JOURNAL LA LIFESCI

VOL. 05, ISSUE 05 (443-453), 2024
DOI: 10.37899/journallalifesci.v5i5.1575

Effects of the Addition of Local Microorganism Bioactivators (MOLs) to Tomato Waste and EM4 on the Composite Quality of Market Waste with Coffee Waste Source

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Article Info

Article history:
Received 6 August 2024
Received in revised from 11 September 2024
Accepted 30 September 2024

Keywords:
Market Waste
Local Microorganisms (MOLs)
EM4 Bioactivators
Coffee Amps

Abstract

Market waste that belongs to organic garbage, can be recycled into compost. The natural compounding process takes quite a while, so it requires bioactivators to speed up the compostage process. In addition to the EM4 bioactivator, bioactivators can be made by ourselves with tomato waste that called local microorganisms (MOL) of tomato waste. The carbon content of coffee amps is high enough that it can be used as a compound mixture material as a source of carbon. The study aims to analyze the influence of the addition of local microorganisms (MOL) of tomato waste and EM4 on the composite quality of the market waste with coffee amps as carbon sources. The composing process was done using a composer for 14 days. The study used nine units of trials with two treatments and one control with three repetitions. The entire parameters on both composts produced with the treatment have been in accordance with SNI 19-7030-2004 standards. In compounds with local microorganisms (MOL) of tomato waste, the average carbon content was 19,23%, nitrogen 1,19%, phosphorus 0,51%, potassium 0,35%, and the C/N ratio 16.26 with temperature 30.67°C and pH 6.93. Compared to the compound with the bioactive EM4, the average content of the carbon element was 18,48%, the nitrogen content was 1,15%, the phosphates 0,50%, the potassiums 0,31%, and the C/N ratio 16.16 with temperature 31°C and pH 6.97. The results show that local microorganisms (MOL) of tomato waste have potential as a substitute for EM4 bioactivators.

Introduction

Market deflation has become one of the problems that has not yet been resolved. The accumulation of market waste can produce odors that disturb the surrounding community when not properly managed and handled. The most common type of waste found around residents' settlements is market waste. The smell generated by the market waste stacks without proper treatment and management will disturb the surrounding communities. Market waste belongs to organic waste that can be recycled into compost fertilizer.

Waste management can be done in several ways such as resource reduction, reuse, recycling, treatment, and disposal. Market waste belongs to organic waste that can be processed into composite fertilizer (Rasyid et al., 2017). Composites are organic fertilizers that are slowly compounded to repair soil structures and stimulate life in soil. In addition to adding elements of harvest, compost can also maintain soil functions that help the growth of plants (Pande Putu, 2019; Agustina et al., 2015). Compositing naturally takes quite a long time, up to six to twelve months. Therefore, bioactivators are needed as additives that can help the compositing process go faster (Widiyaningrum, 2016). Although in small quantities, composts made from organic

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

materials contain minerals that have important functions for plants (Sulfiana, 2022; Sánchez; Sayara et al., 2020).

There are two stages in simple composition: the active phase and the maturing phase. In the early stages of composition, mesophilic microbes will consume oxygen and degradable organic matter (Nguyen et al., 2022). The temperature on the compound pile will rise rapidly as the pH rises. The temperature will slowly decrease after most of the organic material of the composite has been compressed. At this stage, advanced compost maturity will occur where humus clay complexes will form. The volume and biomass of composite organic material will decrease during the compositing process (Tang et al., 2021). The volume of organic material can shrink by 30-40% (Widiyaningrum, 2016).

The bioactivator is known as a solution containing a mixture of various types of effective microbes that has a role in helping the process of decomposition of organic material (Wikurendra et al., 2022). The addition of bioactivators is aimed at increasing the number of microorganism populations on the organic material cluster which allows the decomposition process to run faster (Darmawati, 2017). Bioactivators are biologically active ingredients to enhance the activity of compositing processes. Bioactivators are not part of the type of fertilizer, but merely a substance that helps the compositing process because it contains effective microorganisms. Microorganisms in bioactivators accelerate the process of composing organic matter so that plants can take advantage of phosphate content directly. The advantage of using bioactivators is that they contain selected strains as the highest adaptation packaged in natural materials so that the viability of microbes can beined for up to one year. The bacteria contained in the bioactivator include photosynthetic bacteria, lactic acid, yeast, mushrooms, and Actynomycetes (Agustina, 2020; Ponidi & Rizaly, 2023; Syakir et al., 2024; Anggraeni, 2019).

Effective Microorganism-4 (EM4) is one of the most commonly used bioactivators in compositing processes (Mirwandono et al., 2018). EM4 consists of cultures of various microorganisms. Prof. Teruo Higa of Ryukyus University, Japan, was the first to discover an EM4 bioactivator solution. About eighty types of microorganisms were found in EM4. Effective microorganisms are selected to ferment organic material. The photosynthetic bacteria, Lactobacilus sp., Steptomycycetes sp., yeast, and Actinomycetes are the five main groups present in EM4. EM4 is used to clean up wastewater, accelerate the composition of organic garbage or animal dirt (composite activator), and improve the water quality of fish and shrimp debris (Maysabila et al., 2023; Maysabila et al., 2023).

In addition to EM4, bioactivators can be made by themselves, called Local Microorganisms (MOLs). Local microorganism solutions can be produced through various types of organic waste that have gone through the fermentation process (Kumar et al., 2021). Decayed tomatoes can be recovered by the Lactobacillus microbes and used as a breeding medium for decaying microorganisms that can help the compositing process (Widianti, 2023; Bello et al., 2016).

In the process of compositing, microorganisms require a source of energy as a fuel to decompose organic material during the compositing process (Ayilara et al., 2020; Insam & De Bertoldi, 2007). Carbon content is a source of energy used by microorganisms. Coffee amps that contain high enough carbon can be used as a mixture material as a source of carbon in a compost. According to Kasongo et al., (2011), the chemical characteristics contained in coffee pepper are C-organic 44.87%, N 1.69%, P 0.18%, K 1.49%, Na 0.04%, C/N 27 ratio, and pH 5.6.

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

Coffee amps applied to soil have a positive effect, i.e. stabilized soil pH, increased groundwater, pesticide residues and cadmium heavy metals can be bound (Chalker-scott, 2021; Sheraz et al., 2024). The study aims to analyze the influence of the addition of local microorganism bioactivators (MOLs) to tomato waste and EM4 on the quality of compound fertilizers from market waste with coffeemix sources.

Methods

The research was conducted in June 2024 using a mini-composter made of plastic. Do 3 (three) repetitions with one control variable and two variables with treatment. The main compound consists of market wastes such as broken or rotten vegetables and fruits and coffee beans in a 2 : 1 ratio. Composite compounds include goat dirt as nitrogen additives and wood powder as bulking agents. On the first treatment variable of the compound material mix, local microorganisms (MOLs) of tomato waste were added. On the second treatment variables of the mixture, bioactivator EM4 was added. Compositing was carried out for 14 days with reversal of the material every two days and temperature and pH measurement every day.

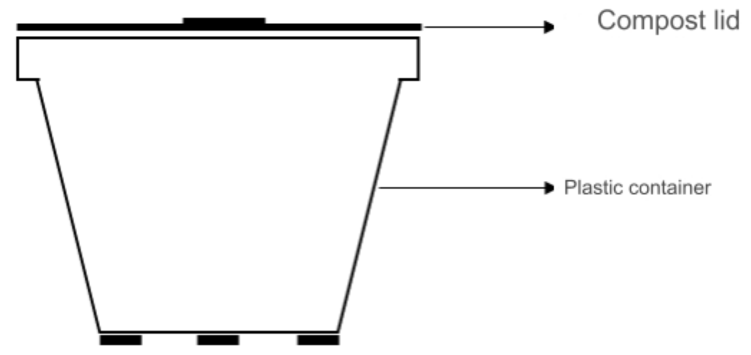

Figure 1. Composter Scheme

Local Microorganism (MOL) waste tomatoes are made up of 1 kg of tomato waste that has been cut into small pieces. The slices of tomate waste are then placed in a plastic bottle and then added 1.5 liters of rice wash water and 200 grams of sand sugar. A mixture of local microorganisms (MOLs) from the tomato waste is then fermented for 14 days. A bottle containing local microbial waste is folded every two days to avoid the sedimentation of the material. Local microorganisms (MOLs) are said to be ready for use when the whole material has been destroyed, mixed, changed colour, and smells like tape.

The variables observed in this study are changes in temperature and daily pH and chemical parameters of the composite carbon (C), nitrogen (N), phosphorus (P2O5), potassium (K¬2O), and ratio C/N. Data on temperature and pH changes are presented in graphical form and analyzed descriptively. The content of the market waste compound with local microorganism bioactivator (MOL) Tomato waste and EM4 was tested in the laboratory to determine that the content of each parameter studied has met the composite standards established in SNI 19-7030-2004.

Results and Discussion

Temperature

Temperature is one of the indicators that indicates the degradation of organic compound material by depleting microorganisms. As for the average temperature measurement results on the total repetition of each variable can be seen in the following graph:

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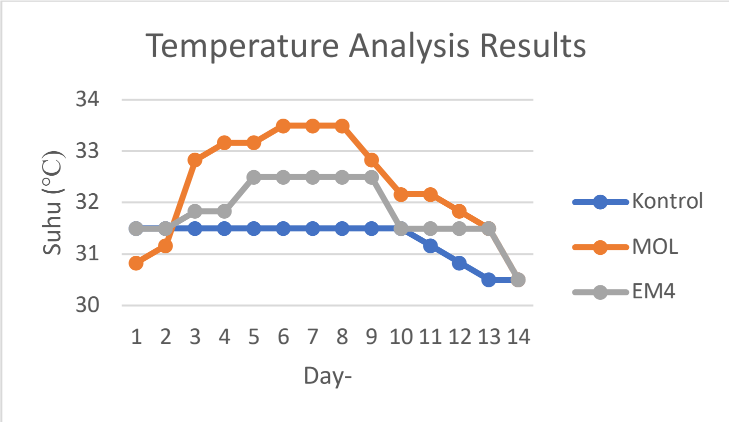

Figure 2. Temperature Analysis Results

Temperatures ranging from 25 to 32 °C indicate fairly good microorganism activity. While temperatures below 20°C indicate a failure to compose. On the 3rd day, the compound temperature with the addition of local microorganism (MOL) treatment of tomato waste and bioactivator EM4 began to show changes. It marks microorganisms that are starting to be active in the melting of organic compound material. The temperature rise is caused by microorganisms that release heat energy during the process of digesting organic compounds. During the compounding process, the temperature of the whole variable ranges from 30 to 33°C. At this temperature, the active microbes are mesophilic microbes, microbes that live at 25 to 45°C temperatures. The entire compound variable does not reach a thermophilic phase where the temperature ranges from 45 to 65°C. It can be caused by a less high stack of material so that the material faster loses heat. This study is in line with a study conducted by Natsir et al. (2022) where the temperature of each composer is only 29 – 31°C caused by the low stack of material. Good compost height ranges from 1 to 2.2 meters with a maximum height of 1.5 to 1.8 meters. On the 14th day the temperature of the entire compound variable is at 30°C. The temperature has been in accordance with the standard set by SNI 19-7030-2004, where the standard of the compost temperature is similar to the groundwater temperature that generally ranges from 28 – 30 °C.

pH

pH becomes one of the indicators of composite maturity influenced by the composite material and the activity of microorganisms in compositing organic material. As for the average results of pH measurement on the total repetition of each variable can be seen in the following graph:

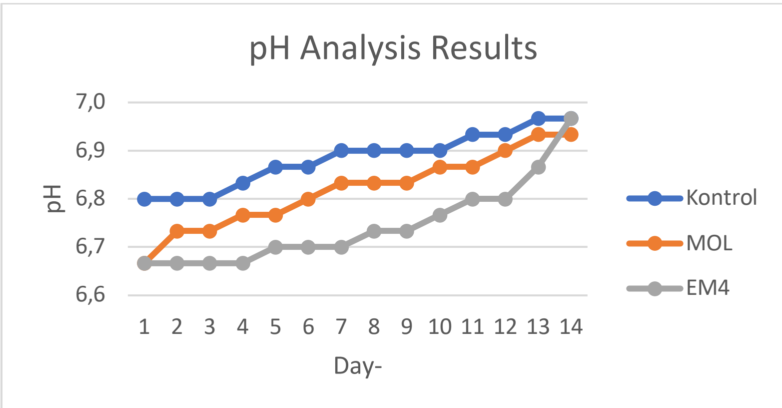

Figure 3. pH Analysis Results

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The pH value of a compost is influenced by the organic content of the compost where protein synthesis occurs by microorganisms. As the compounding process progresses, the protein will break down and ammonia will be released, causing the pH to rise. The activity of microorganisms in degrading the organic material of a composite causes the pH of the composite to change during the compositing period. The pH of the composite according to the SNI 19-7030-2004 standard is at pH 6.8 – 7.49. The pH value of this figure is neutral so that the plant will be easier to absorb the nutrient content of the compost and reduce soil acidity due to the natural acidic nature of the soil. The entire study variable shows a pH range of 6.9 – 7.1 on the 14th day, which means the compositing condition begins to enter the base state where this becomes one of the indicators of composite maturity.

Carbon Content

Carbon content is an important element in agriculture especially in the process of compositing organic materials because organic material can regulate various soil properties and become one of the suppliers of nutrient elements for plants. Carbon is also used by microorganisms as a source of energy in decomposing organic compound material.

Table 1. Inner Composite Carbon Contents (%)

No.	Repetition	Control (A)	MOLs (B)	EM4 (C)
1.	I	16,52	18,90	17,90
2.	II	17,60	19,10	18,95
3.	III	16,90	19,70	18,60
Average		**17,01**	**19,23**	**18,48**

The carbon content of the compound variable with the addition of local microorganisms (MOL) of tomato waste is higher than that of the composite variable using bioactivator EM4. The carbon element content of repeat I was 18.90%, repeat II was 19.10%, and repeat III was 19.70%. The increased carbon content of the compound is influenced by the organic material of the composite. In this study, tomato residues are used as a composite starter or a source of microorganisms that break down organic materials that also contain high levels of carbohydrates. The high carbon content in the three variables of the study throughout the rehearsal is also due to the added organic material of coffee amps waste. The C-organic content in coffee amp reaches 44.87% (Kasongo et al., 2011). Coffee amps that belong to organic waste and have a sufficiently high content of carbon elements can increase the carbon element content in compost. The carbon element content standard has been set in SNI-19-7030-2004 with figures ranging from 9.8 – 32%. Carbon element content on all variables in this study has met the established standard.

Nitrogen Content

The decomposition process of organic compounds produces ammonia and nitrogen. During the compounding process, the decomposer microorganism takes advantage of the nitrogen content in its development (Bachtiar & Ahmad, 2019).

Table 2. Inner Composite Nitrogen Contents (%)

No.	Repetition	Control (A)	MOLs (B)	EM4 (C)
1.	I	0,69	1,10	1,06
2.	II	0,67	1,27	1,24
3.	III	0,67	1,19	1,14
Average		**0,68**	**1,19**	**1,15**

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

The lowest nitrogen content was found in the non-treated (control) compound variable, which only ranged from 0.67 to 0.69%. In contrast to the compost variable with the addition of bioactivators, both local microorganisms (MOLs) of tomato waste and EM4 containing nitrogen ranged from 1.10 to 1.27% and 1.06 to 1.24%. The nitrogen content of both compounds with the addition of bioactivators was in the same range. This shows that local microorganism bioactivators (MOLs) from tomato waste and EM4 do not have a significant effect on the nitrogen content in compost. However, the nitrogen content in compost with the addition of Local Microorganisms (MOL) from tomato waste tends to be higher compared to compost with the addition of EM4 bioactivator. This proves that the organic content in tomato waste can increase the nutrient content of the resulting compost. Low nitrogen content can be caused by organic material compounds which also contain low nitrogen. The main compounds in market waste contain low levels of nitrogen, namely vegetable waste containing 0.38% nitrogen and 0.06% fruit peel waste. Low nitrogen content can also be caused by evaporation of nitrogen during the composting process due to excessive stirring. To overcome the low nitrogen content in compost, research can be carried out by paying more attention to environmental factors such as humidity so that the nitrogen content does not evaporate or be leached during the composting process. Apart from that, composting can be done longer to give microorganisms more time to decompose organic compost material so that it can produce more nitrogen. Based on the standards set in SNI 19-7030-2004, namely the minimum nitrogen content in compost is 0.40%, the non-treated composite variable (control) has met the standard even though the nitrogen content is much lower than the composite variable. with the addition of Local Microorganism (MOL) tomato waste and EM4 bioactivator.

Phosphorus Content

The phosphorus element is an essential element in plant growth where this element will be converted into humus and makes the plant fertile. The deposition of organic compound material is the cause of the existence of the element phosphorus. Microorganisms need phosphorus to build cells like protoplasm and nucleus (Suhesy & Adriani, 2014).

Table 3. Inner Composite Phosphorus Contents (%)

No.	Repetition	Control (A)	MOLs (B)	EM4 (C)
1.	I	0,41	0,50	0,49
2.	II	0,44	0,52	0,52
3.	III	0,42	0,52	0,50
Average		**0,42**	**0,51**	**0,50**

The composite variable with the addition of local microorganisms (MOL) residues of tomatoes has the highest phosphorus content compared to the compost variable without treatment (control) and the composite Variable with addition of bioactivator EM4 is in the range of 0.50 – 0.52%. However, the entire composites variable shows a low phospho content. The content of the phosphat element is closely related to the nitrogen element content, where the lower the content of nitrogen elements in the composites, the lower also the phosphen element content in compost. The standard phosphy content has been set in SNI 19-7030-2004 with a minimum content of 0.10%.

Potassium Content

Microorganisms use the potassium element as a catalyst. The activity of the decaying microorganism greatly affects the increase in the potasium element content. Microorganisms

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such as bacteria and fungi can bind the kalium element in cells. When decomposition occurs, the potash content will be available again (Suhesy & Adriani, 2014).

Table 4. Inner Composite Potassium Contents (%)

No.	Repetition	Control (A)	MOLs (B)	EM4 (C)
1.	I	0,28	0,34	0,31
2.	II	0,31	0,37	0,29
3.	III	0,29	0,33	0,32
Average		**0,29**	**0,35**	**0,31**

The content of the potassium element in the three compound variables at all repetitions has no distant differences from each other. Although the highest element content is in the composite variation with the addition of local microorganisms (MOL) of tomato waste ranging from 0.33 to 0.37%, the figure is still low. The low content of the potassium element in the compost can be caused by condensation during the compounding process. Potassium binding can be released again when the processing time is longer. Low water levels can also be the cause of low potassium content. In addition, the potasium content may also be affected by organic compound material that has low potash content. The potassium element content standard is in accordance with what has been established in SNI 19-7030-2004 is a minimum of 0.20%. The potasium element contents of the whole variable in this study has been in accord with the established standard, which is above 0,20%.

C/N Ratio

If the C/N ratio is too high, which in this case is higher than the carbon content of nitrogen, it indicates that there is still carbon that has not been converted by the microorganism. On the contrary, if it is too small, then there will be an excess nitrogen that can lead to the formation of excess ammonia (NH_3). The longer the composition takes, the lower the C/N ratio.

Table 5. Composite C/N Ratio

No.	Repetition	Control (A)	MOLs (B)	EM4 (C)
1.	I	23,94	17,18	16,89
2.	II	26,27	15,04	15,28
3.	III	25,22	16,55	16,32
Average		**25,14**	**16,26**	**16,16**

The low C/N ratio is caused by a decrease in carbon content and an increase in nitrogen content in the compost. The carbon element comes from composted organic materials such as organic waste and coffee grounds. In the composting process, microorganisms will utilize carbon content as a food source in decomposing organic material. The by-product of the process of decomposing organic material is the emergence of nitrogen content as a source of plant nutrients. According to the compost standards set out in SNI 19-7030-2019, compost is said to be mature if it meets the standard C/N ratio which ranges from 10 to 20. This means that there is no excessive carbon or nitrogen content. If the C/N ratio is too high, namely the presence of excessive carbon elements, this indicates that the decomposition process is not yet complete and requires further microorganism activity to break down the organic compost material. On the other hand, if the C/N ratio is too low, that is, there is excessive nitrogen, it can cause evaporation of ammonia which removes nutrients from the compost. So it can be said that the C/N ratio is an important factor in determining the maturity level of compost and so that the nutrients in the compost can be utilized properly by plants. In this study, only the compost variable without treatment (control) did not meet the standards. This shows that the untreated

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

compost variable has not completed the compositing process or the compost is not yet mature because there is no additional source of microorganisms that helps speed up the compositing process for 14 days. In contrast to the variable compound with the addition of Local Microorganisms (MOLs) tomato waste and EM4 bioactivator which has a source of putrefactive microorganisms so that the composite matures within 14 days. In compost with the addition of Local Microorganisms (MOL) from tomato waste and EM4 bioactivator, there were more microorganisms compared to compost without treatment (control). In compost without treatment (control), the microorganisms only come from market waste, so the microorganisms take longer to decompose the organic compost material. The two variables with the addition of Local Microorganisms (MOL) from tomato waste and the EM4 bioactivator have met the C/N ratio set between 10 and 20.

In this study, both compound variables with the addition of local microorganisms (MOL) of tomato waste and bioactivator EM4 have met the SNI 19-7030-2019 standard and can be said to have ripened after undergoing a compositing process for 14 days due to the C/N ratio that is at numbers between 10 – 20. Local microorganisms (MOLs) of tomato waste have been shown to have the same function as EM4 bioactivators in helping to accelerate the process of composing market waste of damaged or rotten vegetables and fruits. In addition, the microorganisms growing in the Local Microorganism (MOL) of tomato waste can decompose the compound material, which is market waste that is proven to be destroyed by the market waste on the 14th day of the composition. The same is true of research done by Natsir et al. in (2022) where Local Microorganism (MOL) of tomato waste can decompose organic material of household waste with quality that has been in line with SNI 19-7030-2019.

Based on research, local microorganisms (MOLs) contain higher carbohydrates than EM4 bioactivator compounds. This may be due to the fact that the main ingredient is tomato waste. Local micro-organism (Mol) not only contains micro-organisms that can decompose the compound material, but also contains up to 4.70% of high carbs. In addition to the carbs content of tomatoes, the addition of coffee amps to compost also has an influence on the high carbon content of the composite. The high carbon element in coffee is used by micro-organizations as a fuel in the decomposition of organic composite material during the composition period and as one of the suppliers of charges to plants.

Although the contents of coffee amps can add a harvesting element to a compost, adding coffee amp as a composite without a bioactivator cannot accelerate the compositing process. This is demonstrated by the results of research on the control variable up to the 14th day, the main compound material, the market waste, has not been completely decomposed and cannot be said to be ripe since the average value of the C/N ratio is still above the SNI 19-7030-2019 standard of 25.14. Microorganisms melting on the control variable composite only come from the market waste. Unlike local microorganism (MOL) variable additive compounds, tomato waste and EM4 bioactivator have additional sources of microorganic decomposition from both types of bioactivators so that the process of decomposing the organic material of the compound can take place faster.

Conclusion

Local microorganisms (MOL) of tomato waste and EM4 have a different influence on the quality of the composite from the market waste with a source of carbon ampas coffee. Results of the analysis of the content of the element hares on the compound with the addition Local Microorganism (Mol) of the waste tomato is higher compared to the elements hares in the compost with the added bioactivator EM4. In the composites with the bioactivation of Local Micro-organism waste, the average carbon content was 19.23%, nitrogen 1.19%, phosphorus

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0.51%, potassium 0.35%, and the ratio C/N 16.26 with the end temperature 30.67°C and the end pH 6.93. Both bioactivators have met the SNI 19-7030-2019 standard. Based on research that has been conducted, local microorganism bioactivator (MOL) of tomato waste has the potential as a substitute for EM4 bioactivators.

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