Application of local microorganisms from tuna fish and shrimp waste as bio activator for household organic waste composting by Takakura method

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Abstract. Organic waste has the potency to use as bio activator material. This research compares household organic waste compost results with the addition of bio activator from local microorganism activator (LMO) from tuna fish and shrimp waste with Effective Microorganisms (EM4). The composting method used is aerobic composting with the Takakura composting technique. This composting is carried out in 5 variations, variation one without bio activator added, 2 with LMO of tuna fish waste added, variation 3 with LMO shrimp waste added, variation 4 with LMO of tuna fish, and shrimp waste added, variation 5 with EM4 added. Analysis of all compost quality has met SNI 19-7030-2004 standards. A total of 2 kg of raw material produced solid compost becomes 0.7-1 kg of compost. The use of bio activators can speed up the composting process to 8-12 days. The variation of adding LMO tuna fish waste was chosen as a suitable alternative compared to other variations. The composting process with LMO of tuna fish waste results from the fastest composting time of 9 days with a C/N ratio of 18.45%, P₂O₅ 0.56%, and 0.76% K₂O, with 0.85 kg of compost. Scoring results in variation 2 is the best variation in compost maturity quality.

1. Introduction
Garbage or waste is the final product produced by humans as creatures that have many activities. This solid waste problem has become an unresolved problem in Indonesia. Due to the ever-increasing population growth rate and accompanied by a consumptive lifestyle, the production of waste both organic and inorganic waste also increases. Various human activities also affect the amount of waste and the type of waste produced. The waste in Indonesia made is 70% organic waste from the total waste generated, and about 28% is an inorganic waste [1]. Household kitchen activities are a significant contributor to waste. The waste generated from these activities is mainly in the form of organic waste, such as food waste, namely stale rice, vegetables, fruit skins, etc. [2]

The normal composting process is assisted by adding an Effective Microorganism-4 (EM4) activator, which speeds up the compost fermentation process; besides speeding up the composting process, EM4 can also eliminate odours arise during the composting process. Another alternative used as an activator in composting is local microorganisms (LMO) made from natural organic materials such as organic waste generated from daily activities. Local microorganisms originate from certain substrates/materials and are propagated by natural ingredients containing carbohydrates (sugars), proteins, minerals, and vitamins. These local microorganisms (LMO) are in liquids or solutions resulting from the fermentation
of specific substrates or media around us, such as rice, fruits, eggs, milk, snails, fish waste, shrimp waste, and others [3]. LMO solution contains micro and macro elements and contains bacteria that can decompose organic matter, plant stimulants. As agents for controlling plant pests and diseases, LMO can be used as an activator to accelerate the decomposition process. Bacteria such as golden snails and fruits contain carbohydrates such as rice washing water and coconut water and glucose materials such as brown sugar liquid or granulated sugar liquid [4].

Based on several studies conducted, such as research by Mursalim et al. [5], which utilizes fish waste as a medium for local microorganisms for the use of local organic fertilizers and its relation to the growth of mustard plants and research by Nurhasanah and Hedi [6], which utilizes shrimp waste as a liquid organic fertilizer that used to increase the growth of chilli plants. This study used tuna and shrimp waste as an ingredient for making liquid organic fertilizer. In this study, fish and shrimp waste were used as an ingredient of local microorganisms that will be used as an activator of local microorganisms and compared their effectiveness with other activators, namely EM4 in composting organic waste.

In this study, tuna fish waste and shrimp waste can be used as an alternative to making local microorganisms (LMO) functions as an activator when composting household organic waste. This study aims to see the effectiveness of local microorganisms as activators in the composting process and find suitable activators in composting according to the results obtained through analysis of maturity test, quality test, and quantity test of the compost produced. The utilization of tuna and shrimp waste is also expected to reduce the generation of household organic waste generated and also help the community to be able to process waste by composting efficiently and effectively.

2. Methodology

This research was conducted on household organic waste around the Pasar Baru area, Limau Manis, Pauh District, Padang City. The location of sample testing at the Research Laboratory and Solid Waste Laboratory, Department of Environmental Engineering, Andalas University. The raw materials used for composting come from household organic waste in leftover rice, fruit peel, and leftover rice. Each percentage composition of vegetable residues is 59.76%, fruit peels 28.41%, and rice residue 11.83%. Waste composition data can determine the necessary equipment, systems, and program management and planning [7].

2.1. Tools preparation

In this study, the composter used was the Takakura composter. The tool needed is a perforated basket measuring 36 cm x 26 cm x 47 cm. The components required in this Takakura composter are cardboard, paddy husk pads, finished compost, black cloth, and a basket cover. Meanwhile, equipment tests for maturity and quantity of compost consist of a pH meter, thermometer, and scales.

2.2. Material preparation

Material preparation includes preparing raw materials such as household organic waste, raw materials for produce LMO in tuna fish waste and shrimp waste shells, finished compost, and EM4. In making LMO, materials such as tuna fish waste and shrimp waste are needed as bacteria. Coconut water is a source of carbohydrates, and palm sugar is a source of glucose. These ingredients are mixed in a ratio of 1:1:1. The use of LMO and EM4 for composting as much as 5 ml with a weight of organic waste to be composted is 2 kg plus 2 kg of mature compost.

2.3. Preliminary test

There are two essential parameters in determining the selection of raw materials: the C/N ratio and moisture content of raw materials. Preliminary tests determine the optimum conditions for the compost material while the composting process is to see from the parameters of the C/N ratio and the moisture content of each variation of the compost.
2.4. Composting process
The composting process consists of several steps. Firstly, chopping household organic waste and put it into a composter. It was secondly, adding LMO and EM4 activators into the organic waste according to predetermined variations. Thirdly, stirring until homogeneous once every 24 hours until the compost mature to remove the gases formed. Fourthly, check the temperature, pH, colour, texture, and odour every day, record the results, and check before mixing. Moreover, lastly was checking the maturity, quality, and quantity of the compost.

2.5. Compost maturity test
As the composting process is finished, a compost maturity test is done to determine the maturity level of compost. Maturity test parameters include temperature, colour, texture, odour, pH, material reduction, and composting time. The mature compost has a temperature of 30°C, the pH of the compost reaches a neutral pH (6.8-7.49), while the texture and colour of the compost resemble soil and has an earthy odour[8].

2.6. Compost quality test
Compost quality testing conducts to see the maturity and success of composting and see whether or not the compost is suitable for use. Compost quality parameters such as C-Organic, Nitrogen, Phosphorus, and Potassium were measured using the following methods. Determination of C-Organic with the Walkey Black method, measurement of nitrogen by titrimetric method, determination of phosphorus (P₂O₅) by spectrophotometric method, and determination of potassium (K₂O) using the Atomic Absorption Spectrophotometry (AAS) method.

2.7. Compost quantity test
Compost quantity test is done by weighing the solid compost produced by each variation at the end of the composting process.

2.8. Processing and data analysis
The analysis carried out in the study included a test of maturity, quality, and quantity of compost. The subsequent analysis compared household organic waste compost with the addition of LMO activator from tuna fish and shrimp waste with EM4. In this analysis, the best activator based on the solid compost produced with the highest score is the best based on a scoring system. This scoring system consists of two criteria. First, the scoring system uses 1 and 0 for parameters related to quality standards, value 1 given if the variation is within the range of quality standards, while value 0 is provided if the variation is outside the quality standard. Secondly, the parameters related to quality standards use ranking systems. The compost that matures the fastest is given the highest score, while the compost that evolves the longest is given the lowest score. The most significant material reduction variation is given the highest value, while the interpretation with the minor material reduction is given the lowest value. The variation that produces the most compost is given the highest score, while the interpretation with the least amount of compost is given the lowest score.

3. Results and discussion
3.1. Maturity analysis
Analysis of compost maturity includes observing the composting time, level of material reduction, temperature, pH, texture, colour, and odour of each composter. Observations were made every day before mixing on each composter.

3.1.1. Temperature analysis. Temperature is one of the parameters of composting to see the maturity of the compost. This temperature measurement was carried out before mixing the compost and measured every day from the beginning of the composting process until the compost was cooked. An increase in
temperature usually occurs during the composting process, which is generally caused by the microbial activity to produce energy in the form of heat. Composting temperature can be seen in figure 1.

In the initial composting conditions, the measured temperature was relatively high at 33°C in variations 1A and 1B, and the lowest temperature at the beginning of composting was 31°C in 5A variations. Temperatures in the range of 30-60°C indicate rapid composting activity. Temperatures over 60°C will kill some microbes, and only thermophilic microbes can survive [9].

![Compost temperature](image1)

Figure 1. Compost temperature.

In this study, the highest temperature measured was 42°C at variation 1A on the 3rd day, where variation 1A was the control variation without adding an activator. This condition indicates the decomposition process has started because several bacteria convert organic waste into more explicit materials, where the higher the temperature, the higher the temperature[10]. Consume much oxygen and accelerate the process of decomposition of waste. Then as the composting process progresses, the temperature will decrease because there is no decomposition process of organic matter by bacteria. In figure 2, variations 2A and 2B drops 27°C on the 9th day.

3.1.2. pH analysis. Composting can occur in the optimum pH range. The pH of mature compost is usually close to neutral because of the acid release process, which temporarily or locally will cause a decrease in pH [9]. Changes in pH during the composting process for each treatment can be seen in figure 2.

![Compost pH value](image2)

Figure 2. Compost pH value.
In this study, the initial pH of composting was found to be 7.5. The next day, the pH increased to 7.9 due to microorganisms that converted organic acids formed in the previous stage. The increase in pH is caused by decomposing microorganisms that decompose nitrogen in compost material into ammonia which causes alkaline conditions. A pH value that is too high will make the nitrogen element in the compost material turn into ammonia (NH$_3$)[11]. Temperature and pH also affect each other, where the acid will become stronger or weaker when the temperature also changes. Therefore the temperature affects the acid concentration in the composting process so that it affects the pH concentration[9]. The optimal pH of compost so that the composting process runs smoothly is 6.8-7.49, while the pH value at the end of composting in figure 2 is in the range of 7.1-7.3.

3.1.3. Reduction rate. The level of reduction indicates the occurrence of a decomposition process in the compost raw material. A reasonable reduction in compost reaches 20% to 40% or one-third of the compost raw material [12]. Monitoring of compost reduction carried out every day can be seen in figure 3.

![Reduction rate of compost](image)

**Figure 3.** The reduction rate of compost.

Based on figure 3, there was no change in the volume of compost on the first day for all test variations. However, on the second and subsequent days, the importance of compost began to shrink. Compost reduction rate from the beginning to the end of composting ranged from 57.5%-65%. The rate of material reduction is inversely proportional to the quantity of compost produced. The higher the level of reduction, will cause the amount of compost produced to be lower.

On the contrary, if the level of removal of compost is low, the quantity of compost produced will be significant. The highest reduction rate of 65% was experienced by the 5A and 5B test variations, followed by a 62.5% reduction rate in the 3A test variation, then a 60% reduction rate in the 1A, 1B, 2A, 4A test variations. A reduction rate of 57.5% was experienced in test variation 2B. Variations in the 5A and 5B tests have a high percentage reduction rate. These variations are variations with the addition of an EM4 activator, which causes the weight of the compost produced to be small. EM4 contains 90% of Lactobacillus sp. bacteria, phosphate solvents, photosynthetic bacteria, Streptomyces sp., cellulose-degrading fungi, and yeast, so the ability to be able to remodel organic matter in composting is optimal [13]. EM4 with a specific concentration variation causes much organic matter to decompose so that the compost produced is lighter [14].

3.1.4. Texture, colour, and odour analysis. This monitoring is carried out every day before mixing. One indicator of compost can be said to be ripe if it has a texture and colour resembling soil, namely loose surface and blackish-brown in colour [8]. These changes can be seen in figure 4.
Figure 4. Texture, colour, and odour change.

In Figure 4, there is a change in texture, colour, and smell from the beginning of the composting process until the compost is ripe. At the beginning of composting, the texture of the compost is still soft, green in colour like the colour of the raw material, and has an odour like organic waste in general. The changes that occur are lumpy texture where the compost raw material has been combined with the compost, so this happens due to the moving process carried out every day. Over time, at the end of the composting process, compost can be ripe if it has a loose texture like soil. At the beginning of composting, compost was still green or following the colour of the raw material of the waste. Over time, it would turn black at the end of composting. The smell of garbage will smell at the beginning of the decomposition process, and over time, it will change to the smell of earth, which is an indicator that the compost is ripe based on its odour parameters. The reason odour is one of the indicators that must comply with standards is that composting aims to change organic matter to resemble soil characteristics [10].

The variations that experienced the three changes in texture, colour, and smell the fastest were variations 2A, 2B with the addition of MOL of tuna fish waste and variations 4A, 4B with the addition of MOL mixture of tuna and shrimp waste, this variation changes on day 9. For other variations, changes were made on day 10 for variations with the addition of MOL of shrimp waste. On the 11th day, the
variation with the addition of EM4 changed. In comparison, the variation that undergoes the most extended change is the variation that is not given the addition of an activator.

3.1.5. Compost maturity time. The duration of composting for each variation is different due to the addition of activators for composting. Compost is considered ripe if the compost temperature is 30ºC, neutral pH, 20-40% reduction rate, texture, colour, and smell like soil [1]. The composting time for each test variation can be seen in figure 5.

![Figure 5](image_url) Length of time for composting.

The composting process is also influenced by several factors such as oxygen and aeration, C/N ratio, particle size, pH, temperature, and porosity [15]. Based on figure 5, it can be seen that the treatments that have the fastest composting time for nine days are variations 2A, 2B with the addition of LMO activator for tuna fish waste and variations 4A, 4B with the addition of LMO activator a mixture of tuna fish waste and shrimp waste. It can happen because of the help of microorganisms found in the LMO of tuna fish waste, namely Trichoderma bacteria, which can accelerate the decomposition of raw materials into compost[16]. Meanwhile, the test variation with the slowest composting time of 12 days is the 1A and 1B variations, which control variations without adding activators. Compost without adding an activator is compost consisting of only compost raw materials, namely organic waste. Finished compost without the addition of an activator so that there are no additional microorganisms that can trigger the decomposition process of organic matter to be faster and only maximize the performance of microbes found in finished compost so that it requires a longer composting time when compared to compost that is given the addition of an activator.

3.2. Compost quality analysis
Compost quality testing is carried out after the compost is ripe. That is, it has undergone a composting process and is then sifted. Quality analysis based on SN119-7030-2004 includes physical elements and macro elements. Physical aspects include water content, temperature, pH, colour, and odour. At the same time, the macro features include organic C, Nitrogen, C/N ratio, Phosphorus (P2O5), and potassium (K2O) [8].

3.2.1. Moisture content analysis. The reduced moisture content is caused by the evaporation process and the activity of microorganisms. Microorganisms use organic matter and water to produce CO2, thereby affecting the reduced water content. The compost moisture content of each test variation can be seen in table 1.

| Variations | Water Content (%) | SNI 19-7030-2004 | Information |
|------------|------------------|-----------------|-------------|
| 1A         | 29.804           | <50%            | Qualified   |
| 1B         | 30.364           |                 | Qualified   |
Variations | Water Content (%) | SNI 19-7030-2004 | Information |
--- | --- | --- | --- |
2A | 15.169 | | Qualified |
2B | 16.450 | | Qualified |
3A | 18.685 | | Qualified |
3B | 18.947 | | Qualified |
4A | 17.285 | | Qualified |
4B | 17.717 | <50% | Qualified |
5A | 27.706 | | Qualified |
5B | 26.280 | | Qualified |

The decomposition process of organic matter causes the moisture content shrinkage by decomposing microorganisms during the composting process [17]. The water content of the compost in the 1B variation has a high value due to the 1B variation without the addition of any activator, so that organic waste tends to be wet, contains microorganisms that do not absorb much water. Hence, it has the most water content. Variations 2A and 2B, variation with LMO of tuna fish waste have less water content than the other variations. The optimal activity of microbes in decomposing can cause the water content less.

3.2.2. Analysis of c-organic levels. Microorganisms need carbon as an energy source. The C-organic deal of each test variation can be seen in table 2. Based on table 4, the levels of C-Organic in this study varied between 11.480% to 17.589%. That all variations have met the Indonesian national standard. Microorganisms that use more C-Organic in the decomposition process or undergo an evaporation process when C-Organic converts to CO₂, causing low C-organic values. Minor C-Organic value is in variation with the addition of LMO of tuna fish waste. The high C-Organic value is in the 1B variation, namely the control variation without LMO or EM4 activator. The variation of carbon value in each compost can be influenced by the length of time of composting.

Table 2. Composting c-organic value.

| Variations | C-Organic (%) | SNI 19-7030-2004 | Information |
--- | --- | --- | --- |
1A | 16.734 | | Qualified |
1B | 17.589 | | Qualified |
2A | 15.480 | | Qualified |
2B | 14.209 | | Qualified |
3A | 11.977 | 9.8-32% | Qualified |
3B | 12.214 | | Qualified |
4A | 11.750 | | Qualified |
4B | 12.031 | | Qualified |
5A | 14.804 | | Qualified |
5B | 13.456 | | Qualified |

3.2.3. Analysis of nitrogen. Decomposition is a chemical process that produces nitrogen in ammonium and is oxidized again to nitrate. Microorganisms use this nitrogen for the operation of protein synthesis. If microorganisms die, nitrogen will remain in the compost as a source of nutrients [1]. The value of nitrogen content in the composting process of each variation can be seen in table 3.

Table 3. Nitrogen value of compost.

| Variations | N-Total (%) | SNI 19-7030-2004 | Information |
--- | --- | --- | --- |
1A | 1.077 | | Qualified |
1B | 1.045 | Minimum 0.4 | Qualified |
2A | 1.097 | | Qualified |
### Variations

| Variations | N-Total (%) | SNI 19-7030-2004 | Information |
|------------|-------------|------------------|-------------|
| 2B         | 0.962       | Qualified        |             |
| 3A         | 0.740       | Qualified        |             |
| 3B         | 0.682       | Qualified        |             |
| 4A         | 0.660       | Minimum 0.4      | Qualified   |
| 4B         | 0.672       | Qualified        |             |
| 5A         | 0.978       | Qualified        |             |
| 5B         | 0.893       | Qualified        |             |

The variation with the minor nitrogen content is variation IV A of 0.660% with the addition of LMO activator mixture of tuna fish waste and shrimp waste. The variation with the highest nitrogen content of 1.097% is variation 2A which is a variation with waste tuna. The more nitrogen content, the faster the organic matter decomposes because microorganisms that decompose compost raw materials require nitrogen for their development [18].

#### 3.2.4. Analysis of C/N ratio

Based on the analysis of the initial C/N ratio of compost raw materials, the value was 32.58. This value meets the initial standard C/N ratio, which should be in the range of 25-50. This study makes the compost raw material, namely organic waste in leftover rice, vegetable residue, and fruit peels, which can be tested for maturity and compost quality. One of the factors that affect the composting process is the C/N ratio.

The C/N ratio of organic matter is an indicator of nutrient availability. Carbon dioxide is released in the form of gas, while microorganisms capture the decomposed nitrogen. The element nitrogen will remain in the compost even though the organisms are dead, causing the C/N ratio to decrease [9]. The value of the C/N ratio for each test variation can be seen in table 6.

Based on the results obtained in table 4, a low C/N ratio value of 14.111 is obtained from variation 2A with the addition LMO of tuna fish waste, a high C/N ratio value from variation 3B with the addition of LMO shrimp waste. The low C/N ratio is due to its high Nitrogen content and low carbon content. If the C/N ratio is too low, microorganisms' compounds used as energy sources are insufficient to bind free nitrogen. However, if the C/N ratio is too high, it can inhibit the growth of microorganisms[19].

#### Table 4. C/N ratio of compost.

| Variations | C/N ratio | SNI 19-7030-2004 | Informations |
|------------|-----------|------------------|--------------|
| 1A         | 15.538    | Qualified        |              |
| 1B         | 16.825    | Qualified        |              |
| 2A         | 14.111    | Qualified        |              |
| 2B         | 14.770    | Qualified        |              |
| 3A         | 16.178    | Qualified        |              |
| 3B         | 17.909    | Qualified        |              |
| 4A         | 17.800    | Qualified        |              |
| 4B         | 17.902    | Qualified        |              |
| 5A         | 15.138    | Qualified        |              |
| 5B         | 15.076    | Qualified        |              |

#### 3.2.5. Analysis of phosphorus

Phosphorus is essential but is always in a state of deficiency in the soil. Element P is necessary as an energy source. Therefore, P deficiency can inhibit plant growth and metabolic reactions later. Phosphorus value in compost is a minimum of 0.1[8]. The analysis value of phosphorus levels can be seen in table 5.

#### Table 5. Phosphorus value of compost.

| Variations | Phosphor (%) | SNI 19-7030-2004 | Information |
|------------|--------------|------------------|-------------|
| 1A         | 0.222        | >0.1             | Qualified   |
In table 5, the phosphorus content of composting in each variation meets the standard. Phosphorus values for all variations ranged from 0.207 to 0.569%. Phosphorus levels can increase with increasing composting time. The increase of phosphorus happens because bacteria decompose more and more organic matter. Microorganisms need phosphorus to support their activities so that the development and activities of microorganisms are faster in decomposing organic matter. Variations 4A and 4B, namely variations with the addition of LMO mixture of tuna fish waste and shrimp waste, are the high phosphorus levels. The high phosphorus level is because the phosphorus value already contained in tuna fish waste and shrimp waste is relatively high. If the two ingredients are mixed, the phosphorus value is higher [20].

### Table 5. Phosphorus content of compost.

| Variations | Phosphorus (%) | SNI 19-7030-2004 Information |
|------------|----------------|--------------------------------|
| 1B         | 0.207          | Qualified                      |
| 2A         | 0.569          | Qualified                      |
| 2B         | 0.558          | Qualified                      |
| 3A         | 0.418          | Qualified                      |
| 3B         | 0.464          | Qualified                      |
| 4A         | 0.930          | Qualified                      |
| 4B         | 0.909          | Qualified                      |
| 5A         | 0.407          | Qualified                      |
| 5B         | 0.494          | Qualified                      |

3.2.6. Analysis of Potassium. Microorganisms use potassium in the substrate material as a catalyst. The activity of these bacteria will significantly affect the addition of potassium levels. The potassium value that must be present in good compost is a minimum of 0.2% [8]. The potassium value of composting variation showed in table 6.

### Table 6. Potassium value of compost.

| Variations | Potassium (%) | SNI 19-7030-2004 Information |
|------------|---------------|--------------------------------|
| 1A         | 0.716         | Qualified                      |
| 1B         | 0.749         | Qualified                      |
| 2A         | 0.774         | Qualified                      |
| 2B         | 0.764         | Qualified                      |
| 3A         | 0.864         | Qualified                      |
| 3B         | 0.816         | Qualified                      |
| 4A         | 1.289         | Qualified                      |
| 4B         | 1.185         | Qualified                      |
| 5A         | 1.184         | Qualified                      |
| 5B         | 1.090         | Qualified                      |

In table 6, all the composting variations meet the standard values for the potassium parameter. Compost is of good quality if it contains higher levels of potassium. The highest potassium level in variation 4A with the LMO activator mixture of tuna and shrimp waste is 1.289%. The lowest potassium level is in variation 1A, which is a control variation without adding any activator, which is 0.716%. The higher the K element content, the better the compost produced. The potassium content in variation 4A is relatively high because it varies with LMO tuna fish and shrimp waste. The tuna fish and shrimp wastes have a high potassium content, so that if the ingredients are the mixture may cause the potassium content to be high compared to other test variations. Potassium has an essential role in the process of photosynthesis. The element potassium is beneficial for plants because it helps form protein and cellulose in plant stem to become stronger [21].
3.3. Compost quantity analysis
Compost quantity analysis includes the quantity of solid compost. The following table 7 shows the recapitulation of the compost quantity.

| Variations | Raw material (Kg) | Compost (Kg) |
|------------|------------------|--------------|
| 1A         | 2                | 0.8          |
| 1B         | 2                | 0.8          |
| 2A         | 2                | 0.8          |
| 2B         | 2                | 0.85         |
| 3A         | 2                | 0.75         |
| 3B         | 2                | 0.8          |
| 4A         | 2                | 0.8          |
| 4B         | 2                | 0.8          |
| 5A         | 2                | 0.7          |
| 5B         | 2                | 0.7          |

Based on table 7, the solid compost produced in each variation ranged from 0.7 to 0.85 kg. Compost with an activator has a higher reduction rate than the variation that does not use an activator[20]. Variations that use activators to have more microorganisms to decompose organic matter so that more organic matter decomposes. The variation that produces much solid compost is variation 2B with LMO of tuna fish waste. The interpretation that makes a little solid compost is variation 5A and 5B with an activator in EM4. EM4 contains many microorganisms that act as decomposers of organic matter and control bacteria that can inhibit pathogenic fungi allowing the decomposition process in this variation to be optimal and produce a small quantity of compost due to shrinkage of levels.

3.4. Selection of composting variation
Based on the scoring method, the highest total score is variation 2B with LMO of tuna fish waste with a total score of 20. All of these test variations have met the typical values stated in SNI 19-7030-2004[8]. The addition of the LMO of tuna fish waste is a variation with a fast composting time and a high quantity of compost produced to get a high score on the compost quantity score.

4. Conclusion
Based on the compost maturity test, which includes temperature, pH, reduction level, moisture content, texture, colour, and odour, compost's quality and quantity test for all variations have complied with SNI 19-7030-2004 concerning specifications for compost from organic waste. The results of household organic waste composting with LMO of tuna fish waste showed promising results compared to compost with EM4. The use of LMO from tuna fish waste can be an alternative for using EM4 in composting. Based on the scoring results Composting with variations LMO of tuna fish waste activator is the best.

Since the Takakura method applied in this study is limited in material quantity and the input method of the material, it is interesting to conduct a future study to apply the complete Takakura composting method. Interesting to study the microorganism that is present on the LMO also.

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