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Utilization of Local Micro Organisms (LMO) in Making Liquid Organic Fertilizer (LOF) by Utilizing Vegetable Waste

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Abstract: This study aims to analyse the Nitrogen and pH levels of liquid organic fertiliser (LOF) made using microlocal organisms (LMO) based on vegetable waste. The method used was an experimental method through a fermentation process carried out at the Center for Standardisation and Industrial Pollution Prevention Services (BBSPJPPI). The results showed that the LOF produced had a Nitrogen content of 0.03% and a pH of 3, which did not meet the quality standards of liquid organic fertiliser in Indonesia, namely Nitrogen content of 2-6% and a neutral to slightly acidic pH (5-7). The low Nitrogen content is due to the Nitrogen-poor composition of the vegetable waste, while the overly acidic pH is due to the prolonged fermentation time, which triggers the formation of organic acid compounds. To improve the quality of LOF, optimisation is needed in the selection of raw materials, fermentation ratio, and control of fermentation parameters such as time and temperature. This research provides recommendations for the development of higher-quality LOFs that comply with national standards.

Keywords: Liquid organic fertilizer; Local micro organisms; Vegetable waste

Introduction

Household waste is the largest contributor to final waste disposal sites (TPA). The waste problem is a national problem that has a wide impact, including the accumulation of waste in landfills (Nasirudin et al., 2023). Household waste, especially which comes from kitchen activities, usually ranks at the top of the remaining family consumption. Vegetable and fruit waste is often disposed of in open landfills without further processing, disturbs the environment, and creates odors (Fadlilla et al., 2023). Households are the smallest component of waste sources in society. However, this smallest component apparently contributes the most waste, namely 63% of the total waste that goes to the landfill (Gatta et al., 2022). If this is not handled properly, it will cause big problems because it will have a negative impact on the environment (Pujiati & Retariandalas, 2019). What's worse is that some residents just throw it into the river or pile it up in gardens far from residential areas. So special treatment is needed to reduce the amount of waste piled up in final disposal sites. LMO is one way of making fertilizer in either liquid or solid form using microorganisms, while liquid organic fertilizer is a solution from the decomposition of organic materials originating from plant residues, animal and human waste which contain more than one nutrient element. The advantage of this organic fertilizer is that it can overcome nutrient deficiencies quickly, increase and improve the physical properties of the soil and increase the activity of soil microorganisms (Bachtiar & Ahmad, 2019).

Liquid Organic Fertilizer (LOF)

Liquid organic fertilizer is an extract from the decomposition of organic materials. These organic materials can come from plant residues, animal and human waste which contain more than one nutrient element. Tanti et al. (2020) states that one of the materials used as liquid organic fertilizer is waste, where waste is

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waste produced from a production process, both industrial and domestic, which has no economic value. LOF can be used as one of the best alternatives to replace the chemical fertiliser on plants (Hapsari & Suparno, 2023). The nutrients that must be met for plant growth are nitrogen, phosphorus and potassium. Liquid organic fertilizer contains the element potassium which plays a role in every plant metabolic process, namely in the synthesis of amino acids and proteins from ammonium ions and plays a role in maintaining good turgor pressure, thereby enabling smooth metabolic processes and ensuring continued cell elongation. LMO can be created very simply, namely by using household waste or plant residues, fruit, animal waste, stale rice, banana stems, and so on. The advantages of this organic fertilizer are its ability to immediately address nutrient deficiencies, prevent nutrient loss due to leaching, and deliver nutrients quickly (Sitorus et al., 2024). From an economic perspective, the cost of making liquid organic fertiliser from waste leachate is relatively cheaper than commercial fertilisers (Nasirudin et al., 2023).

LMO (Local Micro Organisms)

LMO is a collection of microorganisms that can be "farmed". Their function in the "zero waste" concept is to be a "strater" for making organic compost. LMO (Local Micro Organism) solution is a fermentation product made from locally available resources (Kurniawan, 2018). LMO can be made very simply, namely by using household waste or using leftovers from plants, fruit, animal waste, stale rice, banana tubers and so on. The aim of using LMO is to speed up the process of making organic fertilizer, neutralize organic materials, and improve fertilizer quality (Hudha et al., 2021). The role of LMO in compost, apart from being a nutrient supplier, also acts as a bioreactor component whose job is to maintain optimal plant growth processes.

The function of a bioreactor is very complex, namely supplying nutrients through an exudate mechanism, controlling microbes according to plant needs, and even controlling diseases that can attack plants (Kurniawan, 2018). The raw materials for making Local Micro Organisms (LMO) consist of 3 components, namely: carbohydrates, which can come from rice washing water (tajin), used rice, cassava dregs, potatoes, wheat, sometimes starch liquid; glucose, can be brown sugar dissolved in air, can be from liquid sugar, melted sugar, can be from sugar water and coconut water; the source of bacteria, can be made from easily destroyed kitchen waste or wilted vegetables. It can also come from other materials, for example crushed snails, rotten fruit, banana weevils, and water hyacinth, etc., so it can come from urine, or any source that contains bacteria (Kurniawan, 2018).

Local Micro Organisms (LMO) of Vegetable Waste

Vegetable waste can trigger the growth of disease-causing microorganisms if thrown away, but it will also cause an unpleasant aroma, degrade environmental cleanliness because it emits methane gas which causes global warming (Indriyanti et al., 2015). Vegetable waste can be processed into starter or local microorganisms (LMO) in making fertilizer. One effort that can solve the problem of vegetable waste is with a technological approach, namely turning it into fertilizer (Aklis & Masyrukan, 2016). Recycling household waste of them can be done by making it an eco-enzyme (Muliarta, 2024). Based on this description, Liquid Organic Fertilizer was made from Vegetable Waste. The characteristic of success in making LMO is the smell that smells like tapai, a sign that making LMO was successful. However, if what you smell is the smell of sewer water, then the LMO being made is considered a failure. This failure was of course caused by several other factors, not being able to close the bottle tightly enough and the storage temperature being inappropriate.

Organic Waste

Organic waste refers to materials derived from the remains of living organisms, including animals, humans, and plants, that undergo decomposition or decay. This type of waste is considered environmentally friendly because it can be naturally and rapidly broken down by bacteria. In general, the most abundant component in waste in several cities in Indonesia is plant remains, which accounts for 80-90%, sometimes even more. The large amount of waste components that can be decomposed is a potential resource as a source of humus, macro and micro nutrients, and as a soil conditioner (Nur et al., 2018). Composting organic materials can reduce greenhouse gas emissions while also providing an opportunity to generate income (Yanqoritha, 2023). Processing organic waste into eco enzymes as a solution to reduce the accumulation of organic waste (Prarikeslan et al., 2023).

One of the most commonly found organic waste is banana peel which comes from plants. This is because there are an abundance of small home businesses who rely on bananas as the main ingredient in processed products. Meanwhile, unused banana peels will accumulate over time and become waste which has an impact on environmental pollution. It is very important to utilize Kepok banana peel waste by utilizing waste that will reduce environmental pollution. Banana peels can be an alternative to replace the role of inorganic fertilizers in increasing agricultural production. The results of research conducted by Arliani et al. (2023) show that liquid organic fertilizer of kepok banana peel and shallot skin has an effect on the growth of ciplukan plants (Physalis angulata L.). The concentration of 35 ml/polybag gives a better effect on plant height, stem diameter, and leaf width in ciplukan (Physalis angulata L.) plants compared to the control treatment and other treatments.

The results of a study conducted by Khanyile et al. (2024) showed that banana peel-based fertilizer improved the growth and yield of the test crops. It was found that the most preferred method in this study was the use of composite peels, i.e. orange peel and banana peel. Other results were also found in the research Sepriani et al. (2016) LOF Kepok Banana Peel Waste with a concentration of 80 ml/polybag is the best concentration to increase plant production mustard greens. Likewise with research applying of 50 ml kepok banana peel liquid organic fertilizer is able to encourage the growth of oil palm seedlings at the pre-nursery stage (Anhar et al., 2021). According to Satuhu and Supriyadi in Wirasaputra et al. (2017), Kepok bananas in the Philippines are known as saba bananas, while in Malaysia they are known as nipah bananas. The fruit is delicious to eat after being processed first. The shape of the fruit is slightly flat so it is sometimes called a flattened banana. The weight of the crop can reach 14-22 kg with a total of 10-16 combs. Each comb consists of 12-20 pieces. When ripe the color of the fruit's skin is full yellow. Utilizing large bananas for various types of food will produce waste in the form of banana peels. Banana peel weight reaches 40% of the fruit (Serna-Jiménez et al., 2021).

Banana peel is an organic material that contains chemical elements such as magnesium, sodium, phosphorus and sulfur which can be used as organic fertilizer. The organic fertilizer from banana peels contains 15% potassium and 2% phosphor (Rusdiyana et al., 2022). Making organic fertilizer using banana peels can be in solid or liquid form. The results of the research conducted by Salman et al. (2024) showed that the interaction between Banana Peel LOF and NPK Phonska had a significant effect on flowering age, harvest age, number of fruits per plant, and fruit weight per plant. The optimal treatment was the combination of banana peel LOF at a dose of 450 ml/l water and NPK Phonska at a dose of 18.9 g per plant.

Method

This research is research on the use of local microorganisms (LMO) from vegetable waste into liquid organic fertilizer (LOF). The method used is an experimental method with a fermentation process that is carried out at the Centre for Standardisation and Industrial Pollution Prevention Services (BBSPJPPI).

Tool

The tools used are a blender, plastic bottle, knife, balance, clear hose, pH meter, spectrophotometer, measuring cup, and Kjeldahl flask.

Material

The materials used are vegetable waste, distilled water, brown sugar, water used for washing rice, kepok banana peels, and H2SO4 solution. Ways of making.

Making LMO

LMO vegetable waste is produced from 250 grams of spinach waste, 250 grams of kale waste, 250 grams of mustard greens waste. Next, the waste is crushed and blended with 1 liter of rice washing water which is given little by little. Then put it in a 1.5 L plastic bottle, add 50 grams of brown sugar. Next, so that the bottle is not opened every day, the plastic bottle is closed tightly with a lid that has been perforated by a hose connected to a 600 ml plastic bottle that has been given half a bottle of water to remove gas, produced from the fermentation process. Packaging of the Eco-Enzyme harvest should be in tightly sealed plastic bottles. Alternatively, it should be packed in small bottles for practicality and quality preservation reasons (Darmawati et al., 2023).

Figure 1. Making LMO from vegetable waste

Preparation of Molasses Solution

Molasses functions as an energy source and fertilizer for bacteria (Mustikarini et al., 2022). Add 300 grams of brown sugar to 300 ml of distilled water to make molasses (ratio 1:1).

Figure 2. Preparation of molasses solution

LOF Creation

200 grams of Kepok banana peel that has been sliced and blended until smooth is put into a plastic bottle. Then add 100 ml of molasses and 1 liter of distilled water. Next, 100 ml of vegetable waste was added. Then the plastic bottle is closed tightly so that air cannot enter, then fermented for 14 days.

Figure 3. Creation of LOF

Nitrogen Level Test

Nitrogen content testing was carried out at the Center for Standardization and Industrial Pollution Prevention Services (BBSPJPPI) on 10 ml fermentation samples taken, placed in a Kjedahl flask. Next, add one spatula of Kjeldahl tablets and 10 ml of concentrated H2SO4. Then it is destroyed until it boils and the solution becomes clear. Then the clear solution that has been digested is diluted to a volume of 100 ml. Next, 10 ml of sample was taken for analysis using a spectrophotometer. The test results are then described in line with the results obtained.

Test pH

The process of making organic fertilizer generally goes through a decomposition process by microbial activity. Compounds derived from organic materials will be easily broken down by microbes compared to inorganic compounds (Prasetyo & Evizal, 2021). The decomposition of organic materials or LOF through a process called fermentation. During the decomposition process, the degree of acidity (pH) is measured using a pH meter.

Result and Discussion

The resulting liquid organic fertilizer (LOF) has a brownish yellow color but is not thick, has a strong sour smell, and has a precipitate, namely vegetable waste powder. Based on the manufacture of LOF from LMO vegetable waste which has been carried out, the following results were obtained:

Table 1. Lab Test Results

Parameter	Unit	Test results
Up to Nitrogen	%	0.03
pH	-	3

Based on the results obtained in laboratory tests, liquid fertilizer contains a small percentage of nitrogen. This is because LOF (liquid organic fertilizer) does not only contain one nutrient, but contains many nutrients such as essential macro and micro nutrients (N, P, K, S, Ca, Mg, B, Mo, Cu, Fe, Mn and other organic materials (Yusmayani, 2019). Nitrogen serves to stimulate vegetative growth (Pane et al., 2023). The nitrogen content in fertilizers indeed varies depending on the type and source. Urea fertilizer is one of the most concentrated nitrogen sources, containing approximately 46% nitrogen, making it a highly efficient option for quickly delivering nitrogen to plants. However, it is prone to nitrogen losses through volatilization and leaching, which can reduce its effectiveness if not applied carefully or with additional stabilizers. Organic fertilizers, such as manure, compost, or by-products like feather meal and blood meal, typically contain lower nitrogen levels. For instance, blood meal contains around 12% nitrogen, and feather meal has about 7-12%, while manure and compost vary significantly depending on their composition and treatment, often delivering slower, sustained nitrogen release (Swify et al., 2023). Natalina et al. (2017) argue that the decrease in nitrogen levels is due to nitrogen as a result of the decomposition of organic materials released into the air. When the liquid organic fertiliser is exposed to air, nitrogen in the form of ammonia is volatile (Grosz et al., 2022). The concentration of dissolved oxygen, nitrite accumulation, changes in process conditions, substrate composition, COD/N ratio, pH, and temperature all affect nitrogen production (Kemmou & Amanatidou, 2023). Some factors, such as environmental conditions and microbial activity, play an important role in determining nitrogen levels (Viancelli & Michelon, 2024). Based on the results of Table 1, the LOF obtained does not meet the LOF quality standards set by the Indonesian government, namely organic C content ≥ 10%, N, P and K content ranging from 2-6% (Kementerian Pertanian, 2019).

Based on the table above, the pH is low, Kochakinezhad in Arifan (2020) believes that such a low pH decrease can be influenced by the LMO fermentation time being too long. In acidogenic fermentation, long fermentation times lead to greater production of volatile fatty acids (VFAs), such as acetic acid and butyric acid. According to research Mathe et al. (2024) for the preparation of liquid digestate as fertilizer in hydroponic systems, a continuous pH of 7 is considered ideal. In line with Mathe, Gonde et al. (2023) argues that maintaining a pH of 7 optimizes ammonium production while supporting microbial activity. This balance is beneficial for the use of digestate as an organic fertilizer, this setting ensures ammonium-rich effluent without excessive microbial spoilage, in harmony with the nutritional requirements of the plants. These acids increase the concentration of H+ ions, which further lowers the pH of the solution, (Sanchez-Ledesma et al., 2024). The resulting LMO has a pungent sour aroma. This is in accordance with opinion Suwatanti et al. (2017) Acid-forming bacteria will lower the pH so that the compost is more acidic. The sour smell produced by LMO is the result of fermentation which produces organic acids (Arifan et al., 2020).

In the view of Yang *et al*., (2024), color and sediment are influenced by the decomposition of organic matter and microbial activity during fermentation. Certain microorganisms, such as *Aspergillus sp*, can play a role in decomposing complex organic compounds, which contribute to the formation of color and sediment. The production of liquid organic fertilizer (LOF) is a natural process that utilizes bacteria through fermentation (Sumarna & Rushiana, 2023). The strong sour odor indicates the presence of active fermentation, which produces volatile acids. This is common when organic matter is incompletely decomposed or anaerobic conditions predominate during fermentation (Dewi et al., 2022). According to Ji et al. (2017) the presence of powder sediment may originate from undigested or partially decomposed organic or mineral particles that precipitate during storage. It may also reflect incomplete homogenisation during processing. According to the opinion of Salpiyana (2020), if the smell of LOF is a sour smell, it means that the fertilizer that has been made has been successful. In line with opinion Sulfianti et al. (2022) stated that observing the aroma and color, the fertilizer chopped using a blender was brownish yellow and had a tape aroma, indicating that the fermentation process was taking place perfectly. Kusrinah (2016) believes that the characteristics of unsuccessful (failed) production of liquid fertilizer are the odor produced, if it smells foul and pungent the fertilizer is declared a failure.

Conclusion

Based on the results of the research and discussion above, it can be concluded that LOF made using vegetable waste with a Nitrogen content percentage of 0.034 does not meet the LOF quality standards set by the Indonesian government, namely an N content of around 2-6%. The pH content is 3 which means acid due to decomposition of organic matter. Such a low pH decrease can be influenced by the LMO fermentation time being too long. Research needs to be conducted by future researchers to improve the value of the N element so that it can meet the standards set by the Indonesian government. To improve the quality of LOF, optimisation is needed in the selection of raw materials, fermentation ratio, and control of fermentation parameters such as time and temperature. This research provides recommendations for the development of higher-quality LOFs that comply with national standards.

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Authors Contribution
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