

MACRONUTRIENT CONTENT OF DRY LEAVES COMPOST BY VERMICOMPOSTING METHOD

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ABSTRACT

Waste management is one of the criteria for the evaluation of Green campus and sustainable university. Organic waste takes place in concern because of the domination of waste in university, such as food waste and dry leaves waste. Mismanagement in dry leaves will promote the campus area to look dirty. One method to control the dry leaves waste is the vermicomposting process. The purpose of this research is to evaluate the macronutrient content of dry leaves compost after the vermicomposting process. The research was conducted in the Faculty of Civil engineering and Planning, Universitas Islam Indonesia, Yogyakarta. The vermicompost sample in this study refers to the quality standards according to SNI 19-7030-2004 regarding compost quality standards. The results of vermicompost content value are obtained on day 56 is Phosphor amounting to 0.194%, amounting to 0.129% Potassium, and C / N ratio of 7.73. From the data that has been obtained can be concluded that the results of vermicompost are less effective as organic compost compared to the standards.

Keywords: Earthworms, Macronutrients, Organic waste, Vermicompost.

INTRODUCTION

The promotion and implementation of sustainable practices have become serious challenges for higher education institutions nowadays. The faculty, students, and staff should be compromised in building a better future for the generations to come. The universities with the faculties inside it play a significant role when promoting sustainable practices is critical and influences the success of other sustainability programs in society (Ferrer-Balas, Buckland, and Mingo, 2009; Juárez-Najera, Dieleman, and Turpin-Marion, 2006; Lehmann et al., 2009; Velázquez et al., 2006; Zilahy, and D. Huisinigh, 2009). Institutes of higher education worldwide are change agents for sustainability and are expected to be community role models and lead

efforts in social and environmental responsibility (Huang and Lee, 2014). One of the many environmental problems that must be addressed is the one related to the increasing amounts of solid waste. Tangwanichagapong et al. (2017) described the efforts of greening a university campus through waste management by adopting the reduce, reuse and recycle principles.

Various activities and operations on campus produce specific amounts of solid waste that need to be managed or disposed of properly to avoid adverse environmental impacts of improper disposal. And the common essential byproduct that is generated by the university campus is a solid waste. Qdais et al., 2019 said that a prerequisite to adequately managing solid waste in an integrated manner is the knowledge of quantity and composition of the solid waste generated. Solid waste in university was dominated by organic waste from food waste and the dry leaf of trees that fell. The research is more focused on dry leaf waste management. To control dry leaf waste was applied by vermicomposting technology.

Some researchers explained that Vermicomposting is the process of producing compost by utilizing earthworms to turn the organic waste into high-quality compost that consists mainly of worm cast and decayed organic matter (Ismail 2005; Devi and Prakash 2015). This method could help to convert the organic wastes (agro-wastes, animal manure and domestic refuse) into highly nutrient fertilizers for plant and soil (Gajalakshmi and Abassi 2004). It is said to be a high nutrient fertilizer because vermicompost consists of finely divided peat-like material with excellent structure, porosity, aeration, drainage and moisture-holding capacity (Ismail 2005; Edwards et al. 2011). There is also an organic fertilizer with rich Nitrogen, Phosphorus, & Kalium (NPK), micronutrients, and beneficial soil microbes (nitrogen fixing and phosphate solubilizing bacteria and actinomycetes), which is a sustainable alternative to chemical fertilizers, which is an excellent growth promoter and protector for crop plants (Sinha et al. 2011; Chauhan and Singh 2015). Today vermicompost is a crucial component of organic farming systems, because it is easy to prepare, has excellent properties and is harmless to plants. Vermicompost also could improve the physical, chemical and biological properties of the soil as well contributes to organic enrichment (Ansari and Jaikishun 2011; Chauhan and Singh 2013).

Based on the above background, the aims of this research is to analysis the macronutrient content of compost that producing form dry leaf waste by Vermicomposting process.

MATERIALS AND METHODS

Time and Research Place

Field research was conducted in October 2016 in the Campus Area of the Faculty of Civil Engineering & Planning, Islamic University of Indonesia, Yogyakarta. Composting using the vermicomposting technique is carried out at the Faculty of Civil Engineering and Planning. In contrast, compost content analysis is carried out at the Integrated Research and Testing Laboratory of Gadjah Mada University and the Water Quality Laboratory of the Faculty of Civil Engineering and Planning, Islamic University of Indonesia.

Data Collection

Data collection is carried out to obtain the required information. The quality of the vermicompost content is strongly influenced by the types of earthworms used, the age of the vermicompost, the types of materials used, the nutrient content, and the difference in water content each material. The characteristics of excellent quality vermicompost are brownish-black to black, odourless, crumb-textured, and ripe ($C/N < 20$). In this study, the sampling was carried out on the 28th, 42nd, and 56th day. It is expected that the vermicompost process shows the excellent quality of physical characteristics ($C/N < 20$). The variables observed were C (carbon) with UV-Vis Spectrophotometry, N (Nitrogen) using the Kjeldahl Method, P (Phosphorus) UV-Vis Spectrophotometry, K (Potassium) Inductively Coupled Plasma (ICP).

The Making Process of Vermicompost

The materials used in this stage consisted of dry leaf waste around the Faculty of Civil Engineering & Planning, UII, and a starter medium using finished vermicompost. In contrast, the tool used in this experiment is a worm reactor. This experiment was carried out through several stages of the following activities: preparing a worm reactor as a place for the vermicompost-making process, inserting ripe vermicompost as a starter medium, inserting dry leaf waste on top of the starter medium, compacting then closing the reactor media with a gunny sack, and checking the worms reactor every week to see the development of the vermicompost process, test the content of C/N, P, K in the sample every 28th, 42nd and 56th day, and analyze the data and compare it with the quality standard of SNI 19-7030-2004. The specifications of the worm reactor used in this study are the dimensions of a cylindrical tube, 45 cm inner diameter, 105 cm tube height, materials used from waste tires and iron. The bottom part is the output of the worm reactor, which was closed using a cloth on the outside. Then, the inside was closed by using plastic.

RESULTS AND DISCUSSION

Initial Conditions of the Vermicompost Process

The making process of vermicompost is carried out at the Integrated campus of the Faculty of Civil Engineering and Planning of the Islamic University of Indonesia using a worm reactor that has been prepared beforehand by utilizing the remaining dry leaves around the site. Before being put into the reactor, the dry leaf worms were collected in a container and weighed to determine how many dry leaves were used compared with the amount of the vermicompost starter medium used.

After the process of collecting and weighing dry leaves, then the leaves that have been collected were put into the worm reactor on the starter media. Finished vermicompost with a ratio of 4 : 1 dry leaf and starter media, then was compacted. The sampling process was carried out after the vermicompost was 28, 42, and 56 days old. The parameters that will be tested by the author in this vermicompost research are Phosphorus (P205), Potassium (K20), and C / N ratio which refers to SNI: 19-7030-2004 regarding Compost Specifications from Domestic Organic Waste which will be tested in Integrated Research and Testing Laboratories Gadjah Mada University.

Macro Nutrient Content in Dried Leaf Compost

The analysis results of measuring macronutrients in dry leaf compost using the vermicomposting technique resulted in varying values based on the time of observation.

Table 1. Macronutrient content from vermicomposting of dry leaf litter

No.	Day of Composting	Variable				
		Nitrogen (%)	Phosphor (%)	Kalium (%)	C-Organic	C/N Ratio
1	28	0.54	0.112	0.141	3.58	6.63
2	42	0.46	0.148	0.135	3.37	7.32
3	56	0.44*	0.194*	0.129	3.4	7.73
	SNI Standard	Minimum: 0.4	Minimum: 0.1	Minimum: 0.2	Minimum: 9.8	Minimum: 10

In Table 1, the total N above can be seen that the total N content in the vermicompost sample tested has decreased slightly from day 28 to day 56. On day 28, the highest value of total N content is 0.54%, on day 42 it was 0.46% and on day 56 the total N content was 0.44%. According to the compost quality standard set by SNI: 19- 7030-2004, a good Nitrogen (total N) content is at least 0.4%. Judging from the results obtained, the total N content in this vermicompost sample has met the compost quality standards that have been set.

Furthermore, the phosphorus (P) content in the sample showed an increase on day 28 to day 56. The phosphorus content in all compost had met the quality standards set. The value of the phosphorus content, which shows the highest value was obtained on the 56th day was 0.194%. It indicates that the phosphorus content in vermicompost samples is suitable for use as organic compost to be applied to plants.

Table 1 shows that there was a decrease in the potassium (K) content on day 28 to day 56. The highest potassium content produced on day 28 was 0.141%, but the next day the potassium content decreased. Judging from the quality standards of compost according to SNI: 19-7030-2004, good compost has a minimum potassium content of 0.20%. From the data obtained, it can be seen that the potassium content in all vermicompost samples is still below the quality standard that has been set.

Furthermore, the C-organic content obtained for the 28th day sample was 3.58%, the 42nd day was 3.37%, and on the 56th day, it was 3.4%. According to the compost quality standards issued by SNI: 19-7030-2004, good content of C-organic in compost is at least 9.8%. Judging from the quality standards that have been determined, the C-organic content in the vermicompost sample has not met the compost quality standard. The composting process, which takes longer to affect the C-organic content will decrease because it has been broken down by microorganisms into simpler compounds. During the composting process, organic compounds will be reduced, and carbon dioxide is released due to the activity of microorganisms which affects the C-organic content of compost produced (Pratiwi et al., 2013).

In Table 1, it can be seen that the content of the C/N ratio increased from day 28 to day 56. The highest content of the C/N ratio resulted in the sample on day 56 was 7.73. Changes in the C/N ratio that occur during the composting period are due to the use of carbon as an energy source and released into CO₂, while nitrogen was used by microbes for protein synthesis and the formation of body cells so that the carbon content

decreases over time. A lot of carbon that was used by bacteria caused the low ratio of C/N. Lisa (2013) states that every organic material contains elements of carbon and nitrogen with different ratios. For a material that contains high C elements, the C/N ratio will also be high. On the other hand, materials containing high N-elements have a low C/N ratio.

The organic material used in this study is fallen dry leaves where the quality is different when compared to green leaves because before the leaves fall, the nutrients in the leaves are translated first to the other plants. In addition, the worm reactor where the composting process is carried out in an open space, resulting in a natural process where if there is rain or excessive heat from the sun causes the microbes in the worm reactor to be less effective in decomposing organic material because bacteria require a specific temperature for their life (Budiyanto, 2010). When viewed from the quality standards set by SNI: 19-7030-2004, the content of a good C / N ratio for compost is 10-20. From the data obtained, the content of the C / N ratio in the vermicompost sample is still below the quality standards that have been set.

Comparison of Vermicompost Sample Results with Market Organic Fertilizers

To standardize the quality of organic fertilizers, Suriadikarta and Setyorini (2005) have surveyed organic fertilizers in Central and East Java to observe the production process and take fertilizer samples. Fertilizer samples were analyzed in the testing laboratory of the Bogor Soil Research Institute. To standardize organic fertilizers, 21 samples of organic fertilizers were taken, consisting of 19 samples of solid organic fertilizers and two examples of liquid organic fertilizers. The results of the chemical analysis of organic fertilizers are presented in Table 2.

Table 2. Macronutrient content, C-organic, and moisture content of some examples of organic fertilizers

No	Type of fertilizer	N-total	P ₂ O ₅	K ₂ O	C-organic	C/N ratio	Water moisture
		%					%
1	Sp organic	0,06	10,96	0,06	5,06	84	13,28
2	Chicken Manure	1,17	1,87	0,38	7,16	6,1	13,01
3	KJD Organic Fertilizer	0,97	2,08	1,21	9,85	10,1	25,34
4	OCP P-organic	9,07	8,58	6,13	15,82	1,7	16,23
5	AU Compost	2,03	0,34	3,25	17,83	8,8	13,10
6	Pellet	2,69	8,25	7,02	12,25	4,7	9,23
7	Sipramin miwon	4,57	0,17	1,73	6,94	2,0	-
8	PO semigrup	0,63	1,86	1,08	9,21	14,26	42,98
9	P. raya cair	4,07	0,18	1,03	4,80	1,2	-
10	Alfinase	0,81	4,47	1,09	19,02	23,5	22,54
11	<i>Fine compost</i>	0,68	1,40	1,09	5,04	7,4	46,43
12	P. raya padat	2,25	0,46	0,57	11,9	5,3	37,96
13	Bokashi	0,73	0,62	1,0	9,39	12,9	43,86
14	PO granula 1	6,57	4,76	3,9	20,2	3,1	13,79
15	PO granula 2	6,08	4,9	4,3	21,2	4,3	11,25
16	Organic 3	6,08	4,9	4,3	21,2	4,3	11,25
17	Organic 4	1,54	7,34	0,41	10,3	7	40,9
18	Organic 5	1,89	1,9	0,27	12,89	7	57,1
19	Organic 6	0,61	0,3	0,09	4,11	7	26,58
20	Organic 7	1,38	0,2	0,09	6,28	5	34,24
21	Compost	0,37	0,77	8,95	8,95	14	62,86

Source: Suriadikarta and Setyorini (2005)

From the results of the survey above, we can see a comparison of the content of the vermicompost sample with organic fertilizers on the market. The vermicompost samples tested were almost the same as the type of organic fertilizer 6 on the market. The comparison can be seen in the following table 3:

Table 3. Comparison of vermicompost and organic 6 samples

No	Type of fertilizer	Parameter				
		Phosfor (%)	Kalium (%)	C-organik (%)	N-total (%)	C/N
1	Sample Vermicompost	0,194	0,129	3,4	0,44	7,73
2	Organic-6	0,3	0,09	4,11	0,61	7

The most critical factor in composting is the ratio of carbon and nitrogen (C / N ratio), seen from table 4.2 at C/N point, the C/N value of the vermicompost sample is higher than Organic 6 sold in the market, the vermicompost sample in this study still can be used even though there is still some macronutrient content that is below the predetermined standard. In addition, another purpose of the making of this vermicompost aims to utilize dry leaf waste around the integrated campus of the Faculty of Civil Engineering & Planning UII which will reduce dry leaf waste, and the results can be used as compost for greening and so on.

CONCLUSION

The vermicompost sample in this study refers to the quality standards according to SNI 19-7030-2004 regarding compost quality standards. The results of the analysis of this study concluded that the phosphorus content in the vermicompost sample had met the predetermined quality standards, with the reached point above the minimum limit of 0.10%. Potassium content and C/N ratio in this vermicompost sample still does not meet the quality standards that have been set. The potassium content is still below the minimum limit of 0.20%, and the C/N ratio in the vermicompost sample is still below the standard value of 10-20. Based on the results of this study, vermicompost is still not adequate for making organic compost because there is some nutrient content which is not following the quality standards that have been set.

CONFLICT OF INTEREST

State that the authors have no conflict of interest.

AUTHOR CONTRIBUTIONS

Kasam, Fajri Mulya Iresha, Alhamdy Adytama: conducted the experiment, Abdul Mutolib, Rofiqul Umam and Ali Rahmat: evaluate and revised the manuscript. All authors agreed to the final version of this manuscript.

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