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Quality of Solid Organic Fertilizer from Moringa Leaves and Peanut Shells with Banana Peel Bioactivator

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Bioactivator
Moringa leaves
Peanut shells
Solid organic fertilizer

ABSTRACT

Fertilizer is a material added to the soil to meet the needs of plant growth and production. Moringa leaves and peanut shells can be used as solid organic fertilizer with the addition of banana peel bioactivator. The purpose of this study was to determine the quality of solid organic fertilizer from moringa leaves and peanut shells with banana peel bioactivator through observation of sensory properties and testing nutrient content. This study used an experimental research method with a complete randomized design (CRD) with a factorial pattern. The first factor was the ratio of ingredients (K_1 = 300 g of moringa leaves and 200 g of peanut shell soil; K_2 = 200 g of moringa leaves and 300 g of peanut shells). The second factor was dose of banana peel bioactivator (B_1 = 25 ml, B_2 = 30 ml). The K_1B_2 treatment had the characteristics of mature organic fertilizer. K_1B_1 and K_1B_2 treatments have the highest pH, which is 7. The K_1B_1 treatment has the best nutrient content with 3.42% nitrogen, 0.11% phosphorus, and 0.22% potassium. The study can be concluded to be that quality organic fertilizer is in accordance with SNI 19-7030-2004.

1. INTRODUCTION

Fertilizer is a material added to the soil to meet the needs of plants for growth and production. Based on the constituent materials, fertilizers are divided into organic and inorganic fertilizers. Currently, farmers still utilize a lot of inorganic fertilizers to supply the nutrients plants need. However, the use of inorganic fertilizers will have a negative impact. The long-term use of inorganic fertilizers will damage the soil, plants, and environment. To avoid the negative impact of using of inorganic fertilizers, switching to organic fertilizers is necessary.

Organic fertilizers function to meet the needs of plants for nutrients. The advantages of organic fertilizers are the availability of more balanced elements, increased soil biological activity, and increased soil organic matter content. Fertilizer is classified based on its form. Solid organic fertilizers and liquid organic fertilizers are the two categories of organic fertilizers. Solid organic fertilizer is a type of fertilizer made from solid organic ingredients. Solid organic fertilizer can be used as an alternative to inorganic fertilizers. Solid organic fertilizers can help improve soil structure, which was initially hard or dense to loosen. Solid organic fertilizer can use organic materials such as moringa leaves and peanut shells, with banana peel waste as a bioactivator.

Moringa leaves contain high levels of nitrogen, phosphorus, and potassium, so they can be used to make organic fertilizers. Based on the results of research by Adiaha (2017), the phytochemical content of Moringa leaves is nitrogen (N) 4,02%, phosphorus (P) 1,17%, and potassium (K) 1,80%. In addition, moringa leaves contain essential minerals such as Ca, Na, Mn, Zn, Fe, Mg, and Cu. One combination of ingredients that can be used is peanut shells. So far, peanut shells have yet to be utilized by the public, even though peanut shells contain nutrients that are good for plants. According to Torkashvand (2015), the phytochemical content of peanut shells was 0.87% N,

1.87% P, and 1.19% K. Therefore, the nutrient content in peanut shells is quite high, so they have the potential to be processed into organic fertilizer.

In the manufacture of solid organic fertilizers, bioactivators can be added to speed up the fermentation process. Bioactivators function as activating agents in the form of microorganisms and help start the process of transforming an organic material into a different product by causing changes in its physical and chemical properties. In addition to bioactivators that are already on the market, bioactivators can be made yourself with organic material waste, such as banana peel waste. The addition of bioactivators can speed up the fermentation process because there are microorganisms contained in them. According to Ozabor (2020), the microorganisms found on banana peel are *Pseudomonas* sp. and *Bacillus* sp.

Based on the explanation of the background above, it can be formulated how quality is determined from solid organic fertilizer made from moringa leaves and peanut shells with the addition of bioactivator made from banana peels through sensory tests and nutrient content (nitrogen, phosphorus, and potassium) based on SNI 19-7030-2004. This research aims to determine the quality of solid organic fertilizer from moringa leaves and peanut shells by adding bioactivators from banana peels through sensory tests and nutrient content (nitrogen, phosphorus, and potassium) based on SNI 19-7030-2004.

This research is expected to provide information and benefits to: 1) society regarding the use of moringa leaves, peanut shells, and banana peel waste processed as solid organic fertilizer. 2) Other researchers can add new knowledge about the benefits of moringa leaves, peanut shells, and banana peel waste and how to process them as solid organic fertilizers.

2. MATERIALS AND METHODS

This research was conducted in Tlangu, Bulan Village, Wonosari District, Klaten Regency for the manufacture of organic fertilizers and sensory tests. Test the content of nitrogen, phosphorus, and potassium, carried out at the Soil and Plant Nutrition Laboratory of the Agrotechnology Study Program at Universitas Muhammadiyah Yogyakarta used the Kejdahl method for testing nitrogen content and the wet ashing method with HNO_3 and $HClO_4$ for phosphorus and potassium content. The research took place on February 4–March 11, 2023.

Tool materials used in the manufacture of fertilizers include plastic, scales, chopping machines, knives, cutting boards, measuring cups, stationery, pH sticks, and pH indicators. Tools used in testing levels of N, P, and K include measuring cups, beakers, measuring flasks, digestion tubes, hot plates, Erlenmeyer dropper pipettes, spatulas, spectrophotometers, and test tubes. Materials used to manufacture fertilizers include moringa leaves, peanut shells, banana peels, rice washing water, and granulated sugar. Materials used in testing the levels of N, P, and K include distilled water, 40% NaOH, concentrated H_2SO_4, 60% $HClO_4$, 65% HNO_3, H_3BO_3, and methyl red indicators.

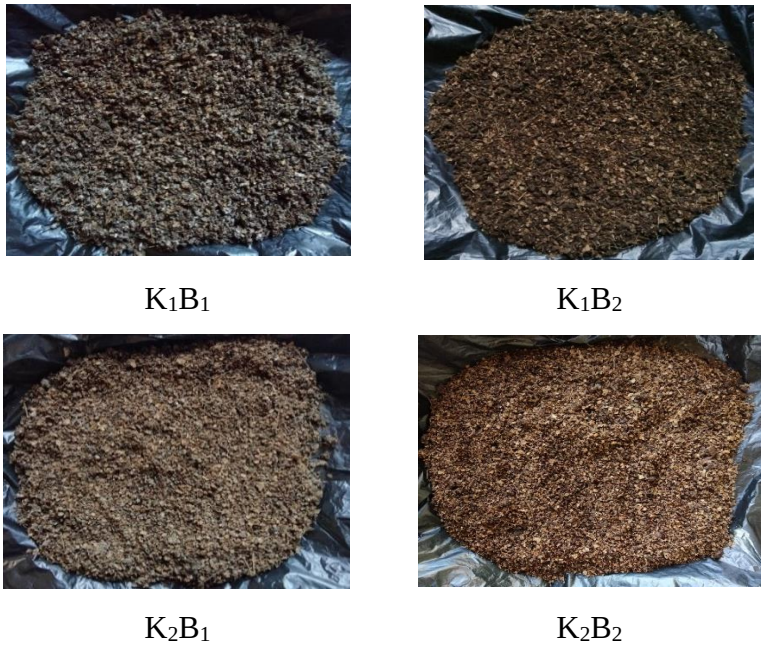
The research procedures include: 1) Preparation of tools and materials; 2) Manufacturing banana peel bioactivators 3) Making solid organic fertilizer: preparing 12 plastic bags labeled with a treatment combination. Put the moringa leaves and peanut shells in plastic according to the treatment combination. Added banana peel bioactivator, 25 ml and 30 ml, according to the treatment label. 4) Sensory test. Making sensory observations on the results of solid organic fertilizer in the form of color, aroma, texture, and pH. 5) Test nutrient content. Conduct a nutrient content test on the results of solid organic fertilizer, including nitrogen (N), phosphorus (P), and potassium (K).

This study used an experimental research method with a complete randomized design (CRD) with a factorial pattern. The treatment factors were as follows: The first factor was the ratio of ingredients (K_1 = 300 g of moringa leaves and 200 g of peanut shell; K_2 = 200 g of moringa leaves and 300 g of peanut shells). The second factor was dose of banana peel bioactivator (B_1 = 25 ml, B_2 = 30 ml). Data analysis used descriptive qualitative analysis and quantitative statistical analysis.

3. RESULTS AND DISCUSSION

3.1. Result

Documentation of the results of solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator can be seen as follows:



K_1B_1 K_1B_2

K_2B_1 K_2B_2

Figure 1. Documentation of color sensory observations on solid organic fertilizer.

Based on the results of research on the use of moringa leaves and peanut shells as solid organic fertilizer with the addition of banana peel waste as a bioactivator, the results of sensory testing (color, smell, texture, and pH) are obtained in table 1.

Table 1. Sensory test (color, smell, texture, and pH) on solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator

Num.	Treatment	Average Observation Results			
		Color	Smell	Texture	pH
1	K_1 B_1	Blackish brown	Less stinging	Rather subtle	7
2	K_1 B_2	Blackish brown	Earthy smell	Crumb	7
3	K_2 B_1	Brown	Sting	Rather subtle	6
4	K_2 B_2	Brown	Less stinging	Crumb	6

Notes:
Color: 1 = Light Brown, 2 = Brown, 3 = Blackish Brown, 4 = Very Black
Smell: 1 = Sewage smell, 2 = Sting, 3 = Less stinging, 4 = Earthy smell
Texture: 1 = Rough, 2 = Rather Rough, 3 = Rather Subtle, 4 = Crumb
K_1 B_1 : 300 g of moringa leaves and 200 g of peanut shell with 25 ml banana peel bioactivator.
K_1 B_2 : 300 g of moringa leaves and 200 g of peanut shell with 30 ml banana peel bioactivator.
K_2 B_1 : 200 g of moringa leaves and 300 g of peanut shell with 25 ml banana peel bioactivator.
K_2 B_2 : 200 g of moringa leaves and 300 g of peanut shell with 30 ml banana peel bioactivator.

Based on the results of research on the use of moringa leaves and peanut shells as solid organic fertilizer with the addition of banana peel waste as a bioactivator, the results of chemical testing (nitrogen, phosphorus, and potassium content) are obtained in table 2.

Table 2. Results of nitrogen, phosphorus, and potassium content in solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator.

Num.	Treatment	The Average Yield of Macro-nutrient Content		
		N (%)	P (%)	K (%)
1	$K_1 B_1$	3,42**	0,11**	0,22**
2	$K_1 B_2$	2,28*	0,10	0,19
3	$K_2 B_1$	2,93	0,09*	0,20
4	$K_2 B_2$	3,05	0,10	0,19*

Notes:
* = Lowest Value, ** = Highest value
$K_1 B_1$: 300 g of moringa leaves and 200 g of peanut shell with 25 ml banana peel bioactivator.
$K_1 B_2$: 300 g of moringa leaves and 200 g of peanut shell with 30 ml banana peel bioactivator.
$K_2 B_1$: 200 g of moringa leaves and 300 g of peanut shell with 25 ml banana peel bioactivator.
$K_2 B_2$: 200 g of moringa leaves and 300 g of peanut shell with 30 ml banana peel bioactivator.

3.2. Discussion

3.2.1. Color Parameter Sensory Test

Based on table 1 and figure 2. the results of sensory observations on solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator obtained the color on each treatment sample is different. Of the four treatments, the best result were obtained from the treatment K_1B_1 and K_1B_2 with blackish brown fertilizer color. Discoloration of solid organic fertilizer brown and blackish brown due to the presence of active microorganisms work during the fermentation process. According to Andriany (2018), the physical properties of the compost change the color of the compost from brownish yellow to blackish brown due to the process of fermentation or decomposition carried out by microorganisms. The blackish-brown color indicates that the fertilizer has matured.

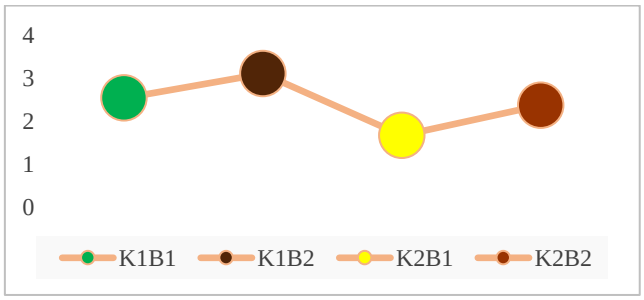


Figure 2. The results of observations of the color of solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator.

The change in color of the fertilizer to blackish brown occurs due to microorganisms decomposing organic matter into simpler ones. Research shows that the color shift happens as a result of microorganisms converting organic matter with a complicated C arrangement to a simple C arrangement during the decomposition process (Kumalasari, 2016). So that the end result is a solid organic fertilizer for moringa leaves and peanut shells with a blackish brown color in accordance with the standard provisions (SNI No. 19-7030-2004), which state that solid organic fertilizer that has matured will have a blackish color.

3.2.2. Smell Parameter Sensory Test

Based on table 1 and figure 3, the results of sensory observations on solid organic fertilizer made from moringa leaves and peanut shells with the addition of shell waste banana as a

bioactivator showed that among the four treatments, the fertilizer that smelled the best was the K_1B_2 treatment, which smelled of earth.

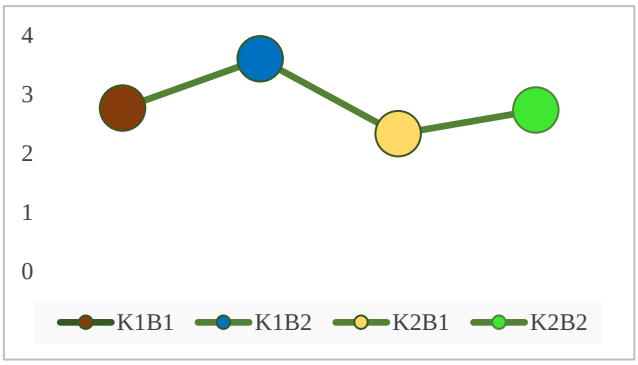


Figure 3. The results of observations on the smell of solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator.

In the K_1B_1 treatment, initially, it had a smell like fertilizer ingredients, which at the end of the fermentation turned into a less stinging one. The K_1B_2 treatment has an initial smell like fertilizer ingredients, which turns into an earthy smell at the end of the fermentation process. In the K_2B_1 treatment, the initial smell was like fertilizer ingredients, which turned into a sting at the end of the fermentation process. Also, there is the K_2B_2 treatment, which has an initial smell like fertilizer that turns into less stinging at the end of the fermentation process. This is in accordance with the fertilizer quality standards based on the national standard agency (SNI 19-7030-2004), which state that mature fertilizer will smell of earth.

The smell of the fertilizer is a sign that decomposition activity has occurred among microorganisms. Unripe fertilizer can be characterized by a pungent odor. According to Nafis (2021), during the decomposition process, the fertilizer smells pungent because the decomposition of the material releases gas in the form of NH_3 (ammonia). This pungent smell is getting longer and will decrease and be replaced with an earthy smell, indicating that the compost has been composted ripe. This is in accordance with the opinion of Zain (2022), which states that at the end of the process of decomposition of organic matter, mature fertilizer produces an earthy odor. The smell of earth on mature fertilizer occurs because the material it contains already resembles soil. According to Puryanto (2022), good compost does not emit a strong, pungent smell but gives off an odor like the smell of earth or the smell of humus.

3.2.3. Texture Parameter Sensory Test

Based on table 1 and figure 4, the results of sensory observations on solid organic fertilizer of Moringa leaves and peanut shells with the addition of shell waste banana as a bioactivator showed that among the four treatments, the texture of the fertilizer was the best in the K_1B_2 and K_2B_2 treatments, namely crumbs.

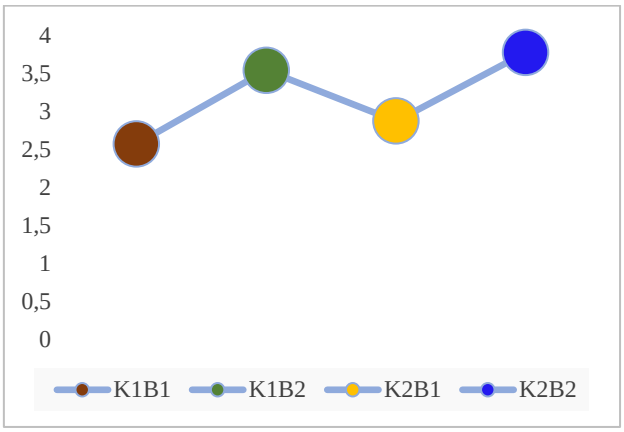


Figure 4. The results of observations on the texture of solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator.

In this study, the peanut shell material was chopped beforehand to simplify the decomposition process. The particle size of the fertilizer is related to its level of maturity. According to Natsir (2022), the more mature the fertilizer, the fewer fibers will result and the particle size will be smaller. The texture of the fertilizer changes due to the decomposition by microorganisms in the fertilizer. This is in accordance with research by Suwatanti (2017), who found that a good fertilizer texture is when the final fertilizer no longer resembles its initial form because it has been destroyed due to natural decomposition by microorganisms living in the fertilizer.

The sensory results of texture parameters show that fertilizer has resulted with small particles. This is in accordance with government regulations regarding quality standards for compost, namely 0.55–25 mm (SNI-19-7030-2004). In the K_1B_2 and K_2B_2 treatments, there was a crumb texture, which was considered good fertilizer characteristic. Crumb texture will make the process of absorbing water into the soil easier, thereby preventing erosion.

3.2.4. pH Parameter Sensory Test

Based on table 1 and figure 5, the results of sensory observations on solid organic fertilizer of moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator showed that among the four treatments, the pH of the fertilizer was the best in the K_1B_1 and K_1B_2 treatments, namely 7.

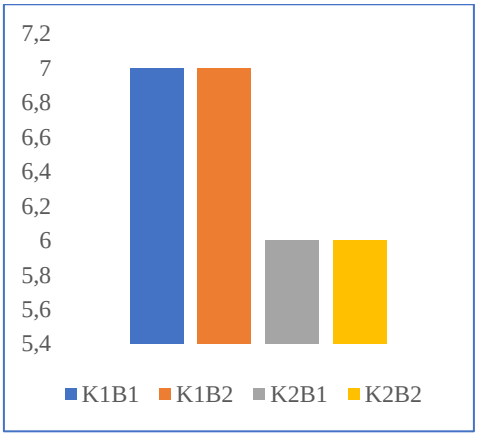


Figure 5. The results of observations on the pH of solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator.

The figure 5 shows the results for each treatment with a different pH value. Different pH values can be affected by the ratio of ingredients used. From the results obtained, it can be said that the pH level is good because it has a pH content range of 6-7. This is reinforced by SNI 19-7030-2004, which states that fertilizer's pH range is 6.80–7.49. The stable pH value can be said to be good for the growth of decomposing microorganisms. This is in accordance with research by Subula (2022), who found that if the pH value is too high, the nitrogen in the fertilizer material will turn into ammonia. Conversely, if the pH is too low, the microorganisms will die.

Different pH values for each treatment indicate that decomposition has taken place. According to Aditya (2015), the decomposition activity that occurs in fertilizers is the overhaul of complex compounds such as carbohydrates, proteins, and fats into simpler compounds to produce organic acids. The K_1B_1 and K_1B_2 treatments had a pH of 7, indicating that the pH is neutral. The neutral pH value of solid organic fertilizer will be easy to determine for used plants. This is in accordance with research by Setyawati (2021), who found that the pH value of solid organic fertilizers that are in neutral range will be easily absorbed and used by plants and is useful for reducing soil acidity. Based on the research results, it is known that the pH content of solid organic fertilizers for moringa leaves and peanut shells with the addition of banana peel waste is a good bio activator because it meets pH quality standards.

3.2.5. Nitrogen Content

Based on table 2 and figure 6, results of nitrogen content in organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator showed that the K_1B_1 treatment had the highest nitrogen content of 3.42%, and the lowest nitrogen content was found in fertilizer with the K_1B_2 treatment of 2.28%.

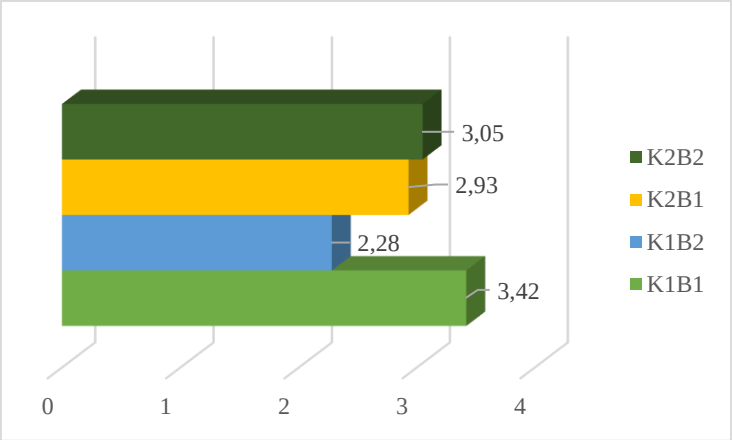


Figure 6. The results of the nitrogen content of solid organic fertilizer for moringa leaves and peanut shell soil with the addition of banana peel waste as a bioactivator.

Based on the figure 6, the nitrogen content formed after undergoing a fermentation process with the raw materials of moringa leaves and peanut shells with banana peel bioactivator has a different nitrogen content in each treatment. A comparison of ingredients and the amount of bioactivator can affect the difference in nitrogen content.

Based on the results of the two-way ANOVA test for nitrogen content, the comparison of ingredients and the amount of bioactivator shows a probability value (sig.) of 0.00 < 0.05, which means there is an effect of the ratio of ingredients and the amount of bioactivator on nitrogen content. This can be seen by the significant difference in the average nitrogen content of each treatment (Fig. 6).

The high nitrogen content in solid organic fertilizers is caused by the fact that moringa leaves have a high nitrogen content. This is in accordance with research by Adiaha (2017), who found that the phytochemical content of moringa leaves is nitrogen (N) 4.02%, phosphorus (P) 1.17%, and potassium (K) 1.80%. In addition to moringa leaves, peanut shells can increase the nitrogen

content of solid organic fertilizer. This is in accordance with research by Khomami (2015), which states that peanut shell compost contains N 2.43%, P 0.67%, K 1.19%, Ca 33.6%, and C/N 9.80.

The addition of banana peels as a bioactivator is also able to increase nitrogen content in solid organic fertilizers because banana peels contain *Bacillus* sp. *Bacillus* sp. is able to fix N_2 so as to increase the availability of nitrogen in the soil. Low nitrogen content can be affected by microbial activity in the decomposition process. According to research by Rosalina (2020), microbes are very active in the decomposition process and use a lot of nitrogen, which causes nitrogen content to drop. Based on the results of the study, the results of the nitrogen (N) content obtained are good and meet SNI 19-7030-2004 because the nitrogen content is above the minimum limit of 0.40%.

3.2.6. Phosphorus Content

Based on table 3 and figure 7, the results of the phosphorus content in organic fertilizer from Moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator showed that the K_1B_1 treatment had the highest phosphorus content of 0.11% and the lowest phosphorus content was found in fertilizer with the K_2B_1 treatment of 0.09%.

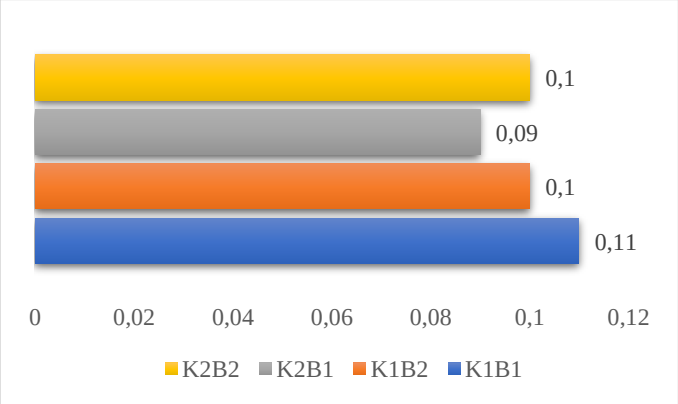


Figure 7. The results of the phosphorus content of solid organic fertilizer for moringa leaves and peanut shell soil with the addition of banana peel waste as a bioactivator.

Based on figure 7, the proportion of moringa leaves to peanut shells and the amount of bioactivator used can both have an impact on the phosphorus content. The highest phosphorus content was obtained in the K_1B_1 treatment using 300 g of moringa leaves and 200 g of peanut shells with the addition of 25 ml of banana peel bioactivator.

Based on the results of the two-way ANOVA test for phosphorus content , the comparison of ingredients and the amount of bioactivator shows a probability value (sig.) of 0.227 > 0.05, which means there is no effect of the ratio of ingredients and the amount of bioactivator on phosphorus content. This can be seen by the average phosphorus content of each treatment (Fig. 7), which shows no significant difference.

Phosphorus content in solid organic fertilizers from moringa leaves and peanut shells and the addition of banana peel as a bioactivator showed different results. Differences in phosphorus content in fertilizers can be affected by *Pseudomonas* sp., which is contained in banana peel bioactivators. According to Asril (2020), several groups of bacteria, such as *Pseudomonas*, *Bacillus*, and *Rhizobium*, have the highest phosphate solubilizing potential. The *Pseudomonas* bacteria group was found to be the best phosphate-solubilizing bacteria. Pseudomonas sp. helps break the chain of other compounds that bind to phosphate elements.

Microorganisms really need phosphorus to build their cells. The decomposition of organic matter and the assimilation of phosphorus occur due to the presence of phosphatase enzymes produced by microorganisms. According to research by Tumimbang (2016), if there is a shortage of compost microorganisms, the process of decomposition of organic matter and assimilation of phosphate will be reduced, so that phosphorus is not used, and if the number of microorganisms

in the fertilizer is sufficient, the decomposition of organic matter takes place perfectly. Based on the results of the study, the phosphorus (P) content in the K_1B_1, K_1B_2, and K_2B_2 treatments complied with SNI 19-7030-2004 because the nitrogen content was above the minimum threshold of 0.10%. Meanwhile, the content of phosphorus (P) in the K2B1 treatment did not meet SNI 19-7030-2004 because the potassium content was below the minimum limit of 0.10%.

3.2.7. Potassium Content

Based on table 3 and figure 10, the results of potassium content in organic fertilizer from leaves of moringa and peanut shells with the addition of banana peel waste as a bioactivator showed that the K_1B_1 treatment had the highest potassium content of 0.22%, and the lowest potassium content was found in fertilizers with K_1B_2 and K_2B_2 treatments of 0.19%.

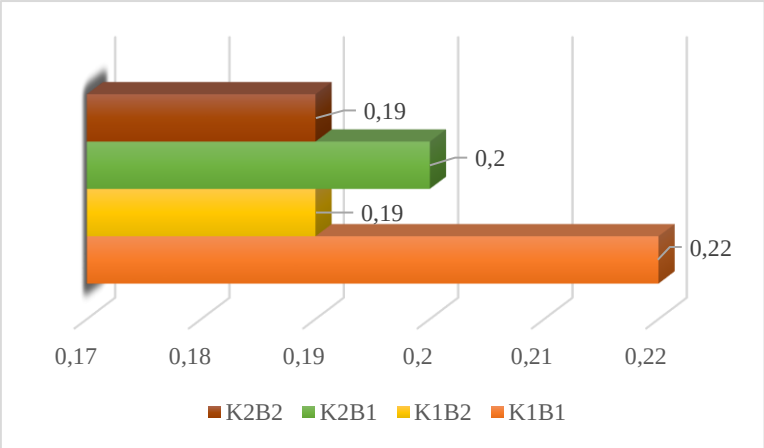


Figure 8. The results of the potassium content of solid organic fertilizer for moringa leaves and peanut shell soil with the addition of banana peel waste as a bioactivator.

Potassium content is formed after experiencing a fermentation process with raw moringa leaves and peanut shells, with the addition of banana peel waste as a bioactivator. Each treatment has a different potassium content. A difference in potassium value can be caused by the comparison of fertilizer ingredients and the number of different bioactivators. The results showed that the addition of 25 ml of banana peel bioactivator could result in higher potassium content. This can be interpreted as meaning that the amount of potassium in the best banana peel bioactivator to get high potassium levels is 25 ml.

Based on the results of a two-way ANOVA test for potassium content on the ratio of ingredients and the number of bioactivators show a probability value (sig.) 0.122 > 0.05, which means there is no effect of the ratio of ingredients and the amount of bioactivator on potassium content. Although the amount of bioactivator has a probability value of 0.009 < 0.05, which means there is an effect of the amount of bioactivator on potassium content, the effect that occurs is not significant and does not affect the potassium content. This can be seen in the average potassium content of each treatment (Fig. 8), which did not show a significant difference.

The potassium content of solid organic fertilizer is influenced by the activity of microorganisms that decompose organic matter. According to research by Bachtiar (2019), the difference potassium content can be caused by differences in the speed at which microorganisms carry out the decomposition process of organic matter during the fermentation process. In essence, potassium is already present in organic stuff, but because it is still complicated, plants cannot directly absorb it. According to research by Worotitjan (2022), during the decomposition process, complex organic waste will break down into simpler organic matter, creating potassium that plants can absorb.

Potassium content below the minimum standard can be caused by microorganisms need for potassium in the decomposition process of organic matter. According to Trivana (2017), which

states that potassium is used by microorganism as a catalyst, the presence of bacteria and their activity will greatly affect the increase in potassium content.

The results showed the potassium (K) content in the K_1B_1 and K_2B_1 treatments were good and fulfilled SNI 19-7030-2004 because of the potassium content above the minimum limit of 0.20%. Meanwhile, the content of potassium (K) in the K_1B_2 and K_2B_2 treatments does not meet SNI 19-7030-2004 because the potassium content is below the minimum limit.

4. CONCLUSIONS

Based on the results of research, solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator average has good quality in terms of sensory observations and tests of nutrient content (nitrogen, phosphorus, and potassium) according to SNI 19-7030-2004. This solid organic fertilizer study did not show a significant difference in each treatment. The K_1B_2 treatment (300 g of moringa leaves and 200 g of peanut shells with 30 ml of banana peel bioactivator) had the characteristics of mature organic fertilizer, namely blackish brown in color, a crumbly texture, and an earthy aroma. The K_1B_1 treatment (300 g of moringa leaves and 200 g of peanut shells with 25 ml of banana peel bioactivator) and the K_1B_2 treatment (300 g of moringa leaves and 200 g of peanut shells with 30 ml of banana peel bioactivator) had the highest pH, namely 7. The K_1B_1 treatment has the best nutrient content with 3.42% nitrogen, 0.11% phosphorus, and 0.22% potassium. The results of the study can be concluded to be that the quality organic fertilizer is in accordance with SNI 19-7030-2004. Suggestion from researchers are: 1) It is hoped that further testing will be carried out on the application of solid organic fertilizers made from moringa leaves and peanut shells with banana peel bioactivator on plants. 2) It is hoped that in future studies, variations will be made on bioactivators other than banana peels.

5. ACKNOWLEDGMENTS

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