNI Compost Quality Standard: 19-7030-2004.

To analyzed the differences of between ASP ad open widrow, normality and homogeneity test were performed. From the results of statistical tests conducted it can be concluded that the carbon-to-nitrogen ratio data of the compost is normal, represented the actual condition of the field (Sig 0.977> 0.05).

The conclusion of the homogeneity test conducted that carbon-to-nitrogen ratio data is not fluctuating and has the same distribution (Sig 0.341> 0.05). From analysis of variance (ANOVA), can be concluded that is no difference of compost quality between ASP (aeration rate 0,4; 0.5; 0.6 L/min.kg) and open windrow.

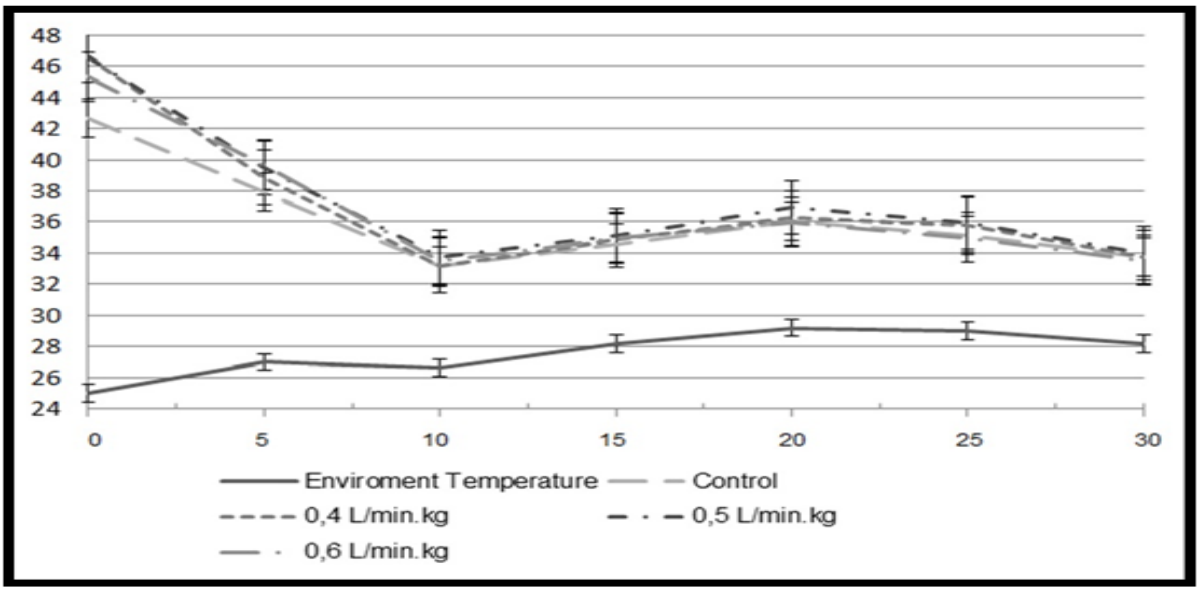

Fig. 3. Temperature profile.

The carbon-to-nitrogen ratio of fresh leaf as the main ingridients is12.46, this value is close to the carbon-to-nitrogen ratio of soil. The carbon-to-nitrogen ratio of the three variations of aeration rate given it was concluded that there was no significant difference between aeration rate variation This is happened because the accumulation of leaf materials used is stacked up for 1 month in Cahaya Kencana Landfill with a humid condition so the composting process has occurred before the mixing process of compost). It also affects the temperature and pH in the composting process.

Relation Between Temperature, pH and carbon-to-nitrogen ratio

From the research conducted found that the relation between variation of aeration rate to fluctuation value at temperature, pH and carbon-to-nitrogen ratio. The variation of aeration rate which produces the highest temperature during the composting process is the aeration rate of 0.5 L/min.kg.PH fluctuations of compost has almost equal values of the three variations of the aeration rate.

The temperature rise is influenced by the microbes present in the compostpile during the composting process especially in the mesophilic and the rmophilicphases, whereas pH fluctuations are influenced by decomposing organic material producing acids that will decrease the pH while producing ammonia will increase the pH in the initial phase. However, the mature compost has a neutral pH which is similar to the ideal mature compost of the Agastirani study (2011). From the research results can be concluded that the decline in pH value will be in line with the rise in temperature (Syafrudin and Zaman, 2007).

This is happened becausebythe beginning of compost degradation, the process of degradation of organic materials are complex and reactive to simple organic acids. The pH value gradually rises because of the number of microorganisms that eat these organic acids into the final product. At last in 28 days the pH returns to the neutral pH. This is a cooling phase in which nitrification processes occur by bacteria that convert ammonia to nitrate.

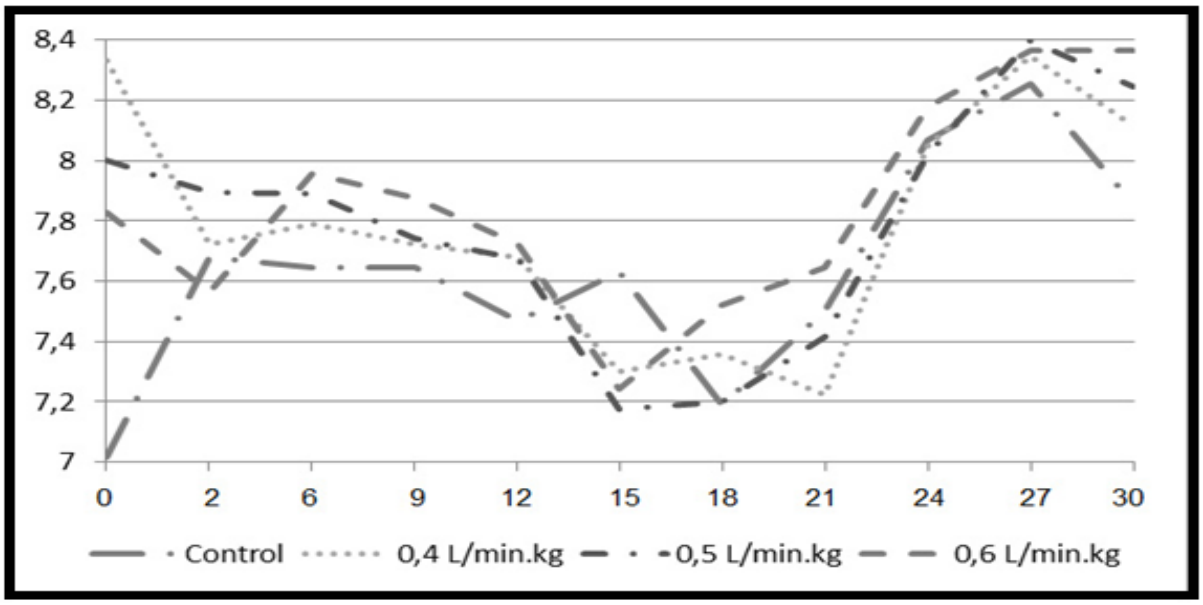

Fig. 4. pH profile.

In the cooling phase occurs the process of decomposition of resistant materials such as lignin, hemiselulose and cellulose by fungi and actynomycetes (Syafrudin *et al.*, 2011). According to CPIS (1992), the high of pH values caused the nitrogen element in the compost transform became ammonia, otherwise too low (acid) pH conditions causing the microorganisms died. The easiest way to fixed the pH value of compost is limit the aeration. In this way organic acid can be produced and will decrease the pH value.

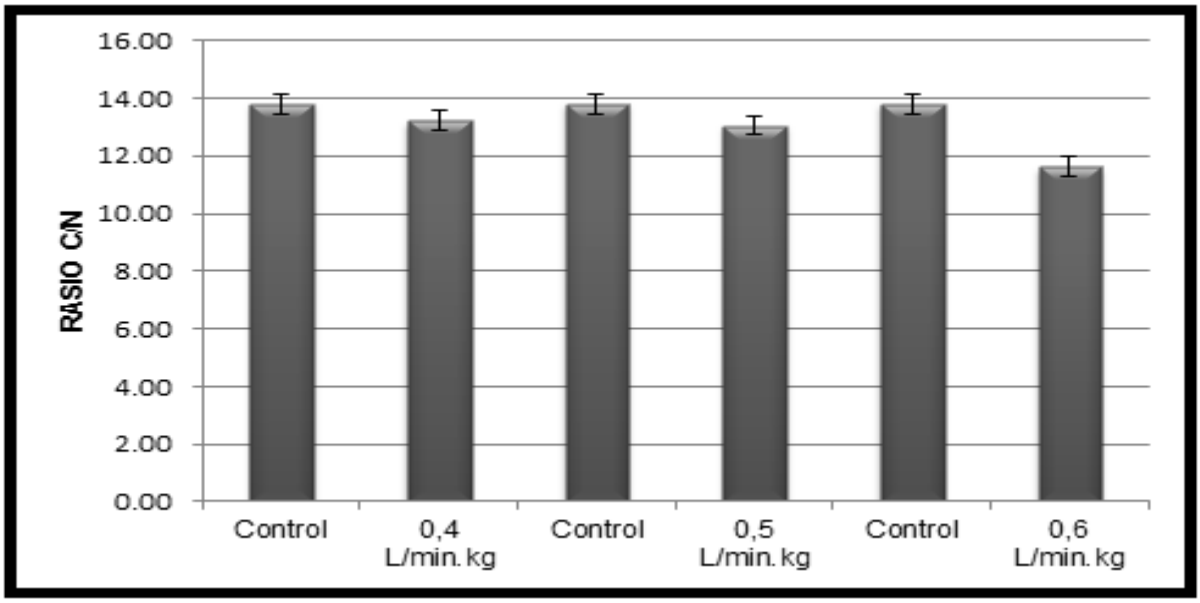

Fig. 5. Carbon-to-nitrogen ratio comparison.

Conclusion

The composting condition of highest temperature change resulted by ASP method in aeration rate 0,5 L/min.kg. pH fluctuation of the compost produced from open windrow method has final neutral pH near 7.7 when compost is said to be mature. The compost quality comparison of aerated static piles and open windrow method based on physical structure had similar physical structure and according to the characteristics of the mature compost.

The quality of compost is appropriate with Indonesian National Standard of Compost Quality: 19-7030-2004. 0.6 L/min.kg aeration rate resulted the best aeration rate in carbon-to-nitrogen ratio data. However, from the results of statistical tests can be concluded that there is no significant difference of compost quality between the ASP and open windrow method in carbon-to-nitrogen ratio data.

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