



Organic waste processing and its application to potato plants through hydroponic techniques



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Article Info

Article History:

Received 19 January 2021

Revised 20 February 2021

Accepted 06 April 2021

Published 30 April 2021

Keywords:

Waste

Organic

Fermentation

Hydroponic



ABSTRACT

The Kalimbu market is one of the traditional markets in South Sulawesi with a very high buying and selling activity. The organic waste that is mostly generated from the activities at the Kalimbu Market is leftover vegetables and fruit. Vegetable and fruit waste provides a big advantage if it is managed properly, which is converted into liquid organic fertilizer through a fermentation process. The liquid organic fertilizers produced can help farmers overcome the high price of synthetic fertilizers and save the earth from pollution. The method used to determine the effect of types of organic waste (vegetable waste and fruit waste) on the physical and chemical quality of solid and liquid organic fertilizers used a randomized block design. Whereas the application of solid and liquid organic fertilizers to the production and nutritional content of potato plants used a treatment consisting of P0: basic fertilizer + without liquid organic fertilizer and P1: basic fertilizer + liquid organic fertilizer. The results of research on the manufacture of liquid organic fertilizer from Kalimbu market waste with vegetable and fruit samples also showed that the two samples required different storage times for composting. Plants treated with liquid organic fertilizer from the Kalimbu market waste have better stem growth, leaf number, and stem number.

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Citation: Irmawanty, Safitri, D, Rukman, W.Y., & Syam, H. (2021). Organic waste processing and its application to potato plants through hydroponic techniques. *JPBIO (Jurnal Pendidikan Biologi)*, 6(1), 84-95. DOI: <https://doi.org/10.31932/jpbio.v6i1.I040>

INTRODUCTION

Horticulture comes from Latin, namely Hortus (garden) and Colere (grow). Horticulture means the study of science garden cultivation. Horticulture is the dealing branch of agriculture with intensive cultivation of plants proposed for human food medicine and fulfillment of satisfaction (Zulkarnain, 2009). Horticulture is the cultivation of agricultural plants, especially fruit, vegetables, flowers, and ornamental plants. According to the Ministry of Agriculture, which

consists of vegetable crops, fruit plants and medicinal plants is a group of agricultural commodities which have a meaning and position in the process of national agricultural development.

The very high buying and selling activity in the Kalimbu market has an impact on the decline in the quality of the environment in the Kalimbu area and its surroundings due to a large amount of waste production, both inorganic and organic types. Organic waste such as vegetable and fruit waste looks very dominant when compared to inorganic types of waste, causing unpleasant odors and this will have an impact on health. The odor of organic waste comes from the activity of the organism which performs the process of decomposition and produces gas which is easily diffused through the air. In addition to producing gas, piles of organic waste can attract insects, such as flies, which can cause various types of diseases to the digestive system. Organic waste is more easily broken down by the activity of microorganisms so that it can be utilized through the fermentation process (Nur, Noor & Elma, 2016).

Fermentation is a chemical change process, from complex compounds to simpler ones with the help of enzymes produced by microbes (Jay, Loser & Golden, 2005). The fermentation process will cause the decomposition of organic compounds to produce energy as well as the conversion of the substrate into new products by microbes (Madigan, David, Clark & John, 2011). Fermentation is carried out on a food ingredient to obtain new food products that can extend shelf life (Farnworth, 2008). The results of the 2017-2018 survey at 3 temporary waste disposal points (PLS) of the Kalimbu market, found data that vegetable and fruit waste was the most dominant. This is because the fruit is an organic material that is prone to decomposition, while vegetable waste comes from vegetable residues, such as root pieces or whole vegetables that have been damaged due to not being sold.

During the fermentation process, heat will be generated which is an indicator that the activity of microorganisms is going well. In addition to producing heat, water is also produced during the fermentation process so that the resulting fertilizer looks moist and wet (Yumas & Rosniati, 2014). The fermentation process is finished, if there is a decrease in temperature of the fermented material to room temperature (27 °C) and the fertilizer product is produced crumbs (for solids) and does not smell strong (liquid fertilizer) (Purwasasmita, 2009).

The existence of organic fertilizers produced from Kalimbu market waste is a solution to overcome the high cost and scarcity of synthetic fertilizers. Besides, it also reduces the waste problem that has accumulated in the Kalimbu market. Like synthetic fertilizers, organic fertilizers from Kalimbu market waste are very good for spurring growth and crop production, especially horticultural crops. Organic fertilizers have the advantage of containing growth hormones that are useful for plant growth and productivity, increase nutrient absorption and increase plant resistance to pests and diseases, stimulate root growth, stabilize soil pH, maintain soil fertility, add useful soil microbes and improve soil structure. (Murdaningsih, Supardi & Peke, 2020).

Organic waste is defined as material that is discarded because it is no longer used, for example, dirt, leaves, and paper or natural materials available in nature that can damage or imbalance a natural ecosystem (Sofian, 2006). Jutono (2012), defines organic waste as materials or materials that temporarily cannot be used anymore and must be disposed of or destroyed. The materials that can be used to become more useful and profitable materials for the people who use them. Cattelan, Hartel & Fuhrmann, (2018) Stated that organic waste is a material waste from human activities and natural processes that do not have economic value (Cattelan et al. 2018; and Saraswati, Goenadi, Damardjati, Sunarlim, Simanungkalit & Suparyani, 2018), defining organic waste as a resource that is not ready to use and with a touch of simple technology, the organic waste can provide benefits and uses for the community. Examples of organic waste are leaves or litter, paper, wood, coconut shells, and various other types of plants that act as sources of pollutants for nature.

Based on the source, organic materials can be divided into three, namely: natural organic, human organic, and consumption organic. Natural organic waste is an organic waste produced in the wild which is integrated through natural recycling processes, such as dry leaves and all types of plants that are sources of pollution to the environment such as water hyacinths, *Limnocris flava* plants, and several other plants. Organic human waste (human waste) is a term commonly used for human digestive products such as feces and urine. Organic human waste can be a danger to health because it can be used as a vector for diseases caused by viruses and bacteria.

Organic fertilizers are fertilizers that mostly or entirely consist of organic matter derived from plants or animal manure which has been through an engineering process, which can be solid or liquid which is used to supply organic material to improve the physical, chemical, and biological properties of the soil. According to Purwasasmita (2009), organic fertilizer is the final result of the breakdown of parts or remains of plants and animals (living things) such as manure, green manure, compost, meal, guano, and so on. The process of breaking down organic compounds by bacteria into the fertilizer can be described as follows (Purwasasmita, 2009).

The continuous reduction of land that occurs as a result of increasing population and lack of housing results in land conversion. The conversion of functions resulted in a reduction in planted land, while the growth of agricultural products was not as fast as the population growth, causing a shortage of food needs. Indonesian farmers who prefer to use conventional methods of farming have caused insufficient food needs. Farmers use conventional farming methods that use large areas of land to cultivate crops. This is different from the hydroponic system (Sutiyoso, Karsono & Sudarmodjo, 2006). Hydroponics is a method of farming using planting media other than soil, such as pumice stone, gravel, sand, coconut husk, pieces of wood, or foam. This is done because the function of the soil as support for plant roots and as an intermediary for nutrient solutions can be replaced by flowing or adding nutrients, water and oxygen through the media (Roidah, 2014; Ilhamdi, Khairuddin & Zubair, 2020).

RESEARCH METHODS

Research Design

Effect of types of organic waste (vegetable waste and fruit waste) on the physical and chemical quality of solid and liquid organic fertilizers using a randomized block design. Whereas the application of solid and liquid organic fertilizers to the production and nutritional content of potato plants used a treatment consisting of P0: basic fertilizer + without liquid organic fertilizer and P1: basic fertilizer + liquid organic fertilizer. The research implementation procedure was carried out through the process of making liquid organic fertilizer, then applying liquid organic fertilizer through hydroponic techniques (Table I).

Table I. Design of quality of solid and liquid organic fertilizer

Treatment	Group														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15
B	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15

Information:

A = Vegetable waste

B = Fruit waste

Population and Samples

The population is all waste in the Kalimbu market in Makassar City. The samples used as material in this study were vegetable and fruit waste.



Instruments

The instrument in this study was organic waste which was taken at two predetermined points in the Kalimbu market, separated according to its type, namely: vegetable waste and fruit waste, vegetable waste chopped until smooth using a machete or using a crusher. Vegetable waste is added with water (1 waste: ½ water). EM-4 as much as 250 ml / 10 kg of waste and 100 ml of molasses / 10 kg of waste. Put in the fermenter tube.

Procedures

Organic waste taken at two predetermined points in the Kalimbu market is separated according to its type, namely: vegetable waste and fruit waste. The minimum weight of each waste taken is 10 kg. Waste is cleaned of dirt which can hinder the chopping process. The dirt in question is a mixture of plastic, cans, or glass. Vegetable waste is chopped until finely by using a machete or using a crusher with a capacity of 5 kg. Vegetable waste is added with water (1 waste: ½ water) then let stand for 20 minutes. Provide additional EM-4 of 250 ml / 10 kg of waste and 100 ml of molasses / 10 kg of waste. Put into the fermenter tube which is equipped with a filter canister in the middle to separate the solids from the waste liquid. The top surface of the tube is covered with a gunny sack. Doing stirring once a day using a spade. Measuring the temperature of the fermentation process and conducting an examination of the condition of the waste after 20 days of fermentation. After the fermentation process is complete (temperature drops to 27 °C), the solid and liquid fertilizers are separated. Liquid fertilizer can be obtained directly by opening the faucet on the fermenter tube, while solid fertilizer can be removed from the fermenter through the top of the tube. To test the physical and chemical quality of each type of fertilizer (solid and liquid) produced. As with the procedure for making solid and liquid fertilizers from vegetable waste, fruit waste that has been crushed is then added with water (1 waste: ¼ water) then let stand for 20 minutes. Give additional EM-4 and molasses with the same amount at point "6". Follow steps "7" to "11. The fertilizers produced from these two types of waste are then applied to horticultural crops (mustard greens, chilies, and tomatoes) through hydroponic techniques.

Data Analysis

The data analysis in this study was carried out descriptively which included observing the maturity of liquid fertilizer as seen from the research parameters (temperature, color, texture, smell). This observation is carried out every day. Meanwhile, the observation of the application of liquid fertilizer on potato plants was seen from the parameters (plant height, number of leaves, and number of stems). The data and results obtained were analyzed and presented in tabular form. The data collected during the study were analyzed descriptively to see the ratio of liquid fertilizer from vegetable and fruit waste.

RESULTS

The Research Team conducted outreach and coordination with traders in the Kalimbu market regarding research information on the organic waste from the Kalimbu market which will be used as a basic ingredient in the manufacture of liquid organic fertilizers. This socialization and coordination are very important because they can assist researchers in obtaining the organic limb of the Kalimbu market. In this study, the manufacture of organic fertilizers was not carried out on a large scale because of the limited funds provided by the Institute for Development and Community Service Research (LP3M) Unismuh Makassar.

Duration of maturity of Kalimbu Market's Liquid Organic Fertilizer

From the observations that have been made about the maturity time of liquid organic fertilizers, it can be seen from the measurement of temperature, color, texture, and smell of liquid organic fertilizers which can be seen in [Figure 1](#).

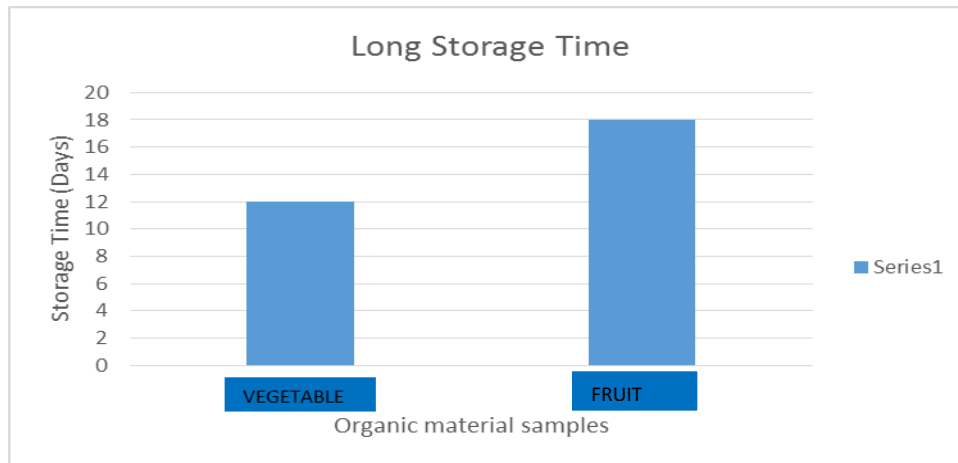


Figure I. Average length of time (days) of maturity of liquid organic fertilizer from the Kalimbu market

Based on [Figure I](#), it can be explained that the time of organic vegetable waste has a shorter maturity period of 12 days while fruit organic waste has a longer maturity period, which is around 18 days (3 weeks). Physical factors that affect the maturity of the Liquid Organic Fertilizer from the Kalimbu Market Waste.

a. Temperature

Measurement of temperature was carried out for 18 days for fruit organic waste and 12 days for vegetable organic waste. The results of temperature measurements that have been carried out can be seen in [Table 2](#).

Table 2. Average temperature parameters of liquid organic fertilizer

Storage Time (Days)	Sampel °C	
	Vegetables	Fruit
1	30.5	30.6
2	30.5	30.9
3	30.9	31.3
4	30.9	31.5
5	31.0	31.5
6	31.2	31.9
7	31.3	32.2
8	30.5	32.4
9	30.0	32.5
10	29.3	31.5
11	28.7	31.5
12	28.1	30.1
13		29.5
14		28.0
15		28.3
16		28.3
17		28.2
18		28.2

Based on [Table 2](#), observations related to temperature parameters during storage show that the temperature of the two types of samples (vegetable waste and fruit waste) has increased. For vegetable waste samples on the 1st to the 7th day, the temperature increased, but the temperature began to decrease on the 8th to the 12th day. Meanwhile, the fruit waste sample experienced an increase in temperature from day 1 to day 9 but had a decrease in temperature on day 10 to day 18.

b. Color

Color observation on liquid organic fertilizers was carried out for 18 days for fruit organic waste and 2 days for vegetable organic waste. The color observation results can be seen in [Table 3](#).

Table 3. Data from color observation of liquid organic fertilizers

Storage Time (Days)	Sample	
	Vegetables	Fruit
1	Green	Brownish Yellow
2	Green	Brownish Yellow
3	Green	Brownish Yellow
4	Yellowish Green	Brownish Yellow
5	Yellowish Green	Brownish Yellow
6	Brownish Yellow	Brownish Yellow
7	Brownish Yellow	Brownish Yellow
8	Brownish Yellow	Brownish Yellow
9	Brownish Yellow	Chocolate
10	Brownish Yellow	Chocolate
11	Brownish Yellow	Chocolate
12	Brownish Yellow	Chocolate
13		Chocolate
14		Chocolate
15		Blackish Chocolate
16		Blackish Chocolate
17		Blackish Chocolate
18		Blackish Chocolate

Based on [Table 3](#), it can be explained that the two samples (vegetable waste and fruit waste) change color. Color observation of vegetable organic waste changes the same color on day 1 to day 3, namely green. Then on day 4 and 5 experience a yellowish-green discoloration, while on the 6th to 12th day the color changes to brownish-yellow.

Observations on fruit organic waste samples also changed, namely brownish-yellow from day 1 to day 8. From the 10th day to the 14th day the organic waste samples again experienced a brown color change, then on the 15th day to the 18th day, they changed color to blackish brown.

c. Texture

Texture observations on liquid organic fertilizers were carried out for 18 days for fruit organic waste and 2 days for vegetable organic waste. The texture observation results can be seen in [Table 4](#). Based on [Table 4](#), related to the observation of the texture of liquid organic fertilizers from samples of organic vegetable waste and fruit organic waste, different decomposition processes occur. Vegetable waste on day 1 and day 2 of organic vegetable samples has not been decomposed.

However, on the 3rd to 7th day, it starts to break down roughly. From the 8th day to the 11th day it starts to decompose finely and on the 12th day it has broken down the liquid.

As for organic waste, the fruit undergoes a slow decomposition process. Where on day 1 to day 6 the organic fruit samples have not been decomposed. From the 7th day until the 13th day it starts to break down roughly. However, from the 14th day until the 17th day it has broken down smoothly and began to decompose liquid on the 18th day.

Table 4. Observation data on the texture of liquid organic fertilizers

Storage Time (Days)	Sample	
	Vegetables	Fruit
1	Not Unraveled	Not Unraveled
2	Not Unraveled	Not Unraveled
3	Unraveled Roughly	Not Unraveled
4	Unraveled Roughly	Not Unraveled
5	Unraveled Roughly	Not Unraveled
6	Unraveled Roughly	Not Unraveled
7	Unraveled Roughly	Unraveled Roughly
8	Unraveled Smoothly	Unraveled Roughly
9	Unraveled Smoothly	Unraveled Roughly
10	Unraveled Smoothly	Unraveled Roughly
11	Unraveled Smoothly	Unraveled Roughly
12	Decompose Liquid	Unraveled Roughly
13		Unraveled Roughly
14		Unraveled Smoothly
15		Unraveled Smoothly
16		Unraveled Smoothly
17		Unraveled Smoothly
18		Decompose Liquid

d. Smell

Odor observations on liquid organic fertilizers were carried out for 18 days for fruit organic waste and 2 days for vegetable organic waste. The results of odor observations can be seen in [Table 5](#). Based on [Table 5](#), odor observations on organic vegetable samples and organic fruit samples indicate a change in odor. On the organic vegetable waste on day 1 to day 7, it smells foul, but on day 8 to day 12, there is a decrease in the foul odor. As for the organic waste, the fruit experienced three odor changes, namely foul-smelling, slightly foul-smelling, and odorless which occurred on the 18th day.

The observation result of plant height in [Table 6](#) shows that there is a difference in the yield of plant height. This difference is accompanied by different types of fertilizers. The liquid organic fertilizer treatment showed that the plant height produced was the highest, namely 0.25 at 5 days, 0.95 at 10 days, 1.29 at 15 days, and 15.29 at 20 days.

The results of observing the number of potato leaves in [Table 7](#) show that there is a difference in the results of the number of leaves. This difference is accompanied by different types of fertilizers. In the liquid organic fertilizer treatment, it showed that the number of leaves produced was the highest, namely 2 at the age of 10 days, 5 at the age of 15 days, and 7 at the age of 20 days.

The results of observing the number of stems in [Table 8](#) show that there is a difference in the yield of plant height. This difference is accompanied by different types of fertilizers. The liquid

organic fertilizer treatment shows that the number of plant stems produced is 2 at 10 days of age, 4 at 15 days of age, and 5 at 20 days of age.

Table 5. Observation data on the texture of liquid organic fertilizers

Storage Time (Days)	Sample	
	Vegetables	Fruit
1	Smells bad	Smells bad
2	Smells bad	Smells bad
3	Smells bad	Smells bad
4	Smells bad	Smells bad
5	Smells bad	Smells bad
6	Smells bad	smells a bit foul
7	Smells bad	smells a bit foul
8	Smells a bit foul	Smells a bit foul
9	Smells a bit foul	Smells a bit foul
10	Smells a bit foul	Smells a bit foul
11	Smells a bit foul	Smells a bit foul
12	Smells a bit foul	Smells a bit foul
13		Smells a bit foul
14		Smells a bit foul
15		Smells a bit foul
16		Smells a bit foul
17		Smells a bit foul
18		No smell

Table 6. Potato plant height in the treatment of basic fertilizers and liquid organic fertilizers

Treatment	Plant height (cm) at age (days)			
	5	10	15	20
P0	0.2	0.73	1.03	12.85
PI	0.25	0.95	1.29	15.29

Table 7. The number of potato leaves plants in the basic fertilizer treatment and liquid organic fertilizer

Treatment	Number of leaves (strands) at age (days)			
	5	10	15	20
P0	0	1	4	5
PI	0	2	5	7

Table 8. The number of potato stems on the treatment of basic fertilizers and liquid organic fertilizers

Treatment	Number of stems (fruit) at age (days)			
	5	10	15	20
P0	0	1	3	4
PI	0	2	4	5

DISCUSSION

Liquid fertilizer is a solution that contains one or more carrier elements needed by plants that are easily dissolved. The advantage of liquid fertilizer is its ability to provide nutrients

according to plant needs. Liquid organic fertilizers have several benefits, including being able to encourage and increase the formation of leaf chlorophyll thereby increasing the ability of plant photosynthesis and absorption of nitrogen from the air, increasing plant vigor so that plants become strong and strong, increasing plant resistance to drought, stimulating the growth of production branches, increasing formation flower and ovule, reduce the fall and, flower, and ovule (Huda, 2013; Febrianna, Priyono & Kusumarini, 2018).

Duration of maturity of Liquid Organic Fertilizer from Kalimbu Market Waste

Based on observations that have been made with two types of Kalimbu market waste, namely organic vegetable waste and fruit organic waste. Regarding the length of time for the maturity of liquid organic fertilizers from two organic wastes from the Kalimbu market, it shows that the longest time required for liquid organic fertilizer to mature is for the fruit which occurs for 18 days. This is because the organic waste of the fruit which will be used as liquid organic fertilizer is taken along with the skin so that it takes a long time for the storage process to ripen liquid organic fertilizer, while for the organic vegetable waste it has a faster time in the storage process for the maturation of liquid organic fertilizer, which is only averages of 12 days. Liquid organic fertilizer that has been ripe/finished, which shows a change in the color of the two types of waste, the texture of the basic material is liquid and odorless. The two types of waste observed in this study indicate that not all samples are cooked at the same time, because of different sources of basic materials, there are basic ingredients that are very biodegradable and not, as well as the water content contained in the waste. This shows that vegetable waste contains more water and microorganisms so that the composting process runs faster when compared to the fruit waste that is taken and its skin.

According to Amrullah (2015), market vegetable waste is material that is discarded from efforts to improve the appearance of vegetables to be marketed. Vegetable waste usually consists of materials that contain a lot of water, so that they rot easily and quickly.

Liquid organic fertilizer (MOL) is a liquid containing microorganisms (bacteria) that are useful for plants such as *Rhizobium sp*, *Azospirillum sp*, *Acetobacter sp*, *Pseudomonas sp*, *Bacillus sp*, and phosphate solubilizing bacteria and is the result of self-production from natural materials around us (local). This natural material is a preferred place as a medium for living and developing microorganisms which are useful in accelerating the destruction of organic matter (decomposers) or as additional nutrients for plants (Rahayu, 2016). MOL can be used as liquid organic fertilizer, as a decomposer or a source of compost, and as a natural pesticide. According to the research results, giving mole as MOL can fertilize red spinach plants (Latifah & Winarsih, 2012).

Application of Organic Liquid Fertilizer from Kalimbu Market Waste for Potato Plants

The application of liquid organic fertilizer from the Kalimbu market limba is applied simply to hydroponic plants and gives visible results, especially on plant height, number of leaves, and number of plants.

Plant height

The results of the analysis of potato plant height data on hydroponic plants showed differences with hydroponic plants that were not given liquid organic fertilizers from the waste from the Kalimbu market. This is by the results of research by Karamina & Fikrinda (2016), the use of liquid waste or liquid organic fertilizers on potato plants can minimize the occurrence of soil damage and as a source of energy and food for microorganisms in the soil. The use of liquid organic fertilizers is also able to add nutrients so that the nutrient cycle in the soil will be good.

This is indicated by the increased production of cultivated potato plants, especially in increasing plant height.

Number of leaves

The results of observing the number of leaves on hydroponic plants also showed that there were differences in the results of the number of leaves. This difference was accompanied by the different types of POC that were applied and the different dosages applied. According to Rao (2004) that the application of liquid organic fertilizers to plants can accelerate the synthesis of amino acids and proteins, thereby accelerating the growth of the number of plant leaves. Liquid organic fertilizers can also accelerate leaf growth if applied in high concentrations but with regular administration (Suwandi & Nurtika, 1987).

Number of Stems

Giving liquid organic fertilizer to hydroponic plants also gave results that were significantly different from plants that were not given hydroponic fertilizer from the number of stems. According to Indrakusuma (2000), the application of liquid organic fertilizer which is complete in its nutrient content will cause different synthetic growth rates. The application of liquid organic fertilizers to potato plants is expected to accelerate the synthesis process of amino acids and proteins, thereby accelerating plant growth. This is by the opinion of Rao (2004) who states that liquid organic fertilizers containing streptomycetes microorganisms contain potassium which plays an important role in every process of plant metabolism and plays a role in maintaining maximum turgor pressure, thus enabling metabolic processes and ensuring elongation of cells in the stem.

CONCLUSION

From the research that has been carried out, namely the manufacture of liquid organic fertilizer from Kalimbu market waste by using bio-activator EM4, the analysis results obtained from the analysis of liquid organic fertilizers which contain nitrogen. From the liquid organic fertilizer from Kalimbu market waste with vegetable and fruit samples, it was also concluded that the two samples require different storage times for composting. Vegetable waste has a composting time of 12 days and is faster than fruit waste which has a composting time of about 18 days. Plants treated with liquid organic fertilizers from Kalimbu market waste have better stem growth, leaf number, and number of stems.

ACKNOWLEDGMENT

Thank you for the research funds that have been given by the Research Institute for Development and Community Service (LP3M) the Muhammadiyah University of Makassar.

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