RESEARCH ARTICLE

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The Strategy for Improving Quality of Organic Fertilizer in Integrated Waste Disposal Sites Diponegoro University Towards Commercial Fertilizer

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Diponegoro University was one of universities in Indonesia that was able to manage their waste independently by establishing the integrated waste treatment facility. The amount of organic waste was generated about 5.06 m^3/day. Organic waste was dominated by leaf litter with C/N high ratio that caused composting process ran slow and made low quality compost. The composting process was affected by nutrient balance defined as the C/N ratio. The addition of animal manure (sheep and cattle) was used to adjust the C/N ratio and generated high-quality compost. The nutrient content of compost was easily absorbed by plant and applied directly to the soil. Composting was done aerobically for 21 days by using organic waste from Integrated Waste Disposal Sites Diponegoro University. C/N ratio was set between 20–30. Best quality of compost was produced from a mixture of solid waste and cow feces with C/N ratio might be 20. The temperature of the compost increased reach 39 °C on the 8th day. Mature compost achieved at day 14 were identified from parameter NH_4^+–N 0,01 g/kg, NH_4^+–N/NO_3–N 0,15, and electric conductivity was 0.79 ds/m. Concentration of C-Organic was 48.24%, total N was 0.246%, P as P_2O_5 was 0.02%, and K as K_2O was 0.54%. pH mature compost was 7.21. The results of this study showed that the mature compost was reached in just 14 days. Only C-Organic did not meet the quality standards of organic fertilizer in regulation minister of agriculture No. 70/SR.140/10/2011.

Keywords: Integrated Waste Treatment, Cow Feces, Goat Feces, Mature Compost.

1. INTRODUCTION

Currently, the compost had a very important role in agriculture as compost not only be beneficial to keep the soil functions,[1] but it could also serve as a source of nutrients for plants.[2] The amount of organic waste at the Integrated Waste Disposal Sites Diponegoro University to do the composting of 5.06 m^3/day ($\eta = 75\%$). Most of the organic waste was derived from waste leaves.[3] C/N ratio on citrus leaves and oak leaves of 40–60.[4] The C/N ratio indicated that the carbon content was high enough, so the composting process nitrogen would be exhausted first. This would cause the composting process became slow. The composting process was strongly influenced by the value of C/N ratio at the beginning of composting. C/N ratio greater compostable products showed that the organic material decomposes yet perfect. Conversely C/N ratio of compost were lower, it indicated that the organic material was decomposed and almost into compost.[5]

Manure had proven to be strongly beneficial for plant growth and soil fertility in the long term, both in chemistry and physics. It was more important than the use of manure that was intensifying agricultural systems. Manure contained nutrients (especially N, P and K) were more easily absorbed by plants as compared with organic fertilizer derived from plant biomass were applied directly into the ground.[6] Cow feces has a C/N ratio of about 24. The value of goat feces C/N ratio 21.12%.[7] In addition, goat feces nutrient content of 1.41% containing N, P content of 0.54%, and K content of 0.75%.[8] Based on this background, researchers conducted a study on strategies to improve the quality of organic fertilizer from the integrated waste treatment facility, Diponegoro University towards commercial fertilizers to use cow feces and goat.

2. EXPERIMENTAL DETAILS

This research was conducted in the integrated waste treatment facility while sample testing done in the laboratory environment, Department of Environmental Engineering, Faculty of

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Engineering, Diponegoro University. Solid waste that went into integrated waste treatment facility Undip enumeration first so homogeneous in size with the aim to accelerate the decomposition process. The solid waste put into each composter. Type pile used a compost pile heights set to have a height approximately 30 cm on each variation. Composting was carried out for 21 days on each variation. Effect of composting time determined by sampling and analysis of the quality of both the physics and chemistry of compost regularly. Compost was taken at each variation then analyzed the chemical and physical parameters to determine the quality of the compost produced. Physical and chemical parameters were measured by Ministry of Agriculture regulation No. 70/SR.140/10/2011. The parameters were examined, i.e., N-Total, total-P, total-K, NH_4^+–N, NO_3^-N, pH and electrical conductivity. Reagent used had pure analysis (pa) Merck products, Germany.

3. RESULTS AND DISCUSSION

3.1. Characteristics of Solid Waste

Integrated waste treatment facility of diponegoro university was dominated by the litter of leaves with the following characteristics.

Chemical characteristics of the particular solid waste was not sufficient for the composting process and creating limitation to the efficiency of the composting process.[9] Based on the preliminary test, the pH value of solid waste in integrated waste treatment facility was amounted to 5.65. This value was not yet meets the standards of the pH value as compost material so that composting was running optimally. According to Ref. [10] the optimal pH range for composting ranges between 6–8. Based on Ref. [11] the composting process at too high pH could cause odors that disturbed the environment due to the release of ammonia (NH_3) into the air. While the condition had too low pH (acid), it could cause the majority of microorganisms decomposing to die. Moreover, the content of water was also in fairly low concentrations, i.e., 10.1%. According to Ref. [3] in order to optimally run the composting process, the water concentration needed to be maintained in the range of 40–60%.

Based on these characteristics, solid waste from integrated waste treatment facilities did not meet the optimal parameters in composting, so needed to be given the addition of other materials for composting.

3.2. C-Organic and N-Total Analysis

Analysis of C-organic was done every seven days. The result showed that solid waste control at week 0 (k0) had a concentration of C-organic by 29.69%, a mixture of solid waste and goat feces at 34.23%, and a mixture of solid waste plus cow feces at 49.83%. The concentration of C-Organic compost during composting 3 weeks was fluctuated. On the 1st week, the content of C-organic increased was in a range of 19–27%. Then there was a decreased on the 2nd week that was experienced by the control compost and compost by the addition of goat feces. However, with the addition of cow feces, the content of C-organic was stable from 1st through 3rd week which indicated that the compost had been mature and decomposition process had been perfect. While available an increase in the content of C-organic of control at 3rd week was possible because it was still not perfect and still went by the decomposition process in the compost.

N-total with the addition of cow Feces compost always increased at 1st with a concentration of 1.7% and 2nd week with a concentration of 2.64%.[3] The content of N-total in the composting process was likely to increase due to the mineralization of nitrogen from organic matter by composting microorganisms. As for the addition of cow manure compost tend to fluctuate with the increase on 2nd week with a concentration of 1.59%. Decreasing the concentration of N-Total occurred in compost with the addition of cow and goat feces on the 3rd week, it was because the possibility of the nitrogen content was too high, causing volatiles ammonia, causing the value of N-total declined. Generally, the concentration of N-total matured at above 0.4%. The results of composting had fulfilled SNI 19-7030-2004 for compost standard.

Table I. Characteristics of solid waste.

No.	Parameters	Unit	Result
1	pH	–	5.65
2	P total	%	0.001
3	K total	%	0.004
4	C-organic	%	49.83
5	N total	%	0.73
6	Ammonium	g/kg	0.09
7	Water content	%	10,1

3.3. C/N Ratio Analysis

The result showed that there were fluctuations in the value of C/N ratio that was influenced by the value of N-Total was also experiencing heaving. This was possible because the composting process was not too optimal. However, if the terms of the speed of the composting process, the greater the C/N ratio of the starting materials, the longer time was required for the composting process. The addition of manure also affected the rate of decline in C/N ratio. With the C/N ratio of the starting materials compost under 25–50 range C/N so that the composting process was running optimally according to Ref. [12] then the composting process the compost with the addition of manure occurred faster than with compost control on 2nd week obtained C/N ratio was good enough that 26.93 of compost with the addition of goat feces and 18.64 for the compost with the addition of cow feces. Values had met and approached the ranges specified by SNI 19-7030-2004 namely 10–20.

3.4. P-Total and K-Total Analysis

Potassium compost according to standard SNI 19-7030-2004 minimum was 0.2%. As well as nitrogen and phosphorus, potassium content in the compost was strongly influenced by the potassium content in the raw material used.[3] Based on the results showed that the concentration of K-highest total owned by the addition of goat feces compost, which was 0.539%. While the lowest was the control compost. This proved that the addition of manure affect the total potassium concentration in the final compost.

3.5. Compost Maturity

Based on the above parameters, it was found that the results of composting on 2nd week had shown signs of maturity, especially compost by the addition of cow feces. This was reinforced by the value of other parameters. The pH value of the compost on 2nd week of compost with the addition of goat feces was 7.81;

with the addition of cow feces was 7.21; and control compost was 4.9. The pH value of the compost with the addition of cow feces met the standards of compost according to SNI 19-7030-2004 i.e., in the range of 6.8 to 7.49. Meanwhile, with the addition of goat feces compost had a pH value that was closer to the standard, and control was still acidic compost thereby inhibiting the activity of microorganisms in the composting process.[11] The optimum pH value for the development of microorganisms was about 6–8.

Compost maturity could also be defined in terms of Nitrification. When the NH_4–N concentration decreases and NO_3–N Appeared in the composting material it was considered ready to be used as a compost.[14] An NH_4–N/NO_3–N ratio lower than 0,16 was established by Ref. [9] as a maturity index for composts of all origins. The ratio of NH_4–N/NO_3–N smallest was on 2nd week with a value of 0.15. This value was generated on the composition of the compost with the addition of goat feces. The ratio of NH_4–N/NO_3–N in a mixture of compost with cow feces at 0.223. The water content of the compost was respectively 25.2%, 28.1%, and 19.9% in the composition of organic waste plus goat feces, cow feces, and control. Compost had a moisture content $<50\%$ mean that the water content of compost on all variations on the 14th day had fulfilled the standard of SNI 19-7030-2004.

4. CONCLUSION

This study discussed about strategy for improving quality of Organic Fertilizer Towards Commercial Organic Fertilizer. Mature compost was reached in just 14 days when garbage coupled with cow Feces. Macro nutrient (P total, K total, and N-Total fulfill the compost standards in Ministry of Agriculture regulation No. 70/SR.140/10/2011.

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