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Utilization of Organic Waste as Takakura Compost and Its Effect on The Growth of Chili Plants

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ABSTRACT

Garbage is still an environmental problem in Indonesia. One of the main causes of Indonesia's expanding waste problem is domestic garbage, of which 75 percent is organic waste. Although organic waste is easy to decompose, its accumulation can increase the greenhouse effect. Therefore, it is necessary to reduce organic waste. Takakura compost is one method of reducing organic waste that is not widely known. This experimental study was conducted to provide an overview of the Takakura composting method and its effect on the growth of chili plants. Composting uses an EM4 activator, and the variables observed in the composting process are described descriptively: temperature, pH, texture, odor, color, and humidity. The experimental plant variables were chili plant height in control and experimental groups, described descriptively and statistically tested with One-way ANOVA. The experimental group used in the compost produced followed the compost maturity parameters in SNI 19-7030-2004. The planting trial showed no effect between planting media added with compost and those that only used soil as growing media.

1. Introduction

Waste is still an environmental problem in Indonesia. The longer this waste problem does not decrease, the more it increases as the population of Indonesia increases. The research results of Prajati and Pesurnay (2019) showed that population density was the most influential factor in waste generation in nine provincial capitals of Sumatra. The increase in the amount of waste continues to concern the government. It requires the cooperation of various parties, including the community, to reduce the growth in waste.

Waste is generally divided into organic and inorganic (Chazanah & Nandiyanto, 2022). Inorganic waste is difficult for microorganisms to break down, whereas organic waste is waste that breaks down readily. Based on the source, waste can come from households, offices, traditional markets, business centers, public facilities, areas, and others. According to data from the National Waste Management Information System, in 2021, household waste will have the highest composition among other waste, at 41% (Ministry of Environment and Forestry, 2021). Meanwhile, the composition of waste based on the highest type of waste comes from food waste by 28.9%. Settlements produce the most waste and have 75% organic waste composition (Puspitasari et al., 2022).

Household waste comes from the kitchen and other household activities (Afifah et al., 2021). Although most household waste is organic waste, the increase in the generation of organic waste that is not treated correctly will risk causing environmental pollution. Food waste, such as fruit scraps or vegetable waste, is part of the kitchen and household waste. Kitchen waste in the form of food waste that is not processed properly will be wasted in landfills and will experience spoilage. The decay process produces methane gas, which is part of greenhouse gases. So, it can increase the effect of greenhouse gases. Sharpsteen and Wright (2021) mentioned that food waste emissions increase global warming, almost equivalent to transportation emissions.

Therefore, efforts need to be made to reduce food waste or kitchen waste in the form of organic waste. Although organic waste can be easily decomposed, it has increased global warming. One effort to reduce the generation of organic waste from kitchen waste is to use the composting method. Composting has several benefits, such as saving money and resources, improving environmental quality, especially soil, and reducing environmental pollution (Al-Rumaihi et al., 2020).

Composting is the decomposition of organic matter with the help of microorganisms. Several composting methods already exist in the community. The Takakura composting method is one of the simplest and can be applied on a household scale. Composting with the Takakura method does not require large land, it is easy to move, the decomposition process is fast and does not produce odors (Warjoto et al., 2018). This method has been quite widely introduced to the public. However, some still do not know about the Takakura method's composting process and the compost quality produced by this method. Thus, the purpose of this study was to give a general overview of the variations in the temperature, texture, color, odor, pH, and moisture of compost made using the Takakura composting method. This study also aims to ascertain how applying compost prepared using the Takakura method affects the growth of chili plants.

2. Method

This research is an experimental study. The study was conducted from March 2 to May 19, 2022, in Banyuwangi. The study began with composting the Takakura method with an EM4 activator. The materials used are derived from kitchen waste (vegetable waste, orange fruit peels, and chicken eggshells). The waste used was 2.5 kg at the beginning of composting, and waste was added five times during the observation of composting variables. The composting variables observed are temperature, pH, texture, odor, color, and humidity. Composting variables were monitored twice a week from March 2 to April 3, 2022. During the observation of variables, activators (30ml) were added twice, namely in the third and fifth monitoring.

After the Takakura compost was ready, the study continued with compost trials on chili plants. This compost testing uses a control group and an experimental group. Each group uses a growing medium weighing 500 grams. Here are the details of the testing group in this study.

C1 = Cayenne pepper plants with a composition of planting media in the form of 100% soil (the control group)

C2 = Cayenne pepper plants with a composition of planting media in the form of 80% soil and 20% Takakura compost (the experimental group)

C3 = Cayenne pepper plants with a composition of planting media in the form of 80% soil and 20% commercial compost (a mixture of leaves and goat faeces) (the experimental group)

The number of seeds planted for each group is 6 (1 seed for one planting hole). The depth of the planting pit is about 1 cm. Measurements and observations are carried out for 40 days every two days in one week. The variable studied is plant height. Variables are measured and viewed from the plants that grow the highest for each group and measured using a ruler with 0 cm attached to the top surface of the growing media. Data from composting and planting trials are described descriptively. Statistical data analysis was carried out using the One-way ANOVA test to determine the effect of compost on plants.

3. Result and Discussion

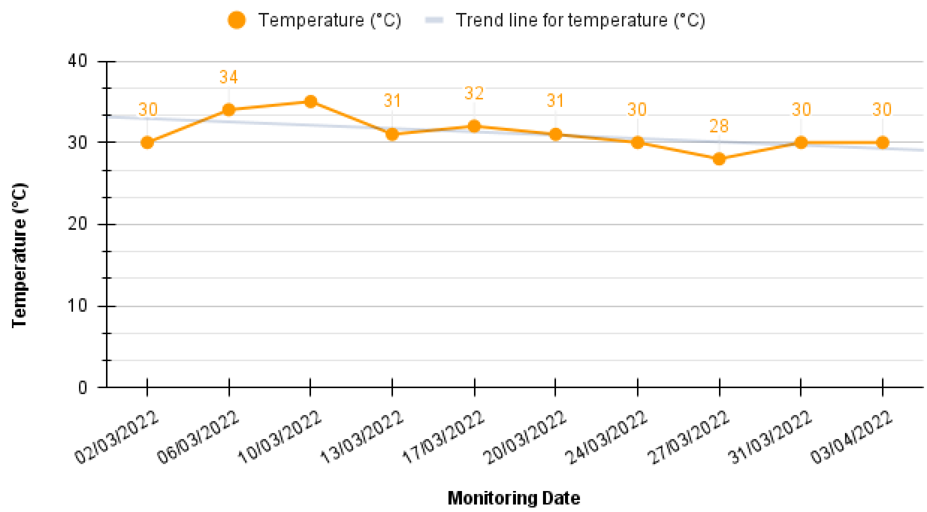
Takakura Composting Method (TCM) was first introduced by Koji Takakura in Japan. This method was then introduced to Surabaya, East Java. The Takakura Composting Method (TCM) is a simple and economical aerobic-based composting technique that uses materials in the surrounding environment (Hibino et al., 2023). Composting with the Takakura method can be applied on either a household or a larger scale. On a household scale, composting using the Takakura method utilizes a basket with small vents (Nuzir et al., 2019). Small vents in the basket are used for composting as a source of air for the growth of decomposing microorganisms.

The composting process with the Takakura method includes several stages. The first stage is the preparation of fermentation liquid (Al-khadher et al., 2021). Fermentation liquid can be sugar or salt. Other liquids that can accelerate the fermentation process include EM-4, molasses, and leachate (Hibino et al., 2023). In making this compost, EM-4 liquid is used, a mixture of microorganisms such as *Lactobacillus sp*., yeast, photosynthetic bacteria, actinomycetes, and cellulose-degrading fungi. The next stage is the preparation of decomposition media in the form of soil and husks with a ratio of 2:1. The final step involves moving the breakdown media, which has been combined with the fermentation liquid, to a container that has been covered with husks up to 5 cm high. Food waste and the decomposition media are then put in the container and stirred periodically. Close the container tightly and make sure no insects can enter (Nuzir et al., 2019).

Food waste to be composted using the Takakura method can be put in periodically and stirred with the decomposition medium. The composting process should also be monitored based on humidity, temperature, and pH conditions to ensure that microorganisms can develop properly(Al-khadher et al., 2021). The addition of food waste can be stopped temporarily to see whether the previous decomposition has produced mature compost. Indicators of mature compost from organic waste are listed in SNI 19-7030-2004, which consists of compost temperature of no more than 30°C, compost pH ranging from 6.80-7.49, maximum humidity of 50%, soil odor, blackish color, and a soil-like texture (Indonesian National Standard (SNI) 19-7030-2004 about Specifications for Compost From Domestic Organic Waste, 2004).

3.1 Temperature of compost

The results of monitoring the compost temperature show that the highest compost temperature is achieved at the third monitoring or eight days after the composting process and the first monitoring. The lowest known compost temperature was 28°C at the eighth monitoring. The temperature produced by compost does not exceed 40°C. Here is a graph of compost temperature fluctuations.



Source: Primary Data, 2022

Figure 1. Compost Temperature Fluctuations in 10 Times Monitoring

Temperature is one indicator of microorganism activity in the composting decomposition process (Jiménez-Antillón et al., 2018). Figure 1 shows temperature changes during the composting process. On the first day of composting, the compost temperature was observed at 30°C. The result is similar to that of research conducted by Kumalasari (2018). The composting process with the addition of EM4 has an initial temperature of 30 ° C. Mesophilic bacteria influence the temperature during the initial phases of composting. Then, during the subsequent monitoring, the temperature increased to 35°C. An increase in temperature indicates the decomposition of waste by microorganisms (Larasati & Puspikawati, 2019).

During the fourth monitoring, the temperature of the compost decreased. Since microorganisms eventually die, this denotes a decrease in the activity of degrading bacteria. Therefore, to maintain the decomposition process still occurs, when an increase in temperature occurs, it would be nice to stir so that there is an even distribution of microorganisms and garbage and air circulation. In this composting process, stirring is carried out along with the monitoring schedule and adding waste (Kumalasari, 2018). It is stated in SNI 19-7030-2004 that the temperature of mature compost is not more than 30 ° C (Indonesian National Standard (SNI) 19-7030-2004 about Specifications for Compost from Domestic Organic Waste, 2004). From Figure 1, it is known that the temperature of compost is constantly at 30°C. The compost is ready to be harvested after 33 days of composting.

3.2 Texture, odor, and color of compost

The compost's texture, odor, and color are monitored qualitatively by direct observation. The compost's texture from the first until the sixth monitoring shows waste that has not been decomposed. During the seventh to tenth monitoring, the compost starts to get finer, and the husk grains look like. The smell of compost-like soil began to smell during the second monitoring. Then, the subsequent monitoring smelled of the earth with the addition of citrus aroma. Based on the color, the compost is black from the second to the tenth monitoring. The following is a table of monitoring data on compost's texture, odor, and color parameters.

Table 1. The Results of Monitoring Compost Texture, Odor, and Color Parameters for 10 Monitoring

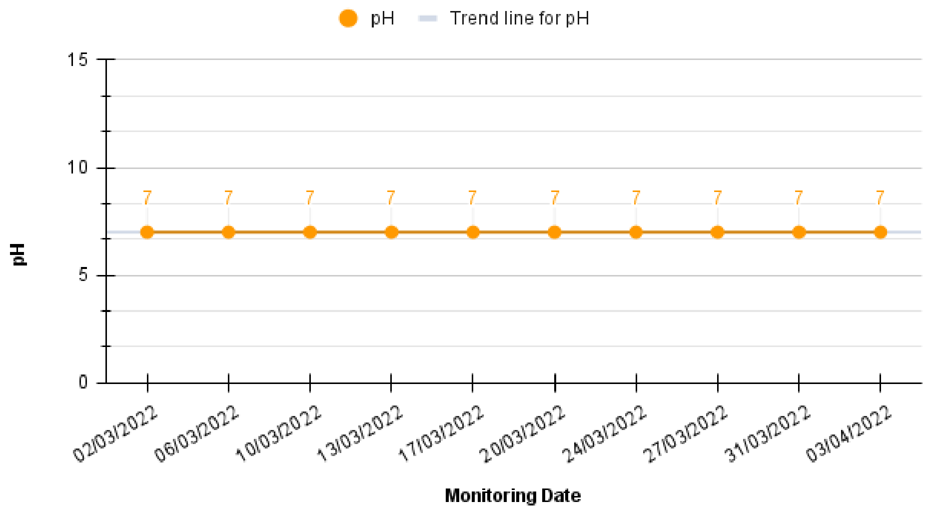
Date Of Monitoring	Monitored Parameters		
	Texture	Smell	Color
02/03/2022	coarse (a mixture of compost and organic kitchen waste)	rotten vegetables	A combination of black from prickly heat, green from vegetables, and white from garlic and white cabbage skins
06/03/2022	rough (still found garbage that has not been decomposed)	like soil	Blackish
10/03/2022	rough (still found garbage that has not been decomposed)	like soil	Blackish
13/03/2022	rough (still found garbage that has not been decomposed)	like soil	Blackish
17/03/2022	rough (still found garbage that has not been decomposed)	is earthy and has a citrus fragrance	Blackish
20/03/2022	rough (still found garbage that has not been decomposed and husk)	is earthy and has a citrus fragrance	Blackish
24/03/2022	compost and husk mixture	is earthy and has a citrus fragrance	Blackish
27/03/2022	compost and husk mixture	like soil	Blackish
31/03/2022	compost and husk mixture	is earthy and has a citrus fragrance	Blackish
03/04/2022	compost and husk mixture	like soil	Blackish

Source: Primary Data, 2022

Based on SNI 19-7030-2004, organic compost is said to be mature if it has a texture like soil, smells like soil, and is blackish. The monitoring of texture, odor, and color parameters listed in Table 4.1 shows that these parameters are constant on the 22nd day after initial composting. The results of this composting showed that on the fourth day or second monitoring, based on the parameters of texture, odor, and color, they were following the criteria for compost maturity listed in SNI 19-7030-2004. This condition is faster compared to the research of Kumalasari (2018), which shows that the texture, smell, and color match the criteria of compost maturity on the seventh day.

3.3 pH of compost

The pH of compost is measured using a *Soil Meter*. Based on the results of measurements carried out in 10 monitoring, the pH produced is 7. The pH is constant from the beginning of the composting process to the end of monitoring. That is, during the composting process, the acid and alkaline levels of compost are neutral. Here is a graph of compost pH fluctuations.



Source: Primary Data, 2022

Figure 2. pH Fluctuations of Compost in 10 Monitoring

pH can indicate the activity of decomposing organisms and can also affect the activity of decomposing organisms. Organic compost is mature and ready to use, according to SNI 19-7030-2004, which has a pH of 6.80-7.49 (Indonesian National Standard (SNI) 19-7030-2004 about Specifications for Compost from Domestic Organic Waste, 2004). The monitoring data in this composting shows that the pH of the compost is constant at number 7 from the beginning of composting to the end of the monitoring period. These conditions meet the criteria for compost maturity. According to some studies, the acceptable pH of microorganisms and bacteria is generally 6 to 7.5.

3.4 Moisture of compost

Another parameter monitored is the moisture level of the compost. The moisture level of compost is measured using a Soil Meter. The features available in the Soil Meter show five humidity categories: DRY +, DRY, NOR, WET, and WET +. Compost moisture consistently falls into the WET+ category from the first to the eighth monitoring. The following are the results of monitoring compost moisture.

Table 2. Compost Moisture Monitoring Results for 10 Monitoring

Date Of Monitoring	Moisture Category				
	DRY+	DRY	NOR	WET	WET+
02/03/2022					✓
06/03/2022					✓
10/03/2022					✓
13/03/2022					✓
17/03/2022					✓
20/03/2022					✓
24/03/2022					✓
27/03/2022					✓
31/03/2022			✓		
03/04/2022		✓			

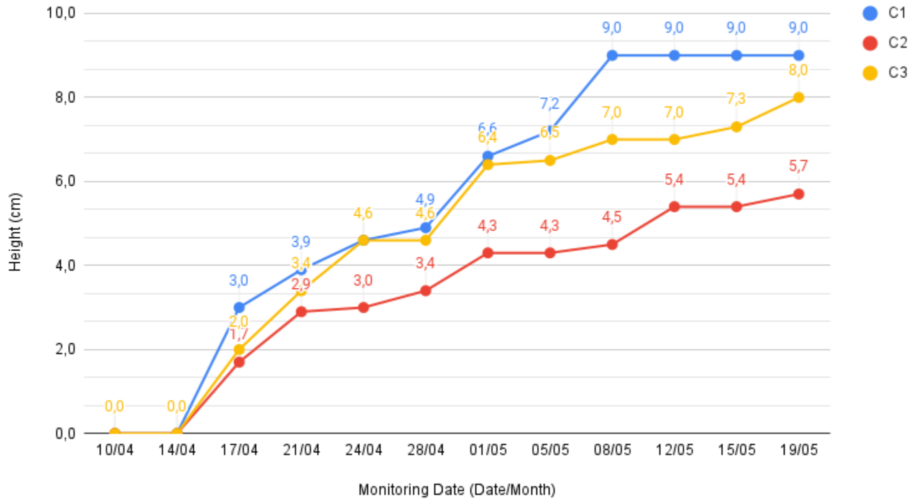
Source: Primary Data, 2022

Compost moisture is closely related to moisture content. Conditions when the water content is abundant will show high humidity. According to Larasati & Puspikawati (2019), the moisture content in organic compost affects the decomposition rate and temperature of the compost. This condition can occur because microorganisms can work optimally under certain conditions, for example, under conditions of appropriate water content. Water content or humidity is usually expressed in percentage terms. However, humidity is expressed in the qualitative form with four categories: DRY +, DRY, NOR, WET, and WET +.Nurjaman (2018) mentions that DRY+= <10%, DRY=10%-45%, normal= 45%-60%, WET 60%-80%, WET+= >80%. These results were obtained by comparing the YL-39 sensor results with the *soil meter*, which was the one used in this lab work. Compost specifications in SNI 19-7030-2004 indicate that the moisture content allowed in organic compost is a maximum of 50% (Indonesian National Standard (SNI) 19-7030-2004 about Specifications for Compost from Domestic Organic Waste, 2004). The monitoring results are written in Table 4.1, and the compost was according to specifications on the 29th day after the initial composting. After several further treatments, moisture meeting these requirements is acquired by supplying husks and allowing them to dry in the sun.

Compost produced from composting 5 kg (2,5 kg at the beginning and adding 250 grams as much as 6 times) of organic kitchen waste produces 150 grams of compost. These results may be influenced by using mixed compost types (goat feces and foliage). However, this needs to be reviewed because there is no underlying research.

3.5 Chili plant height analysis

Changes in plant height can be used as parameters to determine a plant's growth speed (Rahmatullah et al., 2019). Graph 1 shows changes in plant height in the planting trial after 12 monitoring. The graph shows that C1 plants reach the highest plant height of 9 cm 28 days after planting compared to the height of other plants. However, growth in these plants stagnated from the tenth monitoring until the last monitoring.



Source: Primary Data, 2022

Figure 3. Changes in Chili Plant Height 39 Days After Planting

3.6 The effect of Takakura compost on chili plant height

Trials on chili plants were conducted to test the effectiveness of the Takakura method of compost. The seeds used are the result of seeding from fresh chili seeds. The results of measuring the height of each group's plants were analyzed statistically using the One-way ANOVA test to determine the difference in the average height of each group's plants. Here are the test results of One-way ANOVA.

Table 3. One-way Anova Test Results Plant Height (cm) Group C1, C2, and C3

Plant height (cm)	sum of squares	df	mean square	F	Significance value (<0.05)
Between groups	27,949	2	13,974		
in a group	253,640	33	7,686	1,818	0,178
Total	281,589	35			

Source: Primary Data, 2022

The test result showed that there was no significant difference in the height growth of chili plants. The control group (without adding compost), the group with Takakura compost, and the group with mixed compost had the same average plant height. That is, there is no effect between the addition of Takakura compost and mixed compost on the increase in the height of chili plants. This result is similar to the results of research conducted by Farumi (2020), which showed no effect of adding Takakura compost with an EM4 activator on the height of chili plants. Agustin et al. (2022) tested Takakura compost with an EM4 activator, which also had the same result on tomato plants. There is no influence on the height of tomato plants. Adding composts containing goat manure to mustard pakcoy plants also produces similar conditions, and there is no natural effect on plant height growth (Suharjanto et al., 2022).

4. Conclusion

This study found that the temperature produced by compost does not exceed 40°C. On the fourth day or second monitoring, the texture, odor, and color parameters followed the compost maturity criteria listed in SNI 19-7030-2004. The pH of the compost is constant from the beginning of composting until the compost matures, which shows the number 7. On the 29th day after the initial composting or ninth monitoring, the compost moisture followed the compost maturity specifications listed in SNI 19-7030-2004. Compost can be said to have matured on the 29th after the initial composting or ninth monitoring because it has met the specifications for the maturity of organic waste compost listed in SNI 19-7030-2004. There is no effect between the addition of Takakura and mixed compost on the increase in the height of chili plants. Further researchers are expected to use activator materials and other compost culprits to compare the effectiveness of composting. Takakura compost results can be tested to see the content of the compost produced. Planting tests with Takakura compost can be observed over more extended time frames.

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