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The Population of Bacteria and CO_2 Release on Process of Composting Manure and Swamp Grass

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Abstract: This study aimed to analyze the bacteria population, the release of CO_2, pH and organic-C and total-N in the process of compost made from manure and swamp grass. Treatment level consist of 100% manure (K_{100}), 50% of manure + 50% swamp grass ($K_{50}R_{50}$), 25% of manure + 75% swamp grass ($K_{25}R_{75}$), and 10% of manure + 90% swamp grass ($K_{10}R_{90}$). The result of this study indicated the dynamic of different bacteria population on different composting materials by increasing of the composting time. The release of CO_2 decrease on all treatment levels by increasing of the composting time. The pH value increased at all levels of treatment, except the composition of 100% manure. The best composition obtained by mixing of 10% manure and 90% swamp grass.

Keyword: CO_2 release, compost, manure, population, swamp grass

Abstrak (Indonesian): Abstrak (Indonesian): penelitian ini bertujuan untuk menganalisis populasi bakteri, pelepasan CO_2, pH serta C-organik dan N-total pada proses pembuatan kompos berbahan baku kotoran sapi dan rumput rawa. Taraf perlakuan terdiri dari 100% kotoran sapi (K100), 50% kotoran sapi + 505 rumput rawa ($K_{50}R_{50}$), 25% kotoran sapi + 75% rumput rawa ($K_{25}R_{75}$), dan 10% kotoran sapi + 90% rumput rawa ($K_{10}R_{90}$). Hasil penelitian ini menunjukkan bahwa terjadi dinamika populasi bakteri yang berbeda pada komposisi bahan baku yang berbeda dengan bertambahnya waktu pengomposan. Nilai pH mengikat pada semua taraf perlakuan, kecuali 100% kotoran sapi. Komposisi terbaik diperoleh dengan mencampurkan 10% kotoran sapi dan 90% rumput rawa.

Katakunci: populasi, pelepasan CO_2, kompos, kotoran sapi, rumput rawa

1. Introduction

The use of compost as a source of plant nutrients is one of free chemicals program. The materials for compost is organic matter which is potential enough for nutrients supply (Kusuma and Silitonga, 2013). There is a wide range of basic materials for composting, two of them are manure and swamp grass.

Manure is a source of microbes, especially those that play a role in decomposing lignin, cellulose, and hemicellulose. Naturally, all of that three compounds are not in pure condition, so that the biomass degradation process becomes slow (Varnaite *et al.,* 2008). Swamp grass is cattle feed that contains all these compounds. According to Marlina and Syafrullah (2014), the potential of swamp land that has not been used optimally is the swamp grass that are available all year round in large amount.

The process of composting organic waste from the remains of plants can be stimulated by using a bio-activator. Bio-activator is microorganism that can improve a reaction rate (Djuarnani *et al.,* 2006). The rate of composting can be detected based on the rate of respiration. Respiration is an indicator of microbial activity (Cook and Orchard, 2008). Manure is one of the bio-activator that is effective in accelerating the rate of decomposition of organic matter.

Based on research by Gofar *et al.* (2013) which is registered on patent number P00291704700, compost by composition of 10% animal waste and 90% of rice straw produce the best result with an incubation period of one month. With reference to the study, in this study will try to compost manure and swamp grass with different compositions. The purpose of this study is to analyze the bacteria population, the release of CO_2, pH and organic C and total N in the process of compost made of manure and swamp grass.

2. Experimental Sections

Samples of manure taken from cattle pen, Faculty of Agriculture, Sriwijaya University, Indralaya. Calculation of bacteria population, CO_2 release, pH, and nutrient conducted at the Laboratory of Chemistry, Biology and Soil Fertility, Department of Soil Science, Faculty of Agriculture, Sriwijaya University, Indralaya.

Tools which used in this study is a laboratory equipment and supporting tools in measuring the population of bacteria and the respiration rate. Materials which used in this study were: 1) materials for the calculation of microbial populations in the laboratory, 2) materials for titration, and 3) samples of cow manure and swamp grass.

The treatment in this experiment consisted of four levels, namely: 1) 100% manure (w/w) with the symbol K_{100}, 2) 50% of manure + 50% swamp grass (w/w) with the symbol $K_{50}R_{50}$, 3) 25% of manure + 75% swamp grass (w/w) with the symbol $K_{25}R_{75}$, and 4) 10% of manure + 90% swamp grass (w/w) with the symbol $K_{10}R_{90}$. Each treatment was repeated four times so that there are 4 x 4 = 16 experimental units.

Samples of manure and fresh swamp grass was weighed separately according to the comparison (absolute dry equivalent), then thoroughly mixed and put into a plastic jar. In the jar which was contained by composting material was placed two vials bottles, one of them contained 10 mL H_20 and the other one contained 10 mL of 0.2 M KOH, and then the jar was sealed. Activity in the laboratory was to measure the respiration rate of CO_2 which used the titration method every day for 4 weeks and counting of microbial populations by pour plate methods that cast once a week for 4 weeks.

The variables which was observed in this study include: 1) the release of CO_2 every day for four weeks, 2) the population of bacteria on the first, second, third and fourth week, 3) the pH value of the beginning and ending, and 4) the ratio of C and N of the beginning and ending. The release of CO_2 daily presented in the relationship graphs between time and the CO_2 release. The difference between bacterial populations, the release of CO_2, and pH media on compost treated with various compositions were analyzed by $HSD_{0,05}$.

3. Results and Discussion

Bacteria population

Treatment of compost with various material composition significantly affected the bacteria population on a weekly basis. Bacteria population on every week which had logs transformed were presented in Table 1. The results of different test ($HSD_{0.05}$) (Table 1) showed the observation of 1^{st} week, the bacterial population in the treatment of K_{100} and $K_{50}R_{50}$ is significantly higher than other treatments. The treatments that showed the lowest bacteria population was on the composition of the $K_{10}R_{90}$. In 2^{nd} week observations indicate the composition of the bacteria population of the $K_{25}R_{75}$ was significantly different from the bacteria population of the compost with the composition K_{100} and $K_{10}R_{90}$, but it was not significantly different from the composition $K_{50}R_{50}$. The highest population was found in the composition of the K_{100} and the lowest result is the composition of $K_{25}R_{75}$. But overall, the bacteria population is lower than the observations of 1^{st} week.

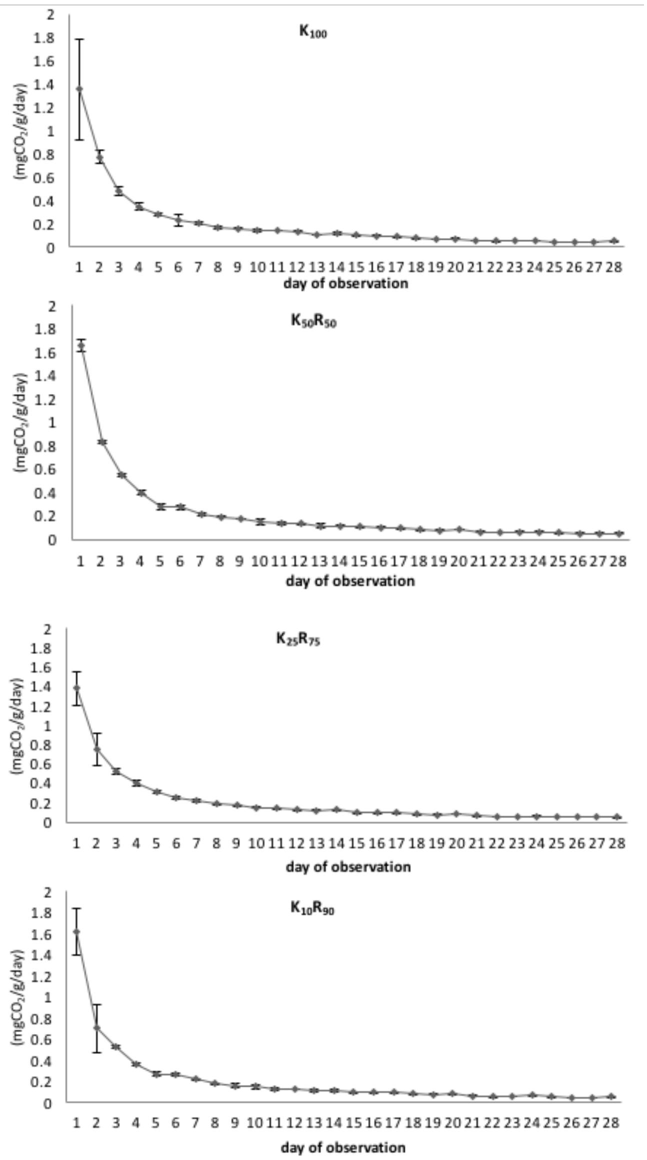

Figure 1. The dynamics of the CO_2 release in various composting compositions

The highest bacteria population in the 3^{rd} week was still on the composition of the K_{100} and the lowest result obtained on the composition of the $K_{10}R_{90}$. Overall treatment at week 3 was significantly different from 1^{st} week of observation. The bacteria population on the composition of $K_{10}R_{90}$ was significantly different from the bacteria population of the compost with the composition of K_{100} and $K_{50}R_{50}$, but it was not significantly different from the composition of $K_{25}R_{75}$.

Decomposition of organic material on manure has been through earlier in the cow's stomach. If we saw it from physical properties side, the texture of K_{100} on the beginning of composting tends to be mushy or had a higher water content than the three-other composting composition. The moisture of this compost was a factor that caused the compost with the composition K_{100} had the highest bacteria population in the observation of week 1 to 3 (Table 1). According to Yulipriyanto (2010), decomposer organisms need water to live. Microorganisms activities takes place very rapidly in a thin film layer of water on the surface of the organic material, microorganisms can only use organic molecules that dissolve in water.

Table 1. The bacterial population of each week of observation

week	The population of bacteria (log spk g^{-1}) on the composition			
	K_{100}	$K_{50}R_{50}$	$K_{25}R_{75}$	$K_{10}R_{90}$
1	11.58 cd	11.73 d	10.91 b	10.39 a
2	10.87 b	10.64 ab	10.43 a	10.78 b
3	10.80 b	10.70 b	10.58 ab	10.39 a
4	10.95 a	10.96 a	10.80 a	10.68 a

Description: The value followed by the same letter on the line (a, b, c, d) showed not significantly difference at $HSD_{0,05}$. $HSD_{0,05}$ value to 1st, 2nd, 3rd, and 4th week of observation period, consecutively 0.26; 0.33; 0.25; and 0.42.

In observation 4th week, bacteria population of each treatment tend to be uniform and not significantly different. This indicated that the same level of maturity of compost in each treatment and also bacteria population continued to decrease until the 4th week. This bacteria population decreasing due to the decrease of food resources availability, ie organic material. According to Sastrawidana *et al.* (2008) lack of nutrient availability for decomposers microbial can inhibit the multiplication of microbes.

The release of CO_2

The composition of the treatment, the period of observation, and their interaction significantly affected the rate of respiration or release of CO_2. Table 2 showed that in the treatment of 100% manure (K_{100}), respiration of 1st week was significantly different from 2nd, 3rd, and 4th week, while respiration at weeks 3 and 4 were not significantly different.

Table 2. The release of CO_2 on a weekly observation

Week	The release of CO_2 (mg CO_2/g/week) in composition				Average (mg CO_2/ g /week)
	K_{100}	$K_{50}R_{50}$	$K_{25}R_{75}$	$K_{10}R_{90}$	
1	3.68 ar	4.21 cs	3.84 ab r	3,98 bc s	3.93 s
2	0.99 aq	1.02 ar	1.03 a q	0.99 a r	1.01 r
3	0.58 ap	0.60 aq	0.60 a p	0.59 a q	0.59 q
4	0.38 ap	0.40 ap	0.40 a p	0.40 a p	0.39 p
Average (mg CO_2/g/ week)	1.41 a	1.56 b	1.47 ab	1.49 ab	

Description: The figure followed by the same letter in the column (p, q, r, s) or line (a, b, c) showed not significantly difference at $HSD_{0,05}$. $HSD_{0,05}$ value of the observation period, the composition and interaction of two consecutive 0.14; 0.14; and 0.27.

Treatment of $K_{50}R_{50}$ indicates the respiration rate significantly different at every week. In the treatment of $K_{25}R_{75,}$ the respiration rate of the observation period week 1 was significantly different from the other three periods of observations, as well as in the period of observation week 2 were also significantly different from the period of observation weeks 1, 3, and 4, while the observation period week 3 and 4 were not significantly different.

Table 2 showed the respiration rate significantly different at each week of observation on the treatment of $K_{10}R_{90,}$. Respiration rate tends to decline in all treatments from week 1 to week 4. This was caused by the decrease of microbial activity. According to Swastika and Sutari (2009) microbial respiration is an indication of microbial activity by measuring CO_2 produced.

Observation period of week 1 indicates that the release of CO_2 in the treatment with the composition of K_{100} significantly different from the treatment of $K_{50}R_{50}$ and $K_{10}R_{90}$. At week 2 to week 4, the release of CO_2 at each treatment was not significantly different. Even on the 4th week the release of CO_2 in the compost with the composition $K_{50}R_{50,}$ $R_{75}K_{25}$ and $K_{10}R_{90}$ were the same. It also can be seen from Figure 1 which presented dynamics of CO_2 release in each treatment during four weeks of observation.

Respiration rate continued to decline from beginning to ending of composting on all treatments (Figure 1). This is according to Subali and Ellianawati (2010), because of the microbes take energy for its activities, from calories that produced in the reaction of biochemical changes in waste of biological materials, mainly carbohydrates materials, continuously so that the content of carbon of organic waste dropped even lower, since the end of the reaction of breathing out of CO_2 and H_2O which was evaporated.

Values of pH, organic C, total-N, and C and N Ratio

The composting process would cause changes in organic matter and pH (Dahono, 2012). In this study, the level of acidity (pH) were analyzed at the beginning and ending of composting (Table 3). Composting treatment significantly affect to the acidity of the ending of composting. Table 3 shows that the pH value in the treatment of $K_{10}R_{90}$ had no significantly difference with $K_{25}R_{75,}$ but significantly different from the treatment of K_{100} and $K_{50}R_{50.}$

Result at the beginning or the ending of the composting analysis (Table 3), the pH of the treatment with the composition $K_{10}R_{90}$ showed the lowest pH. This was occured because the nitrogen content (Table 3) in the composition are also the lowest among other compositions. Acid leaching process, temporarily or locally, would cause a decrease in pH (acidity), while the production of ammonia from compounds which containing nitrogen will increase the pH (Isroi & Yuliarti, 2009).

In addition to changes in pH, the indicator which indicating the passage of the process of decomposition in composting is the decomposition of C/N substrates by microorganisms or other decomposers agent (Graves *et al.,* 2000). Compost quality is usually seen on the nutrient content, where the levels are highly dependent on raw materials or the composting process (Simamora and Salundik, 2006). Analysis of raw materials or basic materials compost in this study are presented in Table 3. The assortment of compost maturation process should be done so that the microorganisms that are active in biological composting process will develop in optimal environmental conditions. One of the conditions that need to be considered is the ratio of nutrient compost material, can be improved by mixing different kinds of waste. Manure had a high ratio of C and N must be mixed with agricultural wastes that had a higher ratio of C and N (Sutanto, 2002). Based on analysis of compost material presented in Table 3. showed that the ratio of C and N on swamp grass (64.86) higher than the C and N ratio of manure (24.00).

Table 3. The analysis results of organic C, total N, ratio of C and N, and the initial pH and the final composting

Composition	Organic C (%)		N-Total (%)		Ratio C and N		pH	
	early	end	early	end	early	end	early	end
K_{100}	57,60	57.53 b	2.40	2.47	24,00	23.29	8,46	8.40 b
$K_{50}R_{50}$	57.97	54.29 a	1.09	2.50	53.18	21.72	7.97	8.22 b
$K_{25}R_{75}$	56.33	53.64 a	1.00	2.58	56.33	20.79	7.67	8,21 ab
$K_{10}R_{90}$	57.32	53.30 a	0.95	2,5 0	60.34	21.32	7.33	7.80 a
swamp grass	57.08	-	0.88	-	64.86	-	7.38	-

Description: The figure followed by the same letter in the column (a, b) shows no significant difference at $HSD_{0,05}$ is worth 3.15.

Graves *et al.* (2000) states the ratio of C and N is one indication of the maturity of compost. Changes in the ratio of C and N occurred during composting due to the use of carbon as an energy source and was lost in the form of CO_2 so that the longer the carbon content is reduced. Changes in pH and the ratio of C and N in this study are presented in Table 3.

ANOVA based on the content of organic C at the end of composting, compost raw material composition significantly affected. Compost with K_{100} was significantly higher compared to treatment $K_{50}R_{50}$, $K_{25}R_{75}$, and $K_{10}R_{90}$. From the analysis (Table 3) showed deterioration in the levels of organic C on composting at the end of all treatments. This occurs as a result of the use of carbon as an energy source for microbes metabolic activities (Graves *et al.,* 2000).

At the end of the composting composition K_{100}, the levels of organic C decreased at least compared to the level of other treatments, although bacteria population on the composition of the K_{100} (Table 1) but low of bacterial activity viewed of CO_2 which released (Table 3). It is caused by the absence of an additional food source for microbes other than those existing on manure. Despite the high population but because of the type of food was limited, then the bacterial activity is low, resulting in a decrease of organic C slightly.

The composition of the composting effect no significant effect on the content of N-total on the final result of composting. According to Table 3, all the compositions of composting showed increased content of total N at the end of composting. Increasing the percentage of total N in composting is a phenomenon that can be found in the composting process, the release of N-organic from tissue becomes available N (Ruskandi, 2006).

Ratio of C and N are determined by the content of organic C and total N in any composting composition itself. The composition of the composting effect is not noticeable to the ratio of C and N at the end of composting. The overall ratio of C and N in all composting compositions decline and the lowest level achieved in $K_{25}R_{75}$, but not significantly different from other treatments. C and N ratio is one of indicator of compost maturity. Mature compost according to Indonesian National Standard (2004) has a ratio of C and N 10-20. The average ratio of compost in each treatment approach 20, so compost results by 4 weeks' incubation was already mature.

4. Conclusion

There was dynamics of different bacteria population in the composition of different raw materials by increasing the composting time. In all treatments, the release of CO_2 was decreased by increasing the composting time. The pH value increases at all levels of treatment, unless the 100% manure (K_{100}). The best composting material composition obtained by mixing 10% of manure and 90% of swamp grass ($K_{10}R_{90}$).

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References

[1] Kusuma, M.E. dan Silitonga, L. 2013. Effect of long process of making compost made from manure of cattle to the quality of compost. Agri Peat Journal. 14 (1). An online journal. https://jurnalagriepat.wordpress.com/2013/09/16/volume-14-nomor-1-maret-2013-pengaruh-lama-proses-pembuatan-pupuk-kompos-berbahan-limbah -FECES-maria-erviana-kusuma-and-lisnawaty-silitonga/accessed on February 02nd 2017.

[2] Varnaite, R., Paskevicius, A., and Raudoniene, V. 2008. Cellulose degradation in rye straw by micromycetes and their complexes. Ekologija 54 (1): 29-31.

[3] Marlina, N. and Syafrullah. 2014. Utilization of compost swamp grass in cucumber (*Cucumis sativus* L.) with technology raft floating in swampy areas. Proceedings of the National Seminar on Suboptimal Land 2014. ISBN: 979-587-529-9. 282-288.

[4] Djuarnani, N., Kristian, B. S. Setiawan. 2006. A quick way to make compost. Agromedia Pustaka, Jakarta.

[5] Cook, V.J. and V.A. Orchard. 2008. Relationship between soil respiration and Soil Moisture. Soil Biology and Biochemistry 40: 1013-1018.
[6] Gofar, N., Marsi, H. Widjajanti. 2013. Methods of making the carrier microbe biological fertilizer made from rice straw. P00291704700 patent registration no. Kemenkumham, Director General of Intellectual Property Rights, Jakarta.
[7] Yulipriyanto, H. 2010. Soil Biology and Their Management Strategy. Graha Ilmu, Yogyakarta.
[8] Sastrawidana, D.K., Lay, B. W., A. Fauzi, M. and Santosa, D. A. 2008. The use of local bacterial consortium for bioremediation of textile waste using a combination of anaerobic-aerobic system. News Biology. 9 (2): 123-132.
[9] Swastika And Sutari, S. 2009. Treatment Against activator and is the incubation period of weathering waste rice straw. Journal Bumi Lestari. 9 (2): 211-216
[10] Subali, B. And Ellianawati. 2010. Effect Against Time composting element ratio c / n and composting levels hearts Term air. Proceedings of Scientific Meeting XXIV HFI Central Java and Yogyakarta. 49-53.
[11] Dahono. 2012. Composting and Organic liquid fertilizer from cow dung and urine. Workshop for Agricultural Technology (LPTP). Riau islands.
[12] Isroi and Yuliarti, M. 2009. Compost. Lily Publisher, Yogyakarta.
[13] Graves, R.E., Hattemer, G.M., Stetter, D., Krider, J.N. and Dana, C. 2000. National Engineering Handbook. United States Department of Agriculture, Washington.
[14] Simamora, S., and Salundik. 2006. Improving Compost Quality. Agromedia Pustaka, Jakarta.
[15] Sutanto, R. 2002. Application of Organic Agriculture. Canisius, Yogyakarta.
[16] Ruskandi. 2006. Mechanical composting garden waste coconut crop polyculture. Agricultural Engineering Bulletin 11 (1): 33-36.
[17] Indonesian National Standard. 2004. Specifications Domestic Compost from Organic Waste. SNI 19-7030-2004. National Bureau of Standards, Indonesia. Jakarta.