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# Variations of Time for Composting Market Organic Waste Using Aerobic Microorganisms

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The use of fertilizers in agriculture is an absolute must, both organic fertilizers and inorganic fertilizers. Considering the increasing price of inorganic fertilizers, innovation is needed to make organic fertilizers from easily obtained materials, one of which is market organic waste. Among the aerobic microorganisms used are lignolytic, cellulotic, proteolytic, lipolytic and aminolytic which are capable of changing compost in time. The purpose of this study was to analyze the right time in the composting process so as to produce a maximum source of essential nutrients. The research method or stages used is to divide the composting time into 4 parts, namely 5 weeks, 6 weeks, 7 weeks and 8 weeks. The results showed that the C-Organic content in the 5-7 weeks composting phase met the minimum SNI standards, while in the 8-week composting phase it is below the minimum standard of SNI. Phosphorus content is also above the minimum limit of the standard determined by SNI, Meanwhile, Potassium and Nitrogen are below the minimum SNI standard. The content of secondary macronutrients such as Calcium, Magnesium, and Sodium does not exceed the maximum limit set by SNI.
**Keywords:** compost; market organic waste; time period composting

## INTRODUCTION

The waste problem in various countries is very important to overcome. The large amount of waste that is not treated properly will cause various problems such as health, environmental and social problems. The waste problem is directly related to human activities, especially organic waste. Organic waste can be easily decomposed, but if the management of organic waste is not correct, the impact will be very dangerous for public health and the environment.

The market is the place to produce organic waste most often and most of all compared to other public places. This can be seen clearly with the amount of waste generated from vegetable waste and of course the various types. The solution that we have seen from organic waste that is generally in the market is to collect it and eventually it will be taken to a landfill. Things like this are not the best solution to reduce the volume of waste significantly, given the production of waste every day. Therefore, there needs to be special handling related to market organic waste, namely converting market organic waste into organic fertilizer (Dewilda et al., 2021; Hutagalung, 2019).

According to Sutanto (2006), the continuous use of chemical fertilizers causes the soil biological ecosystem to become unbalanced so that the purpose of fertilizing to meet the nutrients in the soil is not fulfilled. One method to overcome the continuous use of chemical fertilizers is by using organic material in the form of compost. Meanwhile, according to (Purba et al., 2018; Trivana & Adhitya, 2017), the function of compost is to add nutrients and improve soil structure, increase water retention ability, and plant growth and production. A plant can grow optimally if the fertilizer dose is given right. Through fertilization, it can improve soil fertility, including replacing nutrients lost due to leaching and those transported at harvest time.

According to (Baroroh & Prabang, 2016), the use of compost as fertilizer is very good, because it can provide the following benefits to provide the nutrients needed by plants, is an alternative substitute for chemical fertilizers because the price is cheaper, quality and environmentally

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friendly is multifunctional because it can be used as a base for organic fertilizers, improve soil structure and texture, increase soil porosity, soil aeration and can increase the composition of microorganisms in the soil.

Compost increases the soil's ability to hold water. Soil mixed with compost has pores with better adhesion so that it can bind and hold water available in the soil. Besides, it can also increase soil biological activity by helping microorganisms in the soil, besides containing bacteria and decomposed fungi, the presence of compost will make the soil moist, this condition favored by bacteria. Compost does not cause environmental problems. Excessive use of synthetic chemical fertilizers can cause environmental problems that can damage the soil and water conditions, while compost improves soil and environmental properties (Huang, 2015)

There have been many studies related to compost fertilizers carried out by many researchers. However, this research is more focused and shows the right time for the process of making compost. The right time means that the compost is perfectly ripe and the nutrient content in it is also completely decomposed and is available to meet the needs of plants. So, it is important to do this considering that many people (farmers) assume that composting takes a long time and is expensive. This research serves to explain these things and provide a correct understanding of the method and timing of composting.

## METHODS

The research was carried out in several stages, among others: Preparation of organic materials (market waste), collection of organic materials, cutting organic matter, composting, compost temperature observations, nutrient analysis in the laboratory.

This research was conducted from August – November 2021, located in Majene, West Sulawesi. This research begins with; preparation of organic materials (market waste), collection of organic matter, counting organic matter, composting in stages according to a predetermined time. Starting with composting which requires a longer time of composting, then followed by composting with less time. Then observation of temperature, color, and water content of compost. After the compost is finished, then proceed with analysis of essential nutrients contained in the compost. The last one is interpretation of observational data and laboratory analysis.

The research was conducted based on several variations of the composting period time with the assumption that the dosage for using Stardec was 0.25% of compost material (250 g of Stardec in 100 kg of compost material), which consists of several treatments, including: 1 = 50 kg of market organic waste +125 g of Stardec, composting time of 5 weeks. 2 = 50 kg of market organic waste +125 g of Stardec, composting time of 6 weeks. 3 = 50 kg of market organic waste +125 g of Stardec, composting time of 7 weeks. 4 = 50 kg of market organic waste +125 g of Stardec, composting time of 8 weeks.

The form of data processing in this study is to compare the quality of compost based on variations in the time of composting. This is done by looking at the results of the analysis of the nutrients contained in each compost based on the treatment period.

## RESULTS AND DISCUSSION

Based on the results of observations and analysis the levels of essential nutrients contained in compost with different composting time variations, the results obtained are as shown in table 1.

### *Organic carbon (C-Organic)*

Based on the results of laboratory analysis, it shows that the C-Organic content in the composting phase of 5 weeks - 7 weeks is above the level determined by the

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minimum SNI of 9.80%, while in the 8-week composting phase the results were below the SNI standard. The decrease in C-organic content was due to the use of element C in the microbial activity of decomposing organic matter. Total C-organic in compost is influenced by the quality of organic matter and the activity of microorganisms involved in the decomposition of organic matter.

Table 1: Average compost sample analysis results 5,6,7 and 8 weeks of composting

| Treatment (week) | Analysis parameters | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | pH | C-org (%) | N-Total (%) | Ratio C/N (%) | $P_2O_5$ (%) | $K_2O$ (%) | Ca (%) | Mg (%) | Na (%) | Water content (%) |
| 1 | 5.3 | 10.25 | 0.24 | 43 | 0.19 | 0.15 | 0.24 | 0.07 | 0.21 | 30.11 |
| 2 | 6.1 | 10.41 | 0.29 | 36 | 0.22 | 0.18 | 0.25 | 0.06 | 0.38 | 25.70 |
| 3 | 6.5 | 10.53 | 0.32 | 33 | 0.32 | 0.19 | 0.32 | 0.12 | 0.25 | 30.08 |
| 4 | 6.8 | 8.95 | 0.32 | 28 | 0.35 | 0.24 | 0.33 | 0.09 | 0.35 | 22.43 |

***Organic carbon (C-Organic)***

Based on the results of laboratory analysis, it shows that the C-Organic content in the composting phase of 5 weeks - 7 weeks is above the level determined by the minimum SNI of 9.80%, while in the 8-week composting phase the results were below the SNI standard. The decrease in C-organic content was due to the use of element C in the microbial activity of decomposing organic matter. Total C-organic in compost is influenced by the quality of organic matter and the activity of microorganisms involved in the decomposition of organic matter.

The C-organic nutrient is a source of energy in the process of metabolism and cell multiplication of bacteria. The use of C-organic elements as a source of energy for bacteria will produce waste in the form of organic acids and alcohol. Changes in C-organic are caused by the activity of microorganisms present in the compost. These microorganisms will consume organic material from the compost as a source of energy in the preparation of cells by releasing $CO_2$ and $H_2O$ (Baroroh & Prabang, 2016).

Plants can absorb nutrients through the roots or the leaves. Carbon and Oxygen nutrients are taken from the air as $CO_2$ through leaf stomata in the process of photosynthesis. Hydrogen nutrients are taken from groundwater ($H_2O$) by plant roots. In small amounts, the plant also absorbs water through the leaves. Research with radioactive elements shows that only the nutrient Hydrogen from water is used by plants, while oxygen in the water is released as a gas (R. A. Bachtiar et al., 2018; Purba et al., 2020)).

Carbon is exchanged between the soil and the atmosphere through photosynthesis and decomposition. Plants absorb $CO_2$ and hold carbon at the same time releasing oxygen through photosynthesis. The carbon held by plants is then transferred to the soil through the roots during the process of breaking down plant residues. Furthermore, carbon is retained in the soil in the form of plant residues which slowly incorporate into the soil through a humification process and incorporate into soil aggregates that are not immediately emitted. There is a dynamic cycle in the absorption, deposition, and transformation of carbon between air and soil through plants (Herman, 2014; C. Huang, 2021)

***Total nitrogen (N-Total)***

The total N content in all composting phases is classified as low and is below the minimum SNI standard of 0.40%, this is

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because the composted waste is in the form of vegetable waste which is classified as nitrogen supply for the composting process. Organic matter degrading microbes require large amounts of nitrogen for their activities. Nitrogen is needed by microbes for microbial metabolism and growth. The availability of nitrogen in high amounts due to a more complete decomposition process, while low nitrogen is caused by compost raw material which contains low nitrogen and may evaporate a lot due to poor packaging (Meity et al., 2016).

Nitrogen is the main macronutrient which is very important for plant growth. Nitrogen has an important role in stimulating the vegetative growth of plants, making plant leaves dark green, N is what makes up the plasma cells and plays an important role in the formation of proteins. When the plant is deficient in N nutrient, it shows symptoms in plants such as stunted growth, stunted root growth and leaves turning pale yellow (Bachtiar, 2006).

The nutrient N starts with the physical / chemical fixation of $N_2$ - the atmosphere that supplies the soil along with the preparation (rain), and by microbes, both symbiotically and non symbiotically, which supply the soil both through their host plants after death. These dead cells along with plant/animal remains will become organic material that is ready to be decomposed and through a series of mineralization processes (ammonification and nitrification) will release N minerals ($NH_4^+$ and $NO_3^-$) which are then immobilized by plants or microbes. If ammonia gas does not immediately undergo ammonification, it will immediately volatilize (evaporate) into the air, as well as atmospheric $N_2$ gas. Nitrogen is absorbed by plants in the form of $NO_3^-$ or $NH_4^+$ from the soil (Bachtiar *et al*, 2018; Mehta, 2018).

***C/N Ratio***

The C/N ratio decreases with each phase, this explains that the longer the composting process takes, the more mature the compost will be. However, this C/N ratio is still relatively high based on the minimum SNI standard of 10 and a maximum of 20. Basic materials with a high C/N ratio will be difficult to decompose so that materials and activators are needed that can reduce the C/N ratio. Fast or slow decomposition is influenced by the compounds contained in the organic material. The nutrient content of C and N in the raw material affects the speed of decomposition. The activity of microorganisms is limited by the limitation of N protein for metabolism. If the C/N ratio is more than 25, hence the level of mineralization is low, the source of N in the soil is immobilized by microorganisms, and N fixation is only temporary. If the C/N ratio is less than 20, then N undergoes a mineralization process and the dead microorganisms will become other, simpler elements (Sutanto 2006).

During the composting process, from 5 weeks to 8 weeks, the C/N ratio decreased, indicating decay of organic matter. $CO_2$ is released a lot, while N is not, so the C/N ratio drops. This process continues to form humus. The process of breaking down organic matter to form humus is called humification. The decrease in the value of the C/N ratio in each compost is due to a decrease in the amount of carbon used as a source of microbial energy to break down or decompose organic material. The C/N ratio contained in the compost describes the level of maturity of the compost, the higher the C / N ratio means the compost has not broken down completely or in other words, it is not yet ripe (Kafrawi et al., 2018).

***Phosphor ($P_2O_5$)***

Phosphorus content (P2O5) in all composting phases has a high enough value and is above the minimum SNI standard of 0.10%, nitrogen and phosphorus are needed by microbes for microbial metabolism and growth (Bachtiar *et al*, 2018). The high phosphorus content of compost is thought to be due to the high phosphorus content of the compost base material so that the

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phosphorus content in the compost is quite high even though the P element has been used by microbes in its activity.

Phosphorus is a macronutrient that is essential for plant growth. Plants absorb P from the soil in the form of phosphate ions, especially $H_2PO_4^-$ and $HPO_4^{2-}$ which are present in soil solutions. Besides these ions, plants can absorb P in the form of nucleic acids, phytin, and phospho humic. Phosphorus contained in organic fertilizers plays a role in plants in the process of respiration and photosynthesis. Preparation of nucleic acids, the formation of plant seeds, and producing fruit. Besides, phosphorus is also able to stimulate root development so that the plants are resistant to drought and accelerate the harvest period (Elfiati, 2005).

Phosphorus content is also influenced by the high nitrogen content, the higher the nitrogen contained, the multiplication of microorganisms that remodel phosphorus will increase so that there is an increase in the phosphorus content in compost fertilizer as the composting time increases. Phosphate solubilizing bacteria are generally also able to dissolve elemental potassium in organic matter. Phosphorus (P) as an organic material has a very important role in soil fertility, photosynthesis, and plant chemical physiology. Phosphorus is also needed in cell division, tissue development and plant growth points (Widarti et al., 2015).

***Potassium ($K_2O$)***

Potassium is a macronutrient that is needed by plants and is absorbed by plants in the form of K + ions. Potassium is classified as a mobile element in plants, both in cells, tissues, and xylem and phloem. Potassium is abundant in the cytoplasm. The role of potassium in regulating cell turgor is related to the concentration of potassium in the vacuole. Potassium in the cytoplasm and chloroplasts is needed to neutralize the solution so that it has a pH of 7-8. Besides, potassium is important for plant growth because it is an enzyme activator (Rahman, 2008).

Potassium ($K_2O$) content of compost from all composting phases is classified as low, which is below the minimum SNI standard of 0.20%, this is because the K element is needed by microorganisms in the composting activity of organic matter. The element of potassium in compost raw materials, functions in microbial metabolism and as a catalyst. States that potassium is used by microorganisms in composting as a catalyst, in the presence of bacteria and their activity. Greatly, affects the increase in potassium content. Potassium is bound and stored in cells by bacteria and fungi, if it is decomposed again, the potassium will become available again (Pandebesie & Rayuanti, 2013).

Phosphate solubilizing bacteria are generally also able to dissolve elemental potassium in organic matter. According to Hidayati et al., (2011), Potassium is used by microorganisms in the substrate material as a catalyst, with the presence of bacteria and their activities will greatly affect the increase in potassium content. Potassium can be bound and stored in cells by bacteria and fungi (Mirwan & Rosariawari, 2012).

The availability of K in the soil varies greatly depending on soil properties, including soil parent material, content, and type of clay, the content of organic matter, drainage, and cation exchange capacity (CEC). K content in the soil ranges from 0.5-2.5% and about 90-98% of the K are in the unavailable form, 1-10% in the slowly available form, and 1-2% in the readily available form. The readily available forms of K are K in soil solution and K adsorbed by the soil colloids. The slowest available form of K is in the form of soil minerals (Sofyan et al., 2011).

***Water content***

The moisture content greatly affects the duration of composting / decomposition of organic materials in the compost. Water content is related to the availability of oxygen for the activity of aerobic microorganisms, if the moisture content of the material is in the range of 40-60.5%, the

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decomposing microorganisms will work optimally. Based on the results of the analysis, the compost, water content of all treatments was below 40% so that the decomposing microorganisms could work optimally to decompose the organic materials in the compost. Humidity has a very important role in the process of microbial metabolism and oxygen supply. If the compost is too moist, it will cause the composting process to take longer and if the humidity is too low, the degradation efficiency will decrease due to the lack of water to dissolve organic matter which will be decomposed by microorganisms as an energy source (Pandebesie and Rayuanti, 2013).

According to Widarti et al. (2015) stated that humidity plays a very important role in the process of microbial metabolism and indirectly affects oxygen supply. If the humidity is too low, the efficiency of degradation will decrease due to the lack of water to dissolve organic matter which will be degraded by microorganisms as an energy source.

***Compost pH***

According to Maradhy (2009) research, the optimum pH for the composting process ranges from 6.5 to 7.5. During the early stages of the decomposition process, organic acids are formed. An acidic atmosphere will encourage fungal growth and will decompose the lignin and cellulose contained in the litter which will become compost.

The results showed that the value was almost neutral, although for the 5 weeks treatment, it was still low compared to the others because the weathering process that occurs has not been maximized. In the treatment of 6 to 8 weeks, the pH value ranges from 6.1 - 6.8, has met the pH standard based on SNI 2004, namely 4-8. Under normal conditions, compost will not cause problems, which means that the composting process can maintain the pH in a neutral range . At neutral pH, the activity of microorganisms in organic fertilizers runs perfectly, so that the nutrients released from organic fertilizers are getting better (Tantri et al., 2016).

***Secondary Macronutrients (Ca, Mg, dan Na)***

Based on the results of laboratory analysis for secondary macronutrients such as calcium (Ca), magnesium (Mg), and sodium (Na), the content of these three elements does not exceed the maximum limit of the SNI standard value. So that the microelements contained in the compost can be said to meet the needs of plants and are not toxic for plants.

Calcium is an essential nutrient for plants, this element has a function in plant growth, namely regulating the osmotic pressure of cell sap and as a regulator of plant metabolism. Calcium is essential for the growth of plant meristems, especially for activating root-tip functions. Calcium is absorbed by plants in the form of $Ca^{2+}$. Lack of calcium causes inhibition of the growth process of plant buds, in the sense that the buds cannot open (keep rolling), especially for legumes, cassava, shallots and potatoes. Meanwhile, for other plants lack of Ca elements can cause symptoms in root growth (Afandi, 2005).

Magnesium is absorbed in the form of $Mg^{2+}$ and is part of chlorophyll, in general Mg makes up 0.2% of plant parts. Deficiency of this element can cause chlorosis. Symptoms will appear on the lower leaf surface. Mg is abundant in fruit and also in soil. In the soil Mg comes from the decomposition of rocks or minerals such as biotite, serpentine and olivine. Magnesium plays an important role in phosphate nutrition and acts as a carrier of phosphorus, especially into seeds, as an activator of a number of enzymes including transfer phosphorylase, dehydrogenase, and carboxylase (Bachtiar *et al,* 2018).

## CONCLUSIONS

Based on the content of essential nutrients contained in the compost, with a composting period of 8 weeks, it produces higher nutrients than other composting

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times. Regarding the results and discussion, it can be concluded that in general the content of macroelements such as organic carbon, phosphorus, potassium has a value above the minimum standard of SNI. Meanwhile, micronutrients (calcium, magnesium, and sodium) also meet the maximum standards set by SNI.

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