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Study on Biofertilizer Derived from Pineapple Peel and Elephant Grass Ash with Variables of Material Weight and Fermentation Duration

Dian Pratiwi Tejo Kusumo[1✉], Dimas Arnanda[2], Kindriari Nurma Wahyusi[3], Dyah Suci Perwitasari[4], Retno Dewati[5]

[1, 2, 3, 4, 5] Department of Chemical Engineering, Faculty of Engineering and Science, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Indonesia

✉ **Corresponding Author :** Dian Pratiwi Tejo Kusumo (e-mail: 21031010015@student.upnjatim.ac.id)

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ABSTRACT

This research develops a biofertilizer production method using pineapple peel waste and elephant grass ash as raw materials. Pineapple peel contains nutrients that can improve soil fertility, while elephant grass, commonly used as livestock feed, has high silica content beneficial to the soil when used as fertilizer. The research aimed to produce a biofertilizer and examine the effects of material weight and fermentation duration on the levels of Nitrogen (N), Phosphorus (P), and Potassium (K), assessing whether the results meet Indonesian National Standard (SNI) fertilizer requirements. The fermentation process lasted approximately 35 days. The fermented biofertilizer was analyzed using the Micro Kjeldahl method for Nitrogen, UV-Vis Spectrophotometry for Phosphorus, and Atomic Absorption Spectrophotometry (AAS) for Potassium. The results showed the highest concentrations of Nitrogen (2.98%), Phosphorus (2.43%), and Potassium (3.39%) were obtained using 40 grams of elephant grass ash and 35 days of fermentation. The analysis indicated that increasing the amount of elephant grass ash and the fermentation duration resulted in higher N, P, and K levels. These findings align with SNI fertilizer standards, highlighting the potential of using sustainable and easily accessible materials to enhance organic fertilizer production efficiency.

INTRODUCTION

Unmanaged organic waste can lead to significant problems. Improperly discarded organic waste can trigger diseases in the surrounding community and damage the environment. One type of organic waste that is not yet widely processed is pineapple peel waste and elephant grass. The waste problem can be addressed by processing it. One way to process it is by converting it into a biofertilizer. Many people are unaware of the benefits of biofertilizer, but in reality, it offers numerous advantages, including acting as a plant decomposer, improving the organic content of the soil, maintaining soil nutrients, and aiding nitrogen fixation in the soil. The production of biofertilizer is particularly attractive because it requires minimal cost and can improve soil balance while creating harmony in the soil's microbial environment. Biofertilizer contains microbes such as Azotobacter, Bacillus, Rhizobium, and many others. The microbes used in biofertilizers can promote plant growth, add nitrogen, dissolve phosphates, and inhibit plant growth diseases.

Pineapple plants are among those highly favored by the public. However, most people only use the fruit's flesh, while the peel is discarded as waste. We often encounter pineapple peel waste that is thrown away and not utilized, even though pineapple peel has many benefits. The peel contains vitamins (A and C), carotenoids, flavonoids, tannins, alkaloids, calcium, phosphorus, magnesium, iron, sodium, and the enzyme bromelain. The pineapple peel has a carbon (C) content of 45.25% and nitrogen content of 1.57%. Elephant grass is classified as a type of grass. Napier grass (Pennisetum purpureum) is one type of grass that is easy to find, grows quickly, and can be propagated in tropical regions. This plant can be used as cut grass, dried, or made into silage. The chemical content of 5 grams of elephant grass ash includes 5.35% phosphorus and 24.2% potassium. A study by Okorie in 2015 found that banana peel contains 9.8% potassium, 6.09% nitrogen, and 0.49% phosphorus. Meanwhile, bamboo leaves contain 0.74% phosphorus and 0.91% potassium. In this study, an NPK fertilizer was produced with nitrogen (N) content of 0.33%, phosphorus (P) of 0.08%, and potassium (K) of 0.21%. Pineapple peel contains carbon (C) at 45.25% and nitrogen at 1.57%, while 5 grams of elephant grass ash contains 5.35% phosphorus and 24.2% potassium. With these contents in pineapple peel and elephant grass ash, along with the addition of the bioactivator EM-4, it is expected to produce an NPK fertilizer with nutrient levels approaching the standard.

The method used for producing biofertilizer is through fermentation. Fermentation is described as a chemical process in which an organic substrate is transformed through the activity of enzymes produced by microorganisms. The basic principle of fermentation is to activate the activity of specific microbes to alter the properties of the material, thereby producing a beneficial fermentation product. The microorganisms commonly involved in food fermentation are bacteria, yeast, and molds. During the fermentation process, Effective Microorganisms (EM-4) are also added. Several factors influence the fermentation process, such as bioactivators, temperature, pH, material size, and fermentation time. This study is conducted to determine the effect of material concentration and fermentation duration in order to obtain a biofertilizer with NPK levels that approach the standard.

RESEARCH METHODS

Preparation of Research Materials

In this study, the main materials used are pineapple peel, obtained from pineapple vendors in the Medokan area of Surabaya, and elephant grass ash, sourced from the Driyorejo area in Gresik. In the preparation stage of the research materials, to prepare the pineapple peel solution, the pineapple peel is first cut into small pieces and then ground. After that, the ground pineapple peel is squeezed to obtain the filtrate of the pineapple peel juice and the pulp. The filtrate is then diluted with 5 liters of water, resulting in the pineapple peel solution. As for the preparation of the elephant grass ash, the grass is first cut into small pieces and then burned. Afterward, it is placed in a furnace at a temperature of 340°C, producing the elephant grass ash. After the preparation of these research materials, they are ready to be used for this study.

Fermentation Process

The equipment used in the research incuded a fermentor bottle, tubing, a water-filled bottle, a faycet, and a beaker glass. The research proedure began with the preparation of the two materials. For pineapple peel preparation, the peels were ground and squeezed to produce filtrate and pulp. The filtrate was then diluted with water to create a pindieapple peel solution. For the preparation of elephant grass ash, the grass ash was cut into smaller pieces and then burned in a furnace to obtain the ash. The prepared materials were then mixed (according to the variables) into a single container. Once evenly mixed, the mixture was added with the EM-4 Bioactivator and stirred again until homogeneous. The mixture was placed in a closed fermentor bottle and fermented for the predetermined time variables.

Analysis Method

Finally, After the fertilizer is applied according to the predetermined variables, the biofertilizer will be tested for its Nitrogen, Phosphorus, and Potassium content. To analyze the Nitrogen content, the Micro-Kjeldahl method will be used. Then, to analyze the Phosphorus content, the UV-Vis Spectrophotometry method will be employed, and to analyze the Potassium content, the Atomic Absorption Spectrophotometry method will be used.

RESULTS AND DISCUSSION

The Effect of Elephant Grass Ash Weight and Fermentation Duration on the Nitrogen Content Produced

The content of the materials, namely pineapple peel and elephant grass ash, was analyzed first before carrying out the fermentation process to determine the effect of the substances contained in the materials on the levels of N, P, and K in the biofertilizer. The results of the analysis of the pineapple peel and elephant grass ash content are presented in the following table :

Table 1. Results of Pineapple Peel Content Analysis

Element	Content (%)
Nitrogen (N)	0,58
Phosporus (P2O5)	1,15
Potassium (K2O)	1,63

Table 2. Results of Elephant Grass Ash Content Analysis (5 grams)

Oxide	Total Content (%)	Element	Total Content (%)
SiO2	29,9	Si	17,5
P2O5	10,5	P	6,13
SO3	0,8	S	0,5
K2O	56,5	K	72,9
MnO	0,12	Mn	0,16
Fe2O3	1,59	Fe	1,97
CuO	0,068	Cu	0,097
ZnO	0,11	Zn	0,16
Rb2O	0,30	Rb	0,49
MoO3	0	Mo	0,1
Re2O7	0,06	Re	0,09

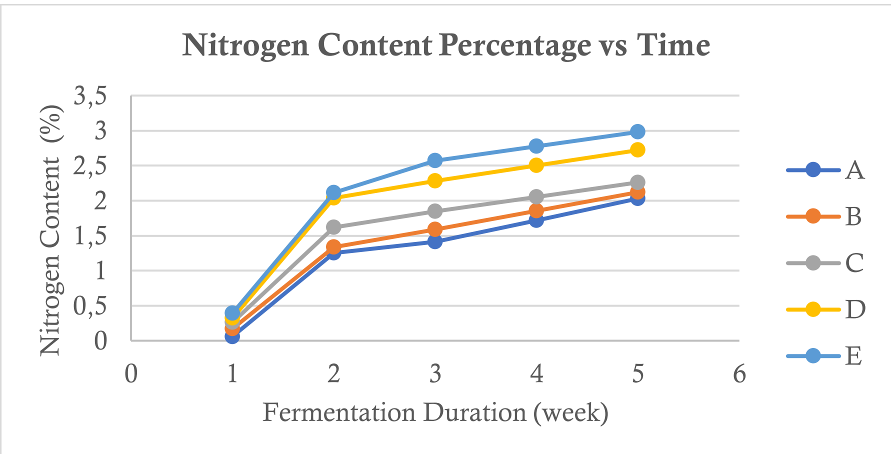

Figure 1. The Relationship between Fermentation Duration and the Resulting Nitrogen Content

Based on Figure 1, it can be seen that the Nitrogen (N) content during the first week of the fermentation process is very low. This is evident in the graph, where the ash weight of 20 grams of elephant grass has the lowest Nitrogen content at 0.06%. This indicates that the microorganisms are still in the initial phase, known as the lag phase. It can then be observed that from the first week to the second week, there is a significant difference, indicating that the microorganisms are starting to enter and adapt, as well as begin to break down their compounds. Although not very significant, there is a consistent increase from the third week to the final week, as the microorganisms have adapted well and entered the exponential growth phase. This greatly affects the Nitrogen content, as the population of microorganisms increases, leading to higher Nitrogen production during fermentation. This is in accordance with a study by Fitriani in 2021, which found that the longer the fermentation duration, the higher the Nitrogen (N) content, as microorganism growth in the fertilizer becomes optimal.

The Nitrogen content obtained, as shown in Figure 1, shows an increase from the first to the fifth week. This is because during the fermentation process, which occurs under anaerobic conditions or without the need for oxygen, the fermentation process is not contaminated by air or other microorganisms except for those in the material and EM-4, allowing for more optimal microbial development and material breakdown compared to aerobic fermentation. This is in line with a study by Sufianti in 2021, which found that an increased bacterial content leads to a higher Nitrogen content. The changes in Nitrogen content in each treatment varied due to the different rates at which microorganisms break down the fermentation material. Under anaerobic conditions, microorganisms are more actively developing, as their metabolism functions optimally without air. In anaerobic processes, some microorganisms can digest energy without oxygen, and anaerobic composting utilizes microorganisms that do not require air to degrade or break down organic material. Therefore, it can be said that the longer the fermentation process under anaerobic conditions, the higher the Nitrogen content produced. The best Nitrogen content was obtained at a 40-gram concentration of elephant grass ash with a fermentation time of 35 days, which was 2.98%. This content shows that the Nitrogen in the liquid organic fertilizer already meets the SNI 19-7030-2015 standard, with a minimum Nitrogen (N) content of $\geq$ 0.40%.

The Effect of Elephant Grass Ash Weight and Fermentation Duration on the Phosporus Content Produced

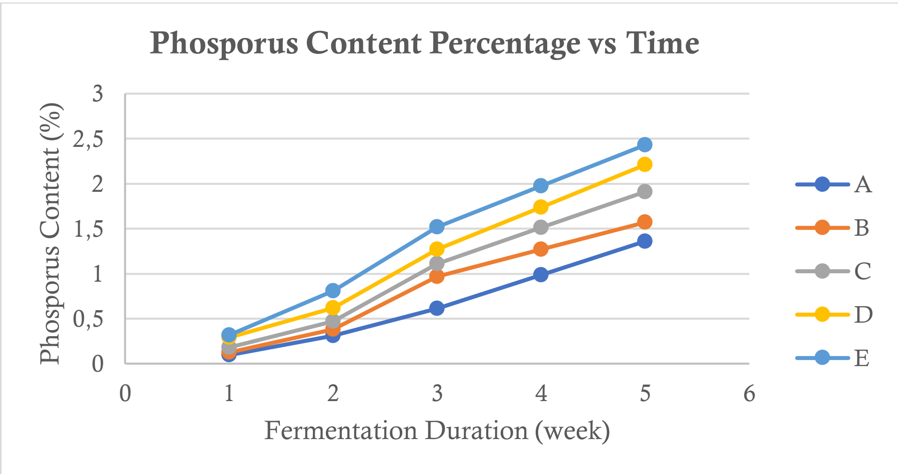

Figure 2. The Relationship between Fermentation Duration and the Resulting Phosporus Content

Based on Figure 2 above, it can be seen that the Phosphorus (P) content in the first and second weeks shows a small difference. This indicates that the fermentation process is still in the lag phase, where the microorganisms are still adapting to the environment and then begin to divide. This is evident in the graph, where the weight of 20 grams of elephant grass ash in the first week has the lowest Phosphorus content at 0.095%. The microorganisms will then rapidly develop and begin to absorb the Phosphorus present in the environment. From the second to the third week of the fermentation process, it can be seen from Figure 2 that a larger increase begins to occur compared to before, indicating that the fermentation process is in the exponential phase, where the microorganisms have passed the adaptation stage and are multiplying rapidly. This causes the bacterial population to increase significantly. In the fourth and fifth weeks, the results continue to show an increase, indicating that the fermentation process is still in the exponential phase. The fermentation process has not yet reached the stationary phase, where the rate of cell division in microorganisms starts to decrease because the bacteria begin to release compounds or secondary metabolites that are toxic to the medium, causing some bacteria to die and their population to no longer increase rapidly. According to Meriatna in 2018, when the nutrients in the medium decrease, microbial growth starts to decline, so the breakdown process becomes less optimal, which is also called the stationary phase. The best Phosphorus content was obtained at a 40-gram concentration of elephant grass ash with a fermentation time of 35 days, which was 2.43%. This content shows that the Phosphorus in the liquid organic fertilizer already meets the SNI 19-7030-2015 standard, with a minimum Phosphorus (P2O5) content of ≥ 0.10%.

The Effect of Elephant Grass Ash Weight and Fermentation Duration on the Potassium Content Produced

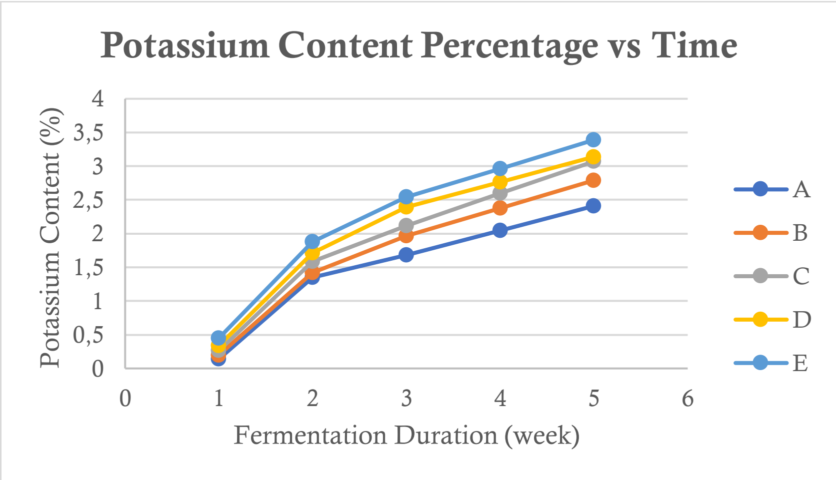

Figure 3. The Relationship between Fermentation Duration and the Resulting Potassium Content

Based on Figure 3, it can be seen that the Potassium (K) content during the first week of the fermentation process is very low. This is evident in the graph, where the weight of 20 grams of elephant grass ash in the first week has the lowest Potassium content at 0.14%. This indicates that the microorganisms are still in the initial phase, known as the lag phase. From the first week to the second week of fermentation, there is a significant difference, which suggests that the microorganisms are beginning to enter and adapt, as well as start breaking down their compounds. Although not very significant, there is a consistent increase from the third week to the final week, as the microorganisms have adapted well and entered the exponential growth phase. This greatly affects the Potassium content, as the population of microorganisms increases, leading to higher Potassium production during fermentation. This is in accordance with a study by Fitriani in 2021, which found that the longer the fermentation time, the higher the Potassium (K) content, as the microorganism growth in the fertilizer becomes optimal. The best Potassium content was obtained at a 40-gram concentration of elephant grass ash with a fermentation time of 35 days, which was 3.39%. This content shows that the Potassium in the liquid organic fertilizer already meets the SNI 19-7030-2015 standard, with a minimum Potassium (K2O) content of ≥ 0.20%.

CONCLUSION

By mixing a solution of pineapple peel, elephant grass ash, and the bioactivator EM-4, a biofertilizer with high N, P, K content can be produced. The increase in the concentration or weight of elephant grass ash added, as well as the fermentation duration, significantly influences the N, P, K content produced. This is evident in the variable where 40 grams of elephant grass ash and a fermentation duration of 35 days resulted in 2.98% Nitrogen, 2.43% Phosphorus, and 3.39% Potassium. The results obtained are still in the exponential phase, so they will continue to increase until reaching the stationary phase, where the levels will stabilize and begin to decrease as the death phase begins. The results of the fermentation of the biofertilizer made from pineapple peel and elephant grass ash over 5 weeks can be said to meet the SNI 19-7030-2004 standard for compost specifications from domestic organic waste, where the Nitrogen content is ≥ 0.40%, Phosphorus (P2O5) content is ≥ 0.10%, and Potassium (K2O) content is ≥ 0.20%, and also meets the maximum limits quoted from the Ministry of Agriculture Regulation in 2011, which states that the maximum levels of Nitrogen, Phosphorus, and Potassium in liquid fertilizer are 6%.

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This research can be continued by using a longer fermentation method to obtain higher levels of N, P, and K in the produced fertilizer and to observe the entire growth phases of microorgannism.

REFERENCES

Aditya, (2017). *Pembuatan Pupuk Organik Cair (POC) dari Bonggol Pisang melalui Proses Fermentasi*. Institut Teknologi Sepuluh Nopember Surabaya.

Affandi, (2015). *Pemanfaatan Urine Sapi yang Difermentasi sebagai Nutrisi Tanaman*. Andi Offset Yogyakarta.

Andriani, (2022). Pembuatan Pupuk Organik Cair dari Limbah Cair Kelapa Sawit menggunakan Proses Fermentasi dengan Penambahan Abu Tandan Kosong dan *Fiber*. *Chemical Engineering Journal Storage*, 2(5), 1-5.

Baroroh, (2015). Analisis Kandungan Unsur Hara Makro dalam Kompos dari Serasah Daun Bambu dan Limbah Padat Pabrik Gula (Blotong). *Jurnal Bioteknologi*, 12(2)

BSN, (2004). *SNI 19-7030-2004 : Spesifikasi Kompos dari Sampah Organik Domestik*. Bandung

Fitriani, (2021). Pemanfaatan Limbah Cair Industri Kelapa Sawit sebagai Pupuk Organik Cair dengan Penambahan Abu Tandan Kosong Kelapa Sawit. *Jurnal Prosiding SNST 11*, 11(1)

Hafsan, (2011). *Mikrobiologi Umum*, Alauddin Press Makassar.

Hendarto, (2021). Pengaruh Pemberian Dosis Pupuk NPK dan Jenis Pupuk Hayati terhadap Pertumbuhan dan Poduksi Tanaman Bawang Merah (*Allium ascalonicum L.*). *Jurnal Agrotopika*, 20(2)

Ismiyati, (2020). Identifikasi Kenaikan Titik Didih pada Proses Evaporasi terhadap Konsentrasi Larutan Sari Jahe. *Jurnal Konversi*. 9(2)

Kementrian Pertanian Republik Indonesia, (2011). *Peraturan Pemnteri Pertanian Nomor 70 tentang Pupuk*. Jakarta

Lubis, D. A. (1992). *Ilmu Makanan Ternak*. PT. Pembangunan Jakarta.

Masyithah, Z (2006). *Buku Ajar Perpindahan Panas*. Universitas Sumatera Utara Medan.

Meriatna, (2018). Pengaruh Waktu Fermentasi dan Volume Bioaktivator EM-4 (*Effective Microorgansim*) pada Pembuatan Pupuk Organik Cair (POC) dari Limbah Buah-Buahan. *Jurnal Teknologi Kimia Unimal*. 7(1)

Nur, (2016). Pembuatan Pupuk Organik Cair dari Sampah Organik Rumah Tangga dengan Bioaktivator EM-4. *Jurnal Konversi*. 5(2)

Okorie, (2015). Nutrient and Heavy Metal Composition of Plantain (*Musa paradisiaca*) and Banana (*Musa Paradisiaca*) Peels. *Journal of Nutrition and Food Sciences*. 5(3), 1-3.

Rahmah, U. A. (2021). Pengaruh Waktu Fermentasi Pembuatan Pupuk Organik Cair (POC) Kasgot terhadap Kandungan Unsur Hara. *UIN Raden Intan Lampung*.

Rahmadina, (2022). Pembuatan Pupuk Cair dari Limbah Air Kelapa dan Limbah Kulit Pisang dengan menggunakan Bioaktivator EM-4. *Chemical Engineering Jounal Storage*. 1(1)

Raksun, (2019). Aplikasi Pupuk Organik dan NPK untuk Meningkatkan Pertumbuhan Vegetatif Melon (*Cucumis melo L.*). *Jurnal Biologi Tropis*. 19(1)

Rasmito, Agung (2019). Pembuatan Pupuk Organik Cair dengan Cara Fermentasi Limbah Cair Tahu, Starter Filtrat Kulit Pisang dan Kubis, dan Bioaktivator EM-4.*Jurnal IPTEK*. 10(1). 1-8.

Rini, A. R. S. (2016). Pemanfaatan Ekstrak Kulit Buah Nanas (*Ananas comosus L. Merr.*) untuk Sediaan Gel Hand Sanitizer sebagai Anti Bakteri *Staphylococcus aureus* dan *Escherichia coli*. *UNNES Press Semarang*.

Salasa, A. M. (2017). Aktivitas Ekstrak Kulit Buah Nanas (*Ananas comosus L.*) terhadap Pertumbuhan Pseudomonas aeruginosa. *Jurnal Media Farmasi*. 13(2). 1-5.

Santi, S. S. (2008). Kajian Pemanfaatan Limbah Nilam untuk Pupuk Cair Organik dengan Proses Fermentasi. *Jurnal Teknik Kimia*. 2(2)

Seseray, (2013). Produksi Rumput Gajah (*Pennisetum purpureum*) yang diberi Pupuk N, P, dan K dengan Dosis 0, 50, dan 100% pada Devoliasi Hari ke-45.*Jurnal Sains Peternakan*. 11(1)

Subula, (2022). Study on the Quality of Compost using EM-4 (Effective Microorganism) and Mole (Local Microorganism) from Mas Conch. *Jambura Edu Biosfer Journal*. 4(2). 46-55.

Sudiarti, D. (2017). The Effectiveness of Biofertilizer on Pant Growth Soybean "Edamame" (Glycin max). *Journal SainHealth*. 1(2). 46-55.

Sulfianti, (2021). Analisis NPK Pupuk Organik Cair dari Berbagai Jenis Air Cucian Beras dengan Metode Fermentasi yang Berbeda. *Jurnal Agrotech*. 11(1). 36-42.

Tanti, Nidya (2021). Analisa Unsur Hara Markro Pupuk Organik Cair dari Limbah Industri Keripik Nanas dan Nangka. *Jurnal Photon*. 8(1)

Wardani, (2021). Pembuatan Mikroorganisme Lokal berbasis Limbah Organik sebagai Aktivator Kompos di Desa Sikunang, Kecamatan Kejajar, Kabupaten Wonosobo. *Jurnal Pengabdian kepada Masyarakat*. 1(1). 63-66.