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Research article

Characteristics of Liquid Organic Fertilizer Made from Milkfish Viscera (*Chanos chanos* Forsskal) at Differents Long Time Fermentation

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Abstract

Fish viscera contains nutrients consisting of protein, lipid, and minerals that can be used to stimulate plant growth. Milkfish visceral waste is one type of material that can be used as organic fertilizer. The aim of this research was determining the effect of different fermentation times on the liquid organic fertilizer derived from milkfish viscera waste on the growth rate of purple eggplant (*Solanum melongena*). Samples of milkfish viscera were reduced in size using a blender. The milkfish viscera were cooked to a temperature of 100°C was done to sterilize microbes. Homogenization was also carried out with the addition of water (1:2), 5% molasses, and *Trichoderma* sp. at a concentration of 100 g/L. The fermentation process was conducted for 7 days, 10 days, 13 days, and 16 days, respectively. ANOVA analysis and Tukey's test revealed that different fermentation durations resulted in significant differences in pH, yield, c-organic, nitrogen, potassium, plant wet weight, root length, plant height, number of leaves, leaf width and stem diameter but did not significantly differ in phosphorus. A duration of 16 days yielded the highest values for pH (5.80), c-organic (4.46%), nitrogen (0.34%), phosphorus (0.06%), potassium (0.59%), plant wet weight (58.67 grams), root length (36.50 cm), plant height (25.67 cm), number of leaves (10.00), leaf width (15.07 cm), and stem diameter (8 .00 mm).

Keywords: Eggplant, liquid organic fertilizer, milkfish viscera, *Trichoderma* sp.

1. Introduction

The development of the fishing industry is currently increasingly rapidly, because it is supported by the large potential of fisheries resources in Indonesia. In the processing industry and household use of fish, many parts of the fish are discarded, such as the head, tail fins, bones and viscera, which ultimately causes waste. According to data the Ministry of Maritime Affairs and Fisheries in 2019, Indonesia fisheries production resulted 30%-40% of waste or up to 8.6 million tons and around 2 million tons of this waste is discarded as unused waste. The potential for fish waste is so large, it would be a decline in the quality since it could cause a foul smell and disturb the environment. Soft-boned milkfish product is a one famous food icon traditional from Semarang, Central Java Indonesia. Based on the data Semarang City Central Statistics Agency in 2019, the number of processed milkfish products in the city of Semarang reached 3000 tons per year. Increasing soft-bone milkfish production, the more milkfish viscera waste produced. So far, milkfish viscera have not been utilized optimally, even though fish viscera have quite high nutritional content such as ash 0.24%, fat 20.40% and protein 14.89% (Nurhayati *et al.,* 2022). Hence, milkfish viscera was potential to be used as liquid organic fertilizer (Suartini *et al.,* 2018). Furthermore, fish waste contains many nutrients, namely N (nitrogen), P (phosphorus) and K (potassium) which are components of liquid organic fertilizer.

Liquid organic fertilizer is a solution obtained from the decomposition of organic materials. The Central Bureau of Statistics (BPS) Agricultural Census 2019 reported that the pattern of fertilizer use by rice farmers in Indonesia is almost dominated by inorganic fertilizers. Farmers who use inorganic fertilizers are 86,41%, while those who use balanced fertilizers (organic and inorganic) are 13,5% and those who utilize organic 0,07%. Excessive use of inorganics can kill various living creatures including microbes which are very beneficial for improving soil fertility and can cause the extinction of animal populations which are predators of insect pests. Agricultural technology that guarantees food safety is organic agricultural technology, namely the use of technology that comes from nature, such as the use of Liquid Organic Fertilizer. Based on Muhammad and Madaniyah (2015), the use of organic fertilizer produces fresh vegetable products which can increase plant resistance, while ensuring that the fresh vegetable products produced are safe for consumption by consumers.

The liquid organic fertilizer fermentation process is generally carried out for 30 days (Zahroh *et al.,* 2018). The long time fermentation can be accelerated by *Trichoderma* sp bioactivator and providing molasses as a source of nutrition. *Trichoderma* sp. is a group of fungi that plays a role as a decomposer of organic material in making liquid organic fertilizer. Apart from being a decomposer, *Trichoderma* sp. It also has the ability to protect plants from attacks by soil-borne pathogens and increase plant growth (Apzani *et al.,* 2017). Various organic compounds in liquid organic fertilizer produced by *Trichoderma* sp. plays a role in stimulating growth, accelerating the flowering process, increasing the biosynthesis of biochemical compounds, inhibiting pathogens, and increasing the production of secondary metabolite compounds (Lehar, 2012). The aim of this research was to determine the effect of different fermentation time on liquid organic fertilizer made from milkfish viscera waste to the growth rate of purple eggplant (*Solanum melongena*).

2. Materials and Methods

2.1 Raw Material Preparation

The Fresh viscera (without a rotten odor) cleaned from blood and dirt stuck to the fish's stomach with method wash fish viscera then mashed fish viscera with using a blender (Suartini *et al.,* 2018). After mashing, fish viscera was cooked until temperature 100°C to sterilize microbes contained inside it. If fish viscera were already cold, water was added with comparison fish viscera and water, namely 2:1 until forming a uniform slurry of the fish viscera. The purpose of adding water to fish viscera was to make it fertilizer organic in the normal level of pH.

2.2 Microbial Preparation

Isolated mold *Trichoderma* sp. Was cultured on Potato Dextrose Agar (PDA) media dissolved with aquadest. The media was then heated on a hot plate until it boiled and then poured into a petri dish. The tools and media used were sterilized using an autoclave at 121°C with a pressure of 1 atm for 15 minutes. After sterilized the *Trichoderma* sp. was inoculated into the PDA medium for 7 days. The culture of *Trichoderma* sp. reactivated with solid media, namely 100 grams of ground corn. The material of ground corn that has been given *Trichoderma* sp culture. Left for 7 days for the fungal growth process (Dewi, 2019).

2.3 Process for Making Liquid Organic Fertilizer

Slurry the viscera in liquid form already obtained homogenized with add molasses 5% concentration and *Trichoderma* sp 100 g/L. Formulation fertilizer was places in to jerry cans for the fermentation process. The processing was carried out in a way aerobic with system circulation closed use an aerator. Closed circulation was carried out to avoid contamination by pathogenic bacteria from the open air. The length time of fermentation liquid organic fertilizer process was carried out based on the treatments of this research, namely 7 days (A), 10 days (B), 13 days (C), and 16 days (D).

The tests on the growth rate of purple eggplant (*Solanum melongena*) plants which consisted on plant wet weight, length of root, plant height, number of leaves, leaf width and stem diameter were carried out on the plantation land of the Agricultural Technology Research Institute, Central Java. The ingredients used in this research were milkfish viscera obtained from UD. Putri Laut, Semarang City, Central Java. Fungal isolate *Trichoderma* sp. in slanted agar form obtained from BPTPHP (Food Crop Protection, Horticulture and Plantation Center) Ungaran, Central Java. Molasses in liquid form is obtained at the Bu Maya Flower Shop, Semarang City, Central Java. The equipment used were destructor (Pyrex, Indonesia), distillator (Pyrex, Indonesia), set of distillation tube (Pyrex, Indonesia), spectrophotometer (visible spectrophotometer 721, China), flamphotometry (Shimatzu, Japan), pH meter (TDS-3, China), autoclave (Gea 18L, Indonesia), incubator (Memmert, Germany).

2.4 pH (AOAC, 2002)

The pH test procedure was carried out using a pH meter. Liquid samples were measured using a pH meter which had previously been calibrated using a buffer solution with pH 4.0 and pH 7.0. The pH value can be seen after the scale needle was in a constant position.

2.5 Yield (AOAC, 1995)

Liquid organic fertilizer yield testing is carried out by determining the ratio of the final weight (B) of the product produced to the initial weight of the material used (A). The resulting yield value shows the effectiveness of the fermentation process or decomposition of organic material in liquid organic fertilizer. Yield fertilizer organic liquid obtained with formula as following:

Yield = B/A x 100%

2.6 C- Organic (AOAC, 2002)

The test procedure refers to the Walkey and Black method (AOAC, 2002) in which sample was destructed using $K_2Cr_2O_7$ with a concentration of 1N and concentrated H_2SO_4, then dilute using distilled water. The sample that has been destroyed and diluted was then cooled, after the cooling process, the volume is adjusted to exactly the 100 ml mark. The next step is measuring the sample with a spectrophotometer with a wavelength of 561 nm. The calculation of C-Organic concentration of liquid organic fertilizer is as follows:

C-Organic content (%) = ppm curve x 100/mg sample x 100ml/1000ml x correction factor

2.7 Nitrogen (AOAC, 1995)

Nitrogen testing is carried out based in the form of destruction, distillation and titration. The organic N and N-NH_4 contained in the sample are destroyed with sulfuric acid and selenium mixture to form ammonium sulfate, then distilled by adding excess base and finally the distillate is titrated. Nitrogen in the form of nitrate is extracted with water, which is then reduced with devarda alloy, distilled and finally titrated.

2.8 Phosphorus (AOAC, 2002)

The P_2O_5 was carried out using concentrated HNO_3 and concentrated HClO heated at high temperatures. The clear extract was taken and added with distilled water, 2N HNO_3 and Vanadate solution then left for 30 minutes and observed on a spectrophotometer at a wavelength of 650 nm, where

77= (a + bx) × dilution

P_2O_5 (%) = P × 2.2914 where

a = mL of titrant examples and blanks, bx = normality solution standard HNO_3

a = weight equivalent Phosphor, 2.2914 = conversion to %

2.9 Potassium (AOAC, 2002)

Potassium concentration measurements were carried out based on the Flamephotometry method (AOAC, 2002). K_2O measurements were carried out using concentrated HNO_3 and concentrated HClO heated at high temperatures. Then the clear extract was taken and added with distilled water, HNO_3 2N, vanadate solution, then observed on a flamephotometer and compared with the standard solution (0; 5; 10; 15; 20 ppm).

K (%) = ppm curve x ml 1000 mL extract −1 x 100 mg sample −1 x dilution factor x correction factor

2.10 Planting and Fertilizing

Seedlings plant eggplant purple (*Solanum melongena*) which has obtained from Plant Depot Decorate SAE Agrofarm moved to in panting media polybag. The planting media used was husk rice and land with ratio 1:1. Planting media mixture was three of the four fully entered into the poly bag with size 30 cm x 30 cm. Planting done with method put seeds eggplant purple to part middle poly bag with amount one plants on each poly bag. The fertilization process is done with method give fertilizer organic liquid from waste milkfish viscera in each treatment with method watering at the roots. Before application to plants, liquid organic fertilizer is diluted 10 times first. Liquid organic fertilizer was sprinkled on purple eggplant plants every 2 days in the afternoon for 1 month to see the effectiveness of the liquid organic fertilizer. Based on Maryani *et al*. (2022), liquid organic fertilizer can be obtained in approximately 10-15 days of fermentation. Liquid organic fertilizer can be transferred to a prepared container, then water is added in a ratio of 1:10. Liquid organic fertilizer ready used as fertilizer.

2.11 Test the Growth Rate of Purple Eggplant Plants (Wardhana *et al.*, 2016)

Gross weight plants were counted with method weigh plants (grams) without through a drying process moreover formerly. Root length (cm) was done by cleaning the plant roots from adhering dirt and then measuring the length using a ruler from the base of the root to the tip of the root. Plant height (cm) was measured using a ruler from the base of the stem to the tip of the leaf starting at 7 days, 14 days, 21 days, and 28 days. The number of leaves (strands) was carried out at the same time as the plant height, namely 7 days, 14 days, 21 days and 28 days. Leaf width (cm) was measured using a ruler on all plants from side to side on the widest leaf following the radius of the leaf segments starting at 7 days, 14 days, 21 days and 28 days. The stem diameter (mm) was measured with use period shove starting 7 days, 14 days, 21 days, and 28 days.

3. Results and discussion

3.1 Nutrient Content

Based on the pH test results of liquid organic fertilizer in Table 1, It was observed that the longer the fermentation process, the more the pH value will increase. The pH value in this research is in accordance with the requirements for liquid organic fertilizer from the Decree of the Minister of Agriculture of the Republic of Indonesia number 261/KPTS/SR.310/M/4/2019 concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers and Soil Improvements which states that the standard pH value in Liquid Organic Fertilizer between 4-9.

The pH value decreases at the beginning of the process due to the decomposition of organic materials due to microbial activity which produces organic acids. However, during processing time, the increasing in the pH value will occur due to the activity of microorganisms in decomposition which provide input of OH ions from the process of decomposing organic material.

Table 1. Nutrient Content of Liquid Organic Fertilizer from Milkfish Viscera

No.	Treatment	pH	Yield (%)	C-Organik (%)	Nitrogen (%)	C/N Ratio	Phosphor (%)	Potassium (%)
1.	A	$4,05 \pm 0,05^{a}$	$88,44 \pm 1,68^{d}$	$4,46 \pm 0,27^{d}$	$0,24 \pm 0,01^{a}$	$18,33 \pm 0,98^{a}$	$0,06 \pm 0,01^{a}$	$0,14 \pm 0,01^{a}$
2.	B	$4,65 \pm 0,17^{b}$	$85,78 \pm 0,77^{c}$	$3,57 \pm 0,22^{c}$	$0,28 \pm 0,01^{b}$	$12,61 \pm 1,15^{b}$	$0,06 \pm 0,01^{a}$	$0,16 \pm 0,01^{b}$
3.	C	$5,26 \pm 0,04^{c}$	$82,44 \pm 0,77^{b}$	$2,32 \pm 0,23^{b}$	$0,31 \pm 0,01^{b}$	$7,59 \pm 0,97^{c}$	$0,06 \pm 0,00^{a}$	$0,18 \pm 0,01^{c}$
4.	D	$5,80 \pm 0,16^{d}$	$77,33 \pm 1,15^{a}$	$1,34 \pm 0,18^{a}$	$0,34 \pm 0,01^{c}$	$3,90 \pm 0,57^{d}$	$0,06 \pm 0,00^{a}$	$0,20 \pm 0,01^{d}$

Note: Data are mean of three replicates ± standard deviation. Data followed by different superscript letters at the same column indicates significant differences. A = 7 days fermentation liquid organic fertilizer; B = 10 days fermentation liquid organic fertilizer; C = 13 days fermentation liquid organic fertilizer; D = 16 days fermentation liquid organic fertilizer.

The results of the process of decomposing organic material by microorganisms produce OH ions which shows an increase which in turn increases the pH value of the liquid organic fertilizer (Kusumadewi *et al.,* 2019). In the next process, microorganisms will convert the organic acids that have been formed so that the material has a high pH and is close to neutral. The pH value of mature fertilizer will be close to neutral.

The yield test on liquid organic fertilizer from milkfish viscera waste in Table 1. can be stated that the longer the fermentation, the lower the yield value will be. The success of the fermentation process is influenced by the type of microorganism, the sugar used and the length of fermentation (Andriani et al., 2021). The fertilizer in this study used molasses, where molasses is a product produced in the sugar crystallization process. The nutritional content of molasses is mostly sugar. In addition, there are also amino acids and minerals. The fermentation process will produce alcohol and gas (Siregar et al., 2024). The longer the fermentation process, the higher the alcohol and gas produced, thereby reducing the yield of the fertilizer produced.. However, the decomposition process to produce the results in this research has gone well because the results show high value due to the role of *Trichoderma* sp. in decomposing organic materials in the fermentation process. The yield was higher than fertilizer organic liquid made from fish waste with addition EM4 biocatalyst is 33% (Kurniawan *et al.,* 2015). The yield was also higher if compared to the yield fertilizer organic liquid made from *Sargassum* sp. with addition protease enzyme, namely 44.19-65.83% (Putra *et al.,* 2022).

The c-organic content of liquid organic fertilizer can be stated that the longer the fermentation of liquid organic fertilizer, the lower the c-organic content. The c-organic content of liquid organic fertilizer from milkfish viscera waste does not meet the SNI 19-7030-2004 standard regarding compost specifications from domestic organic waste which states that the minimum c-organic content in liquid organic fertilizer is 9.8%. The yield was lower due to the presence of microorganism *Trichoderma* sp. which worked as decomposer of organic compound The decomposition process through the activity of microorganisms utilizes the carbon element as an energy source, thus reducing the levels of c-organic produced. The longer the fermentation process takes place, the more microorganisms will grow and require C-organic for the metabolic process in the growth and self-division (Daniarsih et al., 2024). This causes a decrease in organic C content. In the composting process, carbon acts as an energy source for microorganisms. In addition, during the composting process, carbon in the form of CO_2 will undergo an evaporation process so that carbon (C) levels will decrease (Kurniati *et al*., 2022). Hence the amount the carbon content in the compost to decrease with the length of fermentation time.

The nitrogen content in liquid organic fertilizer can be stated that the longer the fermentation of liquid organic fertilizer, the higher the nitrogen content. Nitrogen levels liquid organic fertilizer from milkfish viscera waste does not meet the SNI 19-7030-2004 standard regarding compost specifications from domestic organic waste which states that the minimum nitrogen content in liquid organic fertilizer is 0.40%. The low levels of nitrogen at the start of fermentation are caused by *Trichoderma* sp as a bio decomposer agent which is still in the initial phase and is still adapting and metabolizing to increase cell size. Next, the cells will use carbon from fish viscera waste as food and reproduce. Kurniati et al., (2022) stated that the decrease in nitrogen levels in the first phase of fermentation because the microorganisms needed nitrogen to grow and develop. In addition, it were also caused by breaking down process of protein from the fermented material. The results of this study are in accordance with Daniarsih et al., (2024) who made biofertilizers from domestic waste produce a decrease in C-organic content with increasing fermentation time and a decrease in nitrogen levels in the first phase of the fermentation process. Decomposition improved with increasing N levels until the 16^{th} day. Furthermore, *Trichoderma* sp. will reach equilibrium between the number of those produced and those that die, in this phase the activity of *Trichoderma* sp. will begin to decline due to reduced carbon. Based on Wijaksono *et al.* (2016), nitrogen is an important component as a building block for protein and 50% of the biomass of microorganisms is composed of protein, so the more microorganisms there are, the nitrogen content will increase.

The C/N ratio which plays a role in nutrient balance since the C/N ratio is a comparison between the amount of carbon element content (C) and the nitrogen element content (N) in an organic material. C/N ratio liquid organic fertilizer from milkfish viscera waste does not Indonesian National Standards regarding compost specifications from domestic organic waste which states that the minimum C/N ratio in liquid organic fertilizer is 10. Low C/N ratio in liquid organic fertilizer with a fermentation time of 16 days, this indicates that the organic material has been completely degraded by microbes *Trichoderma* sp. If the nitrogen content in liquid organic fertilizer is higher while the C-Organic is lower, it can reduce the C/N ratio value. The longer fermentation time could lowering the organic matter content. Changes in the C/N ratio that occur during fermentation are due to the use of carbon as an energy source and it is lost in the form of CO_2 so that the carbon content decreases over time (Wijaksono *et al*., 2016).

Phosphorus levels liquid organic fertilizer from milkfish viscera waste does not meet the SNI 19-7030-2004 standard regarding compost specifications from domestic organic waste which states that the minimum phosphorus content in liquid organic fertilizer is 0.10% (Indonesian National Standards, 2004). The low phosphorus content produced in this study could be due to the low total N content of the fertilizer. In fact, the nitrogen element in milkfish viscera protein is greater than the phosphorus element because the phosphorus element in the protein chemical formula is only a side chain. The higher the nitrogen content in the material, the more microorganisms that will break down phosphorus will increase, as well as the phosphorus element content in fertilizer will increase along with the higher the phosphorus content in the material (Fryathama *et al.,* 2016), The longer the liquid organic fertilizer ferments, the higher the potassium content. Potassium levels liquid organic fertilizer from 16-day fermented milkfish viscera waste meets Indonesian National Standard/ SNI 19-7030-2004 the standard regarding specifications for compost from domestic organic waste which states that the minimum potassium content in liquid organic fertilizer is 0.20%. The increase in potassium levels along with fermentation time is due to the metabolic results of the release of K+ ions resulting from the exchange between cations and the decomposition of organic matter that breaks down in liquid organic fertilizer. This metabolic process was carried out by microbes using free K^+ ions contained in organic materials as a catalyst. So, potassium levels will increase along with the increase in the number of microbes present. Potassium is a compound produced by microbial metabolism, where microbes use free K^+ ions in fertilizer making materials for metabolic purposes. So that in the results of decomposition, potassium will increase along with the increasing number of decomposer microbes (Wijaksono *et al.,*2016).

3.2 Growth rate of purple eggplant plants

The results of the research showed for the age of 1 week, the height of the purple eggplant plants did not show a significant difference compared to the age of 2 weeks to 4 weeks since in the first week the plants are not yet optimal in absorbing the nutrients in liquid organic fertilizer.

Differences in plant height can be seen from the treatment of applying liquid organic fertilizer at different long time fermentation processes because liquid organic fertilizer is able to supply the nutrient needs of purple eggplant plants. The quality of life of plants is very dependent on the adequacy of nutrients from the environment, both nutrients from the soil or additional nutrients in the form of liquid organic fertilizer and the ability of the roots to absorb nutrients to support the vegetative phase of the plant such as plant height. Based on Syahputra and Elfis (2023), applying fertilizer to purple eggplant plants optimally can influence the cell division process and cause a good increase in plant height, especially nitrogen which plays an important role in the photosynthesis

Table 2. Growth Rate of Purple Eggplant Plants

Parameter	Treatment	Week (Mean ± SD)			
		1	2	3	4
Plant Height	K	9,00 ± 0,50A,a	10,17 ± 0,29B,a	14,03 ± 0,25C,a	17,27 ± 0,25D,a
	A	10,00 ± 0,00A,ab	11,83 ± 0,29B,b	17,17 ± 0,76C,b	21,17 ± 0,76D,b
	B	10,33 ± 0,58A,ab	12,83 ± 0,29B,bc	18,67 ± 0,58C,c	23,17 ± 0,29D,c
	C	10,67 ± 0,58A,b	14,17 ± 0,29B,c	19,83 ± 0,29C,cd	24,33 ± 0,58D,cd
	D	11,33 ± 0.58A,b	16,00 ± 1,00B,d	21,00 ± 0,50C,d	25,67 ± 0,76D,d
Number of Leaves	K	5,00 ± 0,00A,a	6,00 ± 0,00B,a	6,33 ± 0,58BC,a	7,00 ± 0,00C,a
	A	6,00 ± 0,00A,b	6,00 ± 0,00A,a	7,33 ± 0,58B,ab	8,00 ± 0,00B,b
	B	6,33 ± 0,58A,bc	6,67 ± 0,58A,ab	7,67 ± 0,58AB,ab	8,33 ± 0,58B,b
	C	7,00 ± 0,00A,c	7,00 ± 0,00A,b	8,00 ± 0,00B,b	9,33 ± 0,58C,c
	D	7,00 ± 0,00A,c	8,00 ± 0,00B,c	8,33 ± 0,58B,b	10,00 ± 0,00C,c
Leaf Width	K	6,70 ± 0,17A,a	7,10 ± 0,17B,a	7,53 ± 0,06C,a	7,93 ± 0,12D,a
	A	7,13 ± 0,12A,ab	8,30 ± 0,10B,b	9,37 ± 0,40C,b	11,23 ± 0,60D,b
	B	7,37 ± 0,12A,b	9,27 ± 0,23B,c	11,00 ± 0,50C,c	13,43 ± 0,81D,c
	C	7,57 ± 0,15A,b	9,57 ± 0,12B,c	11,63 ± 0,06C,cd	14,57 ± 0,06D,cd
	D	8,57 ± 0,40A,c	10,50 ± 0,44B,d	12,10 ± 0,36C,d	15,07 ± 0,40D,d
Stem Diameter	K	3,07 ± 0,12A,a	3,67 ± 0,15B,a	4,33 ± 0,15C,a	4,73 ± 0,06D,a
	A	3,37 ± 0,12A,b	4,33 ± 0,15B,b	5,33 ± 0,15C,b	6,00 ± 0,20D,b
	B	3,73 ± 0,06A,c	5,33 ± 0,15B,c	6,00 ± 0,20C,c	6,67 ± 0,15D,c
	C	4,07 ± 0,12A,d	5,73 ± 0,06B,d	6,67 ± 0,15C,d	7,33 ± 0,15D,d
	D	4,37 ± 0,12A,e	6,07 ± 0,12B,d	7,33 ± 0,15C,e	8,00 ± 0,20D,e

Note: Data are mean of three replicates ± standard deviation. K = Without aplication of liquid organic fertilizer; A (Application of 7 days fermentation liquid organic fertilizer); B (Application of 10 days fermentation liquid organic fertilizer); C (Application of liquid organic fertilizer fermentation 13 days); D (Application of liquid organic fertilizer fermentation 16 days). Superscripts with different capital letters on the same line indicate significant differences for observation times while superscripts with different lowercase letters in the same column indicate significant differences for the liquid organic fertilizer treatment.

process. The increase in plant height occurs due to the presence of apical meristem cells which continue to divide, which can influence the increase in plant size. Table 2. shows that the observation time for purple eggplant plants and the treatment of applying liquid organic fertilizer with different fermentation times gave less significant differences in results regarding the number of leaves of purple eggplant plants in each treatment. Since the addition of new leaves also occurs along with the fall of the old leaves. However, the number of leaves will continue to increase as the purple eggplant plant ages. The increase in the number of leaves of purple eggplant plants is caused by the presence of organic compounds contained in liquid organic fertilizer which can increase the effectiveness of optimal nutrient supply and absorption in purple eggplant plants. The availability of nutrients in plants responds to the formation of chlorophyll which is directly related to the number of leaves because chlorophyll is mostly found in leaves. The nutrient content, especially nitrogen, is the basic ingredient needed to form amino acids which will be used for plant metabolic processes so that it will influence the increase in the number of leaves of purple eggplant plants. Apart from nutrients, the number of leaves is influenced by sunlight, water, and plant spacing on plant growth and development, so that plants that have more leaves will have more energy available for photosynthesis than those with fewer leaves (Anggun *et al.,* 2017).

Table 2. shows that the observation time for purple eggplant plants resulted in differences in results regarding the leaf width of purple eggplant plants in each treatment. Providing liquid organic fertilizer produces high leaf width because it contains the elements N, P and K. Nitrogen is important in terms of chlorophyll formation in leaves because nitrogen will increase the leaves ability to absorb sunlight. Photosynthate produced from the photosynthesis process will be broken down again through the respiration process and produce the energy needed by cells to carry out cell division and enlargement so that the leaves increase in width. Deep phosphorus fertilizer organic liquid works for development ribbon meristem tissue network. The fertilizer could extend the cells network which eventually affect the size of the leaf of eggplant. Potassium plays a role as activator enzyme essential in reaction photosynthesis and respiration as well as enzymes involved in protein and starch synthesis. The three factors above will interact to influence the growth of purple eggplant plants. The nutrient element that is very influential in the growth and formation of leaves is N. High levels of N generally produce more and bigger leaves, because liquid organic fertilizer contains cytokinins which can stimulate growth and formation more quickly. (Lakitan, 2011).

The results of the research showed that there was a significant effect of providing liquid organic fertilizer from milkfish viscera waste with differences in fermentation time on the stem diameter of purple eggplant plants at the 1st to 4th week of age. Even though stem diameter is a slow growth phase compared to other vegetative growth, the stem diameter of purple eggplant plants will continue to increase as the purple eggplant plant ages. The element potassium (K) plays a role in strengthening plant growth so that leaves, flowers and fruit do not fall (Yusuf *et al.,* 2023). The nitrogen element plays a role in accelerating the process of cell division which causes growth in height and stem diameter. Apart from that, N also contains protein as an energy source for plant growth (Thana *et al.,* 2021). The presence of nitrogen elements in plants can increase the formation of chlorophyll in the leaves. Therefore, the presence of chlorophyll in leaves can speed up the rate of photosynthesis (Ahmad *et al.,* 2022).

The increasing wet weight value of purple eggplant plants was caused by the size of the plant itself which includes plant length, number of leaves, leaf width, stem diameter and root length. Apart from that, the high wet weight in this treatment is also influenced by the speed of plant growth and the number of doses of liquid fertilizer given. Providing liquid organic fertilizer with a 10x dilution is the optimal concentration for the growth of purple eggplant plants. After there was water imbibition, the eggplant plants begin to grow. This is related to the influence of water on enzyme activity in the plant body. Syahputra and Elfis (2023), mentioned the source of the nutrients provided comes from the liquid fertilizer that was applied. The liquid organic fertilizer provided will be absorbed by plants in solution form, so the fertilization process requires enough water because water functions as a solvent.

Table 3. Growth Rate of Purple Eggplant Plants

No.	Treatments	Wet Weight ± SD	Root Length ± SD
1	K	19.33 ± 1.53 a	23.67 ± 0.58 a
2	A	32.67 ± 2.08 b	26.67 ± 0.58 b
3	B	37.33 ± 0.58 c	30.00 ± 0.87 c
4	C	50.33 ± 1.53 d	33.33 ± 0.29 d
5	D	58.67 ± 2.08 e	36.50 ± 0.50 e

Note: Data are mean of three replicates ± standard deviation. Data followed by different superscript letters at the same column indicates significant differences. A = 7 days fermentation liquid organic fertilizer; B = 10 days fermentation liquid organic fertilizer; C = 13 days fermentation liquid organic fertilizer; D = 16 days fermentation liquid organic fertilizer.

The results of the research showed that there was a significant effect on liquid organic fertilizer from milkfish viscera waste with different fermentation times on the root length of purple eggplant plants at 4 weeks of age. In the treatment without POC, the lowest root length was obtained due to the small amount of nutrients available to the plant, which affected the root growth of purple eggplant plants Immature liquid organic fertilizers are often contaminated with intermediate compounds such as ammonia and organic acids which cause poisoning in plants and inhibited the germination of long roots. Fertilizer maturity can be evaluated in various ways, including by detecting the C/N ratio and NH_4+/NO_3 ratio. If the fertilizer used is toxic, then the elements contained in liquid organic fertilizer will have a direct impact on seed germination and plant root length. Increased root growth means the plant can absorb water and nutrients better. Phibunwatthanawong and Riddech, (2019). The same results were shown by Shama & Nimalan (2023) who applied organic fertilizer from tuna fish viscera to chili plants. In addition, Ellyzatul et al., (2018) also reported the growth of cucumber plants using fertilizer from fish waste. Jubin & Radzi (2022) also reported on the growth of corn plants using fertilizer from fish waste. This shows that fish waste, especially viscera, has the potential to be processed into fertilizer and can provide good growth for plants. The use of fish waste can reduce environmental pollution due to fishery waste. Apart from application fisheries waste product as a circular economy could also offer several other environmental benefits at Indonesia. Liquid fertilizer from fisheries waste product could improve land soil fertility and less land degradation. Organic liquid fertilizers are environmentally friendly and non-toxic.

4. Conclusion

Differences in the long-time fermentation of liquid organic fertilizer produced different characteristics of liquid organic fertilizer regarding nutrients which include pH, yield, carbon-organic, nitrogen, phosphorus, and potassium as well as the growth rate of purple eggplant plants which include plant height, number of leaves, leaf width, diameter. stem, root length, and plant fresh weight. The best fermentation time for liquid organic fertilizer from milkfish viscera waste is 16 days. This can be seen from the results of various tests including pH 5.80, nitrogen 0.34%, phosphorus 0.06%, and potassium 0.20% as well as the growth rate at 4 weeks of age which includes a plant wet weight of 58.67 grams, length roots 36.67 cm, plant height 25.67 cm, number of leaves 9.33, leaf width 15.07 cm, and stem diameter 8.00 mm.

Conflicts of Interest

There are no conflicts of interest reported by the writers.

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