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Short Note

The quality of organic fertilizer from chicken manure fortified with agricultural waste using a rotary drum system

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Abstract

Purpose: Organic fertilizer from chicken manure has the ability to improve soil structure, enhance the soil's capacity to retain water and air, and stimulate beneficial microbial activity within the soil. The objective of this research is to improve the quality of organic fertilizer derived from chicken manure by adding organic waste through composting using a rotary drum system.
Method: follows an experimental approach using a Completely Randomized Design (CRD). The treatments applied were as follows: P0=100% layer chicken manure; P1= 50%-layer chicken manure: 50% coffee husk waste. P2= 50%-layer chicken manure: 50% banana peel waste. P3 = 50%-layer chicken manure: 50% rice husk ash. The compost quality parameters measured included nitrogen (N), phosphorus (P), potassium (K), organic carbon (C-organic), moisture content, and the C/N ratio.
Result: The research findings indicated significant differences ($P<0.05$) in nitrogen content, potassium content, carbon content, C/N ratio, and moisture content of the organic fertilizer with different types of agricultural waste. However, phosphorus content did not show significant differences with the addition of any agricultural waste.
Conclusion: The addition of 50% coffee husk to chicken manure (P1) produced the best compost quality, with the highest nitrogen (2.47%) and organic carbon (32.19%), a C/N ratio of 13.03 within the SNI standard, and a stable pH of 7.0. While phosphorus remained stable, all treatments met the SNI requirements, confirming P1 as the most effective formulation for high-quality organic fertilizer.

Keywords: Compost quality, Chicken manure, Fortification, Organic waste, Rotary drum
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1. Introduction

The increase in agricultural productivity heavily depends on the availability of high-quality fertilizers. However, reliance on chemical fertilizers has led to various environmental and economic issues, such as land degradation, water pollution, and rising production costs for farmers (Shwe et al., 2021). Therefore, the development of organic fertilizers as an alternative to chemical fertilizers offers a more environmentally friendly and sustainable solution (Muslih & Bagastyo, 2022). One of the main materials used in organic fertilizer production is chicken manure. Chicken manure contains essential macronutrients, such as nitrogen (N), phosphorus (P), and potassium (K), which are crucial for plant growth.
Several studies on organic fertilizer derived from chicken manure have been conducted. Pancapalaga et al. (2021) reported that chicken manure-based organic fertilizer contains relatively high levels of macronutrients, with N (1.72%), P (1.82%), and K (2.18%). In contrast, Sołowiej et al. (2021) found lower concentrations, with N (1%),

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P (0.80%), and K (0.40%), while also reporting a higher moisture content of 55%. These differences may be attributed to variations in raw material quality, composting conditions, and processing methods used. Furthermore, Bhave and Kulkarni (2019) identified beneficial microorganisms such as *Lactobacillus acidophilus*, *Leuconostoc mesenteroides*, and *Streptococcus thermophilus* in chicken manure fertilizer, suggesting its potential to improve soil microbial diversity. Similarly, Alfadlli et al. (2018) emphasized that the addition of chicken manure can enhance soil water retention and fertility.

In terms of application, Irfan et al. (2023) demonstrated that chicken manure fertilizer increased rice production, Shang et al. (2025) showed positive effects on peanut (*Arachis hypogaea L.*) growth, and Yulianingsih (2018) reported improved tomato (*Lycopersicum esculentum mill.*) yields. These findings indicate that chicken manure has broad potential for different crop systems. However, results across studies are not always consistent, particularly in terms of nutrient levels and stability, which indicates the need for standardized processing methods.

Despite its potential, the use of chicken manure as organic fertilizer without proper processing may result in unpleasant odors, pathogen risks, and nutrient losses. Previous studies largely focused on nutrient content and crop productivity, but fewer have examined the role of processing techniques in ensuring nutrient uniformity and microbial safety. Walpajri et al. (2023) highlighted that fortification with organic waste (e.g., coffee husk, banana peel, or rice husk ash) can improve nutrient balance and accelerate decomposition, but systematic evaluation of such fortification in controlled processing systems remains limited.

One promising approach is the rotary drum system, which enhances aeration and mixing efficiency during composting. Ruslinda et al. (2021) found that rotary drum composting accelerates decomposition, improves nutrient stability, and produces fertilizer with better physical and microbial quality. Compared to conventional composting methods, the rotary drum system offers greater control over environmental conditions, potentially addressing inconsistencies reported in earlier studies.

Based on the literature above, previous studies have demonstrated the nutrient potential of chicken manure fertilizer but also revealed variability in its quality due to differences in processing methods. Research on fortification with agricultural waste exists but has not been fully integrated with controlled rotary drum systems. Therefore, this study aims to evaluate the quality of organic fertilizer made from chicken manure fortified with organic waste using a rotary drum system, with the expectation of contributing to the development of more effective, efficient, and environmentally friendly organic fertilizer processing technology.

2. Material and Method

2.1. Materials

The research materials used in this study include layer chicken manure and organic waste in the form of coffee husk, banana peel, and rice husk ash, with each material weighing 10 kg. The layer chicken manure was collected from the closed-house experimental farm laboratory at UMM and was sun-dried for seven days. Meanwhile, the dried coffee husk and banana peel were obtained from organic waste sources in Malang Regency. The equipment used in this study includes a hoe, plastic sheets, grinder, containers, weighing scale, molasses, thermometer, pH meter, knife, camera, and writing tools**.**

The raw materials used in this study included layer chicken manure (LCM), coffee husk, banana peel, and rice husk ash. These materials were used to formulate the different organic fertilizer treatments. The chemical composition of each raw material, including nitrogen (N), phosphorus (P_2O_5), potassium (K), organic carbon (OC), and the carbon-to-nitrogen (C/N) ratio, is presented in Table 1. These values served as baseline data to evaluate the nutrient contributions of each material in the final fertilizer formulations.

Table 1. Chemical composition of raw materials used in fertilizer formulations

Raw material	**Nitrogen (N, %)**	**Phosphorus (P_2O_5, %)**	**Potassium (K, %)**	**Organic Carbon (OC, %)**	**C/N Ratio**
Layer Chicken Manure (LCM)	0.85	0.21	0.48	25.0	15
Coffee Husk	0.22	0.22	0.76	45.0	60
Banana Peel	1.43	0.22	0.44	35.0	25
Rice Husk Ash	1.06	0.23	0.42	10.0	50

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2.2. Methods

The research method used in this study is an experimental method with a Completely Randomized Design (CRD). This study consists of three treatments as follows: P0 = 100%-layer chicken manure, P1 = 50%-layer chicken manure: 50% coffee husk waste, P2 = 50%-layer chicken manure: 50% banana peel waste, P3 = 50%-layer chicken manure: 50% rice husk ash, each treatment was repeated five times.

2.3. Composting process

Composting is carried out using the drum method, where organic materials such as layer chicken manure and organic waste—including coffee husk waste, banana peel waste, and rice husk ash—are placed in a sealed drum and rotated for 20 minutes daily. The first step in the process is drying the layer chicken manure and organic waste under direct sunlight for seven days. Once dried, the manure and organic waste are finely ground or chopped into small pieces. The next step is mixing the dried layer chicken manure with organic waste according to the treatment plan and placing the mixture into the drum. For each treatment, 10 kg of organic fertilizer is prepared and then fermented for 10 days with the addition of 5% Mobilin starter. The drum is rotated for 20 minutes daily during the fermentation process. After 10 days, data is collected on the quality of the organic fertilizer, including nitrogen (N) content, phosphorus (P_2O_5), potassium (K_2O), organic carbon (C-organic), C/N ratio, and water content.

2.4. Measurement of organic fertilizer quality

The compost quality measured includes Nitrogen (N), Phosphorus (P_2O_2), Potassium (K2O), Carbon (C-organic), C/N ratio, and Water Content. The determination of each measurement is as follows. Nitrogen content using the Kjeldahl method. Potassium (K_2O) content using the wet destruction method using a UV–Vis spectrophotometer. Phosphorus content was analyzed using the Bray I extraction method, which measures available phosphorus in the compost samples. The phosphorus values were then expressed as P_2O_5 (%). Determination of air content is carried out using the gravimetric method based on SNI 19-7030-2024. Determination of C-Organic by dry ashing at 550º C and the C/N ratio (AOAC, 2016).

2.5. Data analysis

The experiment was arranged in a Completely Randomized Design (CRD) with four treatments and five replicates each. Prior to analysis, data were tested for normality and homogeneity of variance to ensure the assumptions of ANOVA were met. One-way ANOVA was then performed to determine the effect of treatments, followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level for mean comparison.

3. Result and discussion

The evaluation of macro nutrient contents, particularly nitrogen (N), phosphorus (P_2O_5), and potassium (K), is essential to determine the quality of organic fertilizers. These nutrients play a vital role in supporting plant growth and improving soil fertility.

3.1. Macronutrient contents (N, P_2O_5, and K) of organic fertilizers

Table 2 presents the concentrations of N, P_2O_5, and K in the different treatments of organic fertilizer formulations compared with the minimum requirements set by the Indonesian National Standard (SNI 19-7030-2004).

Table 2. Macro nutrient content (N, P, K) of fertilizer treatments compared with sni standard.

Treatment	Nitrogen (N, %)	Phosphorus (P_2O_5, %)	Potassium (K, %)
P0 (100% Layer Chicken Manure(LCM)	0.85 ± 0.27^{a}	0.21 ± 0.28^{a}	0.48 ± 0.16^{a}
P1 (50% LCM + Coffee husk)	2.47 ± 0.28^{b}	0.22 ± 0.11^{a}	0.76 ± 0.06^{b}
P2 (50% LCM + Banana peel)	1.43 ± 0.21^{b}	0.22 ± 0.13^{a}	0.44 ± 0.08^{a}
P3 (50% LCM + Rice husk ash)	1.06 ± 0.24^{b}	0.23 ± 0.24^{a}	0.42 ± 0.08^{a}

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SNI 19-7030-2004 Minimum Standard	N ≥ 0.40	P ≥ 0.10	K ≥ 0.20

Note: Different superscripts in the same row indicate a significant difference ($p<0.05$)

3.2. The effect of adding organic waste materials on the nitrogen content of organic fertilizer

From Table 2, it can be seen that the nitrogen content of organic fertilizer from various organic material additions shows a significant difference ($P<0.05$). All treatments produced nitrogen levels that met the requirements set by SNI-19-7030-2004, which stipulates a minimum nitrogen content of 0.4%. The highest nitrogen content was observed in P1, which consisted of 50% chicken manure and 50% coffee husk, reaching 2.47%. This result indicates that the combination of chicken manure and coffee husk can synergistically enhance nitrogen enrichment in compost.

The increase in nitrogen content in P1 is mainly attributed to the high nitrogen levels in chicken manure, primarily in the form of uric acid, urea, and protein. Coffee husks also contribute protein and other nitrogenous compounds that serve as additional nitrogen sources during composting. These raw materials stimulate microbial activity, thereby accelerating organic matter decomposition and nitrogen mineralization. According to Xie et al. (2023), nitrogen content in compost is strongly influenced by microbial activity, where the availability of degradable substrates enhances nitrification and nitrogen accumulation. Similarly, Jara- Samaniego, et al. (2017) reported that the co-composting of animal manure with agro-industrial residues increases total nitrogen content due to a more balanced C/N ratio and improved microbial metabolism.

This study confirms those findings, as shown by the Duncan test results, where the addition of 50% coffee husk (P1) significantly enhanced the composting process, yielding a nitrogen content of 2.47%, which was markedly higher than banana peel addition (P2 = 1.43%) and rice husk ash addition (P3 = 1.06%). These results suggest that coffee husk is a superior additive for improving nitrogen content in organic fertilizers compared to other tested materials.

3.3. The effect of adding organic waste materials on the phosphorus content of organic fertilizer

The phosphorus content of the organic fertilizer in this study showed no significant differences ($P>0.05$) across the various additions of organic waste material (Table 1). Nevertheless, the average phosphorus content obtained still met the requirement set by SNI-19-7030-2004, which stipulates a minimum phosphorus content of 0.1%. This finding indicates that although the treatments improved nitrogen and potassium levels, phosphorus enrichment was less responsive to the addition of different organic wastes.

The lack of significant differences may be related to the compost fermentation process not yet reaching full maturity, as phosphorus mineralization generally occurs at later stages of decomposition. Incomplete composting could reduce phosphorus solubility and limit its availability. Another factor is the influence of pH and temperature conditions. According to Yanqoritha (2023), phosphorus solubility is highly dependent on pH, with optimum availability occurring between 6 and 7. In general soil chemistry, when pH drops below 6, phosphorus may bind with Fe and Al oxides, and when pH exceeds 7.5, it tends to bind with Ca compounds, reducing its availability to plants. Although Fe, Al, and Ca were not analyzed in this study, these interactions are widely recognized in compost and soil systems (Daryono & Alkas, 2017).

Additionally, phosphorus in microbial biomass may not have been evenly mineralized or redistributed in the composting mixture, leading to relatively low or stable phosphorus levels across treatments. Daryono and Alkas (2017) also emphasized that phosphorus availability in organic fertilizer is often limited by the decomposition of organic phosphorus and its conversion into inorganic forms that bind with poorly soluble elements in water. These mechanisms may explain why the phosphorus content in all treatments was relatively low and not significantly different, despite using different organic waste additives.

This finding is consistent with previous studies showing that phosphorus stability during composting is strongly influenced by environmental conditions and the chemical interactions of phosphorus with other minerals (Cortés et al., 2021). Therefore, strategies such as adjusting composting duration, optimizing pH, or adding phosphate-solubilizing microorganisms could be considered to enhance phosphorus availability in future formulations.

3.4. The effect of adding organic waste materials on the potassium content of organic fertilizer

The potassium (K) content of the organic fertilizer in this study showed significant differences ($P<0.05$) among treatments (Table 2). All treatments exceeded the minimum requirement set by SNI-19-7030-2004 (≥0.20%). The highest potassium content was observed in P1 (50% chicken manure + 50% coffee husk), reaching 0.76%, which was significantly higher compared to the other treatments. In contrast, P0 (100% chicken manure), P2 (50%

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chicken manure + 50% banana peel), and P3 (50% chicken manure + 50% rice husk ash) produced relatively similar lower potassium levels, ranging from 0.42% to 0.48%.

The superior potassium enrichment in P1 is likely attributed to the presence of coffee husks, which are known to contain high levels of mineral nutrients, particularly potassium, as reported by Khair et al. (2018). Potassium in coffee husks exists in relatively soluble forms, which facilitates its release during composting. This finding is consistent with earlier studies showing that incorporating agro-industrial by-products such as coffee husk can significantly increase the mineral nutrient content of organic fertilizers (Irfan, et al., 2023).

In contrast, banana peels (P2) also contain potassium, but the decomposition process of banana peel biomass often releases soluble sugars and lignocellulosic compounds that can delay nutrient mineralization (Nguyen et al., 2024). Similarly, the addition of rice husk ash (P3) contributed limited available potassium, since much of the K in rice husk ash is bound in silicate structures, making it less soluble during the composting period (Cortés et al., 2021).

Overall, these results suggest that coffee husk is the most effective additive for enhancing potassium content in composted chicken manure. This agrees with the findings of Xie et al. (2023), who reported that coffee husk compost had improved potassium release and greater nutrient bioavailability compared to other agricultural residues.

3.5. Organic carbon content and C/N ratio of organic fertilizers

Organic carbon content and the C/N ratio are crucial indicators of the maturity and stability of organic fertilizers. Adequate levels of organic carbon ensure the improvement of soil structure and water-holding capacity, while the C/N ratio reflects the balance between carbon and nitrogen during the decomposition process. Table 3 shows the organic carbon content and C/N ratio of the fertilizer treatments compared with the requirements of SNI 19-7030-2004.

Table 3. Organic carbon and C/N ratio of fertilizer treatments compared with SNI standard

Treatment	C-Organic (%)	C/N Ratio
P0 (100% LCM)	24.71 ± 0.39 ^{a}	29.07 ± 2.17 ^{b}
P1 (50% LCM + Coffee husk)	32.19 ± 0.10 ^{b}	13.03 ± 3.84 ^{a}
P2 (50% LCM + Banana peel)	26.95 ± 0.13 ^{a}	18.84 ± 2.96 ^{b}
P3 (50% LCM + Rice husk ash)	25.95 ± 0.30 ^{a}	24.48 ± 1.14 ^{b}
SNI 19-7030-2004 Standard	C-Organic: 9.8–32	C/N: 10–20

Note: Different superscripts in the same row indicate a significant difference ($p<0.05$)

3.6. The effect of adding organic waste materials on the C-organic content of organic fertilizer

The carbon content of the organic fertilizer in this study showed significant differences ($P<0.05$) based on the addition of different organic waste materials (Table 3). Nevertheless, the average carbon content obtained in all treatments still met the quality requirements set by SNI-19-7030-2004, which ranges from 9.8% to 32%. These variations are strongly associated with the chemical composition and degradability of the organic wastes used.

The highest C-organic content was observed in the treatment with the addition of coffee husks (P1 = 32.19%), compared to banana peels (P2 = 26.95%) and rice husk ash (P3 = 25.95%). This can be explained by the fact that coffee husks contain higher amounts of lignin, cellulose, and hemicellulose than banana peels or rice husk ash. Lignin, in particular, is a complex aromatic polymer that is highly resistant to microbial degradation, leading to greater retention of organic carbon in compost (Chan et al., 2024).

On the other hand, rice husk ash primarily consists of silica (SiO_2) and only contains a small proportion of organic matter. Since most of the carbon in rice husks has already been oxidized during the burning process, its contribution to C-organic in compost is significantly lower compared to coffee husks and banana peels. Similarly, banana peels decompose more rapidly due to their high soluble sugar content and lower lignin proportion, which accelerates microbial mineralization and results in reduced carbon retention in the final compost.

These findings are in line with previous studies. Zhang et al. (2022) reported that compost mixtures rich in lignocellulosic materials (such as coffee husk) tend to exhibit higher total carbon content and slower decomposition rates. Meanwhile, Kiss et al. (2023) emphasized that differences in C-organic during composting are primarily driven by substrate quality and the balance between labile and recalcitrant carbon fractions.

In this study, the results confirm that the addition of coffee husk (P1) not only enhanced nitrogen and potassium levels but also contributed to higher C-organic content, indicating its potential as a superior additive for improving both nutrient balance and organic matter retention in composted chicken manure.

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3.7. The effect of adding organic waste materials on the C/N ratio of organic fertilizer

The C/N ratio of the organic fertilizer in this study also showed significant differences ($P<0.05$) among treatments (Table 3). According to SNI-19-7030-2004, the acceptable C/N ratio for organic fertilizers ranges between 10 and 20. In this study, the treatment with coffee husks (P1) had the lowest C/N ratio (13.03), which was within the recommended range. In contrast, the other treatments, particularly P0 (29.07), P2 (18.84), and P3 (24.48), showed higher C/N ratios, with P0 and P3 exceeding the standard threshold.

The relatively low C/N ratio in P1 indicates a more balanced decomposition process, which is attributed to the high nitrogen contribution from chicken manure and the relatively moderate carbon content in coffee husks. This balance facilitates microbial activity, leading to more efficient composting and faster stabilization of organic matter (Kiss et al. 2023). On the other hand, the high C/N ratios in P0 and P3 suggest slower decomposition and insufficient nitrogen mineralization, which may delay compost maturity. The high C/N ratio in P0 (100% chicken manure) is likely due to nitrogen losses during the composting process, such as volatilization of ammonia, while the rice husk ash addition in P3 provided carbon in a more recalcitrant form that was not easily degraded (Zhang et al., 2022).

Banana peel addition (P2) resulted in a C/N ratio of 18.84, which still fell within the acceptable range, although it was higher than P1. This difference may be explained by the high sugar content in banana peels that accelerates microbial activity, but the relatively lower nitrogen availability compared to coffee husks limits further reduction of the C/N ratio.

Overall, these findings highlight that the combination of chicken manure and coffee husks (P1) not only enhanced nitrogen and potassium levels but also optimized the C/N ratio within the ideal range, thereby producing more mature and stable compost. This is consistent with previous studies showing that co-composting animal manure with agro-industrial residues such as coffee husks produces a more favourable C/N ratio compared to other organic wastes (Xie et al., 2023).

The stability and maturity of compost are commonly assessed using organic carbon (C-organic) content and the C/N ratio. In this study, C-organic values ranged from 24.71% (P0) to 32.19% (P1) (Table X), all of which were above the minimum requirement (9.8%) specified in SNI 19-7030-2004. The highest C-organic content was observed in P1 (32.19%), reflecting the greater contribution of carbonaceous material from coffee husk. High C-organic levels indicate that organic matter decomposition was active, contributing to stable carbon fractions during composting.

The C/N ratios showed significant variation among treatments, ranging from 13.03 (P1) to 29.07 (P0). According to SNI 19-7030-2004, the acceptable C/N ratio for mature compost is between 10 and 20. Only P1 and P2, with ratios of 13.03 and 18.84, respectively, met this criterion, indicating their maturity and suitability for agricultural application. By contrast, P0 (29.07) and P3 (24.48) exceeded the recommended threshold, suggesting incomplete decomposition and lower compost maturity.

A lower C/N ratio is typically associated with higher microbial activity and efficient nitrogen mineralization (Cortés et al., 2021). The lowest ratio in P1 confirms its superior maturity level, consistent with its higher temperature and nutrient enrichment observed during composting. These findings agree with previous studies that reported compost maturity and stability are strongly correlated with the reduction of the C/N ratio during humification (Daryono & Alkas, 2017).

Overall, the results demonstrate that while all treatments satisfied the C-organic requirement, only P1 and P2 produced compost that met the maturity standard based on C/N ratio, with P1 being the most effective formulation. This finding is also in line with the favourable pH and macronutrient contents observed in P1, suggesting that the combination of layer chicken manure and coffee husk provides the most balanced composting conditions.

3.8. Moisture content of organic fertilizers

Moisture content is another important parameter in assessing the quality of organic fertilizers, as it influences microbial activity, storage stability, and ease of application. According to SNI 19-7030-2004, the maximum allowable water content for organic fertilizers is 50%. Table 4 presents the water content values of the different treatments compared with this standard.

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Table 4. Water content of fertilizer treatments compared with SNI standard

Treatment	Water Content (%)	SNI 19-7030-2004 Standard
P0 (100% LCM)	38.87 ± 0.47 b	≤ 50%
P1 (50% LCM + Coffee husk)	26.30 ± 1.73 a	
P2 (50% LCM + Banana peel)	36.77 ± 1.29 b	
P3 (50% LCM + Rice husk ash)	37.69 ± 0.45 b	

3.9. The effect of adding organic waste materials on the moisture content of organic fertilizer

The moisture content of the organic fertilizer in this study showed significant differences based on the addition of different organic waste materials. However, the average moisture content obtained still met the Indonesian National Standard (SNI-19-7030-2004) requirement, which sets a maximum limit of 50%. Organic fertilizer with the addition of coffee husks contained coarser fibre and lignin. Lignin is hydrophobic (not easily absorbing water), reducing its capacity to retain moisture in compost. As a result, compost containing coffee husks loses water more quickly than compost containing banana peels or rice husk ash. Additionally, because coffee husks absorb less water than banana peels and rice husk ash, water evaporates more easily during the composting process. Moreover, the rigid and rough structure of coffee husks allows for better air circulation, which accelerates water evaporation and further reduces the moisture content in compost.

On the other hand, banana peels have a high moisture content, around 80-90%, as they consist of fluid-rich tissues. During the composting process, the remaining water from banana peels tends to be retained in the compost, increasing its final moisture content compared to compost with coffee husks. Meanwhile, rice husk ash has high porosity, allowing it to absorb and retain water in compost. This results in higher moisture content in compost with added rice husk ash compared to compost containing coffee husks.

3.10. Physical indicators of compost quality (temperature, pH, and color)

Temperature, pH, and color are important physical indicators that reflect the maturity and quality of compost. An appropriate temperature during composting indicates active microbial activity, while a stable pH within the neutral range (6.5–8.0) is desirable for mature compost. In addition, the dark brown to blackish color is generally used as a visual parameter of compost stability and humification. Table 5 presents the temperature, pH, and compost color of the different treatments compared with commonly accepted reference values.

Table 5. Temperature, pH, and color of compost from different treatments

Treatment	Temperature (°C)	pH (±SD)	Color of Compost	Standard/Reference*
P0 (100% LCM)	38.5 ± 1.2	7.4 ± 0.3	Dark brown	Temperature 40–60 °C (optimum during composting); pH 6.5–8.0 (FAO, 2005)
P1 (50% LCM + Coffee husk)	45.2 ± 1.5	7.0 ± 0.2	Blackish brown	
P2 (50% LCM + Banana peel)	42.8 ± 1.4	6.8 ± 0.2	Brownish black	
P3 (50% LCM + Rice husk ash)	40.6 ± 1.1	7.2 ± 0.2	Dark brown	

The physical characteristics of compost, such as temperature, pH, and color, provide useful insights into the maturity and stability of the final product. As shown in Table 5, the compost temperature ranged from 38.5 °C in P0 to 45.2 °C in P1, with the highest temperature observed in the treatment containing 50%-layer chicken manure and 50% coffee husk (P1). The elevated temperature in P1 indicates more active microbial degradation due to the higher availability of organic matter, particularly nitrogen and carbon substrates, which is consistent with the results of macro nutrient analysis in Table 1 and 2 where P1 exhibited the highest N (2.47%) and C-organic (32.19%). This finding is in line with [FAO, 2005], which suggests that optimum composting occurs at temperatures between 40–60°C.

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The pH values of the compost across treatments ranged between 6.8 and 7.4, which fall within the desirable range for mature compost (6.5–8.0). Specifically, P2 (banana peel mixture) showed a slightly lower pH (6.8), which could be attributed to the release of organic acids during decomposition of fruit residues. Meanwhile, P3 (rice husk ash mixture) had a slightly higher pH (7.2), reflecting the alkalinity contributed by ash materials. These results agree with previous findings that compost pH stabilizes toward neutrality as the organic matter matures and humification progresses (Pancapalaga et al., 2021).

In terms of visual characteristics, all treatments produced compost with a dark brown to blackish color, with the darkest color observed in P1. A darker color is typically associated with the formation of humic substances and is regarded as an indicator of compost maturity and stability (Nguyen et al., 2024). This observation further confirms that the incorporation of coffee husk in P1 improved both the chemical and physical attributes of the compost.

Overall, the results suggest that all treatments produced compost that met acceptable physical quality indicators, with P1 demonstrating superior performance due to its higher temperature during composting, stable neutral pH, and darker coloration, which together indicate more efficient humification and stabilization processes.

4. Conclusion

This study demonstrated that the addition of different organic waste materials significantly affected the nutrient composition and quality of the compost produced from layer chicken manure. Among the treatments, the combination of 50%-layer chicken manure and 50% coffee husk (P1) resulted in the most favorable outcomes, with the highest nitrogen (2.47%) and organic carbon content (32.19%), a C/N ratio of 13.03, which met the SNI 19-7030-2004 maturity standard, and a stable pH of 7.0 within the optimum range (6.5–8.0). Although phosphorus content remained relatively stable across treatments, it still satisfied the minimum requirement of 0.1%, while potassium content was also highest in P1. These results indicate that P1 not only improved compost stability and maturity but also enhanced its macronutrient profile, making it the most effective formulation for producing high-quality organic fertilizer.

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Authors contributions

W.Pancapalaga designed and supervised the study, analyzed the results, and finalized the manuscript. K.Khotimah conducted the composting experiments, collected the data, and contributed to data analysis. M.Umar performed laboratory analyses, prepared the tables, and assisted in manuscript editing. All authors read and approved the final version of the manuscript.

Availability of data and materials

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request. All materials and raw data used in this study are stored at the Department of Animal Science, Universitas Muhammadiyah Malang, Indonesia.

Conflict of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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