



Optimization of Household Organic Waste Composting Using the Biopot Composting Method and Rice Washing Water as a Starter Culture

Devi Kurnia Sari^{1*}, Christin¹, Aulia Annas Mufti¹, Yuni Lisafitri¹, Irhamni¹, Sillak Hasiany¹

¹Environmental Engineering, Institut Teknologi Sumatera, Jalan Terusan Ryacudu, Jati Agung, Lampung Selatan

Correspondence Email (Author): devi.sari@tl.itera.ac.id

Received: 04-04-2026

Accepted: 18-06-2026

Published: 31-10-2026

Keywords:

Organic Waste, Rice Water Starter Activator, Compost Reduction

ABSTRACT

Household organic waste management in Sungai Langka Village was implemented using the biopot composting method combined with rice-washing water as a starter culture. Organic waste was collected at 08:00 WIB from two hamlets: Hamlet 1, consisting of 7 households, generated 8.45 kg/day, while Hamlet 2, consisting of 5 households, generated 7.25 kg/day, resulting in 15.7 kg/day from 12 households. This study aimed to identify the composition of household organic waste, analyze the physical and chemical characteristics of the compost, and determine the percentage of organic waste reduction. Each biopot pipe was filled with 1 kg of organic waste under four treatments: P0 without starter culture, P1 with 100 ml, P2 with 200 ml, and P3 with 300 ml of rice-washing water starter culture. Composting was conducted for 31 days based on maturity indicators, including temperature stabilization, near-neutral pH, dark color, earthy odor, and waste reduction. The results showed that starter culture dosage influenced composting performance. P2 showed the best overall descriptive performance, with the highest waste reduction of 76% and favorable compost characteristics. Most parameters met SNI 19-7030-2004 and SNI 7763:2024, although moisture content required further drying or curing.

1. INTRODUCTION

Sungai Langka Village, located in Gedong Tataan District, Pesawaran Regency, Lampung Province, has considerable potential in the agricultural and plantation sectors, with major commodities including cocoa, durian, oranges, and snake fruit. The diversity of agriculture-based community activities contributes to the generation of household organic waste. If not properly managed, this waste may cause various environmental problems, including ecosystem degradation, soil and air pollution, and increased risks of disease transmission (Siddiqua et al., 2022).

The household organic waste used in this study was collected from Sungai Langka Village and consisted primarily of vegetable and plant residues, including celery, kale, corn, spinach leaves, carrots, lime leaves, papaya leaves, mustard greens, eggplant, and corn cobs. Waste was collected from two hamlets. Hamlet 1, consisting of 7 households, generated 8.45 kg/day of organic waste, while Hamlet 2, consisting of 5 households, generated 7.25 kg/day. Thus, the total daily organic waste generation from 12 households reached 15.7 kg/day. Waste management activities were carried out every Saturday at 08:00 WIB using the biopot composting method, in which each pipe was filled with 1 kg of organic waste to support the decomposition process (Iswanto et al., 2025) (Artiningsih, 2015).

The biopot composting method is a practical small-scale approach for managing household organic waste, particularly in areas with limited space. This method supports the gradual decomposition of organic materials and enables the conversion of household organic residues into compost that can contribute to soil nutrient improvement. However, its effectiveness depends on several factors, including the composition of organic waste, moisture content, aeration, microbial activity, and the use of appropriate starter materials (Jaya et al., 2023). In this study, rice washing water was used as a starter culture in different dosages to support microbial activity and accelerate the decomposition process (Iswanto et al., 2025).

The physicochemical properties of the compost, including carbon (C), nitrogen (N), C/N ratio, phosphorus (P), potassium (K), and organic waste reduction percentage, were systematically analyzed and assessed according to SNI 19-7030-2004 and SNI 7763:2024. Rice-washing water contains carbohydrates that can serve as a nutrient source for microorganisms and may enhance the composting process (Yahya et al., 2024). The findings of this study are expected to contribute to the development of practical household organic waste management practices, support public awareness of composting, and produce compost with potential benefits for improving soil quality and supporting agricultural activities. (Pertiwi, 2024).

2. METHOD

The organic waste used in this study was collected from Sungai Langka Village and consisted of various household organic materials, including celery leaves, kale, corn, spinach, carrots, lime leaves, papaya leaves, mustard greens, eggplant, corn leaves, and corn cobs. The percentage composition of each organic waste component was calculated using the following equation below

$$\text{Organic waste sample (\%)} = \frac{W_i}{W_t} \times 100$$

where W_i is the weight of each organic waste component, such as celery leaves, kale, corn cobs, or dry leaves, expressed in kilograms (kg), and W_t is the total weight of all collected organic waste, also expressed in kilograms (kg). The calculated value is presented as a percentage (%).

The experimental design used 1 kg of household organic waste per biopot unit. A total of 12 biopot units were prepared, resulting in 12 kg of organic waste used in the composting experiment. The treatment variations are presented in Table 1.

Table 1. Variation scheme

Treatment variation	Description
P0	Application of 1 kg of organic waste without rice-wash water starter (control)
P1	Application of 1 kg of organic waste supplemented with 100 ml of rice-wash water starter
P2	Application of 1 kg of organic waste supplemented with 200 ml of rice-wash water starter
P3	Application of 1 kg of organic waste supplemented with 300 ml of rice-wash water starter

Note: P0 = control without rice-washing water starter culture; P1 = 100 ml rice-washing water starter culture; P2 = 200 ml rice-washing water starter culture; P3 = 300 ml rice-washing water starter culture. Each treatment was conducted in triplicate.

The experiment consisted of four treatment variations, namely P0, P1, P2, and P3, with each treatment conducted in triplicate, resulting in a total of 12 biopot units. Each biopot unit was filled with 1 kg of household organic waste. The biopot units were arranged to minimize positional bias during the composting process. The data obtained from each treatment were analyzed descriptively by comparing the observed physical and chemical compost quality parameters, as well as the percentage of organic waste reduction. Since no inferential statistical test was applied, differences among treatments were interpreted as descriptive comparative trends rather than statistically significant differences. To maintain scientific accuracy, the interpretation of treatment performance was presented cautiously based on the observed data.

Composting was performed using the biopot composting method as the medium for organic decomposition, with the configuration of the experimental setup shown in Figure 1.



Figure 1. Design of the Biopot Method

The data obtained from each treatment were analyzed descriptively by comparing the observed physical and chemical compost quality parameters and the percentage of organic waste reduction. Compost quality assessment was conducted in reference to SNI 19-7030-2004 and SNI 7763:2024, focusing on carbon (C), nitrogen (N), the C/N ratio, phosphorus (P), potassium (K), and organic waste reduction percentage. Since no inferential statistical tests, such as ANOVA or Tukey test, were applied, differences among treatments were interpreted as descriptive comparative trends rather than statistically significant differences. Therefore, P2 was identified as the treatment showing the best overall descriptive performance based on its consistently favorable observed values across several parameters, particularly organic waste reduction, nitrogen, phosphorus, potassium, carbon content, and compost maturity indicators.

3. RESULT AND DISCUSSION

3.1 Organic Waste Composition

Organic waste sampling was carried out once on Saturday at 08:00 a.m. Western Indonesian Time (WIB) in two hamlets. Hamlet 1, consisting of 7 households, generated 8.45 kg/day of organic waste, while Hamlet 2, consisting of 5 households, generated 7.25 kg/day. Thus, the total organic waste generated from 12 households reached 15.7 kg/day, with varying compositions, as shown in Figure 2..

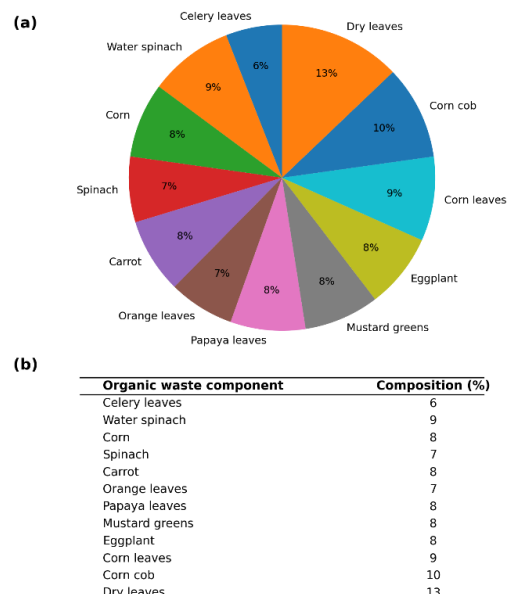


Figure 2. Composition of household organic waste collected from Sungai Langka Village: (a) percentage distribution of organic waste components and (b) detailed tabular summary of each component used as composting raw material

The contribution of celery leaves was relatively small at 6%, while corn cobs and dry leaves accounted for 10% and 13%, respectively. Antimicrobial compounds, including flavonoids, tannins, and saponins, found in celery, orange, and papaya leaves, can suppress microbial activity and, at elevated concentrations, may impede the decomposition process. Similarly, essential oils found in celery and orange leaves have been reported to suppress the growth of certain microorganisms (Zhang et al., 2020). Phenolic compounds and tannins in dry leaves, spinach, and kale can also form protein complexes, thereby reducing the decomposition rate. Moreover, lignocellulosic materials, such as corn cobs and dry leaves, tend to decompose more slowly due to their high lignin content, which is structurally resistant to microbial degradation (Zhang et al., 2020). These findings are consistent with previous studies on lignocellulose degradation in green waste (Wang et al., 2026). Conversely, papaya leaves contain papain, a proteolytic enzyme that is active under specific pH and temperature conditions. This enzyme may enhance the breakdown of protein substrates and accelerate the decomposition of certain organic fractions in composting materials (Zhao et al., 2023). In addition, sufficient nitrogen content and a balanced C/N ratio in green leaves, such as kale, spinach, mustard greens, and celery, are essential for sustaining microbial activity during composting (Machado et al., 2020). Therefore, effective composting requires an appropriate balance of organic materials with a suitable C/N ratio to support microbial performance and produce good-quality compost (Wildawati, 2020).

3.2 Compost characteristics

Monitoring compost maturity involves observing both physical and chemical parameters, including temperature, pH, color, moisture content, carbon (C), nitrogen (N), C/N ratio, phosphorus (P), and potassium (K), in accordance with SNI 19-7030-2004 and SNI 7763:2024. The composting process was monitored every three days until maturity indicators were observed, with a total composting duration of 31 days.

3.2.1 Temperature

Compost temperature during the composting process ranged from 28°C to 30°C, which remained within the standard requirement of $\leq 30^\circ\text{C}$. Temperature measurements were conducted daily at 4:00 PM WIB for 31 days using a digital soil analyzer tester meter. To maintain the composting condition, the compost material was stirred every three days. The recorded temperature data are presented in Figure 3.

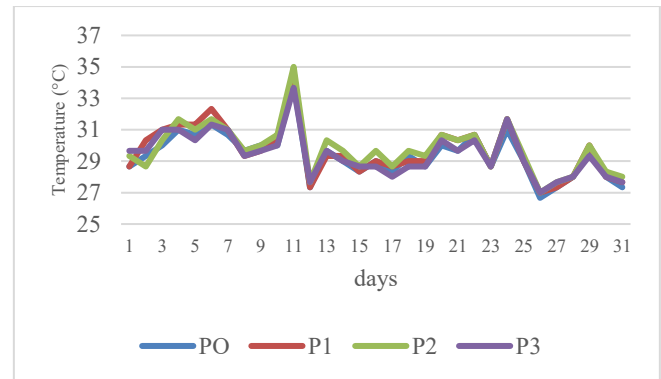


Figure 3. Mean temperature of compost

According to Figure 3, a marked temperature increase occurred on day 11, during which all four treatment variations (PO, P1, P2, and P3) showed a simultaneous rise. This increase may indicate enhanced microbial activity due to the degradation of available organic substrates, which increased microbial metabolic activity and heat release. In addition, changes in microenvironmental conditions, such as increased humidity or improved aeration, may have further stimulated microbial activity.

A sharp temperature decline occurred on day 12, immediately after the peak observed on day 11. This decrease was likely associated with the reduction of easily decomposable organic substrates following intense degradation, which limited microbial metabolism and heat generation. Heat loss to the surrounding environment may also have contributed to this decline. Another noticeable temperature decrease occurred on day 26, particularly in treatment P3, following a temperature increase on day 24. This condition may be attributed to substrate reduction due to microbial activity, the accumulation of inhibitory metabolites, or microenvironmental changes that no longer supported microbial growth (Atmaja, 2017)

3.2.2 pH

During the composting process, pH fluctuations were observed across all treatment variations, with values remaining within the SNI 7763:2024 standard range of 4–9. pH measurements were conducted daily for 31 days at 4:00 PM WIB using a digital soil analyzer tester meter. The pH data obtained throughout the composting process are presented in Figure 4.

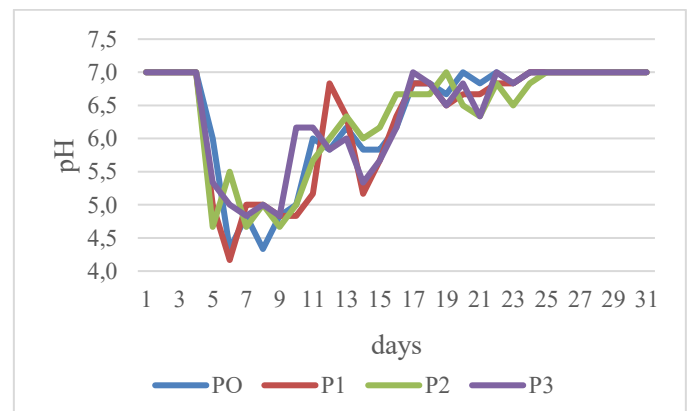


Figure 4. Mean pH of compost

According to Figure 4, during the initial phase of composting (days 1–4), the compost pH remained within the neutral range, around 7.0. This condition may be related to the initial microbial activity involved in organic matter degradation, which commonly generates organic acids that can reduce pH to slightly acidic levels (Park et al., 2022). However, the neutral pH observed on day 1 suggests that acid-producing microorganisms may not yet have been fully active, or that the organic material contained compounds capable of neutralizing acidity (Yang et al., 2023). For example, ammonia produced from nitrogen decomposition in green leaves, such as kale, spinach, and mustard greens, may have contributed to maintaining or increasing pH (Kong et al., 2024).

A notable increase in pH across all treatment variations was observed from day 25 to day 31, with values approaching 7.0. This condition indicates that the compost had progressed toward the maturation stage. The initial decline in pH can be attributed to microbial degradation of organic matter, which produces organic acids, whereas the subsequent shift toward neutrality reflects the gradual reduction of these acids. A final pH of around 7.0 indicates a more stable condition between microbial activity and the remaining organic substrates during decomposition (Ding & Wu, 2025).

3.2.3 Color

The ultimate color of compost is determined by the composition of organic materials involved in the process, including vegetable residues, fruit peels, dried leaves, and other foliage. In this study, the raw material used was household organic waste. The resulting compost color complied with SNI 19-7030-2004. On the 31st day, the compost exhibited a blackish color, indicating that the process had reached the maturation phase and that the decomposition of organic material had progressed optimally. According to Y. Xie et al., (2025), indicators of compost maturity include physical appearance particularly color with mature compost typically being darker than at the initial stage.

Table 2. color of compost

Treatment Variation	Replication	Color Code and Description	Documentation
P0	1	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	
	2	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	
	3	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	
P1	1	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	

Treatment Variation	Replication	Color Code and Description	Documentation
	2	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	
	3	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	
P2	1	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	
	2	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	
	3	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	
P3	1	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	
	2	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	
	3	Hue 10 YR, Chroma /1, Value 2/, Warna 2/1 (Black)	

Note: P0 = Control, P1 = Treatment 1, P2 = Treatment 2, P3 = Treatment 3.

Source: Munsell Soil Color Charts in (Kong et al., 2024)

As shown in Table 2, the blackish color of the compost served as a visual indicator of compost maturity (Kong et al., 2024). The composting process was conducted in triplicate across four treatment variations (P0, P1, P2, and P3), all of which produced a blackish final color. This color change was associated with microbial activity that decomposed complex organic compounds into simpler forms, resulting in a darker appearance by the end of the composting process (Tsivas et al., 2024). On day 31, the compost from all treatments met the physical maturity criteria specified in SNI 19-7030-2004, as indicated by a blackish, soil-like color and an earthy aroma, clear indicators of organic material decomposition. Furthermore, the average color analysis across all treatments on day 31 showed a consistent black color, suggesting that the decomposition process had progressed toward maturity. This blackish coloration can be considered a positive visual indicator of compost quality and is commonly associated with mature compost characteristics (Rashwan et al., 2021).

3.2.4 Moisture content

Moisture content is a crucial factor in composting, as it directly affects microbial activity during the degradation of organic matter. In this study, compost samples were oven-dried at 105 °C for six hours, from 10:00 AM to 3:00 PM WIB, at the Soil Laboratory, Sumatra Institute of Technology. The determination of moisture content followed SNI 7763:2024, which specifies the quality standard for solid organic fertilizer, with an acceptable moisture content range of 8%–25%. The measured values of compost moisture content are shown in Figure 5.

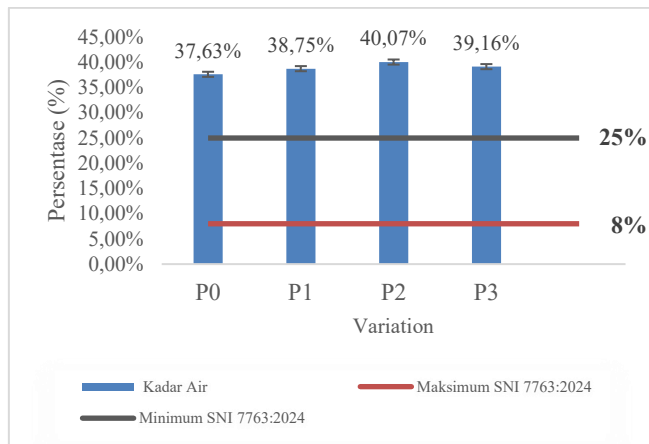


Figure 5. Moisture content in composting

The measured moisture content in all treatments ranged from 37.63% to 40.07%, exceeding the acceptable range of 8%–25% specified in SNI 7763:2024. This indicates that, although moisture content is important for supporting microbial activity during the active decomposition stage (Tang et al., 2023), the resulting compost did not meet the SNI requirement for moisture content at the end of the 31-day composting process. Therefore, additional drying or curing is required before the compost is stored, packaged, or applied in the field. This finding also suggests that moisture control is an important factor in optimizing the biopot composting method, particularly when rice-washing water is used as a starter culture (Aguilar-Paredes et al., 2023).

In the P0 treatment, the lowest moisture content was recorded at 37.63%. This lower value may be attributed to the absence of rice-washing water starter culture, which resulted in relatively lower humidity within the composting material compared with the other treatments. Lower moisture conditions may reduce microbial activity and slow the decomposition of more resistant organic materials, such as dry leaves and corn cobs (Azim et al., 2018).

By contrast, the P2 treatment recorded the highest moisture content at 40.07%. This value suggests that the addition of rice-washing water starter culture contributed to maintaining higher moisture conditions during composting. However, because this value exceeded the SNI 7763:2024 threshold, it should not be interpreted as an indicator of final compost compliance. Instead, the result indicates that P2 supported active decomposition but still requires further drying or curing to obtain compost with moisture content suitable for storage and application. The role of the activator in supporting organic matter decomposition is consistent with the findings of Bang et al., 2024, while environmental

conditions and the characteristics of easily biodegradable organic materials may also influence moisture retention and decomposition efficiency (Sun et al., 2024).

Overall, the moisture content results show that rice-washing water starter culture influenced the moisture condition of the composting material. However, the moisture values obtained in all treatments remained above the recommended SNI threshold. Therefore, future application of the biopot composting method should include better moisture control, such as optimizing starter dosage, improving aeration, and applying additional drying or curing after the active composting phase

3.3 Carbon (C)

Carbon (C) in compost serves as the principal energy source for microorganisms responsible for decomposing organic matter (Jaya et al., 2023), as presented in Figure 6.

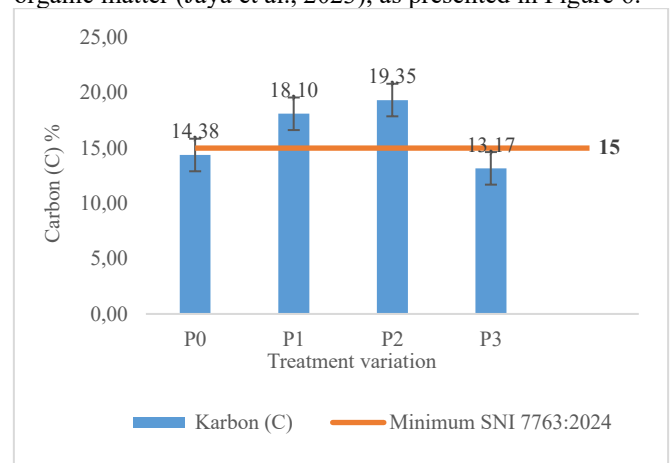


Figure 6. Carbon (C) Concentration in Compost

The analysis of the average carbon (C) content in compost across the P0, P1, P2, and P3 treatment variations showed that the P2 treatment produced the highest value, at 19.35%, demonstrating the effectiveness of the activator in enhancing organic matter decomposition. Materials such as dry leaves, corn leaves, and corn cobs are rich in carbon, which provides essential energy for microbial activity during the composting process. According to Adhikari et al., 2024 planted corn cobs undergo more rapid decomposition, suggesting that direct soil contact and sufficient moisture availability enhance microbial activity and accelerate carbon loss during decomposition. The carbon content in the P3 treatment variation was recorded at a relatively low level of 13.17%, indicating that the nutrients available in the compost were suboptimal, with a corresponding reduction in nitrogen content. Excessive moisture disrupts the microbial balance within the compost and decreases decomposition activity (Suryanto, 2019). Overly wet environmental conditions hinder the optimal performance of decomposer microorganisms, while the presence of green organic waste influences carbon production. As a result, the P3 treatment variation did not meet the quality requirements for solid organic fertilizer (Ahmed et al., 2023). Furthermore, organic materials with high lignocellulose content tend to retain a stable carbon fraction, whereas optimal moisture conditions accelerate degradation, ultimately influencing the final carbon content of the compost (Abban-Baidoo et al., 2024).

3.4 Nitrogen (N)

Nitrogen (N) is essential for microorganisms, supporting cell synthesis and enhancing the rate of organic matter decomposition, as illustrated in Figure 7.

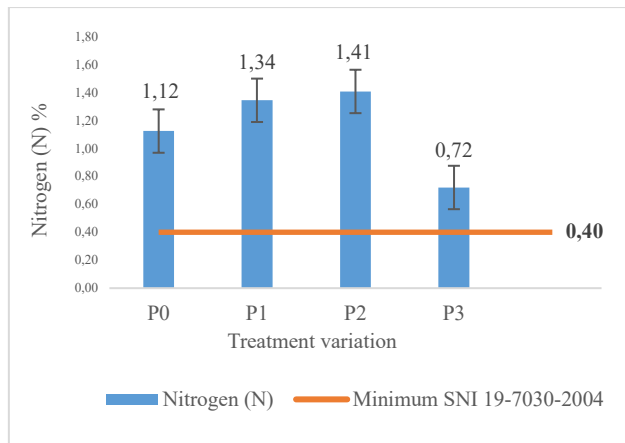


Figure 7. Nitrogen (N) Concentration in Compost

The analysis of the average nitrogen (N) content in compost across the P0, P1, P2, and P3 treatment variations showed that the P2 treatment yielded the highest content at 1.41%, indicating the effectiveness of the activator and the contribution of green leaf organic matter. Nitrogen functions as a key nutrient for microorganisms, supporting protein and enzyme synthesis that facilitates the decomposition of organic matter during the composting process (Yang et al., 2023).

3.5 Ratio C/N

The carbon-to-nitrogen (C/N) ratio is a critical indicator of microbial activity and a key determinant of compost quality, as presented in Figure 8.

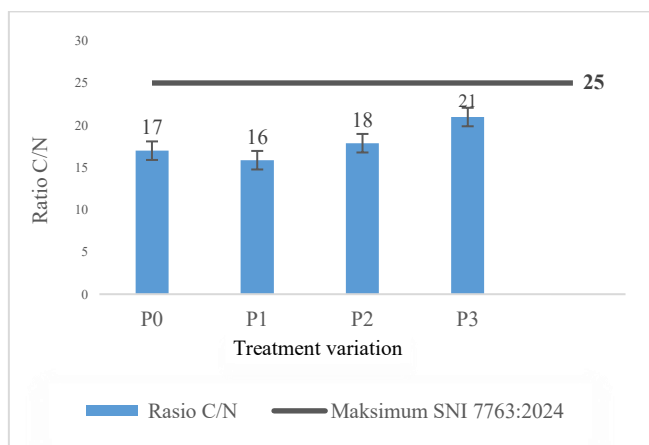


Figure 8. Carbon-to-Nitrogen (C/N) Ratio of Compost

The analysis of the average C/N ratio in compost from treatments P0, P1, P2, and P3 showed that the P3 treatment produced the best ratio of 21, demonstrating the effectiveness of the activator on organic matter decomposition. The C/N ratio is a critical factor in composting, as carbon provides the main energy source for microorganisms, whereas nitrogen

facilitates their growth and cell development. A balanced C/N ratio ensures optimal microbial activity and the production of high-quality compost. Conversely, nitrogen deficiency limits microbial activity and inhibits the decomposition process. The optimal C/N ratio for microbial growth generally ranges between 20 and 35, with nitrogen retention being most efficient at a ratio of around 15, while decomposition proceeds more rapidly at a ratio approaching 20 (S. Xie et al., 2023). These results align with the findings of Zhou (2017), who demonstrated that a C/N ratio of 20 in composting pig manure with rice straw effectively produced nutrient-rich, high-quality compost.

3.6 Phosphorus (P)

The phosphorus (P) content plays a crucial role in supporting microbial activity and enhancing soil fertility, as illustrated in Figure 9.

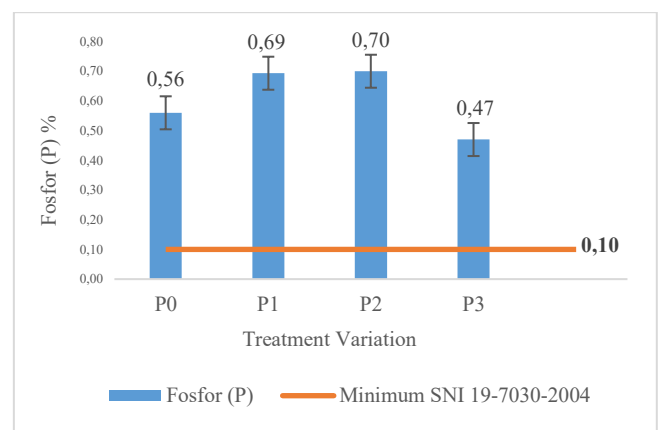


Figure 9. Phosphorus (P) Concentration in Compost

The analysis of the average phosphorus (P) content in compost from treatments P0, P1, P2, and P3 showed that the P2 treatment produced the highest value at 0.70%, demonstrating the effectiveness of the activator in facilitating organic matter decomposition. Increased phosphorus levels in compost are influenced by nitrogen availability, as higher nitrogen concentrations stimulate microbial activity, thereby accelerating the decomposition of organic matter and the subsequent release of phosphorus (Kaswinarni & Nugraha, 2020). Optimal phosphorus levels are essential for improving soil fertility, as they provide key nutrients for plant growth and simultaneously support microbial processes that transform organic matter into mature, nutrient-rich compost (Mulyadi, 2020). The P3 treatment variation produced a lower phosphorus content of 0.47%, which was attributed to the high fiber content in corn cobs and dry leaves. The dominant carbon fraction tended to result in a high C/N ratio, causing microorganisms to focus more on decomposing carbon and nitrogen, while the decomposition of minerals such as phosphorus occurred less efficiently (Mishra et al., 2024).

3.7 Potassium

Potassium plays an essential role in microbial metabolism and plant resilience, as illustrated in Figure 10.

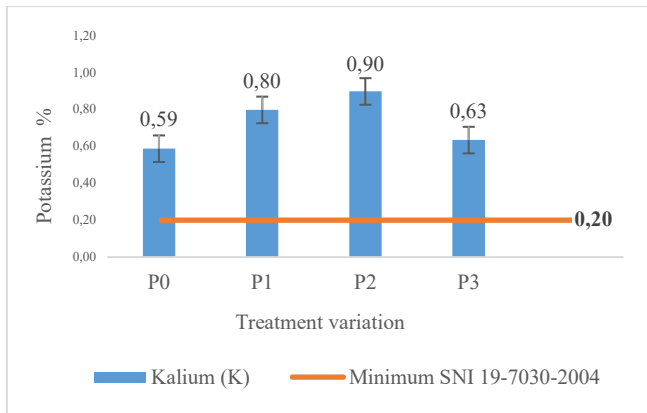


Figure 10. Compost Potassium Content

The analysis of the average potassium (K) content in compost from treatments P0, P1, P2, and P3 showed that the P2 treatment produced the highest value at 0.90%, reflecting the effectiveness of the organic matter utilized. Adequate potassium levels are critical for enhancing plant resistance to pests and drought, as well as for maintaining soil nutrient balance. Thus, compost serves as an effective organic fertilizer by providing balanced nutrition for sustainable soil and crop management (Xu et al., 2021).

3.8 The percentage reduction of organic waste

The percentage reduction of organic waste is a key indicator of the effectiveness of waste processing through composting. In this study, 1 kg of organic waste was used in three replications for each treatment variation (P0, P1, P2, and P3). The addition of an activator during the composting process influenced the degree of waste reduction. The results showed that the P1, P2, and P3 treatments using the biopot method achieved optimal reduction percentages ranging from 60% to 80%, indicating an effective decomposition process, as illustrated in Figure 11.

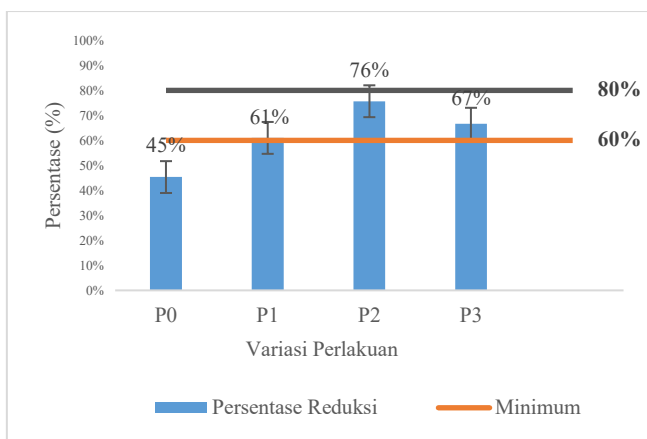


Figure 11. Percentage of Compost Reduction

The analysis of the average compost reduction percentage across treatments revealed that the P2 treatment achieved the highest reduction at 76%, demonstrating the effectiveness of the activator in accelerating organic matter decomposition. The reduction percentage reflects the volume or mass of organic material broken down during composting; higher values indicate a more efficient decomposition process. This

optimal reduction results in mature compost with favorable nutrient content, thereby enhancing soil quality (Yuwono, 2016).

3.9 Comparison of Compost Quality

Compost quality serves as a critical benchmark for assessing the effectiveness of various composting methods and materials. The primary goal of this evaluation is to generate compost that is both environmentally sustainable and effective in enhancing plant productivity. The assessment considered physical and chemical parameters, including temperature, color, and nutrient concentrations of nitrogen (N), phosphorus (P), and potassium (K). The experiment was carried out with three replications across four treatments (P0, P1, P2, and P3), each using rice washing water as a starter with varying spraying dosages (Table 3). All parameters analyzed were assessed in accordance with the Indonesian National Standard (SNI) 19-7030-2004.

Table 3. Comparison of Compost Quality Parameters in Accordance with SNI 19-7030-2004

Parameter	SNI 19-7030-2004	Variation treatment			
		P0	P1	P2	P3
Temp	≤30°C (28 - 30°C)	28° C	28° C	28° C	28° C
Color	Maximum dark brown to black	Dark brown to black	Dark brown to black	Dark brown to black	Dark brown to black
Nitrogen (N)	Minimum 0,40%	1,12%	1,34%	1,41%	0,72%
Phosphorus (P)	Minimum 0,10%	0,56%	0,69%	0,70%	0,47%
Pottasium	Minimum 0,20%	0,59%	0,80%	0,90%	0,63%

Sources: Primary Data, 2025

Based on Table 2, the P2 treatment variation showed the best performance, producing optimal compost that met the quality requirements specified in SNI 19-7030-2004. The decomposition of organic material proceeded efficiently, supported by the chemical compounds in the green materials that accelerated the process and enhanced composting parameters. (Noor et al., 2024).

4 CONCLUSION

The biopot composting method combined with rice-washing water as a starter culture supported the decomposition of household organic waste under the observed experimental conditions. Among the treatments, P2, consisting of 1 kg of organic waste and 200 ml of rice-washing water starter culture, showed the best overall descriptive performance, as indicated by the highest organic waste reduction rate of 76% and favorable values for several chemical parameters, including carbon, nitrogen, phosphorus, and potassium. Most compost quality parameters met the requirements specified in SNI 19-7030-

2004 and SNI 7763:2024; however, the moisture content remained above the recommended threshold, indicating that additional drying or curing is required before storage or field application. Therefore, P2 can be considered the most promising treatment in this descriptive study, although further statistical validation is recommended in future research to confirm treatment differences more robustly.

REFERENCES

- Abban-Baidoo, E., Manka'abusi, D., Apuri, L., Marschner, B., & Frimpong, K. A. (2024). Biochar addition influences C and N dynamics during biochar co-composting and the nutrient content of the biochar co-compost. *Scientific Reports*, 14(1). <https://doi.org/10.1038/s41598-024-67884-z>
- Adhikari, A. D., Shrestha, P., Ghimire, R., Liu, Z., Pollock, D. A., Acharya, P., & Aryal, D. R. (2024). Cover crop residue quality regulates litter decomposition dynamics and soil carbon mineralization kinetics in semi-arid cropping systems. *Applied Soil Ecology*, 193. <https://doi.org/10.1016/j.apsoil.2023.105160>
- Aguiar-Paredes, A., Valdés, G., Araneda, N., Valdebenito, E., Hansen, F., & Nuti, M. (2023). Microbial Community in the Composting Process and Its Positive Impact on the Soil Biota in Sustainable Agriculture. In *Agronomy* (Vol. 13, Number 2). MDPI. <https://doi.org/10.3390/agronomy13020542>
- Ahmed, T., Noman, M., Qi, Y., Shahid, M., Hussain, S., Masood, H. A., Xu, L., Ali, H. M., Negm, S., El-Kott, A. F., Yao, Y., Qi, X., & Li, B. (2023). Fertilization of Microbial Composts: A Technology for Improving Stress Resilience in Plants. In *Plants* (Vol. 12, Number 20). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/plants12203550>
- Atmaja, I. K. M., T. I. W., & W. I. M. A. S. (2017). Pengaruh Perbandingan Komposisi Bahan Baku terhadap Kualitas Kompos dan Lama Waktu Pengomposan. *Jurnal Biosistem Dan Pertanian*, 5(1), 111–119. <https://ojs.unud.ac.id/index.php/beta/article/view/27159>
- Azim, K., Soudi, B., Boukhari, S., Perissol, C., Roussos, S., & Thami Alami, I. (2018). Composting parameters and compost quality: a literature review. In *Organic Agriculture* (Vol. 8, Number 2, pp. 141–158). Springer Netherlands. <https://doi.org/10.1007/s13165-017-0180-z>
- Bang, D., Chung, W., & Chang, S. (2024). Influence of Effective Microbial Additives Inoculation on Indigenous Bacterial Community Dynamics and Co-Occurrence Patterns During the Composting of Mixed Food Waste and Livestock Manure. *Agronomy*, 14(12). <https://doi.org/10.3390/agronomy14122973>
- Ding, S., & Wu, D. (2025). Comprehensive analysis of compost maturity differences across stages and materials with statistical models. *Waste Management*, 193, 250–260. <https://doi.org/10.1016/j.wasman.2024.12.011>
- Iswanto, I., Istiqomah, S. H., Puspawati, C., & Puspitasari, S. (2025). Efektivitas Biopot sebagai Media Pengomposan Sampah Organik Rumah Tangga: Studi Kuasi-Eksperimen. 21, 2(2), 01–11. <https://doi.org/https://doi.org/10.29238/jtk.v21i2.2776>
- Jaya, J. D., Nugroho, A., Elma, M., & Sunardi, S. (2023). Review on Biodegradable Pot: A New Promising Approach for Sustainable Agriculture. *AIP Conference Proceedings*, 2682. <https://doi.org/10.1063/5.0118270>
- Kaswinarni, F., & Nugraha, A. A. S. (2020). Kadar Fosfor, Kalium dan Sifat Fisik Pupuk Kompos Sampah Organik Pasar dengan Penambahan Starter EM4, Kotoran Sapi dan Kotoran Ayam. *Titian Ilmu: Jurnal Ilmiah Multi Sciences*, 12(1), 1–6. <https://doi.org/10.30599/jti.v12i1.534>
- Kong, Y., Zhang, J., Zhang, X., Gao, X., Yin, J., Wang, G., Li, J., Li, G., Cui, Z., & Yuan, J. (2024). Applicability and limitation of compost maturity evaluation indicators: A review. *Chemical Engineering Journal*, 489, 151386. <https://doi.org/10.1016/J.CEJ.2024.151386>
- Machado, R. M. A., Alves-Pereira, I., Lourenço, D., & Ferreira, R. M. A. (2020). Effect of organic compost and inorganic nitrogen fertigation on spinach growth, phytochemical accumulation and antioxidant activity. *Heliyon*, 6(9). <https://doi.org/10.1016/j.heliyon.2020.e05085>
- Mishra, A. K., Shinjo, H., Jat, H. S., Jat, M. L., Jat, R. K., & Funakawa, S. (2024). Assessing the impact of rice-wheat-maize residue decomposition rate and nutrient dynamics of residue and soil using different placement method in the IGP of India. *Frontiers in Sustainable Food Systems*, 8. <https://doi.org/10.3389/fsufs.2024.1409370>
- Noor, R. S., Shah, A. N., Tahir, M. B., Umair, M., Nawaz, M., Ali, A., Ercisli, S., Abdelsalam, N. R., Ali, H. M., Yang, S. H., Ullah, S., & Assiri, M. A. (2024). Recent Trends and Advances in Additive-Mediated Composting Technology for Agricultural Waste Resources: A Comprehensive Review. In *ACS Omega* (Vol. 9, Number 8, pp. 8632–8653). American Chemical Society. <https://doi.org/10.1021/acsomega.3c06516>
- Park, G. W., Moon, M., Park, J. H., Jo, J. H., Kim, H. J., Lee, J. Y., Lee, H. S., Lee, J. pyo, Lee, S., Lee, S. Y., Lee, J., Na, J. G., Kim, M. S., & Lee, J. S. (2022). Improving hydrogen production by pH adjustment in pressurized gas fermentation. *Bioresource Technology*, 346, 126605. <https://doi.org/10.1016/J.BIORTECH.2021.126605>
- Rashwan, M. A., Naser Alkoaik, F., Abdel-Razzak Saleh, H., Blanqueza Fulleros, R., & Nagy Ibrahim, M. (2021). Maturity and stability assessment of composted tomato residues and chicken manure using a rotary drum bioreactor. *Journal of the Air and Waste Management Association*, 71(5), 529–539. <https://doi.org/10.1080/10962247.2020.1859416>
- Sun, S., Guo, C., Wang, J., Ren, L., Qu, J., Guan, Q., Dou, N., Zhang, J., Chen, Q., Wang, Q., Wang, J., Li, J., Gao, Z., & Zhou, B. (2024). Effect of initial moisture content, resulting from different ratios of vegetable waste to maize straw, on compost was mediated by composting temperatures and microbial communities at low temperatures. *Chemosphere*, 357. <https://doi.org/10.1016/j.chemosphere.2024.141808>

- Suryanto, E. (2019). PENGARUH APLIKASI DOSIS EM4 (Effective Microorganism 4) TERHADAP RASIO C/N DAN TEKSTUR KOMPOS DARI KOTORAN KAMBING SEBAGAI SUMBER BELAJAR BIOLOGI SMP. *Jurnal Lentera Pendidikan Pusat Penelitian LPPM UM METRO*, 4(1).
- Tang, R., Liu, Y., Ma, R., Zhang, L., Li, Y., Li, G., Dingmei Wang, Lin, J., Li, Q., & Yuan, J. (2023). Effect of moisture content, aeration rate, and C/N on maturity and gaseous emissions during kitchen waste rapid composting. *Journal of Environmental Management*, 326. <https://doi.org/10.1016/j.jenvman.2022.116662>
- Tsivas, D., Vlyssides, A., & Vlysidis, A. (2024). Differentiation of the composting stages of green waste using the CIELAB color model. *Journal of Chemical Technology and Biotechnology*, 99(10), 2198–2208. <https://doi.org/10.1002/jctb.7370>
- Wang, X., Qiu, M., & Zhang, L. (2026). Effects of inoculation timing with lignocellulose-degrading compound microbial inoculum on green waste composting. *Bioresource Technology*, 439, 133291. <https://doi.org/10.1016/j.biortech.2025.133291>
- Xie, S., Tran, H. T., Pu, M., & Zhang, T. (2023). Transformation characteristics of organic matter and phosphorus in composting processes of agricultural organic waste: Research trends. *Materials Science for Energy Technologies*, 6, 331–342. <https://doi.org/10.1016/j.mset.2023.02.006>
- Xie, Y., Wu, P., Qu, Y., Guo, X., Zheng, J., Xing, Y., Zhang, X., & Liu, Q. (2025). The Evolution of Nutrient and Microbial Composition and Maturity During the Composting of Different Plant-Derived Wastes. *Biology*, 14(3). <https://doi.org/10.3390/biology14030268>
- Xu, Q., Fu, H., Zhu, B., Hussain, H. A., Zhang, K., Tian, X., Duan, M., Xie, X., & Wang, L. (2021). Potassium improves drought stress tolerance in plants by affecting root morphology, root exudates and microbial diversity. *Metabolites*, 11(3), 1–17. <https://doi.org/10.3390/metabo11030131>
- Yahya, H., Cut Nina Latisa Maura, & Arief Rahman. (2024). EFFECT OF DIFFERENT CONCENTRATIONS OF RICE WASHING WATER IN THE COMPOSTING PROCESS WITH THE MAC DONALD METHOD. *Indonesian Journal of Environmental Sustainability*, 2(2), 108–115. <https://doi.org/10.22373/ijes.v2i2.5958>
- Yang, Q., Zhang, S., Li, X., Rong, K., Li, J., & Jiang, L. (2023). Effects of microbial inoculant and additives on pile composting of cow manure. *Frontiers in Microbiology*, 13. <https://doi.org/10.3389/fmicb.2022.1084171>
- Zhang, J., Ying, Y., Li, X., & Yao, X. (2020). Changes in tannin and saponin components during co-composting of *Camellia oleifera* Abel shell and seed cake. *PLoS ONE*, 15(3). <https://doi.org/10.1371/journal.pone.0230602>
- Zhao, B., Wang, Y., Li, L., Ma, L., Deng, Y., & Xu, Z. (2023). Adjusting pH of the Secondary Composting Materials to Further Enhance the Lignocellulose Degradation and Promote the Humification Process. *Sustainability (Switzerland)*, 15(11). <https://doi.org/10.3390/su15119032>
- Zhou, J. M. (2017). The Effect of Different C/N Ratios on the Composting of Pig Manure and Edible Fungus Residue with Rice Bran. *Compost Science and Utilization*, 25(2), 120–129. <https://doi.org/10.1080/1065657X.2016.1233081>