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The Effect of Various Decomposers on Quality of Cattle Dung Compost

Nur Shoodiq Alfadlli[1], Safuan Noor[2], Bayu Setya Hertanto[2], and Muhammad Cahyadi[2*]

[1]PT. Persada Pupuk Indonesia, Subang, Purwakarta, 41118, Indonesia
[2]Department of Animal Science, Faculty of Agriculture, Universitas Sebelas Maret, Surakarta, 57126, Indonesia

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* Corresponding author:
Telp. +62 271-637457
E-mail: mcahyadi@uns.ac.id

ABSTRACT

The aim of this study was to compare the utilization of decomposer from bioethanol waste (DLB) with various commercial decomposers on quality of compost made from cattle dung. This study used completely randomized design (one-way ANOVA) with four treatments and five replications. Materials used in this study were cattle dung, water, molasses, DLB and various commercial decomposers (A, B, and C). The treatments in this study were cattle dung + BLB 0.5% (P0), cattle dung + decomposer A 0.5% (P1), cattle dung + decomposer B 0.5% (P2) and cattle dung + decomposer C 0.5% (P3). Then, the mixtures were aerobically ripened until four weeks. During composting, compost was stirred weekly. Furthermore, mature compost was analyzed to evaluate the amount of C Organic, total N, total P, total K, total Ca, total Mg, C/N ratio and pH value. The analysis of variance showed that there was no difference of the quality and pH value of compost made from cattle dung with utilization of DLB and commercial decomposers. It could be concluded that utilization of DLB in composting of cattle dung had identically quality and pH value of compost with utilization of commercial decomposers, therefore, this technology could be an alternative to process waste from home industry of bioethanol.

Keywords: Bioethanol waste, Cattle dung, Compost quality, Decomposers

Introduction

Global ethanol consumption pattern has rapidly been growing in the last few years. by The dramatic growth of ethanol consumption is driven to reduce dependencies and expenditure on fossil fuels and to decrease greenhouse gas emission. In Indonesia, the development of ethanol industry is slow due to restricted raw materials. Most of home industries of bioethanol utilize by product of sugar industry such as molasses for major raw material (Isa and Kusmiati, 2013). One of areas producing bioethanol in Indonesia is Bekonang, Sukoharjo Regency, Jawa Tengah Province.

Bioethanol industry in Bekonang is home industry developing started from 1940's. The main raw material used to produce bioethanol is molasses obtained from PT. Perkebunan Nusantara IX. A total of 120 home industries have legally been authorized to operate their businesses until 2016. Bioethanol produced in Bekonang is mostly used for medical and cosmetic fields (Isa and Kusmiati, 2013). This existence of bioethanol home industry is very helpful to provide job for peoples who live around the industry area, on the other hand it triggers to produce waste. Every one liter of bioethanol produces 1 kilogram of waste. In addition, the production capacity of bioethanol industry in this area is about 6,000 liters per day, therefore, it will generate no less than 6,000 kilograms of waste (Ariyanto *et al.,* 2014). This waste leads to some damages to the environment such as odor pollution and decreasing the pH value of productive lands. However, liquid waste of bioethanol industry in Bekonang meets the minimum quality standard defined by Indonesian government, so it classified as waste containing high organic matters and it can furthermore be processed to avoid environment pollution (Moertinah, 2010).

High organic matter contents in the bioethanol industry liquid waste indicate the possibility to be processed into something beneficial for peoples. Nurcahyani and Utami (2015) reported that liquid bioethanol waste could be processed to be liquid fertilizer. It also able to be used as probiotics for feed fermentation (Hadi *et al.,* 2016). Additionally, probiotics could be utilized as decomposer agents in composting. The use of 0.25 and 0.5% of decomposer agents in composting made from livestock dungs produced good quality of compost (Bahar and Haryanto, 2000; Sariubang *et al.,* 2002). Moreover, the use of 2.5% of decomposer agents improved nutrient content of composts made from cattle and goat manures, especially C and N ratio (C/N ratio), Potassium (K), and Phosphor (P) (Suhesy and

Adriani, 2014). Utilization of bioethanol industry liquid waste as decomposer agents to produce organic fertilizer made from cattle dung has not previously been reported therefore the evaluation of the use of bioethanol industry liquid waste to nutrient contents of compost is needed. The objective of this study was to compare the use of various commercial decomposers to nutrient contents of cattle dung compost.

Materials and Methods

Production of decomposer from bioethanol waste

A total of 20 liters of liquid waste has been prepared to produce decomposer (DLB). It was then mixed with 0.5 kg of shrimp paste, 1 kg of herbs and spices, 100 g of urea, 1 kg of bran, and 20 liters of water. This mixture was furthermore pasteurized at 69^oC for 5 minutes and it was left at room temperature until reaching approximately 25^oC. In addition, 5 liters of coconut water and 0.5 liter of starters were added into the mixture and it was gently homogenized. Homogeneous mixture was ready to be anaerobically fermented for 3 days. It was separated and packed into 1 liter bottle and it was ready to be used as fermentation agents (Ariyanto *et al.,* 2014).

Production of compost

Firstly, decomposers must be prepared as much 0.5% of dung weight (v/m) according to previous study reported by Bahar and Haryanto (2000). Water and molasses were used as mixtures for decomposers by following ratio 1:1:1. Moreover, those mixtures (mixture I) were put into sprayers and ready to be used for next step. The contents of each decomposer are presented in the Table 1.

This study used 80 kg of raw cattle dung producing by female cross of Simental and Ongole grade cattle. Furthermore, those dungs were divided into four groups of treatment where each treatment consisted of 20 kg cattle dung. Each treatment was containing five samples. Mixture I was homogeneously sprayed to the dung in accordance to each treatment. Moreover, 4 kg of dung sprayed with mixture I was put into 20 cm high of plastic jars with many holes in their walls. Therefore, a total of 20 samples were used in this study. Those samples were then ripened for four weeks and they were homogenously reversed every three days. The pH value and temperature of composts were observed every week. Harvesting of compost has been carried out after four weeks of ripening. Mature compost was indicated by texture that similar to soil, no bad smell detected, and dark brown color of compost appeared.

Analysis of compost nutrients

Mature compost was analyzed to determine organic C, nitrogen (N), potassium (K), calcium (Ca), magnesium (Mg), C/N ratio, and pH value. Organic C and N content were analyzed using proximate analysis, phosphor content (P) was analyzed using Spectrophotometer (Spectronic, USA), potassium content (K) was measured using Flamephotometer (Jenway, UK) based on Tan (1996), and Ca and Mg contents of compost were determined by using standard operational procedure for Atomic Absorption Spectrophotometer (Merck, USA) conducted at the Laboratory of Chemistry and Soil Fertility, Faculty of Agriculture, Universitas Gadjah Mada. The C/N ratio was calculated by comparing between organic C content and N content. Nutrient contents of compost were expressed in percent (%). The pH value was conducted at the end of ripening using digital pH meter, and temperature of compost was carried out using digital thermometer.

Experimental design and analysis of data

This study used one way model of completely randomized design (CRD) with four treatments and five replications. Treatments in this study were cattle dung composting with 0.5% DLB (P0), cattle dung composting with 0.5% decomposer A (P1), cattle dung composting with

Table 1. Composition of decomposers used in this study

Parameter	Value in DLB[1]	Value in product A[2]	Value in product B[3]	Value in product C[4]
Phosphate solvent bacteria	2.3×10^5	3.4×10^5	5.5×10^7	1.94×10^8
Lactobacillus Sp.	3.3×10^7	3.0×10^5	6.8×10^7	NA
Yeast	3.9×10^7	1.95×10^3	NA	1.26×10^9
Actinomycetes	Positive	Positive	1.4×10^8	NA
Photosynthetic bacteria	Positive	Positive	NA	NA
E. Coli	Negative	Negative	Negative	Negative
Salmonella	Negative	Negative	Negative	Negative
pH	4.55	3.73	NA	7.4
Organic C	31.17	1.88	7.5	0.86
Nitrogen (N) (%)	0.52	0.68	2.35	0.08
C/N Ratio (%)	59.94	NA	NA	10.75
K_2O (%)	1.26	0.84	2.24	0.49
P_2O_5 (%)	0.59	0.014	3.5	0.18
Calcium (Ca) (%)	0.08	0.31	1.1	0.014
Magnesium (Mg) (%)	0.15	0.04	0.1	0.03

[1]Result of Laboratory of Soil Science test, Universitas Sebelas Maret, [2]Result of laboratory test of Institut Pertanian Bogor, [3]Result of laboratory of Biota Agro Jaya test, [4]Result of laboratory test of Universitas Padjajaran. NA is not available.

0.5% decomposer B (P2), and cattle dung composting with 0.5% decomposer C (P2), respectively.

The data collected in this study was analyzed by using one-way analysis of variance (ANOVA) with a significance level of 5%. Moreover, Dunnet test has been conducted to differentiate means among treatments (Steel and Torrie, 1993). The mathematic model used was as follow:

$$Y_{ij} = \mu + t_i + \varepsilon_{ij}$$

Y_{ij} is the response of the j^{th} unit receiving the i^{th} treatment, μ is an overall mean effect, t_i is the effect due to the i^{th} treatment and ε_{ij} is random error.

Result and Discussion

Means of organic C, N, P, K, Ca, Mg, C/N ratio, and pH value of cattle dung compost made with DLB and various commercial decomposers are shown in Table 2. Analysis of variance showed that the utilizations of DLB and various commercial decomposers did not significantly affect the physical property and nutrient contents of cattle dung compost.

The result of this study indicated that various decomposers did not affect the pH value of cattle dung compost (P=0.55). The pH value of cattle dung composts ripened for 7 weeks were 7 (Table 2). This value of pH was neutral which is mean that compost has been mature and could be used for organic fertilizer. Khan *et al*. (2009) reported that neutral pH might due to perfect process of enzymatic oxidation and mineralization of basic cations. The pH of compost in this study was different with previous study conducted by Suhesy and Adriani (2014) that used cattle and goat manures as raw materials composted by *Trichoderma*. The pH value of previous study was higher than this study (7 vs 8.9). However, pH of compost in present study was in the range of Indonesian standard for organic fertilizer (6.80 to 7.49). In addition, compost temperature can be also an indicator for compost maturation. Compost temperature was ranged from 29 to 34°C (Figure 1).

Temperature trend in four treatments was the same. The improvement of temperature was found during 2 weeks of composting and it was gradually decreasing during third to fourth weeks. This dynamic process of temperature alteration may be caused by quick mineralization of organics C and N in the beginning of composting by microbes who responsible to break organic matter that produce CO_2 and heat in composting system (Adegunloye *et al*., 2007; Chandna *et al*., 2013). Decrease in temperature is occurred after mixing of compost due to evenly heat transfer and aeration in each part of compost. This process accelerates decomposition rate of compost (Ishii *et al*., 2000).

Table 2. Physical property and nutrient contents of cattle dung compost made with different decomposers

Parameter	Treatment				P-Value
	P0	P1	P2	P3	
pH	7.00 ± 0.00	7.04 ± 0.05	7.02 ± 0.04	7.00 ± 0.07	0.55
Organic C (%)	39.59 ± 0.69	39.88 ± 0.37	39.91± 0.32	39.64 ± 0.28	0.59
N Total (%)	2.17 ± 0.20	2.28 ± 0.26	2.25 ± 0.18	2.46 ± 0.30	0.72
C/N ratio (%)	18.35 ± 1.77	17.69 ± 1.96	17.85 ± 1.34	16.32 ± 1.97	0.34
P Total (%)	0.11 ± 0.05	0.11 ± 0.05	0.10 ± 0.06	0.11 ± 0.05	0.88
K Total (%)	1.22 ± 0.17	1.16 ± 0.16	1.25 ± 0.20	1.30 ± 0.19	0.21
Ca Total (%)	0.48 ± 0.18	0.54 ± 0.04	0.49 ± 0.20	0.54 ± 0.11	0.88
Mg Total (%)	0.09 ± 0.01	0.10 ±0.01	0.09 ± 0.01	0.08 ± 0.01	0.08

P0: physical property and nutrient contents of cattle dung composted by 0.5% bioethanol waste decomposer (DLB).
P1: physical property and nutrient contents of cattle dung composted by 0.5% commercial decomposer A.
P2: physical property and nutrient contents of cattle dung composted by 0.5% commercial decomposer B.
P3: physical property and nutrient contents of cattle dung composted by 0.5% 0.5% commercial decomposer C.

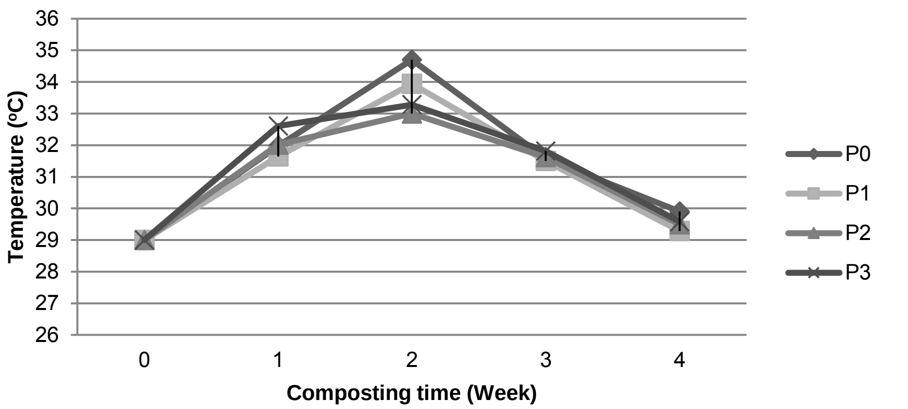

Figure 1. Compost temperature during composting.

Utilization of DLB and commercial decomposers in composting of cattle dung did not affect organic C content of compost (P=0.59). Organic C of compost is mostly affected by its main raw materials. Six *et al.* (2000) described that organic C in the raw materials of compost was used as a main energy source by microbial decomposers for their activities which are dominated by *Bacillus sp.* (Adegunloye *et al*., 2007; Shrestha *et al*., 2011; Chandna *et al*., 2013). This result indicated that decomposers used in this present study have similar activity to break organic C, so organic C content of compost was not significantly different, i.e. about 39.76% (Table 2). However, organic C content of cattle dung compost in present study was higher than previous study reported by Trivana *et al*. (2017) that used EM4 as decomposer agent. In that study, organic C content of compost was 22.48%. Moreover, Wong *et al.* (1999) explained that compost ripened for 60 days generated compost containing 27.2% of organic C. Indonesian standard for organic fertilizer established that mature compost must contain at least 9.8% of organic C (SNI, 2004). Different ripening time of composting may lead differences of organic C content in compost. Ripening times of current and previous studies were 28 and 60 days, respectively. Longer ripening time of composting will produce smaller organic C content of compost. This phenomenon indicates bacterial activity in degrading of organic matters in compost (Trivana *et al*., 2017).

The N content of composts made by DLB and various commercial decomposers were not significantly different (P=0.72). It might be due to all decomposers work perfectly in decomposition of compost raw materials. The number of N in decomposers did not affect N total of compost. The N total of cattle dung compost was mostly originated from main material used in composting such as cattle dung (Bernal *et al.,* 2009). Total of N in this study was ranged from 2.17 to 2.46% (Table 2). This result was quite similar to previous study using EM4 as decomposer agent, i.e. 2.13% (Trivana *et al*., 2017). This result suggested that microbes contained in the decomposers have similar activity in demineralization of nitrogen. The existence of lignocellulolytic bacteria in cattle feces inhibited degradation rate of nitrogen (Sánchez-Monedero *et al*., 2001). Compost N content will increase at the end of composting due to mineralization of organic N of raw materials (Chandna *et al*., 2013). N content of compost produced in present study met the minimum limit of Indonesian standard for organic fertilizer criteria, i.e. no less than 0.40% (SNI, 2004).

The C and N ratio was statistically not different in composts made by various decomposers (P=0.34). The C/N ratio of compost was ranged from 16.32 to 18.35% (Table 2). This result indicated that activity of microbial contained in DLB was similar to activity of commercial decomposers. Moreover, C/N ratio in present study was higher than previous study (Kusmiyarti, 2013). In that study compost was also made using cattle dung and decomposer Bionic ripened until 9 weeks and C/N ratio of compost was 11 to 14. In addition, ratio of C/N in this study met Indonesian standard for organic fertilizer, i.e. ranged from 10 to 20. The activity of microbes during composting plays important part in determining of C/N ratio. Iglesias-Jimenez *et al*. (1993) and Bernal *et al*. (2009) revealed that during active phase of composting process, organic C was decrease due to decomposition of organic matters by microbes. Degradation rate of organic matter slowly decreased during composting process due to the limitation of free carbon sources and formation of new organic matters during passive phase of composting. These processes produce stable final products which are ready to be used for fertilization (Hao *et al*., 2004).

Analysis variance showed that the use of different decomposers did not affect P (P=0.88) and K contents of cattle dung compost (P=0.21). Martin *et al*. (2007) reported that the use of microbes will accelerate decomposition process that may lead enhancement of P needed by microbe to growth and when microbes end their lives, those P will be released to the environment so that P content is unchanged. Eghball *et al*. (2002) explained that 70% of P compost originated from raw materials used when compost made. Additionally, K content of compost was ranged from 1.16 to 1.30% (Table 2). This result was higher than previous study reported by Suhesy and Adriani (2014), i.e. 0.6%. Hashim *et al*. (1996) reported that K content of cattle dung compost was depend on raw materials used, rice hull can improve K content of compost. Bacteria and yeast are synergize in utilizing P and K contents, however, those microbes only use small parts of P and K for their metabolism activities. Phosphate solvent bacteria contained in decomposers are also able to dissolve K in organic matters (Trivana *et al*., 2017). Most of K content of compost is available in dissolved form in water so it can be absorbed in large quantity by plants. Availability of K in compost made from cattle dung can restore soil nutrient balance (Wong *et al*., 1999; Eghball *et al*., 2002). In addition, P and K contents in this study met Indonesian standard for organic fertilizer, i.e. 0.1 and 0.2%, respectively.

Variance analysis showed that the use of different decomposers did not affect to Ca (P=0.88) and Mg (P=0.08) contents of compost fertilizer. Levels of Ca and Mg in compost are mostly affected by major materials used in composting system. Highest Ca content of compost was found in compost made from chicken excreta, while highest Mg content was found in pig manure compost than compost from cattle dung (Sager, 2007). Moreover, Barber (1995) proved that availability of Ca and Mg was depend on the main ingredient used in composting, degree of weathering, and liming treatment. The Ca content of compost made from sheep manure was 0.86% (Sadik *et al*., 2010). Mg content in this study was higher than study published by Wong *et al*. (1999), i.e. 0.09 versus 0.008%. Number of Ca and Mg in cattle dung compost can be improved by liming in composting. Furthermore, Eghball *et al*. (2002) added that Ca and Mg are micronutrients that important for plants growth and livestock manure can provide them. According to Sembiring and Irianty (2012), level of Mg content in present study is still needed to be improved because plants need at least 0.15% of Mg and SNI (2004) established the maximum Mg content in organic fertilizer is 0.6%.

Conclusions

This present study concluded that cattle dung composted by DLB and various commercial decomposers have similar pH, Organic C, N, C/N ratio, P, K, Ca, and Mg. Isolation and characterization of specific microorganisms in bioethanol industry waste should be taken into account for further composting study.

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