Jurnal Presipitasi
Media Komunikasi dan Pengembangan Teknik Lingkungan
e-ISSN: 2550-0023

Vol 21, No 3, 2024, 759-772
Article available at homepage presipitasi

Original Research Article

Application of Local Microorganisms in the Composting Process using the Biopori Absorption Hole Method on the Content of Macro and Micronutrients

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Abstract
Organic waste can be used to make compost. One method of composting is by using Biopore Absorption Holes. Processing organic waste into compost can be done by adding local microorganisms (MOL) as bioactivators with varying MOL doses (0,25,50,175,100,125) % for every 5kg of food waste and vegetable waste categories. Composting process uses biopori absorption hole method with a depth of 80cm and diameter of 6 inches. MOL can be made from vegetable or fruit waste because the materials used are simple and easy to obtain. In the composting process, addition of MOL can increase the content of macro and micro nutrients. This research aims to determine the effect of reducing volume of compost and analyze the content of C, N, P, K, Fe, and Zn, from the composting process with different MOL doses and types of waste that have been determined. The research results showed that C, P, Fe and Zn tests had met the quality standards, while N and K tests had not met the quality standards. It can be concluded that the most effective activator dose is 25ml/L in food waste category because the compost produced meets the quality standards of SNI 19-7030-2004 concerning Compost Specifications from Organic Waste.

Keywords: Biopore infiltration holes; compost; macro micro nutrients; local mycoorganisms

1. Background

The large population in Indonesia influences the amount of waste produced. The higher the population, the higher the waste produced. Waste is something that is considered no longer useful for humans (Cundari et al., 2019). Based on its nature, waste is divided into 2 types of organic waste and inorganic waste. Organic waste is a type of waste that comes from organic materials and is cheap to decompose, such as food waste, leaf waste, animal waste, and others. Meanwhile, inorganic waste is waste made from materials that are difficult to decompose quickly due to their synthetic nature, such as plastic, glass, metal, and other waste (Indah et al., 2021)

It is necessary to reduce organic waste because the waste storage capacity at Final Processing Sites (TPA) is decreasing. Therefore, one alternative to reduce organic waste is by composting using the right method. (Afifah et al., 2019). Organic waste can be used to make compost. The composting process can be done by piling up and allowing the waste to decompose so that it becomes compost. One method of composting is by putting organic waste into the Biopore Absorption Hole (LRB). Therefore, it is necessary to reduce the size of the waste and add waste-decomposing bacteria (Indah et al., 2021). Biopore infiltration holes can be used as a means of absorbing rainwater into the soil on narrow plots of land in urban areas, there by minimizing flooding. Biopore absorption holes can also be used as a medium for the composting process. Therefore, this research was used to determine the quality of compost fertilizer using the Biopori Absorption Hole utilization method. (Syahri et al., 2022). Processing organic waste into compost can be done by adding local microorganisms (MOL) as bioactivators. Local microorganisms (MOL) contain micro, macronutrients, and bacteria that can stimulate plants, control pests in plants, and break down organic matter. (Subula et al., 2022)

Local microorganisms (MOL) are microorganisms that are often used as activators in the process of making compost fertilizer. The process of making MOL requires 3 important elements, carbohydrates, glucose, and a source of microorganisms. Carbohydrates can be used as an energy source for microbes such as spur water, cassava or tape, fruit peels, and banana tubers. Meanwhile, glucose functions as an energy source that is easy to digest for the reproduction process. Glucose can be made from palm sugar, coconut water, sugar cane juice, and others. MOL can be made from vegetable or fruit waste so it is easy to apply by the general public because the materials used are simple and easy to obtain (Dewantari et al., 2023).

Utilizing biopore absorption holes can be used as a rainwater absorption area and can also be used as a composting process method. This research was conducted to utilize LRB as a method of composting household waste that is space efficient and easy to apply. Apart from that, to determine the effect of the composting process using the biopore absorption hole method on the macro and micro nutrient content of compost fertilizer by adding local microorganism activator (MOL) with varying doses to each type of compost waste (Bachtiar & Ahmad, 2019). Based on SNI 19-7030-2004 concerning Specifications for Compost from Organic Waste, it is explained that the parameter requirements set are that ready-to-use compost or mature compost must meet the compost temperature of greater than 22°C, the pH of the compost ranges between 6.80–7.40. Apart from that, the resulting compost has the characteristics of an earthy smell, blackish color, and a soil-like texture (BSN, 2004).

2. Method

2.1. Research Location

The research was carried out at the Department of Environmental Engineering at Diponegoro University by collecting organic waste from household activities in the campus area, and vegetable waste from vegetable stalls around campus. The organic waste is chopped and put into the Biopore Absorption Holes, 5kg per hole. The number of biopore holes is 12, with 6 biopore holes for food waste and 6 biopore holes for vegetable waste. Organic waste to which local microorganism activators have been added is then mixed and put into the biopore absorption hole (LRB) according to the specified dose.

Figure 1. Chopping waste in the composting process

Figure 2. Adding variations in MOL dosage for 5kg of waste

2.2. Preparation of Local Microorganisms

The process of making local microorganisms (MOL) is carried out by using fruit waste as a fermentation material. The ingredients used to make fruit MOL are 1 kg of fruit waste, 200 grams of brown sugar or granulated sugar, 1L coconut water, 1L rice washing water. The steps for making fruit MOL are cutting fruit waste into small pieces which are put into a gallon of used mineral water, then mixing 200g of glucose or brown sugar solution into 1L of coconut water and rice water each. Stir all ingredients until evenly mixed. Make a hole in the lid of the container to insert a hose to prevent an explosion due to fermentation gas. Leave and ferment for 18 days. Fermentation was carried out for 18 days with the aim of activating the activity of the microbes that were already present in the MOL manufacturing material solution (Suwatanti & Widiyaningrum, 2017). The fermentation process will produce gas. The more active the mole solution is, the more gas is produced (Wardani et al., 2021). Check by opening the bottle cap to find out that the MOL emits a fermented smell (Mukrimaa et al., 2016). In the process of making fruit MOL, the addition of sugar affects the composting time. Sugar will make the composting process faster (Septiani et al., 2022)

Lokal microorganisms (MOL) fruit contain phenolic acid which can increase Iron (Fe), Calcium (Ca) and Aluminum (Al) ions which increase the phosphorus (P) content in the soil. High phosphorus content will affect plant growth and make plants more tolerant to pests or diseases (Tarigan et al., 2020)

2.3. Making Compost Fertilizer by Using Biopori Infiltration Holes

Making Biopore Absorption Holes is done by looking for locations for making biopore holes, the areas that can drain or absorb rainwater, such as yards, parks or home gardens. We can water the land that will be hollowed out first to make it easier to make holes. Make a hole in the wet soil using a biopore drill by pressing the drill clockwise and turning it until the biopore drill enters the soil. Carry out the process of drilling the soil repeatedly until it reaches a depth of approximately 80cm. Biopore Absorption Holes (LRB) are small holes in the ground that are filled with air until they enter the water flow. Biopori Absorption Holes have the advantage of being able to increase water infiltration into the soil, and being able to prevent landslides and erosion. Apart from that, biopore absorption holes can also be used as a means for processing organic waste. Waste that is put into biopore absorption holes can be used as an energy source for microorganisms that live in the soil. This waste can turn into compost after undergoing a decomposition process. This compost fertilizer is able to reduce methane gas much more strongly so as not to cause global warming (Hutabarat et al., 2017).

2.4. Data Collection

The composting process was carried out for 42 days in September-October 2023. During the composting process, measurements were made of the reduction in the volume of organic waste, measurement of pH, temperature and humidity parameters in the compost. Measurements were taken in the morning and evening. Compost sampling is done by stirring the compost and taking samples on day 7, day 14, day 28 and day 42.

The samples that have been taken are tested for water content. because the water content test results were too high so drying was needed to reduce the water content. The compost waste that is dried in the sun is then measured again for its water content using the gravimetric method. After measuring the water content of the sample, macro parameters (C, N, P, K), C/N ratio, micro parameters (Fe and Zn) are tested in the laboratory. Carbon (C) testing was measured using the Walkey and Black method, Nitrogen (N) using indophenol wet digestion, Phosphorus (P) using ascorbic acid wet digestion, Potassium (K), Iron (Fe), and Zinc (Zn) using the destruction method + analysis with AAS. The research was conducted at the Environmental Engineering Laboratory at Diponegoro University.

Figure 3. Compost samples

Figure 4. Laboratory tests for macro and micro nutrients

3. Result and Discussion

3.1 Acidity (pH)

The pH value can influence the activity of microorganisms in the composting process. Microbial growth is influenced by pH. If pH is too low it will cause the microorganisms in the compost to die, which can disrupt the composting process (Kaswinarni & Nugraha, 2020). pH parameter measurements were carried out every day for 42 days using a pH soil meter. Observations of the pH of compost fertilizer can be seen in figure 5 and figure 6:

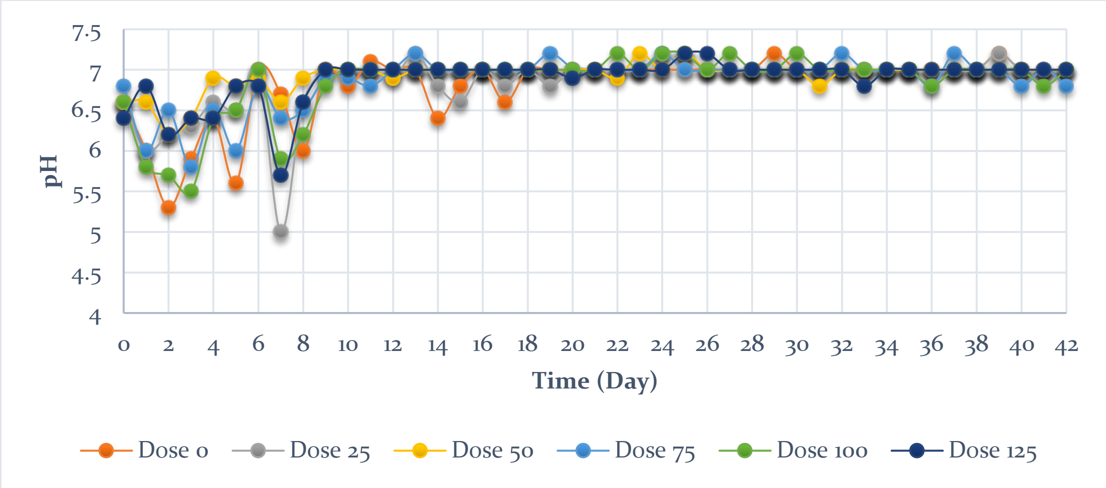

Figure 5. Results of pH observations in vegetable waste

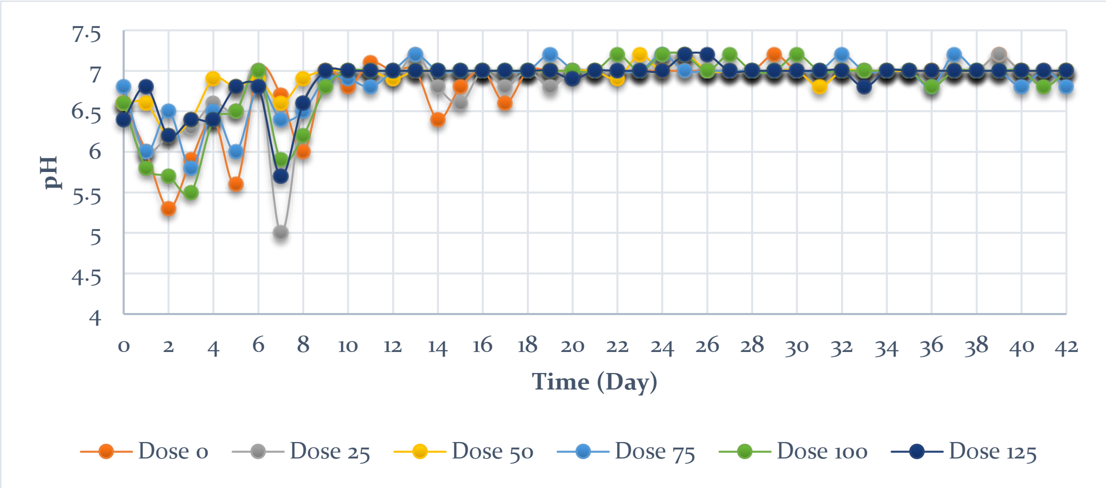

Figure 6. Results of pH observations in foodwaste

The results of observations of the degree of acidity (pH) of compost fertilizer which was observed for 6 weeks, the values obtained ranged from 4.2 – 7.3. This shows that compost has weak and neutral acid properties. This pH observation meets the SNI 19-7030-2004 quality standard, a pH value between 6.8 – 7.9. The pH value of mature compost is close to neutral according to the soil pH (Maryadi et al., 2018). A soil pH value that is neutral or close to neutral will be easily absorbed by plants, and can reduce the acidity content of the soil (Suwatanti & Widiyaningrum, 2017). In the composting process, fluctuations occur in daily pH observations. These daily pH fluctuations occur due to the activity of microorganisms in the process of decomposing organic matter. At the beginning of the research, compost was acidic due to the formation of simple organic acids, then the pH increased due to the protein breaking down and releasing the ammonia content in it. Some of the ammonia in compost will be released or converted into nitrate. Then the nitrates are identified by decomposing bacteria which will make the pH of the compost neutral (Suwatanti & Widiyaningrum, 2017)

3.2 Humidity

Moisture in compost is related to the activity of microorganisms in the composting process. These microorganisms will produce water vapor which will cause the humidity of the compost to increase.

(DEWANTAR et al., 2023). Moisture measurements are carried out to determine moisture levels due to microorganism activity which can affect composting time. Moisture parameters were measured every day for 42 days using a soil meter. During the composting process, fluctuations occur in moisture measurements ranging between 4-10 on a soil moisture meter. The lowest humidity was observed on the 39th day of vegetable waste compost with an activator dose of 100ml and on the 40th day of vegetable waste compost with an activator dose of 25ml in the morning observation. This can be caused by various factors, one of which is temperature, climate and weather. During the 5th week of observation, it rained, causing the humidity in the compost to become high again. Apart from that, humidity is also influenced by temperature. The higher the environmental temperature, the more compost will evaporate and the humidity will decrease. In the composting process, the temperature can be influenced by existing conditions such as daily weather, rain, and temperature at the time of measurement. Apart from that, it can also be caused by low compost piles, causing the heat to not be able to be generated. It stays in the pile for a long time and makes the compost temperature low. (Ismayana et al., 2012). If the compost temperature is low, it will cause steam or dew on the compost so that the humidity will be higher. (DEWANTAR et al., 2023

Humidity can be influenced by the water content of the compost. The decrease in water content occurs due to water evaporation. Based on SNI 19-7030-2004 concerning Specifications for Compost from Organic Waste, the maximum water content in compost is 50%. humidity compost below 50% will cause the compost to dry out and slow down the maturation of the compost. Compost conditions that are too dry will cause the organic material to not dissolve in water so that microbial activity is not optimal (Mohamad et al., 2021)

The rain that occurred in the 35th week caused the humidity in the compost to increase. This causes the compost to fail in several biopore suction holes, because the moisture content exceeds the maximum limit. (Ng Lende et al., 2017). According to research from (Suwatanti & Widiyaningrum, 2017) high humidity will cause composting to be slow because the activity of microorganisms decreases, so that the nutrients in the compost will dissolve and the volume of the compost will decrease. Apart from that, humidity affects the development of microbes and influences changes in compost temperature. This decrease in microorganism activity causes the compost to produce an unpleasant and pungent odor

3.3. Water Content

Water content parameters were measured on samples on the 7th day, 14th day, 28th day and 42nd day using the gravimetric method. Observations of the water content of compost fertilizer can be seen in Figure 3

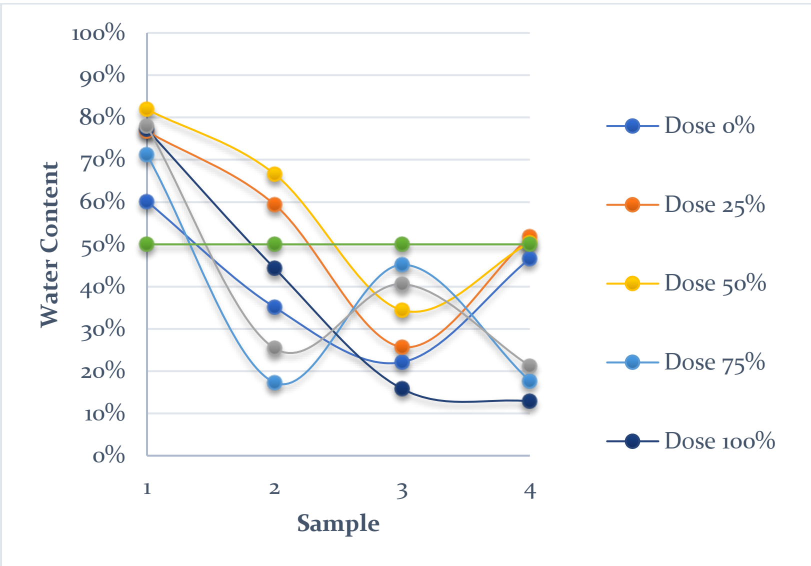

Figure 5. Results of observations of water content in foodwaste compost

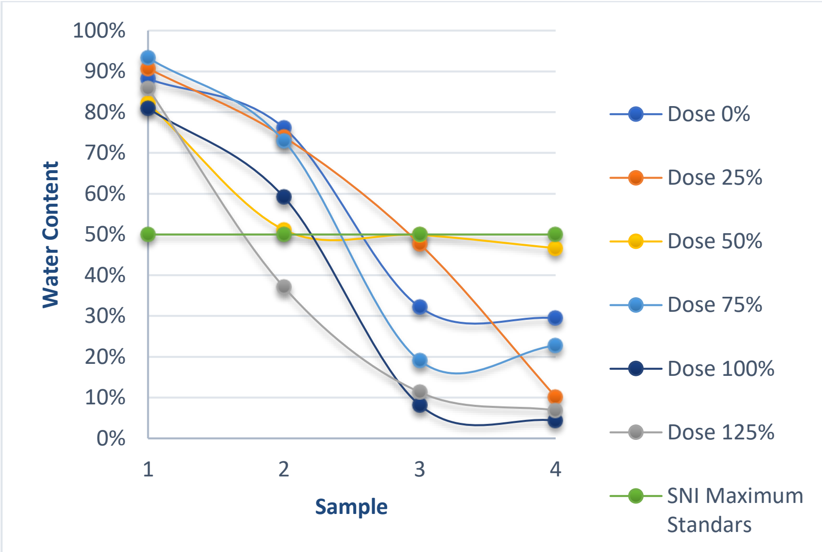

Figure 6. Results of observations of water content in vegetable compost

The water content at week 6 ranged from 4.36% - 51.80%. The lowest water content was found in LRB 11 in vegetable waste with an activator dose of 100%, while the highest water content was in LRB 2 in food waste with an activator dose of 25%. This water content is too low because organic waste is degraded by aerobic microbes. The aerobic decomposition process runs faster than anaerobic decomposition. In LRB 2 there is water in the LRB so the compost becomes wet and causes a high water content. This is influenced by environmental factors, including the slope of the land on the LRB and the type of soil. LRB 2 is in an area with a lower ground level. Apart from that, in the composting process there is an electron transport process which will produce water (H2O) thereby affecting the water content of the compost (Ditria Pribadi et al., 2018). From observations, good compost is compost that has a maximum water content of 50% (Mohamad et al., 2021). It can be concluded thay compost in LRB 2 and LRB 3 does not meet quality standards maximum moisture contents of 50% in accordance with SNI 19-7030-2004 concerning Compost Specifications from Organic Waste

3.4. Macro Nutrient

3.4.1. Carbon (C)

Carbon is the main component of organic matter. The higher the organic content in the compost or soil, the higher the Carbon content will be (GULTOM, 2024). Carbon in the soil is at least 2% (Jovita, 2018) Water content parameters were measured on samples on the 7th day, 14th day, 28th day and 42nd day using the gravimetric method. Observations of the water content of compost fertilizer can be seen in table 3:

Table 1. Results of Carbon (C) in compost waste

Time (Week)	C-ORGANIC												SNI quality standards (%)
	FOOD WASTE WITH MOL DOSE						VEGETABLE WASTE WITH MOL DOSE						
	0%	25%	50%	75%	100%	125%	0%	25%	50%	75%	100%	125%	
7	7.74	4.54	4.33	10.86	9.35	4.61	7.76	4.54	4.33	10.88	9.35	4.62	9,8
14	13.25	16.58	12.99	11.26	6.17	10.87	8.22	10.77	10.88	10.96	11.36	9.41	
28	10.49	10.92	11.32	10.60	11.35	10.18	10.36	8.91	9.76	8.53	8.84	8.15	
42	10.44	10.43	10.67	8.74	9.35	10.84	11.01	10.36	10.40	11.44	10.66	10.40	

From the results of observations of the carbon content in compost fertilizer which was observed for 6 weeks, values ranging from 8% – 11% were obtained. The lowest carbon content was 8.74% in food waste with a dose of 75% and the highest was 11.44% in vegetable waste with a dose of 75%. Low organic matter content in the soil can cause the soil to experience degradation both physically, chemically and biologically so that the soil will experience compaction (Jovita, 2018). These carbon observations show that carbon observations in food waste at doses of 75% and 100% do not meet the SNI19-7030-2004 quality standards because they are less than the quality standards. The type of vegetable waste with a dose of 75% also does not meet the standards because it exceeds the SNI19-7030-2004 quality standard

3.4.2. Nitrgogen (N)

Nitrogen is one of the nutrients contained in soil. The main function of nitrogen is in the process of forming proteins in plants. nitrogen also functions to form chlorophyll in plants, stimulate plant growth during the vegetative phase the formation of amino acids, enzymes, fats and other compounds (Jovita, 2018). Nitrogen (N) parameters were measured on samples on the 7th day, 14th day, 28th day and 42nd day. Observations of nitrogen (N) in compost fertilizer can be seen in table 2:

Table 2. Results of Nitrogen (N) in compost waste

Time (Week)	N-TOTAL												SNI quality standards (%)
	FOOD WASTE WITH MOL DOSE						VEGETABLE WASTE WITH MOL DOSE						
	0%	25%	50%	75%	100%	125%	0%	25%	50%	75%	100%	125%	
7	0.26	0.13	0.15	0.19	0.60	0.40	0.11	0.13	0.11	0.19	0.28	0.17	0,4
14	0.49	0.56	0.56	0.64	0.79	0.50	0.86	1.21	0.67	1.14	0.43	0.55	
28	0.59	0.62	0.29	0.55	0.53	0.51	0.34	0.42	0.26	0.60	0.58	0.35	
42	0.37	0.52	0.28	0.32	0.36	0.28	0.33	0.40	0.24	0.26	0.28	0.24	

The results of the total N content of compost showed that the lowest total N was 0.24 in vegetable waste with a molar dose of 50% and 125%, while the highest total N was 0.52 in food waste with a dose of 25%. The N value which increases and decreases during the composting process is caused by nitrogen (N) which is fluctuating. (Indasah & Muhith, 2020). These results show that the nitrogen (N) value in compost that meets the minimum quality standards of 0.4% in accordance with SNI 19-7030-2004 concerning Specifications for Compost from Organic Waste is compost with food waste with a molar dose of 25%.

3.4.3. Phosporus (P)

Phosphorus is an essential macro nutrient in compost fertilizer which is important for plant eventhough The phosphorus content in soil is not as high as nitrogen (N), potassium (K). Phosphorus functions for the formation of protein, as well as the formation of grains in plants (Aziz, 2013). Phosphorus is able to trigger the growth and development of plant roots and the formation of flowers (Ardiana et al., 2019). Phosphorus (P) parameters were measured on samples on the 7th day, 14th day, 28th day and 42nd day. Observations of Phosporus (P) in compost fertilizer can be seen in table 3:

Table 3. Results of Phosphorus (P) in compost waste

Time (Week)	PHOSPORUS												SNI quality standards
	FOOD WASTE WITH MOL DOSE						VEGETABLE WASTE WITH MOL DOSE						
	0%	25%	50%	75%	100%	125%	0%	25%	50%	75%	100%	125%	(%)
7	0.23	0.35	0.19	0.23	0.21	0.21	0.16	0.15	0.10	0.16	0.20	0.22	0,1
14	0.91	0.89	0.58	0.43	0.56	0.48	0.41	0.39	0.35	0.41	0.51	0.48	

Time (Week)	PHOSPORUS												SNI quality standards
	FOOD WASTE WITH MOL DOSE						VEGETABLE WASTE WITH MOL DOSE						
	0%	25%	50%	75%	100%	125%	0%	25%	50%	75%	100%	125%	(%)
28	0.55	0.74	0.25	0.33	0.24	0.25	0.18	0.19	0.14	0.13	0.23	0.22	
42	0.45	0.50	0.43	0.25	0.38	0.34	0.18	0.25	0.19	0.24	0.29	0.32	

From the results of observations, phosphorus in compost fertilizer exceeds the quality standards set by SNI 19-7030-2004 concerning Specifications for Compost from Organic Waste, namely 0.1%. Phosphorus is easily absorbed by plants at a pH of around 6-7. Phosphorus can be used as a medium for transporting energy from plant metabolism, triggering root growth, fruit formation, seed formation and plant flower formation, triggering plant cell growth, triggering cell division in plants, and enlarging cell tissue in plants. Lack of phosphorus in plants can result in slow plant growth and stunted plants. the phosphorus formation cycle can be seen that phosphorus comes from weathering (Jovita, 2018)

3.4.4. Potassium (K)

Potassium is the third macro nutrient absorbed by plants after nitrogen and phosphorus. The function of potassium for plants is to help plants during the process of photosynthesis, transport minerals, water, and assimilation results, increasing plant immunity against disease. Lack of potassium in plants can cause plants to become dark green, not fresh and wilt easily, brown spots on the leaves, dry and yellow leaf tips. (Jovita, 2018). Potassium (K) parameters were measured on samples on the 7th day, 14th day, 28th day and 42nd day. Observations of potassium (K) in compost fertilizer can be seen in table 4:

Table 4. Results of Potassium (K) in compost waste

Time (Week)	POTASSIUM (K)												SNI quality standards
	FOOD WASTE WITH MOL DOSE						VEGETABLE WASTE WITH MOL DOSE						
	0%	25%	50%	75%	100%	125%	0%	25%	50%	75%	100%	125%	(%)
1	0.03	0.04	0.02	0.03	0.03	0.03	0.02	0.02	0.01	0.02	0.02	0.03	0,2
2	0.11	0.11	0.07	0.05	0.07	0.06	0.05	0.05	0.04	0.05	0.06	0.06	
4	0.07	0.09	0.03	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.03	
6	0.06	0.06	0.05	0.03	0.05	0.04	0.02	0.03	0.02	0.03	0.04	0.04	

There are fluctuations in the potassium test results. In food waste waste doses of 0%, 25%, and 75% there was a decrease, while for the rest it remained the same and increased. From the research results, the lowest potassium data was obtained at 0.02% in vegetable waste with a molar dose of 0% and 50%, while the highest potassium yield was 0.06% in food waste with a control dose and a dose of 25%. Potassium deficiency in plants can cause plants to become dark green, not fresh and wilt easily, leaves with brown spots, dry and yellow leaf tips (Jovita, 2018). This shows that the potassium in the compost does not meet the minimum quality standard of 0.2% according to SNI 19-7030-2004 concerning Specifications for Compost from Organic Waste

3.4.5. C/N Ratio

The C/N ratio is the ratio between the elements carbon (C) and nitrogen (N). The ratio of compost fertilizer based on SNI is in the range of 10-20. Composting time can go hand in hand with the high C/N ratio. The higher the C/N ratio indicates that the element carbon (C) has not been completely oxidized to carbon dioxide (CO_2) and the element nitrogen (N) has not been eliminated maximally(Rahmawanti & Dony, 2014). C/N ratio were measured on samples on the 7th day, 14th day, 28th day and 42nd day. Observations of C/N ratio in compost fertilizer can be seen in table 5:

Table 5. Results of the C/N Ratio in Compost Waste

Time (Week)	C/N RATIO												SNI quality standards
	FOOD WASTE WITH MOL DOSE						VEGETABLE WASTE WITH MOL DOSE						
	0%	25%	50%	75%	100%	125%	0%	25%	50%	75%	100%	125%	
1	29.29	35.14	28.06	57.08	15.51	11.42	72.02	35.41	38.77	55.93	33.18	26.64	10 - 20
2	27.25	29.83	23.24	17.52	7.83	21.79	9.59	8.90	16.16	9.59	26.22	17.04	
4	17.79	17.47	39.11	19.27	21.23	20.09	30.44	21.41	37.13	14.21	15.18	23.01	
6	28.09	20.15	37.97	27.24	26.07	39.23	33.81	26.20	44.07	44.71	38.04	44.14	

An increase in carbon content from the 6th week to the 8th week of composting can reduce the amount of carbon used as an energy source for microbes to break down or decompose organic material. During the composting process, CO2 evaporation does not occur and this causes an increase in carbon (C) levels and a decrease in nitrogen (N) levels so that the C/N ratio of the compost increases. A C/N ratio that is too high will slow down the composting process(Widarti et al., 2015). There were fluctuations in the observed results of the C/N ratio. The lowest result was 20.15 for food waste with a mole dose of 25% and the highest was 44.71 for vegetable waste with a mole dose of 75%. This is caused by several factors, one of which is the compost which is too wet because on day 41 there was heavy rain. This affects the results of laboratory tests on compost fertilizer, especially the decrease in the nitrogen test from the 6th week and the 8th week, causing an influence on the C/N ratio. Therefore, it is necessary to reduce the C/N ratio before applying it to the soil. (Rahmawati & Dony, 2014) because the C/N ratio data does not yet meet the quality standards of 10-20 according to SNI 19-7030-2004 concerning Compost Specifications from Organic Waste.

3.5. Micro Nutrients

Nutrition in the soil is related to the activity of these nutrients which include macro nutrients and micro nutrients. Plants require micronutrients in small amounts. Micro nutrients include iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), and others. Micro nutrients are as important as macro elements in plants(Hasyyati et al., 2023). In this research, testing for micro nutrients includes the elements iron (Fe) and Zinc (Zn). Iron has benefits during plant physiological processes, during the process of photo synthesis and chlorophyll formation. The zinc element helps in the process of forming carbohydrates, forming root growth substances, and helping the formation of chlorophyll. (Pratiwi et al., 2017)

3.5.1. Iron (Fe)

Iron (Fe) is a micro nutrient that plants need in small amounts. Iron content that is too high will be toxic to plants(Ardiana et al., 2019). Low Fe content can be characterized by several symptoms, including: chlorosis (tissue damage or failure to form chlorophyll) on the leaves, especially young leaves, there are brown spots on the leaves, the plant becomes stunted(GULTOM, 2024)

The iron content in plants functions in plant metabolic processes (Ardiana et al. al., 2019). Low levels of Fe in the soil can cause high levels of minoacids in the leaves and a decrease in the number of ribosomes. (where protein formation takes place). This can cause incomplete protein formation and inhibit the formation of chlorophyll(Jovita, 2018). Iron (Fe) parameters were measured on samples on the 7th day, 14th day, 28th day and 42nd day. Observations of iron (Fe) in compost fertilizer can be seen in table 6:

Table 6. Results of Iron (Fe) in compost waste

Time (Week)	IRON (FE)												SNI quality standards
	FOOD WASTE WITH MOL DOSE						VEGETABLE WASTE WITH MOL DOSAGE						
	0%	25%	50%	75%	100%	125%	0%	25%	50%	75%	100%	125%	(%)
1	1.11	0.75	0.85	0.44	0.58	0.63	0.16	0.31	0.33	0.38	0.22	0.50	0-2
2	1.50	1.30	1.35	1.35	1.10	1.12	0.50	0.49	0.56	0.87	0.72	0.64	
4	1.16	1.48	0.69	0.49	0.24	0.69	0.99	0.60	1.13	0.76	0.46	0.44	
6	0.80	1.00	0.80	0.84	0.73	1.06	0.97	1.12	0.93	0.84	0.97	1.06	

From the final results of the research, it was found that the iron (Fe) content was the lowest at 0.073 in food waste with a mol dose of 100% and the highest was 1.06 in food waste and vegetable waste with mole dose of 125%. This shows that the iron content is still below the maximum quality standard of 2% according to SNI 19-7030-2004 concerning Specifications for Compost from Organic Waste. Iron that exceeds the threshold can inhibit root development and plant growth. This can also cause a decrease in crop production. The high iron content in the soil can be caused by several factors, including the organic material used in the compost making process (Shofiah et al., 2024). The compost from this research is still safe if applied to soil because the amount of iron content is still below the threshold.

This low of iron (Fe) content can be overcome by increasing the N (nitrogen), P (phosphorus) and K (potassium) content in compost fertilizer.(Juwita et al., 2018). The increase in nitrogen levels in composting is caused by a carbon degradation process, the higher the carbon reduction, the higher the nitrogen content. Adding bran to compost increase phosphorus levels. High levels of Nitrogen in the initial raw material for composting will usually produce compost with sufficient levels of Potassium and Phosphorus in the final results of composting (Noviana et al., 2023). plants with concentration high nitrates that can be used as raw materials for composting include: lettuce, beets, spinach, potatoes, fruits such as berries, nuts, and others (Dezhangah et al., 2022)

3.5.2. Zinc (Zn)

Zinc (Zn) parameters were measured on samples on the 7th day, 14th day, 28th day and 42nd day. Observations of Zinc (Zn) in compost fertilizer can be seen in table 7:

Table 7. Results of Zinc (Zn) in compost waste

Time (Week)	ZINC (ZN)												SNI quality standards
	FOOD WASTE WITH MOL DOSE						VEGETABLE WASTE WITH MOL DOSAGE						
	0%	25%	50%	75%	100%	125%	0%	25%	50%	75%	100%	125%	mg/Kg
7	0.00	0.04	0.00	-0.06	-0.01	-0.02	-0.04	0.03	-0.05	-0.02	-0.07	-0.04	0 - 500
14	-0.03	-0.03	-0.06	-0.07	-0.06	-0.07	-0.08	-0.06	-0.03	-0.08	-0.06	-0.02	
28	0.01	-0.04	-0.03	-0.01	0.10	0.05	0.04	0.10	0.14	0.11	0.22	0.29	
42	0.28	0.34	0.31	0.29	0.30	0.60	0.38	0.22	0.32	0.29	0.31	0.46	

The element zinc (Zn) is a micro nutrient in the soil that plays a role in plant growth. Zinc is needed in small quantities. Zinc content in soil is caused by several factors, including of acidity (pH). The higher the pH in the soil, the lower the content of micronutrients such as Zn, Fe, Cu, and others. (GULTOM, 2024). The research results found that the zinc (Zn) metal content was still below the quality standards of SNI 19-7030-2004 concerning Specifications for Compost from Organic Waste so it was still safe if applied to soil. In plants, the micro element zinc can be absorbed through the leaves. Zinc is absorbed by plants in the form of Zn^{2+} ions. According to SNI 19-7030-2004 concerning specifications for compost from domestic organic waste, the zinc content in the soil must not exceed 500 mg/kg. The high zinc content in soil can be caused by several factors, including the organic material used in the compost making process, and soil pH. The function of zinc in plants is as an activator of the anolase enzyme, an enzyme that catalyzes the glycolysis reaction (Jovita, 2018). The higher the soil pH, the lower the Zn content. Plants that lack zinc will result in plants becoming stunted, short stem segments, smaller leaves, necrosis (cell or tissue death), and chlorosis.

This low of zinc (Zn) content can be overcome by increasing the N (nitrogen), P (phosphorus) and K (potassium) content in compost fertilizer.(Juwita et al., 2018). The increase in nitrogen levels in composting is caused by a carbon degradation process, the higher the carbon reduction, the higher the nitrogen content. Adding bran to compost increase phosphorus levels. High levels of Nitrogen in the initial raw material for composting will usually produce compost with sufficient levels of Potassium and Phosphorus in the final results of composting (Noviana et al., 2023). According to (Dezhangah et al., 2022)plants with concentration high nitrates that can be used as raw materials for composting include: lettuce, beets, spinach, potatoes, fruits such as berries, nuts, and others.

4. Conclusion

From the research results, the degree of acidity (pH) of compost fertilizer ranges from 4.2 – 7.3, which indicates that compost fertilizer has weak acidic and neutral properties. The lowest humidity was observed on the 39th day of vegetable waste compost with an activator dose of 100ml and on the 40th day of vegetable waste compost with an activator dose of 25ml in the morning observation. Good compost fertilizer is compost that has a maximum water content of 50%. In the final results of composting, the macro nutrients carbon (C), sodium (N), phosphorus (P) meet the quality standards, while the potassium (K) and ratio (C/N) do not meet the quality standards. The micronutrients Fe and Zn in compost fertilizer are still below the SNI 19-7030-2004 threshold. Composting with activator doses of 25ml/L and 50ml/L does not meet quality standards in accordance with SNI 19-7030-2004 concerning Specifications for Compost from Organic Waste. So it can be concluded that the most effective activator dose is 100ml/L with vegetable waste because it is able to degrade organic waste quickly and the resulting compost meets the SNI 19-7030-2004 quality standards regarding Compost Specifications from Organic Waste

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