JURNAL KESEHATAN LINGKUNGAN
JURNAL DAN APLIKASI TEKNIK KESEHATAN LINGKUNGAN

ISSN 1829-9407 (Print)
ISSN 2581-0898 (Online)

Volume 22, No. 2, July 2025 ; Page: 257-264; *DOI: https://doi.org/10.31964/jkl.v21i2.993*

OPTIMIZATION OF COMPOST MATURITY FROM FRUIT WASTE WITH THE ADDITION OF RUMEN WASTE AND LEACHATE BIOACTIVATORS

Sri Anum Sari, M. Izzuddin, Budiyanti Mulyaningsih
Ministry Of Health Polytechnic Banjarmasin Environmental Health Department
Jl. H. Mistar Cokrokusumo No. 1A, Sungai Besar Subdistrict, Banjarbaru, South Kalimantan, Indonesia
E-mail: hanumkl.18@gmail.com

Article Info

Article history:

Received November 15, 2024
Revised August 11, 2025
Accepted August 31, 2025

Keywords:

Bioactivator
Leachate
Compost
Organic Waste
Rumen Waste

ABSTRACT

Optimization Of Compost Maturity From Fruit Waste With The Addition of Rumen Waste and Leachate Bioactivators. *Fruit waste generated by vendors in Banjarbaru City has the potential to pollute the environment if not properly managed. One alternative management approach is processing it into compost with the addition of bioactivators. This study aimed to optimize the compost maturation process through the addition of rumen waste and leachate bioactivators. The research was conducted using an experimental design with 12 kg of fruit waste treated with varying doses of rumen waste and leachate bioactivators. The observed parameters included temperature, pH, moisture content, and compost quality based on organic carbon, nitrogen, phosphorus, and potassium content, in accordance with the Indonesian National Standard (SNI 19-7030-2004). The results showed that the combination of 0.5 kg of rumen waste and 1.5 liters of leachate (D2) provided optimal temperature, pH, and moisture conditions to accelerate compost maturation and produced compost with characteristics that met the standard. In conclusion, this combination was effective in accelerating decomposition and improving compost quality, although further studies are needed regarding nutrient content analysis and the development of a more efficient composter design.*

INTRODUCTION

Banjarbaru City is one of the regions with high fruit trading activities, generating substantial amounts of organic waste. Fruit waste is a type of organic waste with significant potential to be processed into compost[1]. The natural composting process usually requires a relatively long time, ranging from 2–6 months, and may even exceed six months depending on environmental conditions. To accelerate this process, the use of bioactivators has become an effective strategy[2].

A bioactivator is a microorganism that can be applied to accelerate the decomposition of organic waste or directly to soil to enhance soil fertility[3]. Compost resulting from decomposition serves as a nutrient source for plants, improves soil structure, reduces clay soil compaction, increases water retention in sandy soils, and maintains ecosystem balance by providing food for soil microorganisms[4]. Thus, accelerating the composting process through bioactivators not only reduces the volume of organic waste but also produces a valuable end product.

The use of bioactivators such as local microorganisms (MOL), EM4, biochar, and other microbial combinations has been shown to consistently accelerate the decomposition of organic materials. The addition of bioactivators enhances microbial activity, accelerates the reduction of the C/N ratio, and speeds up compost maturation compared to composting without bioactivators[5]. One potential locally available bioactivator is rumen content from cattle, which is a by-product of slaughterhouses. Cattle rumen is rich in microorganisms that help break down complex compounds. Various studies have isolated beneficial bacteria from cattle rumen, including cellulolytic, amylolytic, and proteolytic strains[6].

As an organic fertilizer, cattle rumen fluid contains beneficial microorganisms and enzymes that accelerate decomposition and enhance nutrient content[7]. Previous studies have also shown that cattle manure can rapidly decompose in biogas production systems due to the active microorganisms present in the digestive system, indicating its high potential as a bioactivator[8]. In addition, leachate from landfill sites also has potential as a bioactivator because it contains dissolved organic matter, microorganisms, and nutrients that support composting activity[9]. The combination of rumen and leachate is suitable for testing because the two components complement each other: rumen serves as a source of active decomposer microbes, while leachate provides nutrients to support microbial growth and activity[9]. This combination is expected to create more optimal environmental conditions for microorganisms, thereby accelerating decomposition and improving compost quality.

Previous studies have demonstrated that bioactivator use can enhance organic soil quality by improving its chemical, physical, and microbiological properties[10]. For instance, cattle rumen has been proven effective in accelerating the decomposition of vegetable waste[11], whereas leachate is known to enhance microbial activity in organic waste degradation[9]. However, studies integrating both rumen and leachate remain very limited, even though conceptually, the combination of rumen as a microbial inoculum source and leachate as a nutrient source may produce a synergistic effect superior to single use.

Based on this rationale, this study was conducted to evaluate the effectiveness of adding bioactivators in the form of cattle rumen and leachate, both individually and in combination, on the composting process of fruit waste. In addition, the study assessed the quality of the resulting compost according to the Indonesian National Standard (SNI 19-7030-2004), with the aim of contributing to the development of more efficient, faster organic waste management methods that produce compost meeting quality standards.

MATERIALS AND RESEARCH METHODS

This study was conducted at the Chemistry Laboratory and Workshop of the Department of Environmental Health, Poltekkes Kemenkes Banjarmasin. The primary material used was pineapple peel, totaling 12 kg for each treatment, while the additives included cattle rumen waste obtained from a slaughterhouse and leachate from the Banjarbakula Regional Landfill. All materials were placed in laboratory-scale composters, which were designed by the Center for Housing Research and Development, Balitbang PU. The equipment used in this study included a digital thermometer for temperature measurement, a pH meter, and a digital scale.

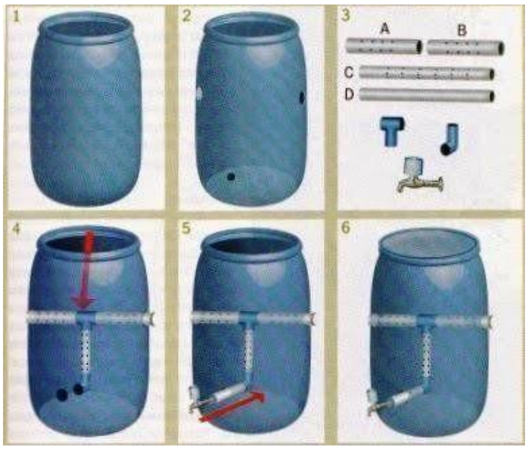
Figure 1. Composter Design

The study was designed with seven treatment variations, including a control without the addition of bioactivators. The combinations of cattle rumen waste and leachate bioactivator doses used are presented in Table 1.

Table 1. Bioactivator Treatment Variations

Treatment	Fruit Waste (kg)	Cattle Rumen (kg	Leachate (L)
Control	12	0	0
D1	12	1	1
D2	12	0,5	1,5
D3	12	1,5	0,5
D4	12	0,5	0,5
D5	12	1	0
D6	12	0	1

The composting process was carried out over a period of 30 days. Pineapple peels obtained from fruit vendors in Banjarbaru City were first shredded to facilitate decomposition, then mixed with bioactivators according to the doses specified for each treatment and placed into the composters. During the composting period, parameters including temperature, pH, and moisture content were recorded daily to monitor the dynamics of changes in compost conditions.
At the end of the composting period, compost quality was assessed based on the Indonesian National Standard (SNI 19-7030-2004), which includes measurements of organic carbon, nitrogen, phosphorus, and potassium content to evaluate compost maturity and suitability. This study was exploratory in nature and did not employ formal replication; however, each parameter measurement was conducted in triplicate to obtain average values as final data. The data were analyzed descriptively, presenting trends in temperature, pH, and moisture content changes, and comparing the final compost quality with the criteria specified in SNI 19-7030-2004.

RESEARCH RESULTS AND DISCUSSION

This section presents the observations of the main parameters during the composting process, namely temperature, pH, and moisture content, as well as the analysis of the final compost quality in comparison with the Indonesian National Standard (SNI 19-7030-2004). The research data are organized in tables and graphs to facilitate interpretation. Each parameter was analyzed based on the pattern of changes occurring in each treatment, including the control and treatments with the addition of bioactivators.

Temperature

Temperature is one of the key indicators in the composting process because it reflects microbial activity in the degradation of organic materials[12]. Temperature changes in each treatment were observed periodically over the 30-day composting period to identify the main phases of decomposition.

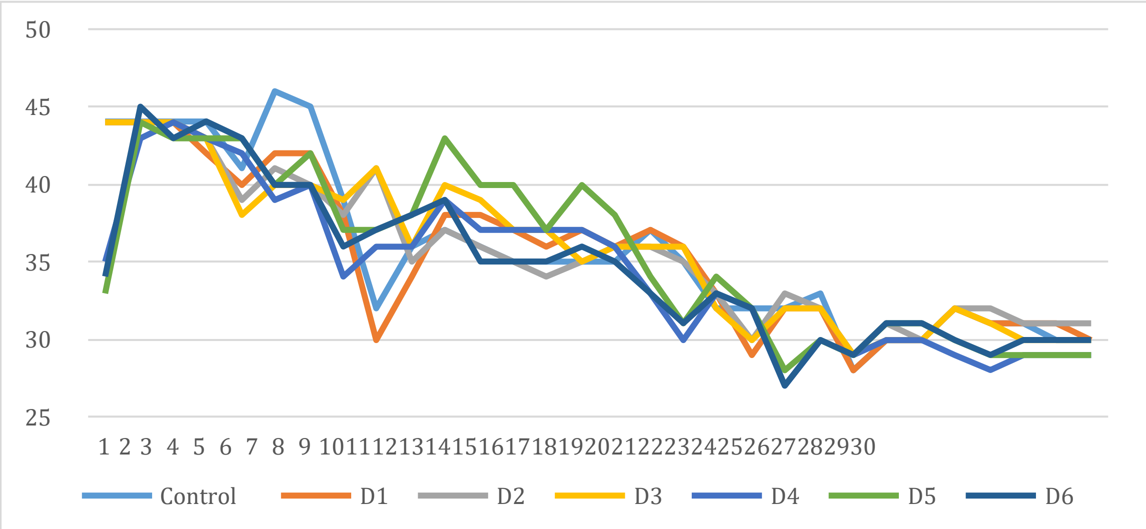

Figure 1. Temperature Changes During Measurement

During the initial phase of composting (day 1 to day 3), all treatments exhibited a sharp increase in temperature, reaching the range of 42–44°C. This surge marks the onset of the early thermophilic phase, during which thermophilic microorganisms begin actively degrading easily decomposable organic compounds, such as sugars and proteins. The rise in composting temperature releases energy in the form of heat, leading to a significant temperature increase[13].

In the middle phase (day 4 to day 15), the temperature in most treatments began to decrease; however, a distinct pattern was observed in treatment D2 (0.5 kg rumen + 1.5 L leachate). This treatment maintained a more stable temperature range of 38–40°C compared to the other treatments. This condition indicates that optimal decomposition activity was sustained without creating extreme conditions that could inhibit the performance of mesophilic microorganisms during composting[14]. The temperature stability in D2 is likely the result of the synergistic effect of the bioactivators, with cattle rumen providing active decomposer microorganisms and leachate supplying nutrients that support microbial metabolism.

During the final phase (day 16 to day 30), the temperature in all treatments gradually decreased toward ambient temperature. Treatment D2 showed a consistent decline, reaching 30–32°C by day 30. This decrease indicates that the decomposition process had slowed, complex organic materials were breaking down, and the compost entered the cooling and maturation phase. According to SNI 19-7030-2004, the ideal temperature for mature compost ranges from 30–40°C[15], indicating that the compost from treatment D2 approached maturity according to the standard.

Overall, temperature observations revealed three characteristic phases in the composting process: the initial thermophilic phase, the middle mesophilic phase, and the final cooling phase. Treatment D2 was the most effective in maintaining optimum temperatures (38–40°C) and gradually reducing them to the mature compost range (30–32°C), suggesting that the combination of cattle rumen and leachate bioactivators can accelerate decomposition while producing high-quality compost[3,10,13].

pH

pH is an important parameter in the composting process because it is related to microbial activity and nutrient availability. Local microorganism starters based on waste often have acidic pH, which can inhibit microbial growth[12]. Extremely low (acidic) pH can hinder decomposer microorganism activity, whereas excessively high (alkaline) pH may result in nitrogen loss through ammonia volatilization. Therefore, monitoring pH changes during composting serves as a crucial indicator of the decomposition process and compost maturity [16]. pH increased with the degradation of organic acids into more stable compounds across all treatments[17].

Soil pH is a key factor influencing organic matter decomposition because it controls the composition and activity of microbial communities, including decomposition enzymes. Optimal decomposition occurs at pH 5.5–7.5, while pH <4.5 or >7 slows decomposition due to suboptimal conditions for microbial activity[18].

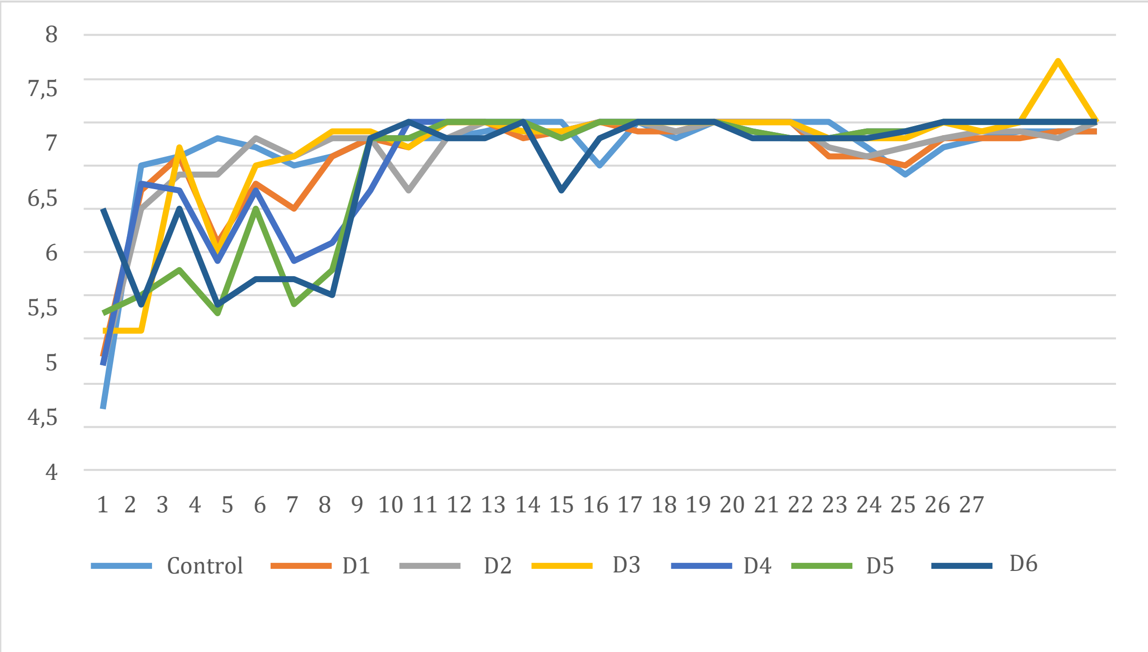

Figure 2. pH Changes During Measurement

In the initial phase (day 1 to day 5), the pH values in almost all treatments decreased. This occurred due to the formation of simple organic acids, such as acetic acid and lactic acid, resulting from the activity of fermentative microorganisms. For example, in treatment D2, the initial pH of approximately 5.5 dropped to 4.5. The early composting stage is typically characterized by acidic conditions[19].

During the middle phase (day 6 to day 15), pH in all treatments began to increase as organic acids were decomposed into more stable compounds. The most consistent increase was observed in treatment D2, which gradually reached a neutral pH range of 6.8–7.0 by day 15. This indicates higher microbial activity, faster pH stabilization, and a more stable final compost product, facilitating the achievement of neutral pH during the mesophilic phase[11,20].

In the final phase (day 16 to day 30), most treatments showed pH stabilization; however, not all reached the ideal range. Treatment D2 remained stable within the neutral range of 6.8–7.2 until the end of composting, in accordance with SNI 19-7030-2004, which specifies the pH of mature compost to be between 6.5 and 8[21]. In contrast, other treatments such as D4 and D6 exhibited greater fluctuations or remained acidic (<6), indicating that decomposition was not yet fully complete. These results demonstrate that the bioactivator combination in treatment D2 not only accelerated decomposition but also stabilized pH toward neutral conditions, which is crucial for the safety and effectiveness of compost when applied to agricultural land.

Moisture Content

Moisture content is a critical factor in the composting process, influencing microbial activity, organic matter decomposition, oxygen diffusion, and the stability of biochemical reactions (22). Excessively dry conditions can inhibit microbial growth. Moisture levels significantly affect microbial development and decomposition efficiency during composting. Overly dry conditions impede microbial activity, while excessively high moisture (>80%) can create anaerobic conditions, slowing decomposition and causing unpleasant odors[23,24]. Therefore, monitoring moisture content serves as an important indicator for evaluating the effectiveness of the composting process.

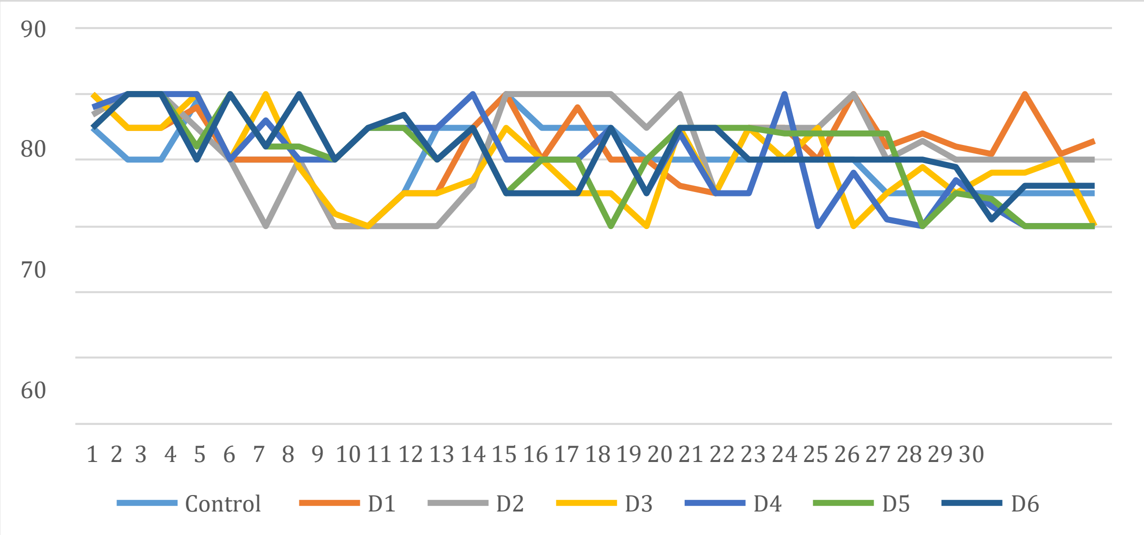

Figure 3. Moisture Content Changes During Measurement

In the initial phase (day 1 to day 5), all treatments exhibited high moisture content, ranging from 75–80%, including treatment D2. This condition is considered ideal for initiating decomposition as it supports the initial growth of decomposer microorganisms[25].

During the middle phase (day 6 to day 20), a slight decrease in moisture content was observed in some treatments. However, treatment D2 maintained relatively stable moisture levels within the range of 70–75%. This stability indicates a balance between microbial activity, which produces water through respiration, and evaporation occurring during the composting process[26].

In the final phase (day 21 to day 30), moisture content continued to decline in all treatments. Treatment D2 reached a final moisture content of approximately 65%, approaching the SNI 19-7030-2004 standard range for mature compost, which is 50–60%[26]. Although slightly higher than the standard, the consistent downward trend indicates that compost in treatment D2 had reached the final maturation stage.

Overall, treatment D2 exhibited a more ideal moisture pattern compared to the other treatments. The combination of cattle rumen as a source of active microorganisms and leachate as a nutrient source appears to create a more balanced moisture environment, enabling optimal decomposition and resulting in higher-quality compost[26].

Based on observations of the three main parameters—temperature, pH, and moisture content—it is evident that treatment D2 (0.5 kg cattle rumen + 1.5 L leachate) performed most optimally in accelerating compost maturation. The temperature in this treatment followed the ideal composting pattern, remaining stable at 38–40°C during the middle phase, then gradually decreasing to 30–32°C by the end of the process, consistent with the mature compost standard. The pH also exhibited a favorable trend, shifting from acidic conditions at the start of composting to a neutral range of 6.8–7.2 at the end, in line with SNI 19-7030-2004. Meanwhile, moisture content in treatment D2 remained stable at 70–75% throughout the process and decreased to 65% at the end, approaching the SNI standard range (50–60%). These consistent results confirm that the combination of cattle rumen and leachate at the D2 dose creates the most favorable environmental conditions for microbial activity, thereby accelerating the decomposition process and producing compost with characteristics approaching quality standards.

CONCLUSIONS AND RECOMMENDATIONS

This study confirms that the addition of bioactivators in the form of cattle rumen and leachate can accelerate the maturation of compost derived from fruit waste. Treatment D2, which combined 0.5 kg of cattle rumen and 1.5 L of leachate, was proven to be the most effective, as indicated by stable temperature, neutral pH, and moisture content approaching the SNI 19-7030-2004 standard. These results demonstrate that this bioactivator combination successfully optimizes composting conditions, allowing the compost to mature faster and achieve quality characteristics close to national standard criteria.

Nevertheless, this study has limitations regarding replication, the use of statistical tests, and the scope of analytical parameters. Therefore, further research is recommended with a more robust experimental design, including heavy metal analysis, microbiological testing, and application at field scale with more efficient composter designs. Such efforts could establish this method as a practical solution for communities and government agencies in managing organic waste and mitigating environmental pollution.

REFERENCES

1. Widhiarso W, Jatiningsih MGD, Nayla M. Pemanfaatan Sampah Organik Kulit Buah Menjadi Eco-Enzyme untuk Disinfektan di Bank Sampah Kusuma Pertiwi. Wikrama Parahita : Jurnal Pengabdian Masyarakat [Internet]. 2023 Apr 21;7(2):236–42. Available from: https://e-jurnal.lppmunsera.org/index.php/parahita/article/view/5893
2. Bernal MP, Alburquerque JA, Moral R. Composting of animal manures and chemical criteria for compost maturity assessment. A review. Bioresour Technol. 2009;100(22):5444–53.
3. Sarijan A, Ekowati NY, Widijastuti R, Panga NJ. Pelatihan Pembuatan Bioaktivator dari Limbah Udang dan Nanas di Kampung Yasamulya SP 2 Kabupaten Merauke, Provinsi Papua Selatan. Jurnal Abdi Masyarakat Indonesia. 2022;3(1):153–62.
4. Erni Suryani. Pemanfaatan Kompos Organik Terhadap Pertumbuhan Tanaman Jagung Dan Sifat Fisik Tanah. JUSTER : Jurnal Sains dan Terapan. 2022;1(1):44–8.
5. Sumiyati S, Priyambada IB, Zahra SAF, Pradhana DR, Julianggara MI, Febriana TF, et al. Comparative analysis of composting with ecoenzymes and bioactivator MOL based on parameters of pH, temperature, and water content. E3S Web of Conferences. 2025;605.
6. Zubaidah A, Prasetyo D, Handajani H, Rohmah SP, Puspita DA. Screening Bakteri Selulolitik Dan Amilolitik Pada Rumen Sapi Sebagai Kandidat Probiotik Pada Budidaya Ikan Secara in Vitro. Jurnal Riset Akuakultur. 2019;14(4):261–71.
7. Pamungkas AC, Okta AN, Mubarok AF, Kusuma AA, Wicaksono FF. Potensi Limbah Rumen Sapi dari Rumah Potong Hewan sebagai Pupuk Organik untuk Tanaman: Review. Jurnal Riset dan Inovasi Peternakan (Journal of Research and Innovation of Animals). 2025;9(2):431–43.
8. As ZA, Hardiono H, A. S. Percobaan Produksi Biogas dari Kotoran Sapi dan Kotoran Ayam dengan Penambahan Enzim Papain. JURNAL KESEHATAN LINGKUNGAN: Jurnal dan Aplikasi Teknik Kesehatan Lingkungan. 2014;11(1):177–83.
9. Mirwan M. Pemanfaatan Bioaktivator Alami Untuk Pengomposan Sampah Organik. Jurnal Envirotek. 2018;9(1).

10. Sulistyo J, Chrisyanti Dewi I, Oktavio A. Pelatihan Pengembangan Inovasi Bioaktivator Untuk Meningkatkan Kualitas Pangan Organik Berbasis Sistem Pertanian Organik. I-Com: Indonesian Community Journal. 2024;4(2):773–80.
11. Awasthi MK, Pandey AK, Khan J, Bundela PS, Wong JWC, Selvam A. Evaluation of thermophilic fungal consortium for organic municipal solid waste composting. Bioresour Technol. 2014;168:214–21.
12. Fatmawati F. Identifikasi Bakteri Potensial Pada Fase Pematangan Kompos Manur. Journal of Pharmacopolium. 2018;1(1).
13. Stani AH. Modelling of Temperature in Full-Scale Systems: a Review of the Biological Heat Generation Within Windrow Composting. Jurnal Teknologi Lingkungan. 2016;13(3):291.
14. Kurnia VC, Sumiyati S, Samudro G. Pengaruh Kadar Air Terhadap Hasil Pengomposan Sampah Organik Dengan Metode Open Windrow. Jurnal Teknik Mesin. 2017;6(2):58.
15. Badan Standardisasi Nasional. Spesifikasi kompos dari sampah organik domestik. 2004.
16. Ani ED. Pemanfaatan Limbah Tomat Sebagai Agen Dekomposer Pembuatan Kompos Sampah Organik. Jurnal Teknologi Lingkungan Lahan Basah. 2016;4(1).
17. Seliaprillia S, Susanawati LD, Suharto B. Pemanfaatan Kulit Jeruk Peras (Citrus sinesis L. Obbeck) dan Kulit Kacang Tanah (Arachis hypogaea) Sebagai Karbon Aktif Terhadap pH dan BOD Pada Air Limbah Perikanan di Daerah Kabupaten Tulungagung. Jurnal Sumberdaya Alam dan Lingkungan. 2019;6(1):18–24.
18. Wang C, Kuzyakov Y. Soil organic matter priming: The pH effects. Glob Chang Biol. 2024;30(6).
19. Ole MBB, Jati W. Jurnal penggunaan mikroorganisme bonggol pisang (. 2013;1–16.
20. C. Sundberg * HJ. Higher pH and faster decomposition in biowaste composting by increased aeration. 2007;95(2):518–526.
21. Li Z, Lu H, Ren L, He L. Experimental and modeling approaches for food waste composting: A review. Chemosphere. 2013;93(7):1247–57.
22. Kurnia VC, Sumiyati S, Samudro G. Pengaruh Kadar Air Terhadap Hasil Pengomposan Sampah Organik Dengan Metode Open Windrow. Jurnal Teknik Mesin. 2017;6(2):58.
23. Purnowo D, Setiawan A, Yusmaniar Y. Pengaruh Faktor Suhu dan Kelembaban pada Lingkungan Kerja terhadap Pertumbuhan dan Perkembangan Mikroba. JRSKT - Jurnal Riset Sains dan Kimia Terapan. 2024;9(2):45–54.
24. Komaruddin M, Septama HD, Atmojo RST. Rancang Bangun Pemantauan Proses Dekomposisi Pupuk Kompos Berbasis Low Cost & Multi Point Board. Barometer. 2019;4(1):174–9.
25. . S. Sistem Kendali Dan Monitoring Kelembapan, Suhu, dan pH Pada Proses Dekomposisi Pupuk Kompos Dengan Kendali Logika Fuzzy. Telekontran : Jurnal Ilmiah Telekomunikasi, Kendali dan Elektronika Terapan. 2021;8(2):154–64.
26. Ratna DAP, Samudro G, Sumiyati S. Pengaruh Kadar Air Terhadap Proses Pengomposan Sampah Organik Dengan Metode Takakura. Jurnal Teknik Mesin. 2017;6(2):63.