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Quality of Liquid Organic Fertilizer Combination Gamal Leaves and Tofu Dregs with Banana Stem Bioactivator

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ABSTRACT

Liquid organic fertilizer is an effective solution to inorganic fertilizers. Gamal leaves and tofu dregs can be used to make fertilizer and banana stem bioactivator to speed up fermentation. The study aim to determine the quality of liquid organic fertilizer (LOF) from the combination of gamal leaves and tofu dregs with the banana stem bioactivators based on sensory properties parameters and N, P, K content. This research method used experimental method with a completely randomized design (CRD). It consists of two factors, As for factor 1, namely the combination of gamal leaves and tofu dregs, P1 = 100 ml : 200 ml, P2 = 120 ml : 180 ml. Factor 2 is banana stem bioactivator, B1 = 100 ml, B2 = 150 ml. Data analysis used descriptive qualitative and quantitative statistics used Two Way ANOVA. In observing the sensory indicators, the average fertilizer yield had a dark brown color, scent like soil, and a pH of 5. Meanwhile, in the content test, only the N content met SNI 19-7030-2004. Thus, it can be concluded that the quality of fertilizer can be used as fertilizer but the color parameters, P and K content do not meet the standards.

1. INTRODUCTION

Indonesia is a well-known agricultural nation in numerous sectors. One of them is the agricultural sector, which can only exist with plant fertilizers. Fertilizer is a substance used to provide essential nutrients to plants. Unfortunately, most farmers rely heavily on government-subsidized inorganic (chemical) fertilizers. In contrast, excessive use of inorganic (chemical) fertilizers damages soil components and kills decomposing microorganisms. Therefore, an effective solution to this issue is transitioning from inorganic (chemical) to organic (natural) fertilizers, readily available in the local environment.

Organic fertilizers are fertilizers derived from a combination of natural or organic materials that contain large amounts of nutrients in small amounts and, in addition to supplying plants with the elements they require, can also improve the biological, physical, and chemical activities of the soil (Rahma et al., 2014). Liquid fertilizer has the advantage of being able to eliminate nutrient deficiencies in plants more rapidly than solid fertilizers. Liquid organic fertilizer contains plant nutrients such as N by 3-6%, P_2O_5 by 3-6%, and K_2O by 3-6%, and its pH ranges from 4 to 9 (Regulation of the Minister of Agriculture, 2011).

Liquid organic fertilizer requires a mixture of supporting organic materials. Two distinct substances can be combined with the intention of enhancing the availability of plant-required nutrients. Gamal leaves are one of the organic materials that can be used as liquid organic fertilizer and are derived from leguminose plants. Due to a lack of knowledge regarding the composition and benefits of gamal leaves, they are typically reserved for animal fodder. The composition of gamal leaves is rich in macro and micronutrients, with Nitrogen by 3.15%, Phosphorus by 0.22 %, Potassium by 2.65 %, Calsium by 1.35 %, and Magnesium by 0.41 %. The content of essential nutrients in gamal leaves can satisfy the high nutrient needs of plants (Novriani et al., 2019).

To meet the need for low phosphorus content in gamal leaves, it is necessary to add tofu dregs, which have a high phosphorus content and is used to make liquid organic fertilizer. Tofu dregs are solid refuse resulting from the tofu factory industrys residual processing of soybeans into tofu. According to Jupry (2020), utilization of tofu dregs has the availability of nutrients needed by plants. The content of essential nutrients needed by plants in tofu dregs is N by 1.24%, P_2O_2 by 5.54 %, K_2O by 1.34%, and C-Organic by 5.803%.

The production of liquid organic fertilizer necessitates using of a bioactivator, which is employed to speed up fermentation. In addition, the bioactivator in the fermentation of liquid organic fertilizer serves as a decomposer or decomposer of organic substances within the material. Banana stems are one form of bioactivator that can be utilized. Bioactivators or local microorganisms (MOL) derived from naturally occurring banana stems contain micro and macro elements as well as bacteria that decompose organic matter. According to research Tuhuteru et al., (2021), the microbial content of banana stems includes nutrient suppliers such as *Lactobacillus*, *Actinomycetes*, Phosphate solvent, and *Saccharomyces*. Banana stem bioactivator or MOL also contains the hormones gibberellin and cytokinin, which function to divide plant tissue in order to accelerate plant growth, including plant height, root dry weight, and leaf area.

Based on the preceding context, the research problems are as follows: How is the quality of liquid organic fertilizer (LOF) derived from the combination of gamal leaves and tofu dregs with the addition of banana stem bioactivator as measured by sensory properties parameters (color, scent, pH) and indicators of Nitrogen (N), Phosphorus (P), and Potassium (K). This study aims to determine the quality of liquid organic fertilizer (LOF) from combination of gamal leaves and tofu dregs with the addition of a bioactivator derived from banana stems based on sensory properties parameters (color, scent, pH) and indicators of nitrogen (N) content, phosphorus (P) content, and potassium (K) content.

In the meantime, it is hoped that the results of this study will provide information for the following purposes: 1) Researchers will acquire additional knowledge and insight regarding the use of organic matter in the production of liquid organic fertilizer. 2) The community is aware of the application and composition of gamal leaves and tofu dregs as liquid organic fertilizer (LOF) with banana stem bioactivator.

2. MATERIALS AND METHODS

This research was conducted from February and April 2023 at the Green House Laboratory of the Faculty of Teacher Training and Education at Universitas Muhammadiyah Surakarta to produce liquid organic fertilizer and conduct sensory evaluations (Color, Scent, pH). Tests of Nitrogen (N) content by using the Kjeldahl method, Phosphorus (P) content, and Potassium (K) content by using wet ashing with HNO_3 and $HCIO_4$ were conducted at Universitas Muhammadiyah Yogyakarta Soil and Plant Nutrition Laboratory, Agrotechnology Study Program.

The tools used in the manufacture of liquid organic fertilizer from the combination of gamal leaves and tofu dregs with the addition of banana stem bioactivators are jars, blenders, basins, digital scales, analog scales, wooden stirrers, stoves, filters, measuring cups, knives, pH indicators, distillation, titration, test tubes, spectrophotometer, flamephotometer, stationery, documentation tools, gloves. Meanwhile, the materials used for making fertilizer are gamal leaves, tofu dregs, banana stems, water, brown sugar, molasses, coconut water, leri water, ground water, bran, pH stick, raffia rope, H_2SO_4 concentrated, distilled water, salt, N_2OH 45%, Zn, H_3BO_3 4%, HCL 0,1 N, HNO_3 concentrated, $HCIO_4$ concentrated, HNO_3 2N, ammonium heptamolybdate vanadate, concentrated extract to P.

The research procedures includes: Preparing Tools and Materials, Make Stock of Banana Stem Bioactivator by conducting sensory observations once every 3 days with stirring before observation. Then, make Tofu Dregs Flour Stock. The next step is to make stock of Gamal leaf extract. Then, make Liquid Organic Fertilizer with prepared materials such as gamal leaf extract, stock of tofu dregs flour, and banana stem bioactivator according to the concentration. Then, observing the sensory properties of each fertilizer every 3 days according to the indicator

parameters of color, scent, pH. Then, after the fertilizer has been fermented, tests for the content of N, P, K include the N Test (Kjeldahl Method), P Test (Wet Ashing with HNO_3 and $HCIO_4$), and K test (wet ashing with HNO_3 and $HCIO_4$).

This research method used an experimental research type with a Completely Randomized Design (CRD) consisting of 2 factors with 4 combinations and 3 repetitions. The first factor is the use of a combination of the basic ingredients of gamal leaves and tofu dregs, namely P_1 : 100 ml : 200 ml, P_2 : 120 ml : 180 ml. Factor 2 is the addition of MOL or banana stem bioactivator, namely B_1 : 100 ml, B_2 : 150 ml. There are 2 data analyzes used, namely descriptive qualitative and quantitative statistics using two-way analysis of variance (Two Way ANOVA).

3. RESULTS AND DISCUSSION

3.1 Sensory Observation

The results of sensory research involving liquid organic fertilizer combined with gamal leaves and tofu dregs with the addition of banana stem bioactivator, conducted using a sensory questionnaire on 10 farmer panelists from four combination samples with three replications, are as follows:

Table 1. sensory observations on liquid organic fertilizer a combination of gamal leaves and tofu dregs with the addition of banana stem bioactivator.

Treatment	Indicator		
	Color	**Aroma**	**pH**
P_1B_1	Dark Brown	Scent Like Soil	5
P_1B_2	Dark Brown	Scent Like Soil	5
P_2B_1	Greenish Brown	Non-pungent Fermentation Odor	5
P_2B_2	Greenish Brown	Scent Like Soil	5

Notes:

P_1B_1 : liquid organic fertilizer with a concentration of 100 ml of gamal leaf extract and 200 ml of tofu dregs with the addition of 100 ml of banana stem bioactivator.

P_1B_2 : liquid organic fertilizer with a concentration of 100 ml of gamal leaf extract and 200 ml of tofu dregs with the addition of 150 ml of banana stem bioactivator.

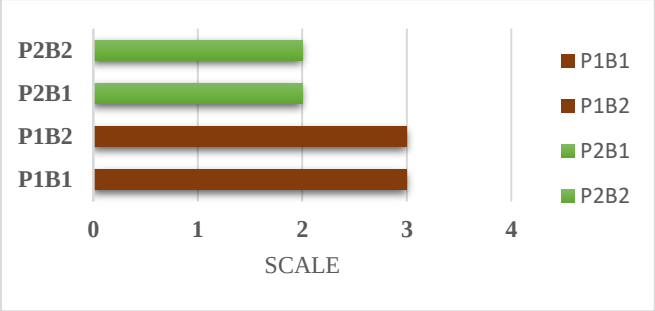
P_2B_1 : liquid organic fertilizer with a concentration of 120 ml of gamal leaf extract and 180 ml of tofu dregs with the addition of 100 ml of banana stem bioactivator.

P_2B_2 : liquid organic fertilizer with a concentration of 120 ml of gamal leaf extract and 180 ml of tofu dregs with the addition of 150 ml of banana stem bioactivator.

The Sensory Observations on liquid organic fertilizer include the following parameters:

3.1.1 Color Parameters

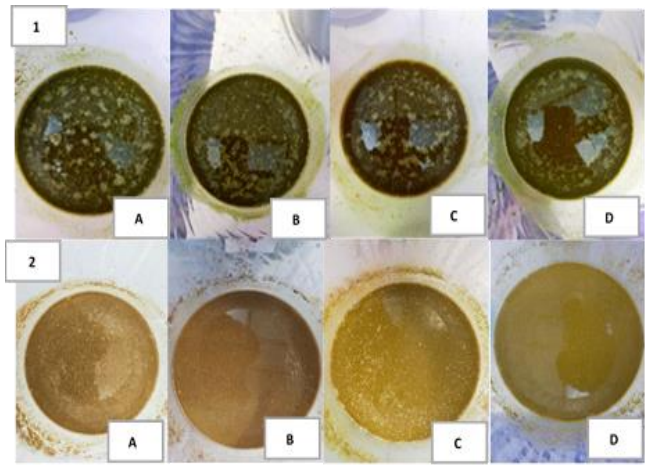
The color parameter is a physical property-based indicator of fertilizer quality based on physical properties. The color change of the fertilizer is a result of the combined ingredients (Fangohoy, 2017). The following bar chart shows the color parameters based on sensory observation research findings:



Note: 1=yellowish brown; 2=greenish brown; 3=dark brown; 4=slightly dark brown

Figure 1. The color of liquid organic fertilizer

Four samples of liquid organic fertilizer are shown in Table 1 and Figure 1. During production, the color of the liquid organic fertilizer is greenish brown; however, after 14 days of fermentation, the color of each treatment varies. In the treatment of P_1B_1 and P_1B_2, the fertilizer color is dark brown; in the treatment of P_2B_1 and P_2B_2, the fertilizer color is greenish brown, as shown in Figure 1. Fertilizer color can be shown in the following figure:



Notes: 1= Early fermentation 2=Final fermentation; A=P_1B_1, B=P_1B_2, C=P_2B_1, D=P_2B_2

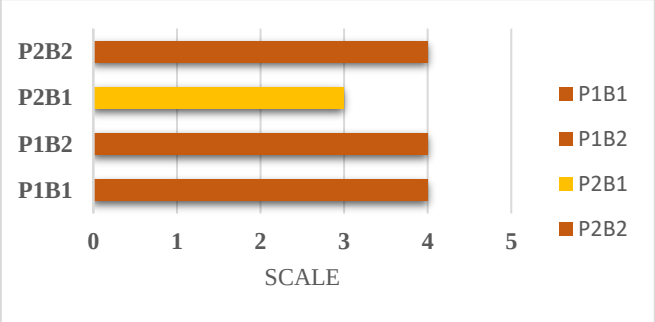
Figure 2. Sensory observation of liquid organic fertilizer

The maturation of liquid fertilizer can be determined by its transformation from its original color to brown. If the color remains the same as when it was first produced, the fermentation time is still too rapid (Sari et al., 2022). The average brown color was generated by the four fertilizer treatment. According to Yuliatin et al., (2018), The transformation of liquid fertilizer color to brown after the fermentation process indicates the fertilizer effectiveness.

In this study, the average color of liquid organic fertilizer combined with gamal leaves, tofu dregs, and banana stem bioactivator did not meet SNI 19-7030-2004 specifications. The requirements of SNI 19-7030-2004 for the maturation of liquid organic fertilizer are dark brown. This is due to the fourth color combination of liquid organic fertilizer based on the used constituent mixture. In accordance with Arifan et al., (2020) finding that the color change produced in liquid organic fertilizer is influenced by the main ingredients used, the color produced from each ingredient can be used as an indicator of the success of making liquid organic fertilizer.

3.1.2 Scent Parameter

Liquid organic fertilizer is successful based on its scent. The scent parameters can be represented as follows in a bar chart based on the research findings:



Notes: 1 = Bad scent; 2=Strong Fermentation scent; 3=Non-pungent Fermentation Scent; 4=Scent Like Soil

Figure 3. The scent of liquid organic fertilizer

In Table 1 and Figure 3, the P_2B_1 treatment produces a non stinging fermented odor. In contrast, when P_1B_2, P_1B_2, and P_2B_2 are treated, an earthy odor is produced. In accordance with research Indrayani et al., (2019), liquid organic fertilizer at maturity will scent of fermentation and not sting and scent like soil. According to Triyanto (2021), the level of maturity of liquid organic fertilizer can be determined by observing the reduction of odor and heat.

During the 14-day fermentation of liquid organic fertilizer, bioactivators derived from banana stems aid the microorganisms activity. During the 14-day fermentation process of the banana stem bioactivator, the odors of tape and alcohol are released. According to the findings of Heryan et al., (2022), the scent that indicates a fermentation process caused by active microorganisms has a fresh sour aroma or a distinct tape scent and does not smell unpleasant. This demonstrates that liquid organic fertilizer satisfies the requirements of SNI 19-7030-2004 for the scent parameter. Because the organic matter in the fertilizer was properly fermented and the nutrients were properly formed, a mature fertilizer has a scent like soil.

3.1.3 pH Parameter

The similarity of the pH values of the four combinations is as follows, according to the results of the investigation on the pH parameters shown in table 1:

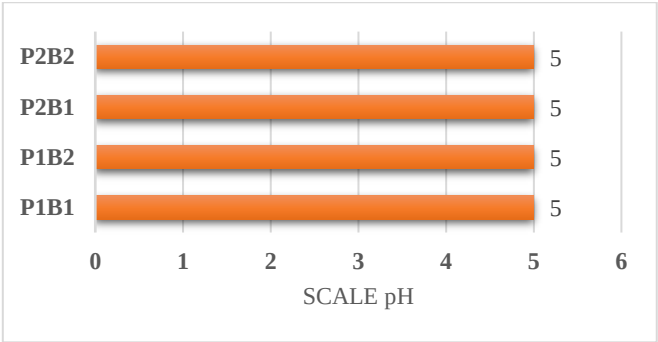


Figure 4. pH of Liquid Organic Fertilizer

The pH parameter in liquid organic fertilizer is one of the quality indicators for liquid organic fertilizer. The pH value during composting has a significant impact on microbial development. If the pH level of the compost is too high, the nitrogen component will convert into ammonia (NH3) (Ekawandani, 2018). The pH of liquid organic fertilizer can be high or low, depending on the fermentation microorganisms (Al-Hadi, 2021).

In Table 1 and Figure 4, the pH of the fermentation process for each of the four liquid organic fertilizer applications of 5. The pH of liquid organic fertilizer can decrease or increase because microorganisms or decomposers in organic matter produce unstable organic acids. Each observation reveals that the pH of mature liquid organic fertilizer is constant and stable. In

accordance with Norhikmah et al.,(2022), during the fermentation of liquid organic fertilizer, decomposition-involved microorganisms convert organic matter into organic acids, resulting in pH fluctuations. The longer the fermentation period, the closer the pH of the fertiliser will approach neutrality.

During the 14-day fermentation period of this investigation, the pH of the fertilizer was 5. It met the standards according to the 2011 Republic of Indonesia Agricultural Regulations concerning Organic Fertilizer, Biological Fertilizer, and Soil Improvement, which states that the minimum pH value of Liquid Organic Fertilizer is between 4-9.

3.2 N, P, K content

On the basis of laboratory results and two-way analysis of variance (Two way ANOVA), the following average yields were determined for the liquid organic fertilizer combination of gamal leaves and tofu dregs with the addition of banana stem bioactivator:

Table 2. the results of the analysis of the average content of Nitrogen (N), Phosphorus (P), and Potassium (K) in the liquid organic fertilizer combination of gamal leaves and tofu dregs with the banana stem bioactivator (%).

Sample Combination	Average Analysis Results		
	N (%)	P (%)	K (%)
P_1B_1	0.71	0.06**	0.09**
P_1B_2	0.72**	0.05*	0.07
P_2B_1	0.47*	0.05*	0.06*
P_2B_2	0.59	0.05*	0.08

Notes: (*) lowest result
(**) highest result

The nutrients contained in the liquid organic fertilizer combination of gamal leaves and tofu dregs with banana stem bioactivator include:

3.2.1 Nitrogen (N) Content

Nitrogen in fertilizer contributes to the synthesis of chlorophyll and the development of plant vegetative organs, such as the production of verdant leaves (Asroh, 2019). Based on of laboratory experiments for nitrogen content in liquid organic fertilizer, the following bar chart can be constructed:

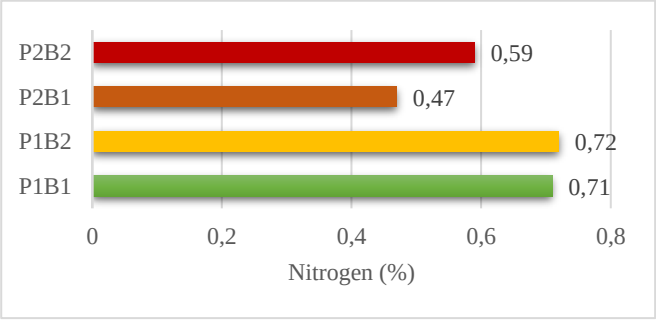


Figure 5. Nitrogen content of liquid organic fertilizer (%)

In Table 2 and Figure 5, the P_1B_2 treatment has the highest Nitrogen content of 0.72%. The lowest Nitrogen concentration was 0.47 % in the P_2B_1 treatment. In terms of the composition of

the used ingredients, the combination of 100 ml : 200 ml contained the highest nitrogen content. According to research Hardikawati et al., (2017), the highest nitrogen content in liquid organic fertilizer can be obtained from a ratio of 100 ml to 200 ml. The highest Nitrogen content is also affected by the addition of bioactivators with the highest combination, namely 150 ml. Because bioactivators in fertilizers can affect Nitrogen content as a result of the decomposition or overhaul of organic materials broken down by microorganisms (Andriany et al., 2018).

Based on the result of Two way ANOVA, it can be concluded that there is an interaction effect between the combination of constituents and the addition of bioactivators on the Nitrogen (N) content, such that each treatment has a different mean, as indicated by a Sig. 0.019 < 0.05 and can be seen from Figure 5. This is consistent with the research Meriatna et al., (2018), which indicates the difference between higher and lesser Nitrogen content is influenced by the growth of microorganisms that divide their cells. Additionally, the fermentation period effects the nitrogen content of the fertilizer. In the production of liquid organic fertilizer, the considerable variation in nitrogen content can be influenced by organic matter containing protein (Jeksen, 2017).

Nitrogen (N) content in liquid organic fertilizer combination of gamal leaves and tofu dregs with the banana stem bioactivator from the four treatment combinations match the requirements of SNI 19-7030-2004 with a minimum standard of Nitrogen (N) content in liquid organic fertilizer, namely 0.40 %.

3.2.2 Phosphorus (P) Content

Phosphorus contributes to the development of seeds, roots, flowers, and fruits in vegetation. Phosphorus content of liquid organic fertilizer is superior to that of solid (Irawan et al., 2021). According to the test results for the Phosphorus content of liquid organic fertilizer, the following bar chart can be constructed:

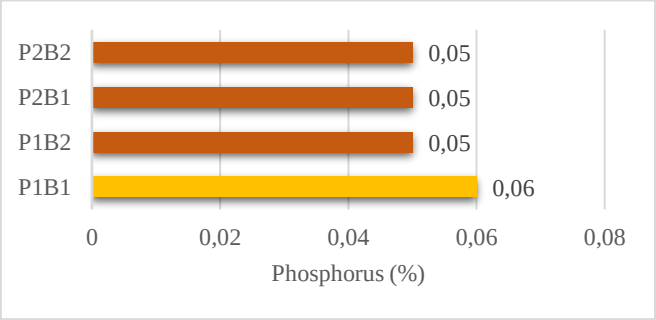


Figure 6. Phosphorus content of liquid organic fertilizer (%)

In Table 2 and Figure 6, the P_1B_1 treatment has the highest Phosphorus concentration in liquid organic fertilizer combined with gamal leaves and tofu dregs with the banana stem bioactivator. The liquid organic fertilizer combination of gamal leaves and tofu remnants with the addition of banana stem bioactivator had the lowest Phosphorus content, at 0.05% on average for the P_1B_2, P_2B_1, and P_2B_2 treatments. Phosphorus content in liquid organic fertilizer is influenced by the nutrient content of the liquid organic fertilizer organic base constituents. Tofu dregs contain more phosphorus than gamal leaves. According to research conducted by Rahmina et al. (2017), the Phosphorus (P) content of tofu dregs is 1.219 %. In the meantime, according to research by Novriani et al. (2019), the Phosphorus content of gamal leaves is 0.22 %.

The duration of fermentation also affects the amount of Phosphorus (P) in liquid organic fertilizer. The average content of the four liquid organic fertilizer treatments decreased, and each treatment had a low average content. In accordance with previous research Rasmito et al., (2019), which states the Phosphorus concentration in fermented liquid organic fertilizer for 10 days is greater than for 15 days. Because the longer the fermentation time, the more air penetrates during fermentation, resulting in the death of decomposing microorganisms due to a lack of nutrients.

Based on the result of Two way ANOVA, it can be concluded that the combination of ingredients, the addition of bioactivator, and the interaction of the combination of ingredients and the addition of bioactivator have no effect on the phosphorus content, as each treatment has a mean close to the Sig. 0.0750 > 0.05 and can be seen fom Figure 6. This is because phosphorus-containing materials in each treatment are not completely broken down by decomposing microorganisms, resulting in a low phosphorus content. According to research Gunawan et al., (2015), phosphate solvent decomposing microorganisms aid in dissolving phosphate to produce available phosphorus content in fertilizers.

The percentage of Phosphorus (P) in the four treatment configurations of liquid organic fertilizer combined with gamal leaves and tofu dregs was categorized as low on average and did not meet SNI 19-7030-2024 standards with a minimum limit of 0.10 %.

3.2.3 Potassium (K) content

The primary function of potassium is to fortify the plant body so that its flowers and fruits do not fall off readily (Lepongbulan et al., 2017). According to the test results for the Potassium content of liquid organic fertilizer, the following bar chart can be constructed:

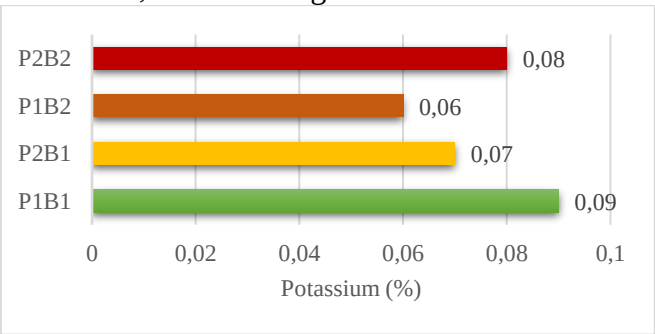


Figure 7. Potassium content of liquid organic fertilizer (%)

The results of Potassium Content test for the four combinations of Liquid Organic Fertilizer treatments in Figure 7 and Table 2 have different average percentages. The highest Potassium content was 0.09% in the P_1B_1 treatment. Meanwhile, the lowest potassium content was 0.06% in the P_1B_2 treatment. The level of Potassium content in liquid organic fertilizer is also influenced by the length of time of fermentation. This is in accordance with research Kusumadewi et al., (2019), Potassium levels are higher in liquid organic fertilizer fermented for one week than for two weeks, because the longer the fermentation, the lower the activity of microorganisms in decomposing organic compounds and the lower the potassium levels obtained. There is no correlation between fermentation time and potassium content.

Based on the result of Two way ANOVA, it is possible to conclude that there is an interaction effect of the combination of materials and the addition of bioactivators on the Potassium (K) content, such that each treatment has a distinct mean with a different Sig. 0.009 < 0.05 and can be seen from Figure 7. Potassium content in each treatment differs due to the number of combined concentrations of the ingredients and the addition of bioactivators to liquid organic fertilizers to speed up the fermentation process carried out by microbes or microbes (Rahmawati et al., 2020). The presence of microorganism activity in the substrate material as a bioactivator in the fermentation process can influence potassium concentration differences (Ratrinia et al., 2014).

The Potassium (K) content of liquid organic fertilizer combined with gamal leaves and tofu dregs with the banana stem bioactivator is low on average and does not meet the SNI 19-7030-2004 minimum limit of 0.20 %.

4. CONCLUSIONS

Based on the research results of liquid organic fertilizer combination of gamal leaves and tofu dregs with banana stem bioactivator, the highest nitrogen content was 0.72% in the P_1B_2 treatment

with sensory properties of dark brown color, soil-like scent , and pH 5. The highest phosphorus content was 0.06% in the P_1B_1 treatment with sensory properties of dark brown color, soil-like scent, and pH 5. The highest potassium content is treatment P_1B_1 was 0.09% with sensory properties of dark brown color, scent like soil, and pH of 5. Thus, according to SNI 19-7030-2004 and Regulation of the Minister of Agriculture of 2011, the quality of fertilizer is not yet SNI 19-7030-2004 standard liquid organic fertilizers because the color parameters, P and K levels obtained are below standard quality standards. However, liquid organic fertilizers can still be used in plants because it comes from organic matter and contains nutrients, although it cannot be traded.

Based on this research, the author suggests that further research is needed with more diverse concentrations of liquid organic fertilizer. It is expected to conduct further tests to determine the quality of liquid organic fertilizer based on micronutrient content.

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