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The Effect of Green Phoskko and EM4 Activators on Making Compost Fertilizer from a Mixture of Pineapple Peel Waste and Rabbit Feces Using the Windrow Method

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Abstract: *Composting is an environmentally friendly method of processing organic waste that can produce high-value organic fertilizer. Organic wastes such as pineapple peels and rabbit manure have potential as compost raw materials due to their high organic carbon and nitrogen content. In this study, a ratio of pineapple peel and rabbit manure of 1:1 (wet weight) was used to obtain an appropriate initial C/N ratio. However, an unbalanced C/N ratio requires special treatment to optimize the decomposition process. The purpose of this study was to determine the effect of using the windrow method with the addition of Effective Microorganisms 4 (EM4) and Green Phoskko activators on C-organic content, total nitrogen, and the resulting compost C/N ratio. The research was conducted using an experimental method with a complete randomized design (CRD) consisting of three treatments, namely: no activator (control), addition of EM4, and addition of Green Phoskko. The compost material was arranged in the form of an elongated pile (windrow), turned periodically, and measured temperature, pH, C-organic content, total nitrogen, and C/N ratio every week for 28 days (4 weeks) of the composting process. Laboratory analysis was conducted at Lampung State Polytechnic Laboratory. The results showed that treatment with EM4 produced C-organic content of 17.26%, total nitrogen of 1.63%, and C/N ratio of 10.59, while Green Phoskko produced C-organic content of 16.22%, total nitrogen of 1.45%, and C/N ratio of 11.18, and the control produced C-organic content of 15.64%, total nitrogen of 1.30%, and C/N ratio of 12.03. the compost treated with EM4 and Green Phoskko has met the standards of good compost quality.*

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Introduction

The use of fertilizers in the world continues to increase along with the increase in agricultural area,population growth, land intensification, and agricultural diversification. Continuous use of chemical fertilizers causes soil hardening due to the accumulation of chemical residues.Whichdifficult to decompose, thus reducing soil fertility. Solid organic fertilizers are increasingly used in farming to prevent this degradation (Rohani et al., 2017). Continuous long-term use of organic fertilizers actually has a negative impact on the physical, chemical, and biological properties of the soil, reducing nutrient availability and microbial life. Livestock waste, such as solid rabbit manure (feces), produces approximately 28.0 g/day per head (Sumarni et al., 2020), while pineapple peel waste reaches a large volume from a production of 2,447,243 tons in 2020 (BPS, 2020). This waste is often left untreated, causing increased soil temperature, a decrease in pH to acidic, unpleasant odors, and the growth of bacteria and fungi.

Excessive use of inorganic fertilizers has serious health impacts, such as kidney failure, nausea, vomiting, headaches, dementia, Parkinson's disease, infertility problems, and cancer due to residues in plants (Issue A, 2018). Without treatment, agricultural land loses its ability to produce sustainably, while accumulated pineapple peel waste pollutes the environment and produces a foul odor (Titisari et al., 2020). Processing waste into organic fertilizers, such as rabbit manure rich in N (2.28%), P (2.48%), K (1.88%), and S (0.38%) (Zakiah et al., 2017), is crucial for soil restoration. Windrow composting, an open method with static piles, offers an efficient solution for processing rabbit manure and pineapple peel waste into quality organic fertilizer. This method is cheap, simple, and efficient on a large scale, reducing CH4, CO2, and NO emissions and degrading recalcitrant compounds (Khater, 2015; Hemidat et al., 2018; Sharma, 2021). The specific combination of this waste with windrows has not been widely explored, although the process is influenced by temperature, humidity, and manual aeration (Purwaningrum & Kusbiantoro, 2021; Couth & Trois, 2012).

Although windrow composting is efficient, information on its negative impacts—such as excessive temperature increases or reliance on green waste—is limited (Sholokhova et al., 2023; Zhu-Barker et al., 2016). There have been no in-depth studies integrating rabbit manure and pineapple peels as a fertilizer for mustard greens, particularly in improving soils damaged by chemical fertilizers. This study fills this gap by testing the effectiveness of windrow composting for sustainable production.The problem formulation in this study is: 1) How does the Green Phoskko and EM4 activator affect the mixture of pineapple peel waste and rabbit manure in making compost on Nitrogen, C-Organic, C/N ratio, Temperature, and pH? 2. From the mixture of Green Phoskko and EM4 activators, which one gives the best results in the composting process using the windrow method in making compost?

Research Methods

Types of research

This research is a true experiment to determine the effect of composting on Nitrogen, Organic C, C/N ratio, Temperature, and pH in making organic compost fertilizer from pineapple peel raw materials with the addition of raw materials, namely rabbit feces using green phoskko and EM4

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activators.

Place and Time of Research

This research was conducted on May 14, 2025 to June 11, 2025 at Jl. Cleanliness Gg. Nurul Hidayah No. 2, Gedong Air, Bandar Lampung City. Pineapple peel samples were taken at Jl. Pisang Pasir Gintung, Tanjung Karang Pusat District, Bandar Lampung City, while rabbit feces samples were taken at Jl. Iman Bonjol No. 35, Langkapura Bari, Bandar Lampung City and sample testing was carried out at the Polinela Analysis Laboratory.

Tools and Materials for Making Compost Using the Windrow Method

InThe process of making compost using the windrow method requires prior preparation of the tools, materials, and ingredients used in the activity. The tools and materials used are:

1. Land.
2. 9 kg of pineapple peel waste.
3. 9 kg of rabbit feces waste.
4. 1 bottle of Em4 dissolved in 5 liters of water.
5. 1 box of green phoskko.
6. 3-6 sacks to line the compost before putting it in the hole.
7. 1 Box of plastic gloves and masks.
8. 2 Knives for chopping rubbish.
9. 1 Roll the raffia string.
10. 7 m UV Plastic.
11. 1 Hanging scale.
12. 1 pH and temperature measuring tool.
13. 3 Plastic bottles.
14. 1 Beaker.

Research methods

The research methods used in this experiment are:

1. This experiment uses the windrow method and aerobic process.
2. Sampling was carried out with 1 repetition.
3. Using 3 (three) treatments with aerobic media using the windrow method with the addition of green phoskko and Em4 activators. The following is the application of the compost:
   a. Pineapple peel (3 kg) and Rabbit droppings (3 kg).
   b. Pineapple peel (3 kg) and Rabbit droppings (3 kg) + Green Phoskko (12 ml).
   c. Pineapple peel (3 kg) and rabbit droppings (3 kg) + EM4 (12 ml).
4. The sampling times were days 0, 7, 14, 21, and 28.

Results and Discussion

Experimental Conditions Conducted

The conditions in this experiment or research consist of 3 treatments with an aerobic process using the windrow method as a medium for making compost with the addition of EM4 and Green Phoskko to reduce the C/N ratio, namely:

1. Treatment 1: Pineapple Peel (3 kg) and Rabbit Dung (3 kg).
2. Treatment 2:Pineapple peel (3 kg) and Rabbit Manure (3 kg) + Green Phoskko (12 Ml).
3. Treatment 3:Pineapple peel (3 kg) and Rabbit Manure (3 kg) + EM4 (12 Ml).

Comparison of Nitrogen Levels from 3 Treatments

Sampling in this study was conducted on days 0, 7, 14, 21, and 28, while the levels of

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N, C-Organic, C/N Ratio are the levels tested in the composting of pineapple peel and rabbit feces. The following table and graph compares the nitrogen levels of the three treatments:

Table 1.Comparison of Nitrogen Levels from 3 Treatments

Day/ Time	Comparison of Nitrogen Levels from 3 Treatments		
	Treatment I Control tank (%)	Treatment II Green Phoskko (%)	Treatment III EM4 (%)
0	1.15	1.15	1.15
7	1.23	1.38	1.42
14	1.68	1.83	1.97
21	1.89	2.05	2.13
28	1.99	2.25	2.36

Source: Personal Data, 2025.

The table above shows changes in nitrogen levels in compost treated with different treatments, namely the Control Tank (without additional activator), Green Phoskko, and EM4, during the 28-day composting process. The results show that each treatment experienced different fluctuations in nitrogen levels, which were influenced by the activity of microorganisms and biochemical processes during composting. The use of the windrow method in this study had a positive effect on the process of increasing nitrogen levels. The windrow system facilitates air circulation, maintains optimal humidity, and allows for regular material turning, thus supporting the growth of aerobic microorganisms that play an active role in the decomposition process. This advantage accelerates the nitrogen mineralization process, especially in treatments given EM4 and Green Phoskko activators, as indicated by the increase in nitrogen levels every week. (Bernal, MP, Alburquerque, JA, & Moral, R, 2009).

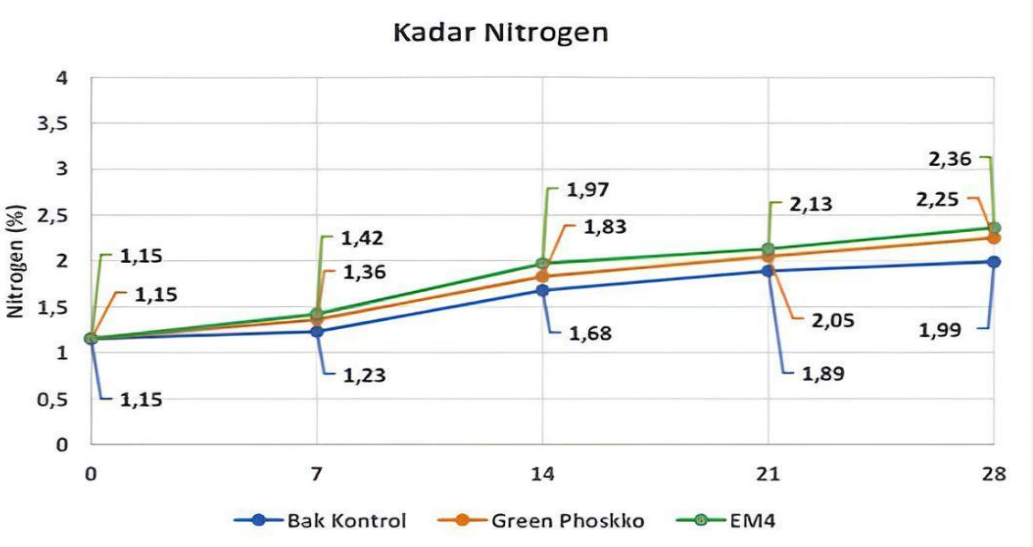

Figure 1. Comparison graph of nitrogen levels

DuringDuring the composting process, the nitrogen content in the Control Tank increased slowly from 1.15% to 1.99%. This occurred because the decomposition process was only supported by natural microorganisms already present in the material, without any additional activators, so the mineralization process was slower. In the initial stage (first week), microbial growth was still slow due to adaptation to the material and suboptimal aeration and temperature conditions. Meanwhile, in the second to fourth weeks, there was a gradual increase

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as more organic material decomposed into available nitrogen forms. However, this increase rate remained lower than the treatment using activators, because there was no acceleration in microbial activity or induced oxygen distribution (Zhou et al., 2023).

In the Green Phoskko treatment, nitrogen levels increased significantly from 1.15% to approximately 2.25% by the end of the period. This occurred because Green Phoskko contained microorganisms and additional nutrients that accelerated the decomposition of organic matter in the form of proteins and complex carbon polymers from the outset. Weekly turning also increased air circulation and even nutrient distribution, thus encouraging the production of ammonium and nitrate through the mineralization process. In the first to second weeks, this acceleration was most pronounced, while in the third and fourth weeks, the increase slowed as most of the organic matter had decomposed and microbial activity began to decline (Adhikari et al., 2009).

Meanwhile, treatment with EM4 resulted in the highest increase in nitrogen content, from 1.15% to 2.36%. This superiority is due to EM4 containing various fermentative microbes such as Lactobacillus, yeast, and Actinomycetes, which are highly efficient in decomposing complex organic compounds from the beginning of the process. Environmental conditions remain stable with regular turning and aeration, allowing the EM4 microbes to continue working optimally throughout the composting period. This fermentative activity accelerates the conversion of proteins and complex nitrogen compounds into mineral forms such as ammonium and nitrate, and maintains nitrogen retention until the end. These results align with research suggesting that the addition of specific microbial inoculants can minimize nitrogen loss and increase total N accumulation in compost (Zhou et al., 2023).

4.2 Comparison of Organic C Contents of 3 Treatments

Sampling in this study was carried out on days 0, 7, 14, 21, and 28.whereasThe N, C-Organic, and C/N ratio levels are tested in the composting of pineapple peel and rabbit feces. The following table and graph compare the C-Organic levels of the three treatments:

Table 2.Comparison of Organic C Contents of 3 Treatments

Day/ Time	Comparison of Organic C Contents of 3 Treatments		
	Treatment I Control tank (%)	Treatment II Green Phoskko (%)	Treatment III EM4 (%)
0	45.00	45.00	45.00
7	35.01	33.22	30.15
14	29.31	27.17	24.93
21	23.14	20.02	18.53
28	21.09	17.23	15.00

Source: Personal Data, 2025.

The table above shows changes in C-Organic levels in compost given different treatments, namely Control Tank (without additional activator), Green Phoskko, and EM4, during the composting process for 28 days. The results show that each treatment experienced different fluctuations in C-Organic levels, which were influenced by the activity of microorganisms during composting. The windrow method was also able to accelerate the reduction in C-organic levels due to regular turning that maintained oxygen circulation, so that aerobic microorganisms could work more optimally in decomposing complex carbon

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compounds (Zhou, M. et al, 2023).

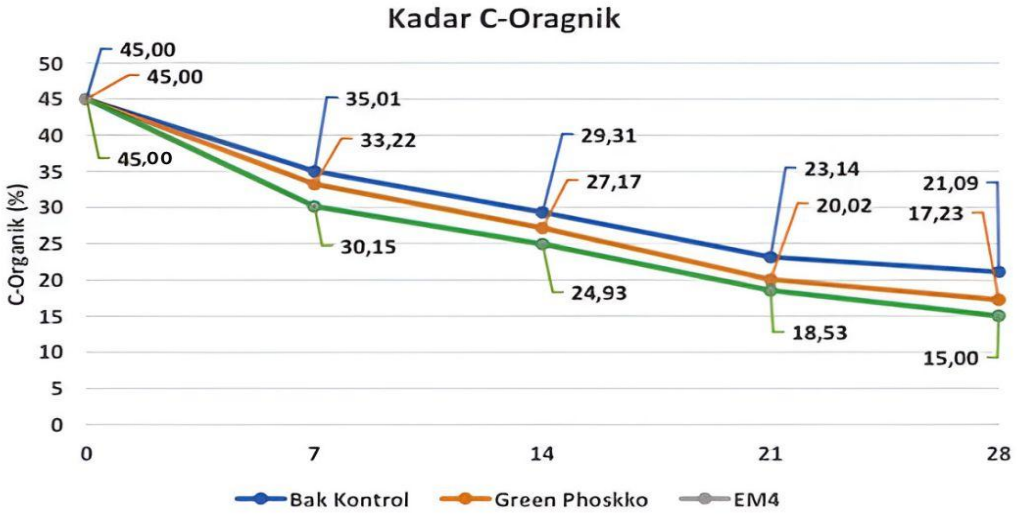

Figure 2. Comparison Graph of Organic C Content

The C-Organic content decreased gradually from 45.00% to 21.09% over 28 days, which indicates that the decomposition process of complex carbon compounds such as lignin, hemicellulose, and cellulose takes place naturally but slowly because it only relies on indigenous (natural) microorganisms without the help of activators or the addition of inoculants; this condition causes the release of carbon in the form of CO_2 gas to occur more slowly and stably, with the greatest decrease in the first and second weeks when the microbes begin to work actively gradually (Utomo, 2019).

In the Green Phoskko treatment, it showed a faster decrease in C-Organic levels, namely from 45.00% to 17.23%, caused by the presence of additional microorganisms such as decomposing bacteria and fungi from the Green Phoskko activator which helped accelerate the degradation of organic compounds into simple compounds such as amino acids, alcohols, and CO_2; coupled with routine turning in the windrow method, oxygen distribution increased so that microbial respiration took place more intensely, especially in the second and third weeks, while in the last week the decrease slowed down because most of the easily decomposed materials had been used up (Marliani, 2015).

Meanwhile, the C-Organic content in the EM4 treatment decreased most drastically from 45.00% to 15.00% because EM4 contains various fermentative microbes such as Lactobacillus, Streptomyces, and Actinomycetes which are very active in decomposing complex organic compounds since the first week, accelerating the conversion of materials into CO_2 and water; temperature and oxygen stability due to regular stirring in the windrow method also maintains the dominance of microorganisms during the process, so that the rate of carbon decomposition remains high and the final results show that the compost has matured with a very low carbon content (Irmanto & Suyata, 2022).

Comparison of C/N Ratio Levels of 3 Treatments

Sampling in this study was conducted on days 0, 7, 14, 21, and 28, while the levels of N, C-Organic, C/N Ratio are the levels tested in the composting of pineapple peel and rabbit feces. The following table and graph compare the C/N ratio levels of the three treatments:

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Table 3.Comparison of C/N Ratio Levels of 3 Treatments

Day/ Time	Comparison of C/N Ratio Levels of 3 Treatments		
	Treatment I Control tank (%)	**Treatment II Green Phoskko (%)**	**Treatment III EM4 (%)**
0	25.00	25.00	25.00
7	24.88	18.92	19.54
14	23.61	14.53	15.67
21	21.93	12.38	13.22
28	19.75	11.84	11.53

The table above shows changes in the C/N ratio levels in compost treated with different treatments, namely the Control Tank (without additional activator), Green Phoskko, and EM4, during the composting process for 28 days. The results show that each treatment experienced fluctuations in different C/N ratio levels, which were influenced by the activity of microorganisms during composting. The decrease in the C/N ratio decreased significantly throughout the windrow composting process, indicating that this method is effective in accelerating the decomposition of organic matter and stabilizing compost (Nur Fatin Mat Saad et al., 2014)

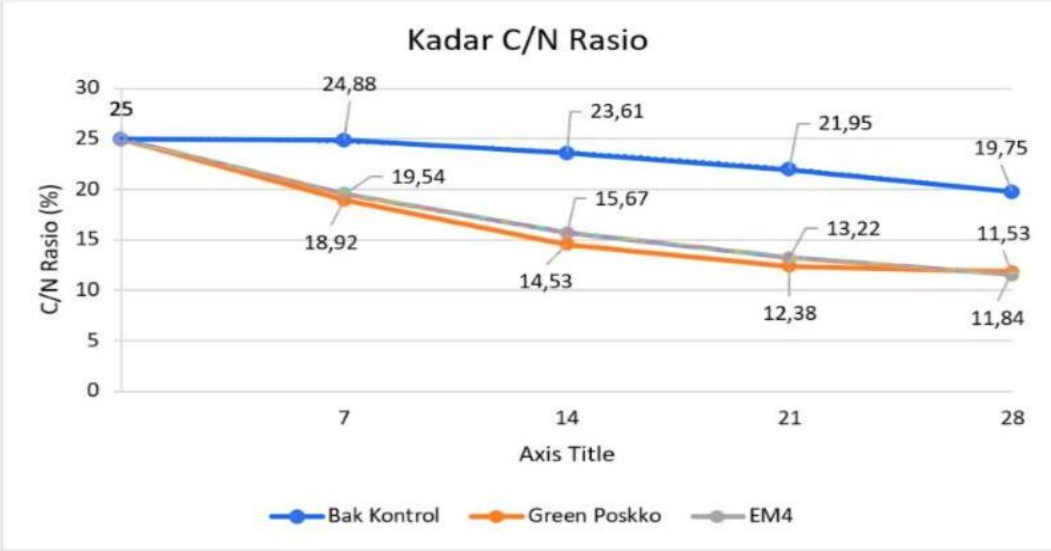

Figure 3. Comparison Graph of C/N Ratio Content

The decrease in the C/N ratio from 25.00% to 14.31% in the control tank treatment indicatesthatThe decomposition process of organic materials takes place gradually because it only involves natural microorganisms, so that the conversion of carbon to CO_2 and the increase in nitrogen levels takes place more slowly without the help of activators, with microbial activity increasing slowly starting from the second week (Utomo, 2019).

In the reduction of the C/N ratio from 25.00% to 11.84% in the Green Phoskko treatmentshowHigh decomposition efficiency because Green Phoskko contains microorganisms and additional nutrients that accelerate organic carbon degradation while supporting nitrogen mineralization; regular turning also maintains oxygen circulation which helps microbes work more optimally during the process, especially in the 2nd and 3rd weeks (Marliani, 2015).

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Meanwhile, the C/N ratio in the EM4 treatment decreased most significantly from 25.00% to 11.53%, because active fermentative microorganisms such as Lactobacillus and Actinomycetes in EM4 accelerated carbon decomposition while supporting the release of nitrogen, whichcauseThe smaller the C and N ratio, this indicates high compost maturity and optimal biological stability approaching the 28th day (Irmanto & Suyata, 2022). According to Enri Damanhuri, the C/N ratio of the soil ranges from (10-12).

Obtainedthe results of the reduction are as follows, In the control treatment, the C/N ratio decreased by (0.48%) from day to day.-0 to day-7, then decreased by (5.37%) from day to day-7 to-14, amounting to (7.66%) from day to day-14 to-21, and (11.03%) from day to day-21 to-28. In the Green Phoskko treatment, a decrease occurred of (32.13%) from day to day.-0 to day-7, then (30.21%) from day to day-7 to-14, (17.36%) from day to day-14 to-21, and (4.56%) from day to day-21 to-28. Meanwhile, in the EM4 treatment, a decrease in the C/N ratio was recorded at (27.94%) from day to day.-0 to day-7, (24.69%) from day to day-7 to-14, (118.53%) from day to day-14 to-21, and (14.65%) from day to day-21 to-28. Based on these data, EM4 treatmentshowThe most stable and consistent decrease in the C/N ratio, while Green Phoskko showed the largest decrease in the first week. This indicates that the addition of the activator can accelerate the decomposition process compared to the control treatment.

Temperature Comparison of 3 Treatments

RetrievalThe samples in this study were taken on days 0, 7, 14, 21, and 28, while the levels of N, C-Organic, C/N Ratio, Temperature and pH were tested in the production of pineapple peel and rabbit feces compost. The following is a table and graph comparing the temperatures of the three treatments:

Table 4. Comparison of Temperature Levels of 3 Treatments

Day/ Time	Temperature Comparison of 3 Treatments		
	Treatment I Control tank (°C)	**Treatment II Green Phoskko (**°C)	**Treatment III EM4 (**°C)
0	34	34	34
7	31	32	31
14	33	33	31
21	33	33	31
28	29	29	28

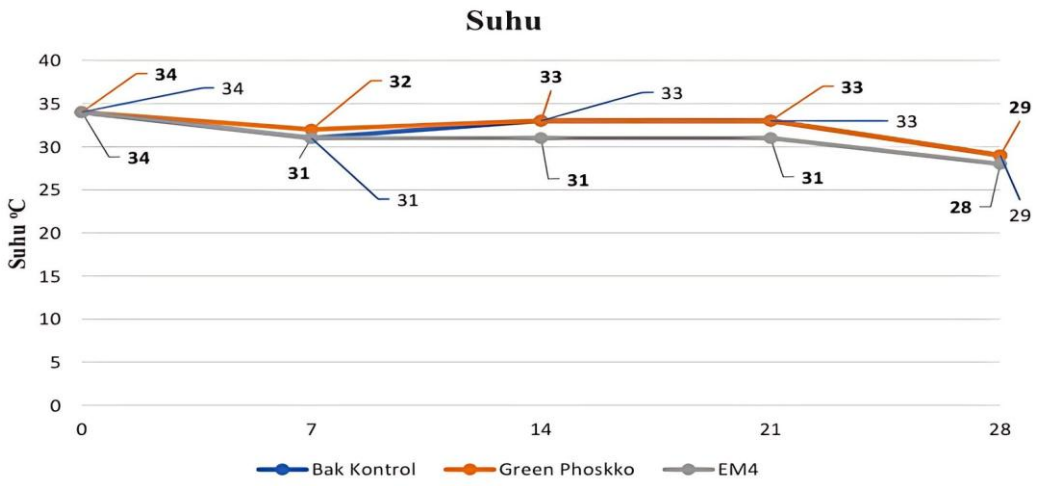

Figure 4. Temperature Comparison Graph

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The temperature in the control tank decreased from 34°C to 29°C over 28 days. This decrease occurred gradually because the decomposition process proceeded naturally without the aid of an activator, thuspeakThe biological temperature was not too high and stabilized quickly. Temperatures rose on days 14 and 21 due to increased natural microbial activity, but a decrease on day 28 indicated that the organic material had largely degraded and the composting process had entered the cooling phase. Without an activator, temperature stability was more influenced by the material and natural ventilation than by treatments with active microbes (Bernal et al., 2009).

TemperaturedecreaseThe temperature fluctuated from 34°C to 29°C with small but stable fluctuations. This indicates that the Green Phoskko activator helps increase microbial activity early on, generating heat from respiration. The temperature stability from day 14 to 21 at 33°C indicates that the decomposition process is active and under control. The decrease at the end of composting indicates that the organic matter is beginning to be depleted and the compost is beginning to mature biologically. This process is in accordance with the characteristics of good aerobic composting (Marliani, 2015).

The EM4 treatment showed the most significant temperature decrease, from 34°C to 28°C. This decrease occurred because EM4 contains active fermentative microbes that accelerate decomposition from the early days. The temperature remained stable at 31°C from days 7 to 21, indicating that the decomposition process was intense and consistent.becomeA temperature of 28°C on the 28th day indicates that the thermophilic phase has passed, and microbial activity decreases as organic matter decreases. This temperature corresponds to the characteristics of mature and biologically stable compost (Irmanto & Suyata, 2022).

The windrow method increases oxygen circulation through regular turning, so that the compost temperature rises to the optimal zone (30–40 °C) and remains stable during the decomposition process, then decreases as the organic material begins to run out (Bernal et al., 2009).

Comparison of pH of 3 Treatments

Sampling in this study was carried out on days 0, 7, 14, 21, and 28, whilelevelN, C-Organic, C/N Ratio are the levels tested in making pineapple peel and rabbit feces compost. The following is a table and graph comparing the pH of the 3 treatments:

Table1. Comparison of pH Levels of 3 Treatments

Day/ Time	Comparison of pH of 3 Treatments		
	Treatment I Control tank	Treatment II Green Phoskko	Treatment III EM4
0	7	7	7
7	7	7	7
14	7	6.5	6.5
21	7	7	7
28	7	7	7

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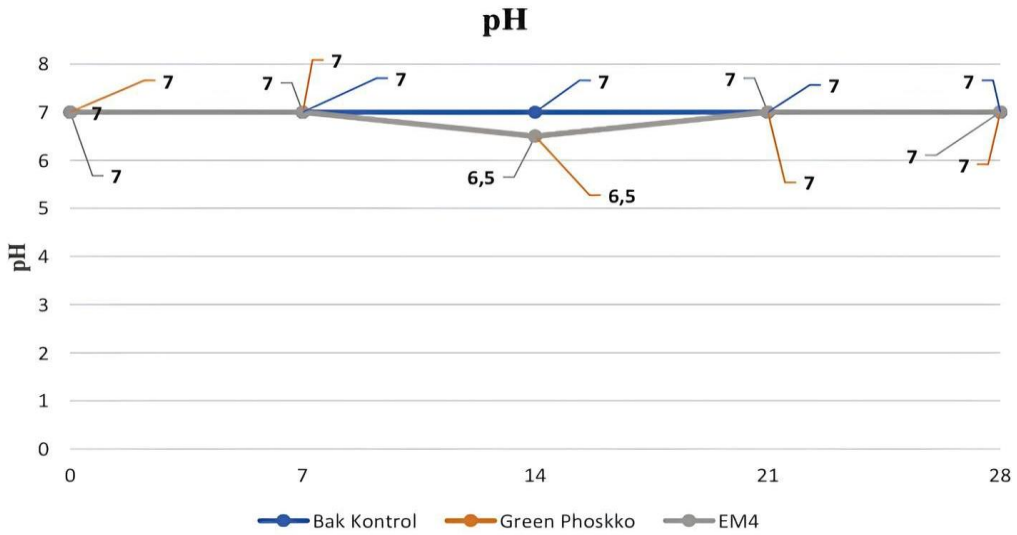

Picture1. pH Comparison Chart

The control tank maintained a stable pH of 7 for 28 days. This stability indicates that the decomposition process proceeded naturally without significant production.compoundacid or base during composting. The absence of a decrease or increase in pH reflects that microbial activity in this process does not produce enough acidic or alkaline metabolites to affect pH, which is common in systems without activators (Bernal et al., 2009). In the Green Phoskko treatment, the initial neutral pH of 7 decreased to 6.5 on the 14th day, thenreturnrose to 7. This decrease in pH is caused by increased microbial activity during the active phase of decomposition, which produces acidic compounds such as organic acids and amino acids as intermediate products. However, the pH then returns to neutral as these acidic compounds begin to break down and are neutralized by other microbes or absorbed into the compost structure. This indicates that the compost has entered the stabilization phase (Marliani, 2015).

The pH in the EM4 treatment also decreased from 7 to 6.5 on the 14th day, before returning to neutral. This decrease indicates high fermentative activity from microorganisms such as Lactobacillus and yeast in EM4, which produce acidic compounds, especially in the early stages of decomposition. Afterward, as organic matter decreases and microbial activity progresses toward the final phase, these acidic compounds are naturally neutralized, returning the pH to 7, indicating compost maturity and stability (Hendriani et al., 2021). Aeration in the windrow method accelerates the decomposition of acidic compounds, so that the initial pH, which had decreased, quickly returns to neutral, reflecting compost maturity and stability (Zbytniewski & Buszewski, 2005).

Conclusion and Recommendation

Based on the results of research on the effect of using Green Phoskko and EM4 activators on the composting process of pineapple peel waste and rabbit feces using the windrow method, it can be concluded that the addition of both activators is able to produce compost with quality that meets quality standards compared to treatments without activators. Although Green Phoskko and EM4 are both effective in accelerating the composting process, the use of EM4 shows more optimal performance, as indicated by a lower C/N ratio and better decomposition efficiency of organic matter. EM4 treatment produces compost with a higher nitrogen content, lower C-organic content, and a C/N ratio indicating that the compost is mature

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and ready to use. Overall, the use of EM4 and Green Phoskko activators has been proven to accelerate the reduction of C-organic content and C/N ratio and increase nitrogen content, thereby increasing the effectiveness and efficiency of the composting process of pineapple peel waste and rabbit feces using the windrow method.

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