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Original research

Comparison of the Concentration of Local Microorganisms (MOL) in Stale Rice During the Composting Process

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Abstract

Background: The symbiotic relationship between microorganisms, specifically decomposing bacteria, and organic material, such as organic waste, leads to the decomposition of the substance and its transformation into compost.
Objective: The aim of this study is to assess the efficacy of local microorganisms (MOL) tape in accelerating the decomposition process of organic waste compost.
Methods: This research used an experimental study strategy known as "control with posttest". This investigation was conducted utilising two distinct groups: the control group and the treatment group. Regarding the intervention group utilising indigenous microorganisms (MOL) stale rice, the research utilised two data analyses: univariate analysis, which involved presenting data in the form of frequency distribution tables, and bivariate analysis, which included conducting a one-way Anova test followed by an LSD test.
Results: The findings indicated that the optimal dosage of a local microorganism (MOL) activator for compost formation was 25 ml, resulting in a duration of 11.6 days. The statistical analysis revealed a significant difference ($p < 0.05$) in the duration of compost formation between the dosage levels of 10 ml, 15 ml, 20 ml, and 25 ml of the local microorganism (MOL) activator.
Conclusions: This research aims to explore the potential of MOL activators in accelerating the composting process of organic waste. By utilising MOL activators, it is anticipated that the problem of slow composting can be effectively addressed, offering a viable solution for the community. Moreover, the ease and affordability of producing MOL activators further enhance their practicality.

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Background

In communities, untreated waste problems can cause various health problems through diseases caused by disease-carrying vector insects such as mosquitoes and flies (Wankhede & Wanjari, 2021). Diseases that are often transmitted by the two insect vectors include dengue hemorrhagic fever and diarrhea

(Utari et al., 2023). The maintenance and preservation of ecosystems is basically very necessary even though there are various challenges that must be faced, for example, environmental health problems caused by human actions in pursuing their welfare which result in discarded and unwanted materials or referred to as waste. Garbage refers to solid waste generated from various human activities such as housing, markets, offices, hotels, restaurants and industrial operations (Barker, 1979).

Waste can be classified into two distinct categories: industrial waste and general waste. Industrial waste is produced as a result of production activity. Industrial trash can be categorised into two forms: special controlled industrial waste and ordinary industrial waste, which encompasses all types of industrial waste (Ahmad et al., 2019; Thürer et al., 2017). Nonetheless, garbage that does not fall under the industrial waste category is referred to as general waste. This general waste is further classified into three categories: special controlled general waste, general waste and faeces, and other general waste, commonly referred to as municipal solid waste (Amasuomo & Baird, 2016). Waste is theoretically classified into three distinct categories: organic waste, non-organic trash, and hazardous and toxic waste. Waste produced by human activities is categorized into organic waste, which can be readily broken down, and non-organic waste, which cannot be broken down. Simultaneously, the industrial sector generates perilous and noxious waste (Mawarni et al., 2022).

The public generally underestimates the need of properly managing untreated garbage. Nevertheless, when waste is not cleaned, it serves as a nourishment for disease-carrying vectors, such as cockroaches, mosquitoes, flies, and rats. This garbage serves as a focal point for these carriers. An escalation in trash can result in a rise in the population of vectors, thus augmenting the likelihood of probable infectious illness occurrences. Consequently, this can endanger the population located near the place where garbage is accumulating, which acts as the main center for the spread of the outbreak. These dangers can also spread to other areas, presenting a concern on a regional, national, and worldwide level (Saadin, 2023).

Waste management is a highly intricate issue that confronts both emerging and developed nations worldwide. Indonesia produced 67.8 million tons of waste in 2020. 37.3% of the waste in Indonesia originated from household activities (Indriani et al., 2023; Indriani & Swadaya, 2017). It is estimated that each individual generates roughly 0.5 kilogrammes of organic waste every day, either directly or indirectly. In 2023, the amount of unmanaged waste was 5.948.380.06 (tons/year) or 33.17% (Kehutanan, 2023). While in Bengkulu Province, the target for handling household waste and similar household waste in Jakstranas in 2023 is 67% (Bengkulu, 2019).

Part of the waste processing in Bengkulu City is managed by the Cleaning and Landscaping Service of Bengkulu City; The rest is managed by the community by way of landfilling and burning. However, Bengkulu City was only capable of handling 1.326 m3 of rubbish. Annually, there has been a rise in waste, particularly in the previous year, when the landfill area grew by 4 hectares to handle 97% of domestic waste. This increase demonstrates the community's limited comprehension of trash reduction or management. According to the National Waste Management Information System (Aziz & Gumilang, 2018; Kehutanan, 2023; Yunita et al., 2021), houses in Bengkulu produce 106.89 metric tons of waste per day and 39.013.94 metric tons per year. The Bengkulu City Government aims to achieve a waste reduction of 58.1%. The significant amount of garbage produced, particularly in Bengkulu City, necessitates the implementation of an alternate solution to address this issue. One possible approach is the use of composting methods specifically designed for organic waste materials.

Farmers are required to be willing and able to utilize local microorganisms that exist around them. The use of MOL as a component of microbial fertilizer is expected to provide benefits for farmers in making organic fertilizer and insecticides, one of which is by using stale rice (Indriani et al., 2023; Indriani & Swadaya, 2017). The results of this activator increase the utilization of organic waste without causing problems or losses for the community, especially those living in the community. The volume of microorganism activator that is available and can be used is 10 ml, 15 ml, 20 ml, and 25 ml with the required duration varying according to needs. The efficacy of making compost can be increased by using local microorganism activators with the addition of 10 ml, 15 ml, 20 ml and 25 ml of local microbial activator (MOL). The benefits of utilizing organic waste are as follows: the processing of organic waste is straightforward and cost-effective; organic waste can serve as fertilizer for an extended duration compared to synthetic fertilizers, as it dissolves and decomposes more rapidly; agricultural products derived from organic fertilizer are healthier due to their lack of chemical additives; and the utilization of organic waste can decrease waste buildup, thereby reducing the proliferation of disease vectors.

The Bengkulu City Department of Cleanliness and Parks supervises part of the waste management process, while the rest is handed over to the community to handle it through landfill and burning. However, Bengkulu City is only able to handle 1.326 cubic meters of waste. The large amount of waste produced, especially in Bengkulu City, requires alternative solutions to overcome this problem. One of these approaches is the application of composting techniques to manage organic waste by using stale rice as a component of microbial fertilizer which is expected to provide benefits for farmers in making organic fertilizer and insecticides. It is hoped that the results of this activator can increase the smooth utilization of organic waste. The aim of this study is to assess the efficacy of local microorganisms (MOL) tape in accelerating the decomposition process of organic waste compost.

METHOD

Study Design

This research uses an experimental approach This study utilizes a quantitative research methodology, employing an experimental approach and a "posttest with control" design across two independent groups.

Tools and materials

The tools used in this research include: shovels, large knives, PVC pipes, polybags/plastic, saws, meters, thermometers, scales, buckets, stationery, measuring cups, pH meters, MOL pipettes 10 ml, 15 ml, 20 ml, and 25 ml, and Check List sheet for observation. The materials used in this research include: the ingredients for local microorganism activator (MOL) are 200 grams of stale rice, 200 grams of shrimp paste, 5 grams of granulated sugar and 1200 ml of clean water. The materials for making compost consist of 8 kg of green vegetable waste, 8 kg of krinyu leaves and 8 kg of banana stems.

Control Temperature, pH and Humidity

a) Temperature: In the composting process, the temperature during compost maturation is maintained between 40 – 50^0 C. If the temperature is too hot or high, sprinkle enough water and then turn it over.
b) Degree of Acidity (pH): The optimum pH during composting is 6.5-7.5. If the raw compost material is too acidic, the pH can be increased by adding lime. If the pH level tends to be high or alkaline, it can be lowered by adding acidic materials (containing nitrogen). Examples are urea and animal waste.
c) Humidity: The ideal humidity for composting is 50%, if the compost is too wet it can be overcome by adding dry ingredients, and if the compost is too dry, add enough water until the humidity is close to 50%.

Time and Place of Research

This research was carried out from July to August 2022 and was carried out at the Environmental Health Workshop of the Bengkulu Ministry of Health Polytechnic.

Procedures

Clean and prepare the research location so that the research can continue well, then prepare tools and composting materials. Making Local Microorganisms (MOL) by preparing 1500 ml used plastic bottles of mineral water. Weigh out 100 grams of stale rice, 100 grams of shrimp paste, and 5 grams of granulated sugar. Then put all the ingredients above into a 1500 ml bottle, then add 1300 ml of plain water, stir well so that the sugar dissolves and let it sit for 4-5 days, leaving the bottle open. The incubation process is successful when the smell of alcohol comes out, the color of the water changes to yellow, there is floating foam and the solution is ready to be used as an activator for making compost.

The preparation for making compost is by using 32 kg of organic waste, consisting of 8 kg of vegetables, 8 kg of krinyu leaves, 8 kg of banana stems, and 8 kg of rotten fruit, then cutting or chopping them to a size of 2 - 5 cm. After that, prepare 16 polybags with the following details: 12 groups for treatment are the addition of Local Microorganism (MOL) activator in the amount of 10 ml, 15 ml, 20 ml and 25 ml each containing 2 kg of organic waste resulting from mixing the 4 ingredients. In the control group there was no treatment, while in the treatment group the organic waste that had been weighed for each group was put into polybags and 10 ml, 15 ml, 20 ml and 25 ml of activator (MOL) were sprayed. Insert the pipe with holes in the pipe wall into the polybag/plastic until it reaches the bottom. Next, the polybag is tied with a rope along with a pipe that sticks out so that there is oxygen intake from the outside.

In aerobic conditions the composting process takes place quickly so that the temperature increases, set the temperature between 40 – 50^0 C. To maintain the temperature, stir it once a week (turning) so it doesn't get too hot and smelly. To determine changes in temperature every day, temperature, pH and humidity measurements are carried out. Temperature measurements are carried out by inserting a thermometer into the mixture until the tip of the thermometer reaches ½ the depth of the waste mixture for 2 minutes, then remove it and immediately read the results.

Meanwhile, to measure pH and humidity, the soil meter is placed in a black polybag/plastic for 2 minutes, after which the results are read. Compost is declared finished when its volume has reduced to one-third of the initial volume, does not smell bad, the organic waste is no longer visible, and is in the form of small grains like soil and has a brownish color.

Data Analysis

This research used two data analyses: univariate analysis, namely presenting data in the form of a frequency distribution table, and bivariate analysis which is carried out using the one-way Anova test followed by the Bonferroni test. The SPSS software is utilized for the analysis of research data.

Ethical consideration

The ethics committee at Dehasen University of health sciences granted approval for this research under the reference number 0013/D-KEPK/FD/I/2024.

RESULT

Univariate Test

Two different types of data analysis were utilised in the research analysis. The first type of analysis was a univariate analysis, which was given in the form of a frequency distribution table. The second type of analysis was a bivariate analysis, which meant that the one-way Anova test was followed by the Bonferroni test. According to Table 1, the findings of the compost weighing that was performed at the conclusion of the composting process for both the treatment group and the control group are shown.

Table 1. Yield Average Weight of Compost Formed in Groups.

Number	Concentration	Compost Weight (Gram)
1	10 ml	516.25
2	15 ml	605.00
3	20 ml	616.25
4	25 ml	623.50

The treatment group that received 25 millilitres of MOL had the highest compost weight, which was an average of 623.50 grammes of the beginning weight of the compost material. This was the group that received the greatest substance.

Bivariate Analysis

Table 2. Results of One Way Anova Test Time (days) Composting Organic Waste Treatment Group

Treatment	Mean	SD	95% CI	P *value*
MOL 10 ml	26.25	0.957	24.73-27.77	
MOL 15 ml	15.75	0.57	18.23-21.27	0.000
MOL 20 ml	16	0.816	14.70-17.30	
MOL 25 ml	12.75	0.500	11.45-21.44	

In the group that received 25 millilitres of local microorganism activator (MOL), the average amount of time it took for the compost to be produced was 12.75 days, as indicated in Table 2. The value of ρ was 0.000, which indicates that it did not have any significance. Using doses of 10 ml, 15 ml, 20 ml, and 25 ml of Local Microorganism Activator (MOL), Bonfferoni's test was carried out in order to determine the magnitude of the difference in the amount of time required for the formation of compost between the four different treatments.

Table 3. Bonfferoni test results. Differences in Composting Time (days) Using Local Microorganism Activator (MOL) Spoiled Rice with Variations in Doses of 10 ml, 15 ml, 20 ml and 25 ml.

Treatment		Different average (Day)	ρ value
10 ml	15 ml	6.5	0.000
	20 ml	10.20	0.000
	25 ml	14	0.000
15 ml	20 ml	3.75	0.000
	25 ml	7.5	0.000
20 ml	25 ml	3.75	0.000

In terms of the amount of time required for the development of organic waste compost, the 20 ml and 25 ml treatments showed the smallest difference, which was 3.75. However, it was observed that the most significant variation in the duration of time required for the creation of organic waste compost was observed in the 10 ml and 25 ml treatments. Based on this disparity, the ρ value was determined to be 0.00 for both the 10 ml and 25 ml treatments, and 0.000 <0.00 for the 25 ml treatment. According to this, there was a substantial difference between each of the treatment groups, and the group that received the most effective therapy was the one that received a dose of 25 millilitres on average.

DISCUSSION

Composting organic waste using Tape Local Microorganism Activator can have an impact on the amount of time it takes for organic waste to begin the composting process. This may be demonstrated by the results of the measurements and observations made during the composting process, which are presented in Table 1. This research is in line with research conducted by Muhith (2019) which identified Local Microorganism Solution (MOL) from tape (Fermented Cassava) as a composting bioactivator of physical, chemical and biological quality. Compost based on concentration and fermentation time.

Based on research on the effectiveness of adding Local Microorganism Activator Stale Rice (MOL) to the length of time organic waste compost is formed, which can be seen in Graph 4.1, the result is that the average length of time organic waste compost is formed in the treatment group with the addition of 25 ml Local Microorganism Activator (MOL) faster with an average composting time of 11.6 days with a ρ value of 0.000. Because the MOL solution contains macro- and micronutrients as well as bacteria, which have the potential to break down organic matter, stimulate growth, and act as agents to control pests and plant diseases, the addition of a Stale Rice Local Microorganism (MOL) activator to the compost material can have an effect on the amount of time it takes for the compost to decompose. In comparison to natural composting, the MOL activator speeds up the process of composting organic waste, which maximises its utilisation while simultaneously minimising the occurrence of any potential adverse effects.

The selection of fundamental materials for the production of MOL activators in the form of cassava tape and prawn paste is essential due to the fact that these products are readily available in conventional markets and, when utilised as components of compost activators, will not be harmful to the soil. In addition, the microorganisms that are found in tape have a purpose in the process of composting. Specifically, they are responsible for the decomposition of organic waste, and shrimp paste serves as a source of protein for the microbes that are responsible for composting. As a result of the use of stale rice and prawn paste as fundamental components, the activator undergoes a fermentation process that lasts for five days in 1200 millilitres of clean water and five grammes of sugar. In the process of decomposing organic waste, bacteria make extensive use of sugar as a raw source for energy production. The fermented cassava tape has a golden colour, and the aroma of alcohol is the most distinguishing feature of this tape (Azkiyah et al., 2021).

Taking into consideration these circumstances, it is clear that the incorporation of a local microorganism activator (MOL) has the potential to accelerate the composting process. This is particularly true in the 25 ml dose variation treatment group, which had a composting period of 11.6 days or more. Because stale rice contains macronutrients like nitrogen (N), phosphorus (P), and potassium (K), the other treatment groups are using 10 ml, 15 ml, and 20 ml of MOL and 25 ml. The micronutrients that are present in stale rice include calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn), and growth regulatory substances like auxin, giberellin, and cytokinins, all of which are beneficial for plant fertility (Daramola et al., 2022). Therefore, the number of microorganisms present in the compost material will determine the rate at which it will result in the formation of organic waste, thereby reducing the amount of time required for the composting of organic waste.

When all of these factors are taken into consideration, it is abundantly obvious that the utilisation of a local microorganism activator (MOL) has the potential to speed up the process of composting. This is especially apparent in the group that received the 25 ml dose variation therapy, which had a composting period that was at least 11.6 days long. Because stale rice contains macronutrients such as nitrogen (N), phosphorus (P), and potassium (K), the other treatment groups are utilising 10 ml, 15 ml, and 20 ml of MOL and 25 ml. This is because stale rice contains carbohydrates. Among the micronutrients that can be found in stale rice are calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn), and growth regulating chemicals such as auxin, giberellin, and cytokinins. All of these micronutrients are beneficial for the fertility of plants. Because of this, the quantity of microorganisms that are present in the compost material will be the determining factor in the rate at which it will result in the production of organic waste, which will ultimately result in a reduction in the amount of time that is necessary for the composting of organic waste.

The findings of the One-Way Anova test, which are presented in Table 2, indicate that there is a distinction between the average amount of time spent composting in the treatment group with the addition of 25 ml of MOL and the amount of time spent composting for each of the treatments under consideration. When compared to the natural composting process, the average time required for composting is 12.75 hours, and the ρ value is 0.000, which is less than 0.00. This implies that there is a considerable difference between the two processes. The inclusion of a 25-ml dose of a Coccal Microorganism (MOL) activator is more successful in accelerating the composting process. This is due to the fact that the 25-ml dose contains a greater number of microorganisms, which in turn is responsible for the faster formation of compost from the decomposition process of organic waste. This is in agreement with the viewpoint expressed by (Riawan, 2016; Suryati, 2014), who asserts that the rate at which the composting process will take place will be proportional to the number of microorganisms that are present in the material that is being composted.

Composting criteria, such as the aroma, colour, and final weight of the compost, are used to determine the amount of time that organic waste needs to be composted. It is necessary to ensure that the composting parameter is satisfied in accordance with the criteria since it is a very crucial factor in deciding whether or not the compost is ready to be used. The parameters of the composting process are measured once every three days along the process (Hemidat et al., 2018; Mondini et al., 2004). The characteristic of mature compost is that it smells like dirt, has a hue that is somewhere between brownish-black and brownish-black, and has a volume that is one-third of its initial weight. After the criteria for mature compost have been satisfied in their entirety, the start time of mature compost can be determined using this information. It is possible to view the beginning time of the mature compost in the appendix, which contains data on measurements and observations that are printed in bold (Bernal et al., 2017; Steel et al., 2018).

In its initial state, the material that is going to be composted is physically in the form of little bits, smells like rubbish, and is green in colour. The composting process will bring about a shift in this circumstance, which is that what was before solely in the form of small pieces will go through a transformation (Hemidat et al., 2018; Mondini et al., 2004). During the process of decomposition, which is caused by bacteria that break down organic matter, the material that makes up compost will eventually deteriorate, and so will the smell and colour of the compost. On day 12, it had a terrible aroma and was brownish black in colour. On day 8, the colour shifted from green to black to brown, and then it ultimately turned the colour of soil. Given the circumstances, it was clear that the microbes that were already there had digested the compost material; nevertheless, the microorganisms that were part of the control group had made only a moderate pace. When opposed to the treatment group, which utilised an activator to speed up the composting process, the microbes in the control group made slower progress in the process of decomposing the compost material.

During the process of composting, there will be a series of stages in which changes in physical form, such as smell and colour, will take place. Material for compost that has a pungent fragrance will eventually develop a rotting smell and will go through the process of maturation (Ayilara et al., 2020). As time passes, the material that makes up compost gradually loses its physical form and undergoes a colour change from brownish green to brown. The compost that has reached its maturity is next dried in the sun with the purpose of achieving the desired compost size, separating the material that has not been entirely decomposed, and regulating the quality of the compost. The C/N ratio of mature compost can be used to assess the quality of the compost, which is better. This can be done by measuring the ratio of carbon to nitrogen in the compost. However, in this study, it was not known which quality was superior; however, by looking at the results of this study, it was able to provide information about the use of a local microorganism (MOL) activator at a dose of 25 ml/2kg of organic waste, which has a faster composting time compared to the activator doses of 10 ml, 15 ml, and 20 ml. This was a significant finding. By utilising tape and shrimp paste as composting activators, which are simple to create, inexpensive, and even free of charge, the community can put the findings of this study to use in order to sort and manage their organic waste into compost. The conversion of organic waste into compost will have a beneficial effect on both society and the environment if it is managed properly.

It is estimated that the process of compost material ripening will take fourteen days, as stated by (Wong, 1985). At the end of the composting process, the material that has been composted will have a fragrant earthy aroma and a physical shape that is crushed and has a brownish-black colour. Due to the fact that the amount of activator dose that was utilised for each experimental group was variable, the volume of compost that was included within each composter was not identical. When we reach the final step of the composting process, we weigh the compost in order to determine its volume.

In comparison to the control group and the other treatment groups, the results of this study indicate that composting with local microorganism activator (MOL) tape in amounts as high as 25 millilitres is more effective than the other treatment groups. When contrasted with the findings of earlier research carried out by (Ali, 2016; Indriani & Swadaya, 2017; Panjaitan, 2014), the effect of adding fix-up plus activators on the amount of time it takes for organic waste to be composted is shown to be significantly different. In this study, the effective dose for composting organic waste was 25 ml with a composting period of 11.6 days, whereas the results of this study showed that the effective dose for composting organic waste was 6 ml with a composting time of 20 days.

CONCLUSION

The average weight of the compost that was created from the highest treatment group was determined by utilising a dose of MOL activator that was 25 millilitres in volume, and the total weight of the compost that was produced was 623.50 grammes. In contrast, the weight of the compost that was formed was 616.25 grammes when the dose of MOL activator was 20 millilitres, 605.00 grammes when the dose was 15 millilitres, and 516.25 grammes when the dose was 10 millilitres. There were formation of compost requires an average of twenty-four days when the composting process is supplemented with ten millilitres of MOL activator. Composting with the addition of the 15 ml MOL activator dose requires an average of 18.6 days for the composting process to be completed. There is an average of fifteen days required for the formation of compost when the 20 ml MOL activator dose is added to the composting process. Composting with the addition of the 25 ml MOL activator dose requires an average of 11.6 days for the composting process to be completed. A local microorganism activator (MOL) dose of 25 millilitres is more effective than the usage of other activator doses of 10 millilitres, 15 millilitres, and 20 millilitres in terms of accelerating the amount of time it takes for organic waste to be composted.

Conflict of interests
The authors declare that there are no conflicts of interest.

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Author Contribution
HA and MG wrote the first draft. JS and SS developed the idea for the article. All authors have seen and approved the final version.

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