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# The effects of the addition of banana peels and coconut water on the increasing nutrition of biofertilizer from rice washing water

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## Abstract

Indonesia is reducing the use of chemical fertilizers for sustainable cultivation of agricultural land, so the use of biological fertilizers needs to be increased. One source of biological fertilizers is rice washing water waste. This research aims to determine the effect of adding banana peel and coconut water to the nutritional content of rice washing water biofertilizer, knowing the right fermentation time, and knowing the content of primary macro nutrients (N, P, K) in the biological fertilizer of fermented rice washing water. In this study there were 2 groups of fertilizers, namely group 1 (7 days anaerobic fermentation) and group 2 (14 days anaerobic fermentation), there were also groups A (rice washing water + banana peel + MOL), B (rice washing water + coconut water + MOL), and C (rice washing water + banana peel + coconut water + MOL). At the end of the research, it will be known that the addition of banana peel and coconut water can increase the organic C, N, P and K content of the biofertilizer in rice washing water. Biofertilizer applied to mustard plants, the 1B fertilizer group showed better yields than the commercial liquid organic fertilizers by increasing the height of the mustard plant up to 17.9 cm for 30 DAP with the primary macro nutient contents in the 1B fertilizer respectively 0.05 % N; 0.03 % P; 0.18 % K.

**Keywords:** banana peels, biofertilizer, fermentation, rice washing water

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## 1. INTRODUCTION

The abundance of agricultural products in Indonesia makes this country known as an agricultural country, where many Indonesians carry out economic activities in the agricultural sector. This could be because Indonesia has a tropical climate, so agricultural activities can be carried out throughout the year. The agricultural sector, which has added value, is one of the factors that can advance the Indonesian economy (Bashir and Susetyo, 2018). To meet the ever-increasing need for agricultural products in Indonesia, agricultural land are striving to achieve maximum efficiency by producing products of the highest quality (Savci, 2012).

In terms of improving the quality of agricultural crops, nutrition is an important factor in this matter. Nitrogen (N), phosphorus (P), and potassium (K) have a crucial

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role in successful plant growth (Biswas et al., 2021). There are two methods for carrying out fertilization activities: chemical fertilizers and biological fertilizers. Chemical fertilizers are able to provide nutrients for plants relatively quickly compared to biological fertilizers, but if used continuously, they can cause the accumulation of organic pollutants in the soil due to their chemical content. This can cause environmental damage, damage soil ecology, and cause heavy metals, nitrates, and other dangerous components to be contained in agricultural products such as vegetables, grains, and fruit, which will later be consumed by humans (Li and Wu, 2008).

One solution to reduce the use of chemical fertilizers is to increase the use of biological fertilizers. Biofertilizer is a fertilizer made from organic waste in solid or liquid form. Biological fertilizers can also be rich in minerals and microorganisms, which can help enrich soil nutrients. These microorganisms can also improve the physical, chemical, and biological properties of soil (Hapsoh et al., 2019). Application of biological fertilizer can significantly increase the activity of soil dehydrogenase, alkaline phosphatase, β-glucosidase, and urease. Among other types of fertilization, long-term application of biofertilizers has the greatest impact on yield and soil quality (Liu et al., 2010).

Biofertilizer can be made using various kinds of waste. As we know, waste production in Indonesia is very large. According to Waste4Challenge research results and data from the DKI Jakarta Cleanliness Service, waste production in the city of Jakarta can reach 6,270 tons per day. The composition of the waste consists of 54% organic waste, 15 % paper, 14 % plastic, 17 % glass, metal, and others. According to the data, only 7 % of this waste is recycled. Therefore, we can see that waste recycling in Indonesia still needs to be improved. Biofertilizer can be produced using a simple fermentation process using organic waste as a carbon substrate.

In order to reduce the use of chemical fertilizers for sustainable agricultural land cultivation, the diversification of biological fertilizer sources needs to be increased. One example of waste that is easy to obtain and has the potential to be used in making biofertilizer is waste water from washing rice. Water used for washing rice contains organic compounds such as starch, P, K, Mg, S, Fe, protein, cellulose, vitamin B1, hemicellulose, and sugar, which have potential for liquid organic fertilizer (Akib et al., 2014). Rice washing water is household kitchen waste that has not been widely used as liquid fertilizer. It contains 92 ppm nitrogen and local microorganisms that are useful for plant and soil fertility.

The macro-element content of liquid fertilizer is nitrogen, phosphorus, and potassium. In order to increase the macro nutrient elements in rice washing water, it is necessary to add other NPK sources. One potential source of potassium from vegetable waste is banana peel. The mineral content of banana peel is 96.5% K2O, 2.4 % $P_2O_5$, and 0.43 % $SO_3$. Apart from that, coconut water also contains a lot of sugar, which is good for bacterial nutrition, and potassium levels of 356 mg/100 mL.

In making liquid organic fertilizer, bioactivators are needed, which can increase the decomposition of organic materials. One of the local microorganisms (MOL) that can be used is leftover stale rice. Stale rice contains the microbes Sacharomyces cerevisiae, Bacillus cereus, and Aspergillus sp., which are able to decompose organic materials well. Using MOL will reduce production costs and decomposition time.

This biofertilizer, made from rice water waste, is safer and more environmentally friendly to use. It is necessary to study the increase in nutrients in rice washing water so that the nutrient content of biological fertilizer in rice washing water can be used sustainably as a substitute for chemical fertilizers. This research aims to determine the effect of adding banana peel and coconut water to the nutritional content of rice washing water biofertilizer, knowing the right fermentation time, and knowing the content of primary macro nutrients (N, P, K) in the biological fertilizer of fermented rice washing water.

## 2. MATERIALS AND METHODS

This research was conducted at the Chemical Engineering Instructional Laboratory, Sumatera Institute of Technology. The research stages carried out included the following steps:

### 2.1. Tools and Materials

In this study, materials used were rice washing water waste, banana peel waste, coconut water waste, and local microorganisms (MOL) from stale rice. The tool used is a fermentation container in the form of a 5-liter jerry can with plastic and aluminum foil as a plug for the jerry can for anaerobic fermentation.

### 2.2. Research Procedure

The research used a quantitative approach. Several variables used in this research, namely: grams of banana; volume of coconut water; volume of coconut water; and grams of banana peel; fermentation time. The dependent variable is the organic C, N, P, and K content in rice washing water biofertilizer. Control variables are: amount of rice washing water (first rice washing water); amount of banana peel pulp; amount of coconut water; number of MOL. There were several groups of biofertilizers for rice washing water, namely:

**Table 1.** Biofertilizer Groups

| | RWW (ml) | BP (gr) | CW (ml) | MOL (ml) | D |
|---|---|---|---|---|---|
| 1A | 500 | 50 | - | 25 | 7 |
| 1B | 500 | - | 50 | 25 | 7 |
| 1C | 500 | 50 | 50 | 25 | 7 |
| 2A | 500 | 50 | - | 25 | 14 |
| 2B | 500 | - | 50 | 25 | 14 |
| 2C | 500 | 50 | 50 | 25 | 14 |

**Notes:** RWW: Rice Washing Water; BP: Banana Peel; CW: Coconut Water; MOL: Local Microorganism Solution; D; Fermentation time in days

Local Microorganism Solution is a fermented solution containing good bacteria for decomposing organic material in liquid fertilizer. Local microorganisms in stale rice consist of Sachharomyces cereviciae and Aspergillus sp.

### 2.3. Biofertilizer Production

In this study, 5 kg of rice was washed with 10 L of water to produce 10 L of rice wash. Then the rice washing water divided into 18 fermentation containers, each containing 500 ml of rice washing water. Then, 25 ml of MOL was added to each fermentation container, and banana peel pulp and coconut water were added according to the variables. Banana peel porridge is made from 500 g of banana peel (only the inside of the peel), which is blended and diluted to 1 L. Then, each fermentation container is tightly closed and left according to the variable fermentation time, namely 7 and 14 days. The MOL concentration is 5 %, namely 25 ml, because the 5 % concentration provides the highest levels of C-organic.

### 2.4. C-Organic Content Analysis

Analysis of C-Organic Content based on SNI 19-7030-2004 is carried out by oxidizing the sample with dichromate in an acidic environment, and then the chromium (III) formed is equivalent to C-organic, which will be measured with a spectrometer. To analyze the C-organic content of liquid organic fertilizer, first weigh 0.05–0.10 g of the sample, then add it to a measuring flask. After that, add 5 ml of 1 N $K_2Cr_2O_7$ solution, shake, and also add 7 ml of 98 % $H_2SO_4$, shake again, then let sit for about 30 minutes.

To make a standard solution with a content of 250 ppm carbon (C), first take 5 ml of a standard solution with a content of 5,000 ppm carbon (C) using a pipette, then put it in a flask, add 5 ml of $H_2SO_4$, and add 7 ml of 1 N $K_2Cr_2O_7$ solution. Prepare Also, the blank used as a standard contains 0 ppm carbon (C). Dilute each with distilled water and adjust the volume to 100 ml, then shake until homogeneous and leave overnight. The next day, measure the absorbance with a spectrophotometer using a wavelength of 561 nm.

### 2.5. Nitrogen Content Analysis

To analyze the nitrogen (N) content of the biofertilizer made, the Kjeldahl method will be used. This method has three processes, namely destruction, distillation, and titration. The organic N and N-$NH_4$ content in the sample will be destroyed by a mixture of $H_2SO_4$ and selenium to form ammonium sulfate, and then excess alkali will be added for distillation.

### 2.5.1. N-Organic

First, weigh 0.25 g of the liquid organic fertilizer sample and transfer it to a Kjeldahl flask. Add a combination of selenium and sulfuric acid, then shake the flask and allow it to stand for several hours. Next, perform the digestion process by gradually raising the temperature from 150 °C to 350 °C. Once digestion is complete, dilute the mixture with distilled water and transfer it into a distillation flask. Finally, add an appropriate amount of distilled water along with boiling stones.

Subsequently, prepare 10 mL of 1% boric acid ($H_3BO_3$) solution along with a Conway indicator to serve as the distillate trapping medium. Initiate the distillation process by introducing 20 mL of 40% sodium hydroxide (NaOH) to facilitate the release of ammonia. Finally, conduct a titration of the collected distillate using 0.05 N sulfuric acid ($H_2SO_4$) until the solution transitions from green to pink, indicating the endpoint of the reaction.

### 2.5.2 N-$NH_4$

To determine the N-$NH_4$ content, weigh 1 g of the liquid organic fertilizer sample and transfer it into a distillation flask. Add boiling stones to regulate boiling, along with liquid paraffin and a blank solution of distilled water to ensure analytical precision. Prepare 10 mL of 1 % boric acid ($H_3BO_3$) solution with a Conway indicator to serve as the distillate absorber. Begin the distillation process by introducing 10 mL of 40 % sodium hydroxide (NaOH) to facilitate ammonia release, which is then absorbed into the boric acid solution.

Proceed with titration of the collected distillate using a 0.05 N standard sulfuric acid ($H_2SO_4$) solution. Continue the titration until the solution undergoes a color shift from green to pink, signaling the reaction endpoint and enabling the determination of ammonium nitrogen content.

### 2.5.3 N-$NO_3$

To quantify the N-$NO_3$ content, the sample containing N-$NH_4$ is first cooled and diluted with distilled water to ensure proper reaction conditions. A receiving solution consisting of 10 mL of 1 % boric acid ($H_3BO_3$) and a Conway indicator is prepared to capture the released ammonia during distillation. The process is initiated by adding 2 g of Devarda's alloy, which facilitates the reduction of nitrate to ammonia. Distillation commences without preheating to prevent excessive foaming; once foaming subsides, controlled heating is applied, gradually increasing the system temperature to the normal boiling point. The final step involves titrating the collected distillate with a 0.05 N standard sulfuric acid ($H_2SO_4$) solution until a distinct color transition from green to pink signifies the endpoint, allowing for precise quantification of nitrate nitrogen.

## 2.6. Phospour Content and Kalium Content Analysis

To determine the phosphorus (P) and potassium (K) content, the wet oxidation method using $HNO_3$ and $HClO_4$ is employed. The resulting extract is then analyzed for phosphorus concentration using a UV-Vis spectrophotometer, while potassium concentration is measured with an atomic absorption spectrometer (AAS). For accurate quantification, a series of standard solutions is required: (a) phosphorus standards (0, 1, 2, 4, 6, 8, and 10 ppm) and (b) potassium standards (0, 0.5, 1, 2, 3, 4, and 5 ppm).

To initiate the analysis, a measured amount of fertilizer sample is transferred into a Kjeldahl flask. Subsequently, 5 mL of $HNO_3$ and 0.5 mL of $HClO_4$ are added, thoroughly mixed, and left to react overnight. The digestion process is carried out by gradually heating the mixture, starting at 100°C. Once the yellow fumes dissipate, the temperature is increased to 200°C. The digestion is considered complete when white fumes are observed. The digest is then cooled, diluted with distilled water, homogenized, and filtered using filter paper to obtain a clear extract for further analysis.

### 2.6.1 K Concentration

Pipette 1 mL of Extract A into a test tube, add 9 mL of distilled water, and homogenize the mixture. Measure the potassium concentration in Extract B (a 10× diluted sample) using an atomic absorption spectrophotometer (AAS) with a potassium standard series as a reference, and record the absorbance.

### 2.6.2 P Concentration

Pipette 1 mL of Extract B into a test tube, as well as each phosphorus standard solution. Add 9 mL of color-developing reagent to each sample and phosphorus standard solution, then homogenize the mixture. Allow the solutions to stand for a few minutes, then measure their absorbance using a UV-Vis spectrophotometer at a wavelength of 889 nm.

## 3. RESULTS AND DISCUSSION

### 3.1 Liquid Organic Fertilizer Content Test Results

The test results for organic carbon (C-Organic), nitrogen (N), phosphorus (P), and potassium (K) content in the produced liquid organic fertilizer are presented in Figure 1 below.

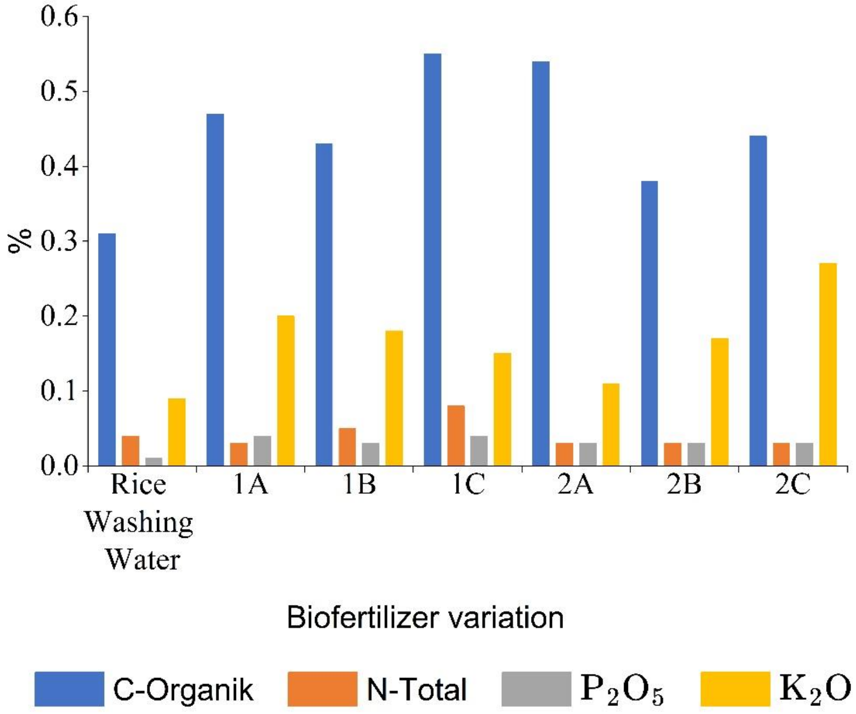

**Figure 1.** Test results of C, N, P, and K content

After testing the organic carbon (C-Organic), nitrogen (N), phosphorus (P), and potassium (K) content, the following data was obtained:

ACB : 0.31 % C; 0.04 % N; 0.01 % P; 0.09 % K
1A : 0.47 % C; 0.03 % N; 0.04 % P; 0.20 % K
1B : 0.43 % C; 0.05 % N; 0.03 % P; 0.18 % K
1C : 0.55 % C; 0.08 % N; 0.04 % P; 0.15 % K
2A : 0.54 % C; 0.03 % N; 0.03 % P; 0.11 % K
2B : 0.38 % C; 0.03 % N; 0.03 % P; 0.17 % K
2C : 0.44 % C; 0.03 % N; 0.03 % P; 0.27 % K

### 3.1.1 Organic Carbon Content

The analysis of organic carbon (C-Organic), nitrogen (N), phosphorus (P), and potassium (K) in the liquid organic fertilizers produced indicates that the C-Organic content in all samples increased compared to pure rice wash water. This increase is attributed to the addition of carbon-rich sources such as banana peels and coconut water, which contributed to a higher overall C-Organic concentration in the fertilizer.

A comparison between fermentation durations reveals that after 14 days (Samples 2A, 2B, 2C), the C-Organic content decreased compared to the 7-day fermentation period (Samples 1A, 1B, 1C). Carbon serves as an energy source for microbial metabolism, and its reduction over time is due to microbial consumption during fermentation (Widiyaningrum, 2016). The longer the fermentation period, the more carbon is utilized by microorganisms.

Among all samples, the highest C-Organic content was recorded in Sample 1C (MOL + Coconut Water + Banana Peel, 7 days) at 0.55 %. This is likely due to the presence of coconut water and banana peels, which are rich in organic carbon. Additionally, the shorter fermentation period (7 days) resulted in less microbial consumption compared to Sample 2C (14-day fermentation), leading to a higher residual C-Organic content.

However, the C-Organic content in the produced biofertilizer ranged between 0.38 % and 0.55 %, which is significantly lower than the standard for liquid organic fertilizers as per Indonesian Ministry of Agricultural Regulation No. 261/KPTS/SR.310/M/4/2019, which requires a minimum of 10%. This discrepancy may be due to insufficient nutrient concentration in the substrate, leading to limited available C-Organic for microbial metabolism.

### 3.1.2 N-Total

The total nitrogen (N-Total) analysis of the various liquid organic fertilizers produced shows variations, with some samples exhibiting an increase while others show a decrease in nitrogen content, as detailed below:

1. Increase in N-Total (Samples 1B and 1C): The observed increase in N-Total suggests that the fermentation process enhances nitrogen levels in comparison to pure ACB due to the microbial breakdown of organic compounds. This increase is attributed to minimal nitrogen loss as volatilized $NH_3$ and relatively low microbial activity, which results in limited nitrogen consumption for microbial reproduction. Additionally, the higher nitrogen content may be due to the proliferation of active decomposer microorganisms, leading to increased inorganic nitrogen ($NH_4^+$ and $NO_3^-$) as fermentation progresses.
2. Decrease in N-Total (Samples 1A, 2A, 2B, and 2C): The decline in nitrogen levels can be attributed to microbial consumption during fermentation, as nitrogen serves as a key nutrient for microbial growth and reproduction (Akib and Setiawati, 2017). Similar findings were reported by Kurniawan et al. (2016), where nitrogen content decreased after several days of fermentation. Additionally, nitrogen loss may result from volatilization in the form of $NH_3$ gas, which escapes into the atmosphere due to microbial metabolic activity. This aligns with the findings of Siburian (2005), which state that nitrogen reduction occurs as microorganisms assimilate nitrogen, leading to its loss through volatilization as ammonia ($NH_3$).

Among all samples, sample 1C exhibited the highest N-Total content at 0.08 %. Variations in nitrogen content across different treatments are influenced by differences in microbial decomposition rates, as microorganisms exhibit diverse efficiencies in breaking down substrates during fermentation (Widyabudiningsih et al., 2021).

However, the nitrogen content in the produced biofertilizer remains within the range of 0.03 – 0.08 %, which is significantly below the Indonesian Ministry of Agriculture's liquid organic fertilizer standard of 3 – 6 % (Decree of the Minister of Agriculture of the Republic of Indonesia No. 261/KPTS/SR.310/M/4/2019). This discrepancy highlights potential limitations in nitrogen availability within the fermentation substrate, leading to lower-than-expected nitrogen concentrations in the final product.

### 3.1.3 $P_2O_5$ Content

The phosphorus (P) content increased across all types of liquid organic fertilizers produced, with the highest concentrations observed in Samples 1A and 1C, both at 0.04%. This increase is attributed to several factors, particularly the presence of MOL (Microbial Organic Liquid) from fermented rice, which contains phosphate-solubilizing bacteria such as *Pseudomonas fluorescens*. These microorganisms facilitate the dissolution of organic phosphate compounds, leading to a higher phosphorus concentration in the final fertilizer.

Phosphate formation is catalyzed by phosphatase enzymes produced by microorganisms. Phosphorus availability is also positively correlated with nitrogen content in the substrate (Saputri et al., 2021). The increased phosphorus levels may result from the activity of *Lactobacillus sp.*, which metabolizes glucose into lactic acid ($C_3H_6O_3$). This process lowers the pH, creating an acidic environment that dissolves phosphate bound in complex carbon chains, making it more bioavailable (Amanillah, 2011).

In 14-day fermentation samples, phosphorus levels tended to be lower compared to 7-day fermentation samples, likely due to nutrient depletion and the subsequent decline in microbial reproduction. The $P_2O_5$ content in the biofertilizer ranged from 0.03 to 0.04 %, which is significantly below the Indonesian Ministry of Agriculture's standard of 3 – 6 % for liquid organic fertilizers (Decree of the Minister of Agriculture of the Republic of Indonesia No. 261/KPTS/SR.310/M/4/2019). This indicates potential limitations in phosphorus availability and solubilization efficiency during the fermentation process.

### 3.1.4 $K_2O$ Content

The potassium content increased in all types of fertilizers produced after fermentation. According to Indriani et al. (2013), the $K_2O$ content increases after fermentation due to the breakdown of compounds, which releases $K^+$ ions as a result of substrate decomposition in liquid biofertilizers. Hidayati et al. (2011) stated that potassium (K) derived from the substrate is required by microorganisms as a catalyst for metabolic activities; therefore, the substrate composition significantly influences the increase in potassium content. The potassium levels in all liquid organic fertilizers (POC) produced showed an increase. This is attributed to microbial activity during fermentation, which causes the breakdown of carbon chains, leading to the accumulation of potassium in the biofertilizer.

The greater the number of bacteria, the higher the potassium content, as bacteria can produce $K_2O$ compounds and utilize $K^+$ ions from the substrate for their metabolic processes (Siburian, 2005). When these bacteria degrade, potassium is released due to bacterial cell decomposition, increasing the potassium content in the fertilizer.

Additionally, fungi present in MOL contain potassium in their cell walls, and when they degrade, they also release potassium into the POC. The addition of a starter (MOL) can enrich $K_2O$ content due to the formation of organic acids during fermentation, which enhances the solubility of nutrients such as calcium, phosphate, and potassium. The highest potassium content was found in Fertilizer 2C at 0.27 %, which involved the addition of banana peels and coconut water. According to Mulyadi et al. (2013), potassium is one of the most abundant nutrients in coconut water. Similarly, Tuapattinaya and Tutupoly (2014) stated that potassium is one of the most prominent elements in banana peels.

The $K_2O$ content in the biofertilizers produced ranged from 0.11 to 0.27 %, which is still significantly lower than the standard for liquid organic fertilizers set by Indonesian Ministry of Agriculture Decree No. 261/KPTS/SR.310/M/4/2019, which requires a range of 3 to 6 %. This discrepancy may be due to incomplete organic matter decomposition and the insufficient concentration of the fermentation solution.

### 3.2 pH Measurement

The initial and final pH measurements of each liquid organic fertilizer are presented in Figure 2.

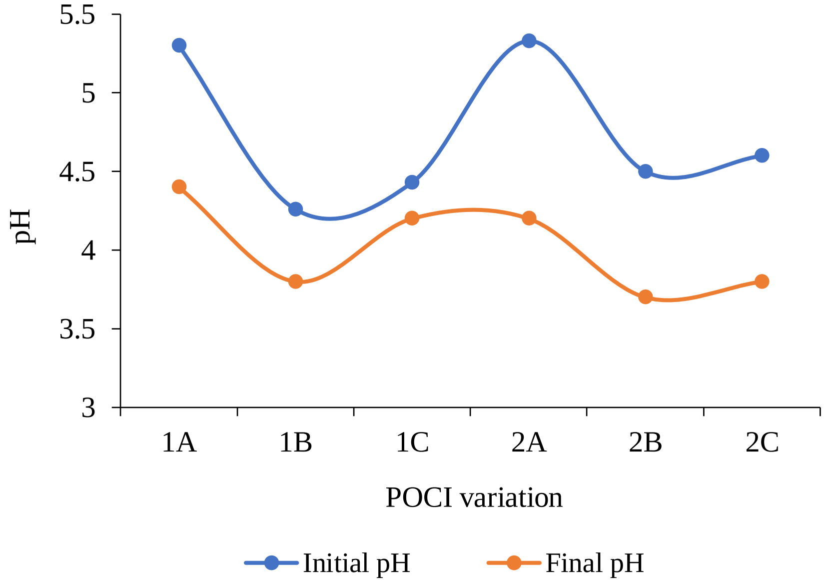

**Figure 2.** pH measurement results

It can be observed that the pH of each liquid organic fertilizer decreased. The pH value drops at the beginning of the fermentation process due to the activity of microorganisms such as *Lactobacillus sp.*, which produce organic acids like lactic acid ($C_3H_6O_3$), acetic acid ($CH_3COOH$), and pyruvic acid (Qoidani, 2017). These organic acids result from the breakdown of carbohydrates, fats, and proteins in the substrate.

However, according to the liquid organic fertilizer standards outlined in Indonesian Ministry of Agriculture Regulation No. 261/KPTS/SR.310/M/4/2019, the final pH of the product should be within the range of 4–9. In contrast, some of the biofertilizer products in this study had a final pH below the standard (below 4), specifically fertilizers 1B, 2B, and 2C. This could be attributed to incomplete decomposition of organic compounds, the addition of coconut water (which has a naturally lower pH), or an excessively long fermentation period, leading to increased acidity. To regulate the pH in this study, controlling the fermentation duration was essential. A longer fermentation time results in a higher accumulation of organic acids, which further decreases the fertilizer's pH.

### 3.3 Comparison of Nutrient Content Between Commercial Liquid Organic Fertilizer (POC) and POC from Previous Studies

After determining the percentage of organic carbon (C-Organic), nitrogen (N), phosphorus (P), and potassium (K) content, a comparison was made with commercial liquid organic fertilizers and previous studies. According to Saputri et al. (2021), a liquid organic fertilizer derived from rice washing water—comprising 1.5 L of rice washing water, 500 g of tomato waste, 500 g of mustard green waste, 150 ml of brown sugar solution, and 150 ml of EM4—fermented anaerobically for 8 days contained 0.21 % nitrogen, 0.011 % phosphorus, and 0.24 % potassium. Meanwhile, in the study conducted by Hapsoh et al. (2019), a liquid organic fertilizer derived from rice washing water mixed with a cellulolytic bacterial consortium and fermented for 14 days contained N, P, and K at 0.04 %, 0.027 %, and 0.1 %, respectively.

Compared to Saputri et al. (2021), the nitrogen content in this study was lower, with the highest nitrogen level recorded at 0.08 % in Fertilizer 1C. However, phosphorus content in this study was higher across all fertilizer samples, ranging from 0.03 to 0.04 %. For potassium content, Fertilizer 2C exhibited the highest level at 0.27 %. It can be observed that the fermentation solution used by Saputri et al. (2021) was more concentrated than in this study. Therefore, increasing the concentration of the fermentation solution could be a potential strategy to enhance the N, P, and K content in future formulations.

Additionally, when compared to Hapsoh et al. (2019), the phosphorus and potassium levels in all fertilizer types produced in this study were higher. However, only fertilizers 1B and 1C exhibited higher nitrogen content at 0.05 % and 0.08 %, respectively.

In comparison with commercial liquid organic fertilizers, the study by Widyabudiningsih et al. (2021) reported N, P, and K levels of 0.05 %, 0.26 %, and 0.02 %, respectively. In this study, Fertilizers 1B and 1C had higher nitrogen content, at 0.05 % and 0.08 %, respectively. However, phosphorus levels in all fertilizers produced in this study were lower than the commercial fertilizer. On the other hand, potassium levels in all fertilizers were higher, ranging from 0.11 to 0.27 %. Moreover, according to Dan and Manuel (2017), the commercial organic fertilizer brand "NASA" contains 0.12 % N, 0.03 % P, and 0.31 % K. The nitrogen and potassium content in all fertilizers produced in this study were lower than those in "NASA" fertilizer, while phosphorus levels were comparable, ranging from 0.03 to 0.04 %.

Considering that the fertilizers produced in this study exhibit comparable nutrient levels to those found in previous studies and commercially available organic fertilizers, they can be deemed suitable for agricultural applications despite not fully meeting standard N, P, and K requirements. This was further validated by a follow-up experiment in which all fertilizer variants were applied to mustard greens. Observations over a 30-day growth period (30 days after sowing) showed that Fertilizer 1B resulted in an average plant height increase of 17.9 cm, whereas the "NASA" fertilizer led to an increase of 17.6 cm.

## 4. CONCLUSION

From this study, it can be concluded that the addition of banana peel and coconut water enhances the organic carbon (C-organic) content, which serves as a nutrient source for fermentation in biofertilizers derived from rice washing water. This, in turn, contributes to an increase in nitrogen (N), phosphorus (P), and potassium (K) content in the biofertilizer.

A fermentation period of 7 days resulted in higher nitrogen and phosphorus content compared to a 14-day fermentation period. When applied to mustard greens, the fertilizer fermented for 7 days yielded the best results, with an average plant height increase of up to 17.9 cm.

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