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The Formulation's Technique Using Microbes to the Speed Decomposition of Biomass Fertilizers

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ABSTRACT

Potential biomass such as paddy straw, Eichornia crassipes and cow dung can be used as raw material for compost. This study aims to determine the ratio of the composition of the best raw materials and determine the minimum time required to produce quality compost. This study used a comparative treatment dose composition of K1 = Cow dung 25% + Straw 50% + Eichornia crassipes 25%, K2 = Cow dung 25% + Straw 25% + Eichornia crassipes 50%, K3 = Cow dung 50% + Straw 25% + Eichorniacrassipes 25%.The weight of the material for each treatment is 5kg. This study used 2formulas,Trichodermasp, EM4 and without Decomposer for comparison. The composting process lasts for 21 days with temperatures ranging from 28,1℃ - 35°C. Compost humidity range 80 to 85%, and pH ranges from 6.5 to 7.5.The results are giving *Trichoderma sp accelerates the compost maturation process. In general, the quality of the compost produced is in accordance with SNI 19-7030-2004 with 50% cow dung + 25% straw + 25% Eichornia crassipes, with the addition of local microbe Trichodermasp can conclude the physical properties of compost like color (3.83), smell (4.42), texture (3.83), and temperature (29,75 ℃), pH 7, humidity 85% .*

Keywords :*EM4, Physical character of fertilizer, Trichoderma sp*

INTRODUCTION

Fertilizer is the most important thing and very crucial in agriculture. Fertilizer plays a very large role in supporting plant growth, and becomes an important nutrient that is needed for plant development, so that it is more fertile and productive. Plants that are met with fertilizer needs will grow and develop optimally. Nutrients in fertilizers can be in the form of organic or inorganic compounds (minerals) (Susetya, 2012).

Currently, farmers still rely on chemical fertilizers to meet the nutritional needs of the plants they cultivate. However, the use of chemical fertilizers in addition to requiring expensive production costs, also has a negative impact on the environment around the land. The use of these fertilizers is not wise and exceeds the recommended dose, will cause the soil structure to become hard and later will occur the eutrophication process (an abundance of nutrients in the waters).That eutrophication will cause an explosion of aquatic weed populations and silting of rivers or other aquatic systems (Tandjung, 2003).

On the other hand, the more farmers depend on chemical fertilizers, the more the need for fertilizers will demand the availability of fertilizers in the market. However, the availability of these fertilizers is not able to meet the needs, so there is a shortage of fertilizers. Minister of Agriculture Regulation 01 of 2020 concerning the allocation of the highest price for subsidized fertilizers, in which there is a regulation on the ration of subsidized inorganic fertilizers, which is increasingly burdensome for farmers in obtaining the fertilizer. When fertilizer is needed it is usually very difficult to find, so this causes the price of fertilizer in the market to soar (Sentosa, 2008). This condition is quite alarming because it coincides with low food commodity prices at the farm level with absorptions that tend to decline.

According to the regulation of the Ministry of Agriculture, No. 2/Pert/HK.060/2/2006,organic fertilizers are fertilizers which mostly or wholly consist of organic materials derived from plant and animal residues, that have been engineered in solid or liquid form which are used to supply organic matter has the physical, chemical, and biological properties of the soil. The addition of organic matter into the soil has a stronger effect towards improving soil properties, and not specifically to increase nutrients in the soil (Roidah, 2012),. For example, Urea has an N content of 46%, much different from organic matter which has a N < 3%. However, Urea only contributes one nutrient, namely N while organic matter provides almost all the elements needed by plants in a relatively balanced ratio, although the levels are very small. Therefore, it is necessary to pay attention to long-term soil management or the sustainability of farming, by paying attention to and maintaining soil organic matter levels.

Utilization of agricultural and livestock waste has not been carried out properly. Lack of public knowledge in the processing of paddy straw, animal waste and *Eichornia crassipes* causes the waste to only become a waste material that can pollute the environment. Making compost is one way that can be done for processing agricultural and livestock waste (Nurhayati., 2011).

The manufacture of compost cannot be separated from the contribution of microorganisms as decomposers such as *Trichoderma* sp and EM4. *Trichoderma* sp is one of the antagonist fungi that acts as a biological agent to control soil borne pathogens. *Trichoderma* sp is one of the soil saprophytic fungi that is naturally antagonistic that attacks many types of fungi that cause plant diseases (Berlian, et al 2013). In addition to this role, *Trichoderma* sp is also a decomposer of organic materials/agricultural waste. Meanwhile, Microorganisms EM4 is a starter material where the microbes utilize spoilage microorganisms that are useful for soil fertility, making compost using EM4, in accordance with the right dose of use based on the instructions for use. Based on the foregoing, organisms in the soil will thrive again, so that the physical soil, namely texture and structure, becomes better, plants will thrive, with high productivity (BBPP, 2013).

Based on the consideration that rotting fungi and microbial formulations have the ability to produce degrading enzymes and are the most active decomposers, it is important to select the best rotting fungi in the decomposition of livestock and agricultural waste. Therefore, it is necessary to examine the ability of these two microorganisms to the speed of decomposition in the manufacture of organic fertilizers. The purpose of this study was to determine the effect of biomass engineering on local isolates to accelerate the maturation of compost made from agricultural biomass and weeds, and the right combination to obtain mature and good quality compost from the engineering results. This is expected to provide information on bioprocess engineering formulations for the speed of decomposition of rice straw using local isolates of microbes.

METHOD

This research was carried out from March 1 to June 30, 2021 in Sendangrejo, Banjardowo, Jombang and Faculty of Agriculture in University of KH.A. WahabHasbullah. The composting was carried out by various treatments, either with or without a combination of cow dung, *Eichornia crassipes*, paddy straw, decomposer; *Trichoderma* sp. and EM4. This process is carried out in an aerobic way. The materials used include cow dung, *Eichornia crassipes* and paddy straw as the bio activator. The materials used for the treatment were 45 kg cow dung, 45 kg *Eichornia crassipes*, 45 kg paddy straw. These materials were divided into each treatment as much as 5 kg. While the provision of *Trichoderma* sp and EM4 as much as 100 ml in each combination treatment.

The equipment used includes sacks, knives, humidity measuring instruments, pH meters, thermometers, chopping tools, raffia ropes, buckets, stationery, gloves, scales, and documentation tools. The research is in the form of an experiment 9 (experimental) using a completely randomized complete random design2 treatment factors as follows. Factor composition, the basic ingredients for making compost, in one treatment are 5 kg with the addition of 1% urea from the weight of the base material. The composition is as follows:

- K1 = Cow dung 25% + Straw of paddy 50% + *Eichornia crassipes* 25%
- K2 = Cow dung 25% + Straw of paddy 25% + *Eichornia crassipes* 50%
- K3 = Cow dung 50% + Straw of paddy 25% + *Eichornia crassipes* 25%

Factor microbes, the addition of local isolate microbes The addition of local isolate microbes is as follows:

- Mo = no local isolate microbes
- Mt = addition of *Trichoderma* sp
- Mb = addition of EM4

So there are treatments with the following combinations (Table 1)

Table 1. Combination of Materials and Addition of Microbes

Combination ingredient	Addition of microbes		
	Mo	Mt	Mb
K1	K1 Mo	K1 Mt	K1 Mb
K2	K2 Mo	K2 Mt	K2 Mb
K3	K3 Mo	K3 Mt	K3 Mb

Information :

- K1 = Cow dung 1,250 kg + Paddy straw 2,500 kg + *Eichornia crassipes* 1,250 kg.
- K2 = Cow dung 1,250 kg + Paddy straw 1,250 kg + *Eichornia crassipes* 2,500 kg.
- k3 = Cow dung 2,500 kg + Paddy straw 1,250 kg + *Eichornia crassipes* 1,250 kg.

The media for making fertilizer is prepared and placed in a cool place without being exposed to direct sunlight or rainwater. After wind-dry conditions, the straw and *Eichorniacrassipes* were chopped to a length of 1-2 cm. The planting media was prepared according to the combination of treatments tested, and mixed until homogeneous, then put the mixture into a plastic bag. EM4 solution, and *Trichoderma* sp. local isolates were prepared as decomposers. The EM4 solution is poured into a mixed media of raw materials for fertilizer according to treatment, each as much as 100 ml, then stirred until blended. While *Trichoderma* sp. Local isolates were derived from the exploration of the rhizosphere at Guava GondangManis plantation, Perak District, Jombang Regency. The fungi cultures have been tested for conidia density and viability, respectively 1.26 x 108 and 100 percent. The results of the *Trichoderma* sp culture are in a test tube, pour enough water, then shaken gently until homogeneous. Furthermore, the resulting solution is poured into an Erlenmeyer which already contains 1 liter of distilled water, and stirred evenly. After that the solution is poured into the media of organic fertilizer according to the treatment as much as 100 ml, then stirred until blended. The dough in the sack is left for 21 days. The control is carried out periodically on the fertilizer mixture.

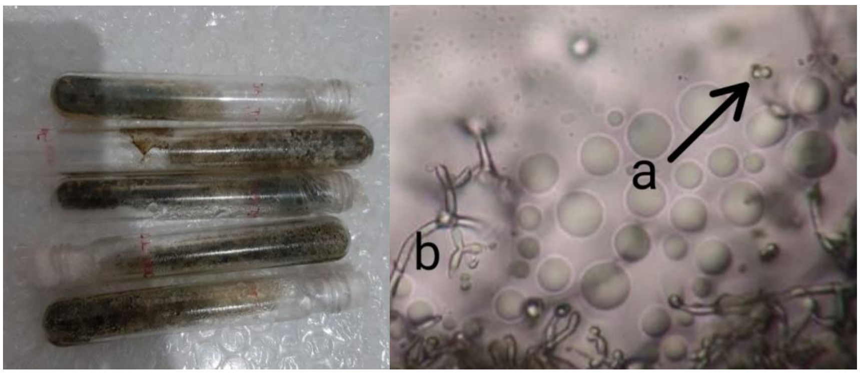

Figure 1. Isolate of *Trichodermasp* (A), (B) Fungi of *Trichoderma* sp (a) spore, (b) hyphae (NurAfifah Documentation, 2020)

The parameters of the observations carried out are as follows:1) Temperature, Humidity, and pH, observed starting from week 0.1st,2nd,3rd, were carried out for each treatment on the dough,2) The final weight of the fertilizer dough, the dough is weighed after the observation time is over, and 3) Organoleptic test, consisting of texture, smell, and color of compost, using a questionnaire given to the participants of the organoleptic examiner.

Table 2. List of Scores of Organoleptic Test Scores for The Physical Properties of The Compost Tested

Color		**Smell**		**Texture**	
Information	**Score**	**Information**	**Score**	**Information**	**Score**
Greenish brown	1	Like the original smell	1	Sticky clumping	1
Raw brown	2	Strong pungent	2	Wet Clumping	2
Brown	3	Not too pungent	3	Dry Clumping	3
SlightlyDark Brown	4	Smells like soil	4	Start Breaking	4
Dark brown	5	Smells good soil	5	Like soil	5

Data were analyzed by F test at 5% level. If there is a significant difference, perform the BNT test with an error rate of 5%.

RESULT

Composting is a process of waste or organic material that undergoes biological decomposition by certain microbes that convert organic waste into compost through biological activity under controlled conditions. There is a change experienced from waste or organic material from the decomposition process, which becomes compost. The changes that occur are the physical form of color, smell, and texture. These changes occurred due to the influence of the addition of materials mixed into the compost and the activity of microorganisms contained in organic materials and starters used in composting. The results of observations on the physical form of compost after 21 days based on treatment can be seen in Table 3.

Table 3. Characteristics of Physical Properties of Compost Fertilizer based on The Composition and The Two Microbes Tested

The average results of the physical properties of the tested composting process				
Treatment	Final Weight (kg)	Color	Smell	Texture
K1Mo	3,62 b	2,03 a	2,46 a	1,4 a
K2Mo	3,55 a	2,13 a	2,53 a	2,3 b
K3Mo	4,15 b	3,03 b	3,16 b	2,3 b
K1Mt	3,85 b	3,13 b	3,4 b	2,53 b
K2Mt	3,9 b	3,46 b	3,4 b	2,8 bc
K3Mt	4,38 b	3,83 c	4,43 c	3,83 c
K1Mb	3,83 b	3,13 b	3,5 b	2,8 bc
K2Mb	3,81 b	3,03 b	3,53 b	2,66 bc
K3Mb	3,84 b	3 b	3,5 b	2,63 bc
BNT 0,5%	0,42	0,32	0,32	0,99

Note: The numbers followed by unequal letters are very significantly different in the 5% BNT test.K1Mo = Cow dung 25% + Straw of paddy 50% + *Eichornia crassipes*25% with no local isolate microbes; K2Mo = Cow dung 25% + Straw of paddy 25% + *Eichornia crassipes*50% with no local isolate microbes; K3Mo = Cow dung 50% + Straw of paddy 25% + *Eichornia crassipes*25% with no local isolate microbes; K1Mt = Cowdung 25% + Straw of paddy 50% + *Eichornia crassipes*25% with local isolate *Trichoderma* sp; K2Mt = Cow dung 25% + Straw of paddy 25% + *Eichornia crassipes*50% with local isolate *Trichoderma* sp; K3Mt = cow dung 50% + Straw of paddy 25% + *Eichornia crassipes*25% with local isolate *Trichoderma* sp; K1Mb = Cow dung 25% + Straw of paddy 50% + *Eichornia crassipes*25% with EM4 bacteria; K2Mb = Cow dung 25% + Straw of paddy 25% + *Eichornia crassipes*50% with EM4 bacteria; K3Mb = 50% cow dung + 25% straw + 25% *Eichornia crassipes* with EM4

Based on Table 3**.**shows that the final weight of the K2Mo combination fertilizer was around 3.55kg, less than the other 8 treatments with a range of 3.62-4.38Kg. In the results of changes in the physical properties of the color section, it is known that the K1Mo and K2Mo treatments have a raw brown color. While the color tends to be a bit dark brown in k3Mt, the average color is brown. On the observation of physical properties based on the smell test, it is known that the K3Mt treatment has an earthy smell, which is indicated by the range of scores at 4.43, which leads to an earthy smell. The treatment of k1Mo and K2Mo still smells like before, with scores ranging from 2.46 and 2.53, leading to a still pungent smell. While the other treatments ranged from a score of 3.00 to 3.53, with a less pungent smell. Based on the results of the texture test, it is known that K3Mt has a texture that is almost likely to start to crumble and is like soil (3.83), which is very significantly different from K1Mo which is still sticky and lumpy (1.4) even after 21 days.

The effect of the dose of raw materials on the physical properties of the tested compost is shown in Table 4 below.

Table 4. Effect of Raw Material Dosage on Physical Properties of Compost Fertilizer tested

Treatment	Final Weight (kg)		Color		Smell		Texture	
K1	3,77	a	2,75	a	3,12	a	2,24	a
K2	3,75	a	2,87	a	3,15	ab	2,58	a
K3	4,12	ab	3,28	b	3,7	b	2,88	ab
BNT 0,5%	0,42		0,32		0,32		0,99	

Note: the numbers followed by unequal letters are very significantly different in the 5% BNT test.

- K1 = Cow dung 1,250 kg + Paddy straw 2,500 kg + *Eichorniacrassipes* 1,250 kg.
- K2 = Cow dung 1,250 kg + Paddy straw 1,250 kg + *Eichorniacrassipes* 2,500 kg.
- k3 = Cow dung 2,500 kg + Paddy straw 1,250 kg + *Eichorniacrassipes* 1,250 kg.

Based on Table 4**.**shows that the K3 treatment was significantly different from the K1 and K2 treatments. The final weight of compost fertilizer with more raw materials in the composition in K3 was significantly different from that in K1 and K2 which were less. While on the physical properties of color, smell, and texture, K3 treatment was significantly different from K1 and K2.

While the effect of the type of microbes used on the physical properties of the tested compost is shown in table 5 below.

Table 5. The effect of the type of microbe on the physical properties of the tested Compost Fertilizer

Treatment	Final Weight (kg)		Color		Smell		Texture	
Mo	3,78	a	2,4	a	2,72	a	2	a
Mt	4,04	ab	3,47	b	3,74	b	3,05	c
Mb	3,83	ab	3,05	b	3,52	ab	2,7	b
BNT 0,5%	0,42		0,32		0,32		0,99	

Note: the numbers followed by unequal letters are very significantly different in the 5% BNT test.

- Mo = no local isolate microbes
- Mt = addition of local isolate *Trichoderma*sp (fungi derived from rhizosphere exploration in Jombang area)
- Mb = addition of EM4 formulation

Based on the effect of the type of microbes on the compost tested in Table 5.it can be seen that the final weight of the compost from the treatment of *Trichodermasp* local isolates (Mt) and EM4 (Mb) which reached the range of 4 kg was significantly different from that without microbial treatment (3.78kg). While its effect on color, smell, and texture properties, Mt was significantly different from that without microbes(Mo) and using EM4(Mb) bacteria.

DISCUSSION

Compost Final Weight

Based on the results of the final compost weight test, the measurement results are obtained as shown in **Table 2.** The results of the final weight measurement of the compost showed that, from all treatments, the value of the final weight loss was significantly different from that of the K2Mo treatment. The K2Mo treatment was 3.55Kg, the final weight of the fertilizer was smaller than the 8 treatments which were larger than 3.62-4.38Kg. This decrease in water content indicates that the compost is starting to enter the ripening phase(Heny, 2015) In addition, the decrease in water content in compost according to the decrease in water content during the composting process is caused by evaporation of water into gas due to the activity of microorganisms. The shrinkage of the weight of the material is due to the reshuffle of the material by microbes so that the water content of the material is reduced and due to the heat generated during composting, resulting in evaporation.

Compost Color

There is a change in the color of the compost after undergoing the decomposition process for 21 days. Compost made from cow dung, straw and *Eichorniacrassipes*, without decomposing microbes (Mo) and with decomposing microbes (Mt and Mb) changed color. In color observation, it is known that the K1Mo and K2Mo treatments have a raw brown color. While in the k3Mt treatment, the color tends to be dark brown. Good compost will produce a brown to black color. The color change that occurs from light brown to blackish color is thought to be hot caused by microbial activity that works during the decomposition process. The good and mature compost is black in color and depends on the basic ingredients for making compost (Aryanto, 2011). This result can be said to be in accordance with the compost quality standard (SNI, 2004) that the color of good compost is brown to blackish. The addition of urea in the microbial decomposition process is carried out as a nitrogen source to grow and reproduce for microbes, so that it serves to accelerate the decomposition of compost raw materials in each treatment. This affects the work of microbes more optimally and produces a blackish brown color.

Compost Smell

After undergoing the decomposition process for 21 days, there was a change in the smell of the compost in the K3Mt treatment from a pungent smell to an earthy smell in the compost, which was indicated by a high value (4,43). This is different from the K1Mo treatment which still stings, which is indicated by a small value (2,46). The higher the value, the pungent smell in the compost will disappear.

This condition is suspected that in the decomposition process microbes are able to break nitrogen bonds in the form of ammonia into free nitrogen. Free nitrogen is utilized by microbes as a constituent element of body protein. The pungent smell in the compost after decomposition is reduced. This condition is due to the fact that the decomposition process has been completed so that the compost does not have a strong smell. This shows that the composting process has been running well. Furthermore, with the opinion of Djaja (2008) that the compost is smells like of earth and smells good is categorized as mature. This result can be said to be in accordance with the compost quality standard (SNI, 2004) that the smell of good compost is earthy.

Compost Texture

One of the changes in the physical properties of organic decomposition products is characterized by changes in the texture of the basic material during the composting process. Based on the results obtained, the texture of the compost in the K3Mt treatment had a texture that almost started to crumble and was like soil, very significantly different from K1Mo which was still sticky and lumpy even though it had been 21 days. The materials used in making compost are destroyed due to decomposition by microorganisms that live in them. The results of the composting process of organic matter undergo decay and weathering of mature organic fertilizers. The texture of the organic fertilizer is ripe, marked by a crumb texture when held(Isroi, et al 2009) During the composting process, composting materials undergo a process of decay and weathering and decomposition that occurs with the help of microbes. In general, the average texture of the compost becomes crumbly. This result can be said to be in accordance with the compost quality standard that a good compost texture is crumb (like soil) (SNI, 2004).

Effect of Composition of Raw Materials and Microbes on Compost

The effect of the comparison of composition on the tested compost is shown in Table 4**.**it can be seen that the K3 treatment was significantly different from the K1 and K2 treatments. Giving cow dung in the study had a greater percentage reduction in C/N ratio. The addition of cow dung had a decrease in the percentage of C/N ratio of 88.92% and the addition of goat manure was 86.94%.(Natalina, 2017)

Based on the effect of composition on the tested compost in Table 5. it can be seen that the texture of the compost from the treatment of *Trichoderma* sp. Local Isolate (Mt) was very significantly different from that without microbes (mo) and using EM4 (Mb) bacteria.The PDA media is a medium rich in carbohydrates and easy digested making it easier for endophytic molds to grow such as *Thricoderma* sp.(Ganjar, 2006). Urea is used by microorganisms as a nitrogen source for the growth of microorganisms to remodel organic matter.

Compost Temperature

The data from the research on temperature changes during the composting process can be seen in the following graph (figure):

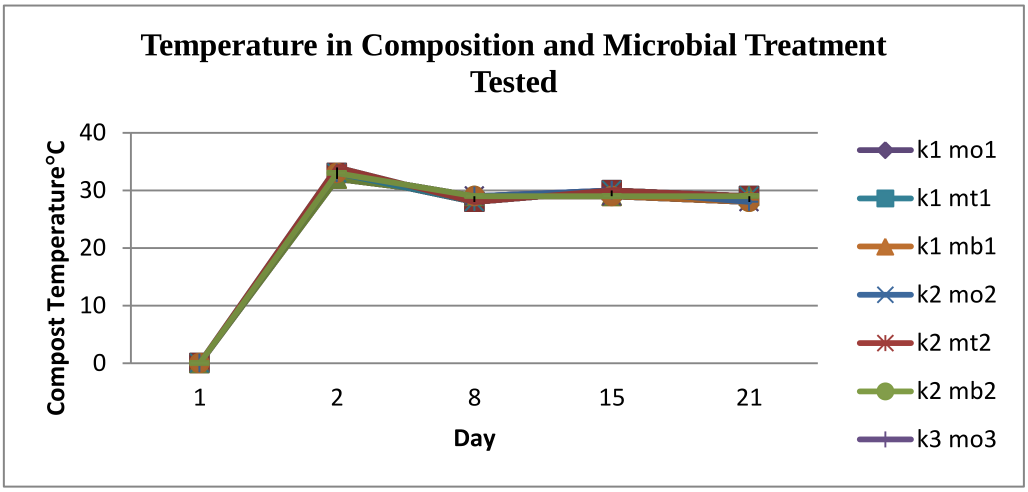

Figure 2. Graph of temprature changes in the composition and microbesl treatment being tested.

Changes in temperature have occurred on the second day. There was an increase in the temperature of all treatments starting to increase on day 2. The temperature increased in the range of 30°C to less than 35°C. C. The highest maximum temperature was obtained in the K3Mt treatment.°In this thermophilic phase, the compost temperature continues to increase and reaches its maximum temperature point. The K3Mt and K3Mb treatments reached the maximum temperature point when the compost was 2 days old at a temperature range of 34° – 35°. In the composting process there is an exothermic reaction that produces heat. Heat is characterized by an increase in temperature that occurs due to the release of energy. The increase in temperature in the pile of organic material used for composting will benefit the thermophilic microorganisms that play a role in the decomposition process (Pinandita, 2017). When the temperature in the composting process is only around 20ºC.then the compost is declared failed, so it must be repeated. Compost maturity occurs at a temperature of 28-29°C on day 20. This temperature is the same as the soil temperature and is in accordance with the requirements of mature compost. The results of this study are in accordance with the final temperature of mature compost is 26°C –30°C (SNI, 2004).

Table 6. Average pH, Humidity, and temperature of Compost Fertilizer Tested after 21 Days

Treatment		pH	Humidity (%)	Temperature(°C)
k1	Mo1	7,1	85	29,5
	Mt1	7,4	84,5	30
	Mb1	7,2	85,5	29,75
k2	Mo2	7,1	84,5	29,75
	Mt2	6,8	84,75	30
	Mb2	7,4	85	29,75
k3	Mo3	7,1	85,25	30
	Mt3	7	85	30,25
	Mb3	7,2	84,75	30

Note: K1Mo = Cow dung 25% + Straw of paddy 50% + *Eichorniacrassipes*25% with no local isolate microbes; K2Mo = Cow dung 25% + Straw of paddy 25% + *Eichorniacrassipes*50% with no local isolate microbes; K3Mo = Cow dung 50% + Straw of paddy 25% + *Eichorniacrassipes*25% with no local isolate microbes; K1Mt = Cow dung 25% + Straw of paddy 50% + *Eichorniacrassipes*25% with local isolate Trichodermasp; K2Mt = Cow dung 25% + Straw of paddy 25% + *Eichorniacrassipes*50% with local isolate *Trichoderma*sp; K3Mt = cow dung 50% + Straw of paddy 25% + *Eichorniacrassipes*25% with local isolate *Trichoderma*sp; K1Mb = Cow dung 25% + Straw of paddy 50% + *Eichorniacrassipes*25% with EM4 bacteria; K2Mb = Cow dung 25% + Straw of paddy 25% + *Eichorniacrassipes*50% with EM4 bacteria; K3Mb = 50% cow dung + 25% straw + 25% *Eichorniacrassipes*with EM4.

Compost pH

The results of the compost pH measurement after 21 days showed a value that was not too significant. The average pH value varied ranging from the lowest pH to 6.8 in the K2Mt2 treatment, and the highest pH was achieved in the K1Mt1 and K2Mb2 treatments, which was 7.4. One of the factors that influence microorganisms is pH, so pH is a good indicator of microorganism activity. results Based on the pH measurement of the tested compost, according to the compost quality standard (SNI, 2004)that the compost fertilizer ranged from 6, 80-7,49.When at the beginning of the decomposition process, organic matter will produce organic acids (Suhana, et al 2017). Under these acidic conditions decompose lignin and cellulose in organic matter. As the compost matures, the organic acids become neutral and the pH ranges from 6-8.

Compost Moisture

Compost moisture for it ranged between 80-85%. This is because if the humidity of the compost material is too high, it will hamper the activity of microorganisms because the cavity in the compost pile is blocked by too much water which reduces the oxygen content in the pile. Conversely, if the humidity of the material is too low, the activity of microorganisms will decrease due to lack of water. Compost material has a characteristic that it will feel wet when kneaded but there is no water dripping from the material.°At the time of research, the humidity of the environment around the manufacture of compost must be considered, this is one of the factors that can affect compost during the study. Environmental conditions that are not suitable for the compost maturation process will result in a non-optimal acceleration.The results of temperature measurements during the study ranged between 29-30(Indriani, 2011).

CONCLUSIONS

The results are giving *Trichoderma*sp accelerates the compost maturation process. In general, the quality of the compost produced is in accordance with SNI 19-7030-2004 with 50% cow dung + 25% straw + 25% *Eichorniacrassipes*, with the addition of local microbe Trichodermasp can conclude the physical properties of compost like color (3.83), smell (4.42), texture (3.83), and temperature (29,75°C), pH 7, humidity 85% .with the best test results, in accordance with the
Indonesian National Standard (SNI) on compost fertilizer.

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