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Quality of Solid Organic Fertilizers for Duck Manure and Trembesi Leaves with Papaya Peel Bioactivator

Musdhalifah Husna Firdausi, Aminah Asngad*
Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta.
Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
*Corresponding Author. E-mail address: aa125@ums.ac.id

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ABSTRACT

Organic fertilizers can replace inorganic fertilizers that are not environmentally friendly. Duck manure and trembesi leaves can be used as raw materials for fertilizer. Adding local papaya peel microorganisms can help the decomposition process of organic fertilizers. This study aims to determine the quality of solid organic fertilizer made from duck manure and trembesi leaves by adding local papaya peel microorganisms as bioactivation. This study used a completely randomized design (CRD) with a factorial pattern and was repeated three times. The treatment factors are as follows: Factor 1 Raw materials (B1 = Duck Manure 300g: 200g Trembesi Leaves. B2 = Duck Manure 200g: 300g Trembesi Leaves). Factor 2 Papaya Peel Local Microorganisms (P1 = Papaya Peel Bioactivator 25 ml, P2 = Papaya Peel Bioactivator 30 ml). The results showed the best sensory quality in the B2P2 treatment; the fertilizer was blackish brown, smelled of soil, had a crumbs texture like soil, and had a pH of 7. The highest Nitrogen and Phosphorus content was found in the B1P2 treatment, while the highest Potassium content was in the B2P1 treatment. Thus, the quality of solid organic fertilizer is by SNI 19-7030-2004.

1. INTRODUCTION

Fertilizer has a crucial role in plant growth and development. Fertilizers can be divided into two types based on the constituent materials: organic and inorganic fertilizers. Organic fertilizers are made from organic materials, while inorganic fertilizers are made from chemicals. The use of inorganic fertilizers can cause problems in the environment. The negative impacts of the excessive use of inorganic fertilizers can damage the soil and the balance of natural nutrients. They can also kill microorganisms, thereby inhibiting the decomposition of organic matter (Kurniawan and Chusnah, 2021).

The existence of organic fertilizers can be used as a solution to replace the use of inorganic fertilizers. Organic fertilizers have many benefits for the environment compared to inorganic fertilizers, which harm the environment. According to Kurniawan's research (2017), organic fertilizers can trigger and increase the microbial population in the soil far better than inorganic fertilizers. Organic fertilizers can also improve soil structure and fertility. Therefore, organic fertilizers can prevent soil erosion.

Organic fertilizers can make from two different materials, a combination in the manufacture of organic fertilizers is needed to improve the quality of organic fertilizers. Duck manure contains the nitrogen, phosphorus, and potassium that plants need. According to Safriyani's research (2020), the results showed that duck manure had 1.03% N, 0.92% P, 0.53% Potassium, and 32.38 Organic C. With these contents, duck manure can be used as organic fertilizer. Besides being made from animal manure, organic fertilizer can make from organic waste from plant residues such as leaves. Trembesi leaves are not only useful as shade and animal feed but also have the potential to be used as organic fertilizer. According to Darma's research (2020) regarding the content of fruit leaves for organic fertilizer, trembesi leaves contain 4.20% nitrogen, 0.12% phosphorus, and 0.62% potassium.

Fermentation is required to manufacture solid organic fertilizers that decompose organic matter. The fermentation process requires bioactivation to help decompose organic matter. Bioactivators are microbial isolates that have been purified and can digest organic matter containing cellulose (Suwahyono, 2017). Bioactivators made from organic materials can also be called local microorganisms. Fruit peel waste is often used as a natural bioactivator in the fermentation process of organic fertilizers. Fruit peel waste has microorganisms that can help in the decomposition process of organic matter. According to Wicaksono's research (2022) regarding the manufacture of liquid organic fertilizer using local microorganisms of papaya peel, the microbes found in local microorganisms of papaya peel are *Pseudomonas*, *Bacillus*, and *Aspergillus ninger*. The three microbes that act as phosphorus solvents in organic matter. The existence of microbial content in local microorganisms papaya peel, papaya peel waste can be used as a natural bioactivator or local microorganisms.

Based on the explanation above, the problems in this study are: What are the sensory characteristics and levels of nitrogen, phosphorus, and potassium content in solid organic fertilizers made from duck manure and trembesi leaves with the addition of microorganisms local to papaya peel as bioactivation? This study aims to determine the sensory characteristics and nutrient content of nitrogen, phosphorus, and potassium in solid organic fertilizers made from duck manure and trembesi leaves by adding microorganisms local to papaya peel as bioactivation.

Doing this research will provide the following benefits: 1). Providing new information and innovations to the public regarding solid organic fertilizers made from duck manure and trembesi leaves with the addition of papaya peel waste as a bioactivation 2). Be an alternative organic fertilizer for farmers to avoid adverse risks in long-term use.

2. MATERIALS AND METHODS

We conducted this research in Tlangu, Bulan, Wonosari, Klaten to manufacture organic fertilizers and sensory tests. Test for Nitrogen, Phosphorus, and Potassium nutrients at the Soil and Fertilizer Laboratory, Faculty of Agriculture, UMY Jl. Brawijaya Tamantirto, Bantul, Kasihan.

The research occurred on the stairs from February 4 to March 11, 2023. The tools used included: plastic, used gallons, baskets, measuring cups, knives, pH sticks, pH indicators, and stationery. The materials used include duck manure, trembesi leaves, and local microorganisms from papaya peel.

This study uses experimental research methods. This study uses a complete random design (CRD) with factorial patterns and is repeated three times. The treatment factors are as follows: Factor 1 Raw materials (B1 = Manure Duck 300 gram: Trembesi Leaves 200 gram. B2 = Manure Duck 200 gram: Trembesi Leaves 300 gram.). Factor 2: Local microorganisms of papaya peel (P1 = papaya peel local microorganisms 25 ml, P2 = papaya peel local microorganisms 30 ml).

The data analysis used is descriptive qualitative data analysis and quantitative data analysis. Qualitative data analysis is needed to explain the sensory properties of solid organic fertilizers. Using the Two Way ANOVA test, quantitative data analysis was used to test nitrogen, phosphorus, and potassium levels.

3. RESULTS AND DISCUSSION

3.1 Sensory Test

The results obtained regarding the quality of solid organic fertilizer, a combination of duck manure and leaf trembesi with the addition of papaya peel waste as bioactivation, sensory test results (color, smell, texture, and pH) are presented in the following table:

Table 1. Sensory Test (Color, Smell, Texture, and pH) Solid Organic Fertilizer Combination of Duck Manure and Trembesi Leaves with the Addition of Local Microorganisms Papaya peel as a bioactivator

No.	Treatment	Result of Observation			
		Color	Smell	Texture	pH
1	B_1P_1	Brown	Less stinging	Slightly Rough	7
2	B_1P_2	Blackish Brown	Less stinging	Slightly Smooth	7
3	B_2P_1	Brown	Less stinging	Slightly Rough	7
4	B_2P_2	Blackish Brown	Soil	Crumbs	7

Explanation:

B1P1: Manure duck 300g + Trembesi leaves 200g with local microorganism peel of papaya 25 ml.

B1P2: Manure duck 300g+ Trembesi leaves 200g with local microorganism peel of papaya 30 ml.

B2P1: Manure duck 200g+ Trembesi leaves 300g with local microorganism peel of papaya 25 ml.

B2P2: Manure duck 200g+ Trembesi leaves 300g with local microorganism peel of papaya 30 ml.

Fermentation of solid organic fertilizer with a combination of duck manure and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivation obtained the following results:

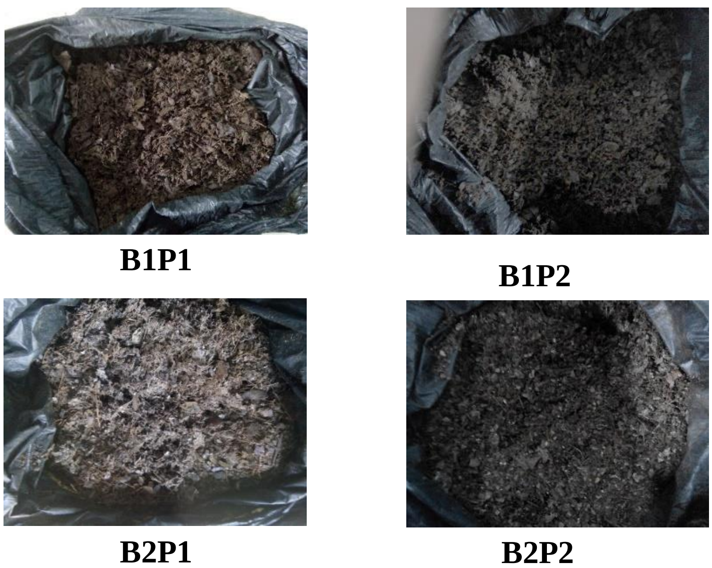
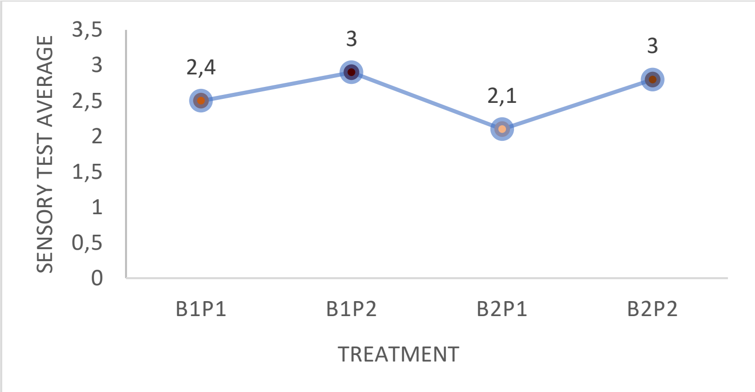


Figure 1. Solid Organic Fertilizer Combination of Duck Manure and Trembesi Leaves with the addition of local microorganisms from papaya peel

3.1.1 Color Parameters

Based on Table 1. and Figure 2. Sensory test results with color parameters on solid organic fertilizer, a combination of duck manure and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivation, showed that the results obtained from the four treatments that had the best results were in the B1P2 and B2P2 treatments with fertilizer that was blackish brown.



Explanation: 1 = Yellowish Brown; 2 = Brown; 3 = Blackish Brown; 4= Blackish

Figure 2. Observation of the color of duck manure organic fertilizer and trembesi leaves with the addition of local microorganisms' papaya peel as a bioactivator.

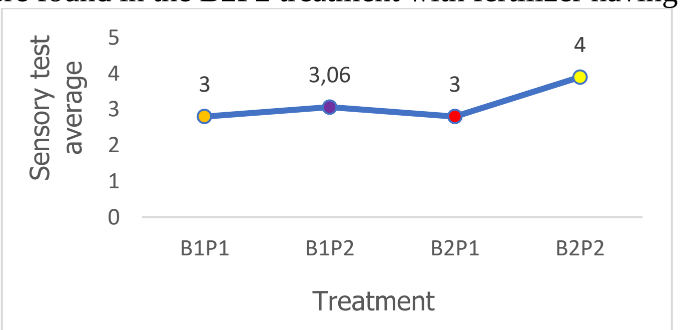
The color of the fertilizer at the beginning of the fermentation is different at the end. The discoloration of solid organic fertilizers is caused by the decomposition of organic matter carried out by microbes in the local microorganisms of papaya peel. These results align with Puspitasari's research (2022), which states that organic matter decomposes and changes during fermentation, forming microbial cell substances and turning into a dark amorphous form. This substance is called matter, like soil. After fermentation, the organic matter changes color to a blackish brown.

In addition, the decomposition process causes organic matter to lose its pigment color, causing the color to change to blackish brown. This statement is in line with the idea of Kumalasari (2016), which states that color change occurs because the decomposition process changes organic matter with complex C carbon chains into simple C carbon chains.

During the decomposition process, the organic matter loses its pigment so that it changes color to blackish brown according to the color of its constituents. Then, solid organic fertilizer with a blackish brown color is formed by standard provisions (SNI No 19-7030-2004), which state that solid organic fertilizer that has matured will have a blackish brown color like soil.

3.1.2 Smell Parameters

Based on Table 1. and Figure 3. Sensory test results with scent parameters on solid organic fertilizer, a combination of duck manure and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivation, the results obtained from the four treatments that had the best results were found in the B2P2 treatment with fertilizer having a scent like soil.



Explanation: 1 = Waste; 2 = Stinging; 3 = Less Stinging; 4 = Soil

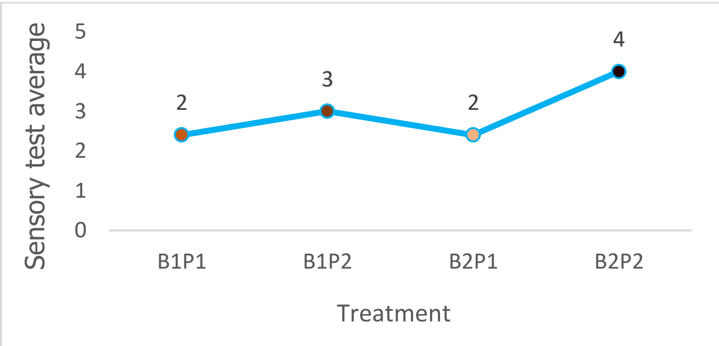
Figure 3. Observation of the smell of duck manure organic fertilizer and trembesi leaves with the addition of local microorganisms' papaya peel as a bioactivator.

At the beginning of the fermentation, the solid organic fertilizer gave off the dominant rotting smell of duck manure. Still, on the 35th day or 5th week, the scent of solid organic fertilizer changed to a soil smell in the B2P2 treatment and a less pungent scent in the other three treatment combinations. Changes in scent in solid organic fertilizers occur due to the activity of microorganisms. This statement aligns with research by Akbar & Asngad (2022), which states that the scent in organic fertilizer comes from microorganisms that decompose organic matter. In addition, microorganisms also produce volatile compounds, namely ammonia. This compound causes solid organic fertilizers to have a less stinging scent at the end of composting.

During the fermentation process, microorganisms decompose organic matter, which causes the scent in the fertilizer to change at the end of composting. This idea is in line with Amalia's research (2016), which states that when organic matter begins to be degraded by microorganisms, at that time, the smell of a mixture of organic matter will slowly disappear and will smell like soil. Then the resulting fertilizer with a soil smell by standard provisions (SNI No 19-7030-2004) states that when organic fertilizer is ripe, it will smell like soil (Andriawan, 2022).

3.1.3 Texture Parameters

Based on Table 1. and Figure 4. Sensory test results with textural parameters on solid organic fertilizer, a combination of duck manure and trembesi leaves with the addition of local microorganisms' papaya peel as a bioactivation, the results obtained from the four treatments that had the best results were found in the B2P2 treatment with fertilizer having a texture the crumbs.



Explanation: 1 = Rough; 2 = Slightly Rough; 3 = Slightly Smooth; 4 = Crumbs

Figure 4. Observation of the texture of duck manure organic fertilizer and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivator

Adding local microorganisms aims to accelerate the process of decomposing organic matter. Fertilizers have a rough texture because microorganisms cannot decompose organic matter properly enzymatically. According to Kurniawan's research (2021), microorganisms produce cellulose enzymes that can degrade plant cellulose bonds. Cellulose bonds in organic matter will degrade, resulting in a smooth texture. *Bacillus* is one of the microbes found in local microorganisms of papaya peel. *Bacillus* microbes can degrade cellulose by secreting their cellulose enzymes so that they can degrade organic matter so that it compacts like soil (Rahman, 2022).

The sensory results of the texture parameter show that the fertilizer has a crumbly texture according to the standard provisions (SNI No 19-7030-2004). Fertilizers that have a crumbly texture are easy for plants to absorb because the nutrient content in the fertilizer has adequately decomposed.

3.1.4 Parameters pH

Based on Table 1. the results of sensory test observations with pH parameters on solid organic fertilizer, a combination of duck manure and trembesi leaves with the addition of papaya peel local microorganisms as bioactivators, of the four treatments showed a pH of around 7, with neutral properties. This pH result complies with the standard requirements (SNI No 19-7030-2004), namely 6.8 to 7.49.

High or low pH levels produced in fertilizers can be influenced by microbial activity that decomposes organic matter into organic acids. This statement aligns with Suwatanti's research (2017), which stated that microorganisms convert nitrogen into ammonia, accelerating the pH's increase to alkaline. Microbes will denitrify it and convert half of the ammonia into nitrate, bringing the pH of the fertilizer to a neutral level. *Pseudomonas* microbes contained in papaya peel local microorganisms can affect the increase in pH levels in fertilizers (Mangungsong, 2019). Local microorganisms of papaya peel can affect the rise in pH levels in fertilizers.

3.2 Content of Nitrogen, Phosphorus, and Potassium

Based on the results of laboratory tests of solid organic fertilizer combined with duck manure and trembesi leaves, the following results were obtained:

Table 2. Content of Nitrogen, Phosphorus, and Potassium in a solid organic fertilizer combination of duck manure and trembesi leaves with the addition of papaya peel as a bioactivator.

Combination	Results Content Test		
	Nitrogen (%)	Phosphorus (%)	Potassium (%)
B1P1	3.26	0.16	0.17*
B1P2	3.64**	0.18**	0.18
B2P1	3.10*	0.11*	0.20**
B2P2	3.43	0.13	0.19

Explanation: (*) lowest yield; (**) highest yield

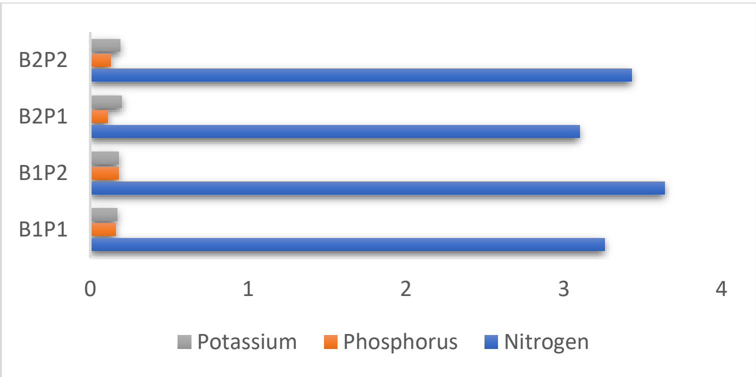


Figure 5. Content of Nitrogen, Phosphorus, and Potassium in solid organic fertilizers

Figure 5. and Table 2. show that the four combinations have different percentages of nitrogen content. The highest nitrogen percentage was found in the B1P2 treatment, with a nitrogen percentage of 3.64%. The highest phosphorus content was found in the B1P2 treatment, with a phosphorus percentage of 0.18%, while the highest potassium percentage was in the B2P1 treatment, with a potassium percentage of 0.20%.

3.2.1 Nitrogen Content

The data in Figure 5. and Table 2. shows that the four combinations have a high nitrogen content above 3%. The high nitrogen content is due to the increase in the value of nitrogen during the decomposition process. This statement is according to Ekawandani's research (2018), which stated that during the CO2 decomposition process, evaporation would occur so that C/N levels would decrease and nitrogen levels would increase. In addition, the high nitrogen content is due to the microbes found in the local microorganisms of papaya peel. One of the microbes in the local microorganisms of papaya peel is *pseudomonas* which has an essential role in increasing nitrogen (Darmawan, 2018).

Table 3. Results of Two-Way ANOVA Nitrogen Content Analysis

Tests of Between-Subjects Effects

Dependent Variable: Nitrogen_Content

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.483[a]	3	.161	386.527	.000
Intercept	135.408	1	135.408	324979.220	.000
Main_Ingredient	.103	1	.103	246.420	.000
Bioaktivator	.378	1	.378	907.380	.000
Main_Ingredient * Bioaktivator	.002	1	.002	5.780	.043
Error	.003	8	.000		
Total	135.895	12			
Corrected Total	.486	11			

a. R Squared = .993 (Adjusted R Squared = .991)

Based on Figure 5. the bar chart shows that the four treatments have different nitrogen percentages. This difference was caused by differences in the concentrations of the main ingredients of the fertilizer, namely duck manure and trembesi leaves, as well as differences in the concentrations of local microorganisms of papaya peel in each treatment. The bar chart results align with the statistical analysis performed with a two-way ANOVA. The results of the two-way ANOVA analysis between the concentration of the main ingredient with nitrogen content and the concentration of the bioactivator with nitrogen content showed sig. 0.00 <0.05 means that there is a difference in the average nitrogen content in each treatment combination, so the concentration of the main ingredient and bioactivator significantly affects the nitrogen content. Meanwhile, the interaction between the main ingredient and the bioactivator showed sig. 0.043 <0.05 means an interaction between the two ingredients on the nitrogen content. It can also be seen in Table 2. that the treatment with a 30 ml bioactivator has a high nitrogen content compared to the 25 ml bioactivator. The treatment with a higher concentration of duck manure has the highest nitrogen content, so the B1P2 (300g duck manure: 200g trembesi leaves + 30 ml papaya peel local microorganisms) treatment obtained the highest nitrogen percentage of 3.64%.

The high nitrogen content is due to the microbes in the papaya peel degrading organic matter to decompose proteins (complex compounds) into simple compounds, one of which is nitrogen, to obtain solid organic fertilizer by the standard provisions of SNI 19-7030-2004 where the nitrogen content contained in organic fertilizer is at least 0.40%.

3.2.2 Phosphorus content

Based on the results of laboratory tests on a solid organic fertilizer combination of duck manure and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivator in the Phosphorus content test in Table 2. it was found that the B1P2 treatment had the highest phosphorus percentage of 0.18%. In comparison, B2P1 had the lowest phosphorus percentage, with a phosphorus percentage of 0.11%. During the maturation process, microbial fertilizers will die, and the phosphorus levels in the microbes will be mixed with compost material, thus increasing the phosphorus levels of organic fertilizers (Kaswinarni, 2020).

The high levels of phosphorus content in the B1P2 treatment were due to the large concentration of local microorganisms of papaya peel used, namely 30 ml. Microbes contained in the local microorganisms of papaya peel play an active role in dissolving phosphorus in organic matter. This statement is according to the research of Wicaksono (2022), which states that Pseudomonas bacteria will utilize previously formed ATP to dissolve phosphorus.

Table 4. Results of Two-Way Anova Analysis of Phosphorus Content

Tests of Between-Subjects Effects

Dependent Variable: Phosphorus_Content

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.009[a]	3	.003	16.571	.001
Intercept	.252	1	.252	1441.714	.000
Main_Ingredient	.007	1	.007	42.857	.000
Bioaktivator	.001	1	.001	6.857	.031
Main_Ingredient * Bioaktivator	.000	1	.000	.000	1.000
Error	.001	8	.000		
Total	.262	12			
Corrected Total	.010	11			

a. R Squared = .861 (Adjusted R Squared = .809)

Based on the bar graph of Figure 5. there are differences in each treatment combination. These results align with the statistical analysis results using two-way ANOVA analysis. The results of the ANOVA show that the main ingredients with phosphorus content are sig. 0.00 < 0.05, then there is a difference in the results of the average phosphorus content based on the main ingredient. From the results of this analysis, we can interpret that the concentration of the main ingredients significantly affects the phosphorus content. This is similar to the result between the bioactivator with phosphorus content and sig. 0.031 <0.05, then there is a difference in the average phosphorus content based on the bioactivation, and the concentration of the bioactivator significantly affects the phosphorus content. Meanwhile, the interaction between the main ingredient and the bioactivator was sig. 1.000 > 0.05 results show no interaction between the concentration of the main ingredient and the bioactivator on the percentage of phosphorus content. It can also be seen in Table 2 and Figure 5. B1P1 treatment with a 25 ml bioactivator has a higher percentage of 0.16% phosphorus content than B2P2 with a 30 ml bioactivator having a proportion of 0.13%. However, the concentration of duck manure in the B1P1 treatment was higher than in B2P2.

The treatment with higher duck manure had a higher percentage of phosphorus than with higher trembesi leaves. This is because the phosphorus content in duck manure is 0.92% higher (Safriyani, 2020) compared to trembesi leaves, which have a phosphorus content of 0.12% (Darma, 2020), so a solid organic fertilizer with phosphorus content is obtained by the provisions of SNI 19-7030-2004, where the phosphorus content contained in organic fertilizer is at least 0.10%.

3.2.3 Potassium content

Based on Table 2. and Figure 5. the B2P1 treatment has the highest percentage of potassium content of 0.20%, while the B1P1 treatment has the lowest potassium percentage of 0.17%. These results indicate that the treatment with higher concentrations of trembesi leaves had a higher percentage of potassium than the treatment with higher concentrations of duck manure.

Table 5. Results of Two-Way Anova Analysis of Potassium Content

Tests of Between-Subjects Effects

Dependent Variable: Potassium_Content

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.002[a]	3	.001	4.563	.038
Intercept	.414	1	.414	3108.063	.000
Main_Ingredient	.001	1	.001	10.562	.012
Bioaktivator	8.333E-006	1	8.333E-006	.062	.809
Main_Ingredient * Bioaktivator	.000	1	.000	3.062	.118
Error	.001	8	.000		
Total	.417	12			
Corrected Total	.003	11			

a. R Squared = ,631 (Adjusted R Squared = ,493)

Based on Table 2. and Figure 5. the B2P1 treatment has the highest percentage of potassium content of 0.20%, while the B1P1 treatment has the lowest potassium percentage of 0.17%. The two-way ANOVA analysis showed that the main ingredients with potassium content obtained sig. 0.012 < 0.05, so there is a difference in the average percentage of potassium based on the main ingredient. These results indicate that the concentration of the main ingredient significantly affects the presence of potassium content. Based on Table 2, the treatment with a higher concentration of trembesi leaves has a higher potassium percentage. While the results of the two-way ANOVA analysis between bioactivators with potassium content sig. 0.809 > 0.05, so there is no significant difference in the average potassium percentage based on the bioactivator. These results indicate that there is no effect of bioactivation concentration on the percentage of potassium content. As seen in Table 2. the B2P1 treatment with 25 ml of papaya peel local microorganisms had a potassium percentage of 0.20% higher than the B2P2 treatment with 30 ml of papaya peel local microorganisms. The interaction between the main ingredient and the bioactivator obtained sig. 0.118 > 0.05 results indicate no interaction between the main ingredient and the bioactivator on the percentage of potassium content.

Treatment with higher concentrations of trembesi leaves had a higher percentage of potassium than treatments with higher concentrations of duck manure. This is because the potassium content in trembesi leaves is 0.62% higher (Darma, 2020) compared to the potassium content in duck manure which has potassium of 0.53% (Safriyani, 2020). So that organic fertilizer is produced by the provisions of SNI 19-7030-2004, where the potassium content in organic fertilizer is at least 0.20%.

Microbial speed can affect the nutrient content level in fertilizer during fermentation. Each microbe has a different speed in decomposing organic matter. This statement is in line with Kusumadewi's research (2019); The results showed that the nutrient content of fertilizers in each treatment was different because the speed of microbes decomposing organic matter was different, where microbial activity during the fermentation process could be influenced by environmental factors such as temperature and pH.

4. CONCLUSIONS

Based on the results of the study, it can be concluded that a solid organic fertilizer combination of duck manure and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivation has sensory quality by standard provisions (SNI No 19-7030-2004) with the color of the fertilizer being blackish brown, having a scent like soil, crumbly textured, and a pH of around 7, as well as the nutrient content of Nitrogen, Phosphorus, Potassium which meets the minimum requirements of the standard provisions of SNI No 19-7030-2004. Of the four treatments, the best sensory quality was found in the B2P2 treatment (200 g duck manure + 300 g trembesi leaves with 30 ml papaya fruit peel local microorganisms). While the highest Nitrogen and Phosphorus content was found in the B1P2 treatment (300 g duck manure + 200 g trembesi leaves with 30 ml papaya peel local microorganisms), and the highest Potassium content was in the B2P1 treatment (200 g duck manure + 300 g trembesi leaves with microorganisms local papaya peel 25 ml).

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