Biogenerasi Vol 10 No 1, 2024

**Biogenerasi**

**Jurnal Pendidikan Biologi**

https://e-journal.my.id/biogenerasi

# IMPROVING THE QUALITY OF SOLID ORGANIC FERTILIZER USING DECOMPOSER

Arie Aryanto, Universitas Terbuka, Indonesia
Hikmah Zikriyani, Universitas Terbuka, Indonesia
Na'ilah Insani Alifiyah, Universitas Terbuka, Indonesia
Raflen Aril Gerungan, Universitas Terbuka, Indonesia
Fauzan Hamdani, Universitas Terbuka, Indonesia
Mustaking, Universitas Puangrimaggalatung Sengkang, Indonesia
*Corresponding author E-mail: arie.aryanto@ecampus.ut.ac.id

**Abstract**

The utilization of cow manure can reduce environmental pollution around livestock farms. One way to utilize cow manure is by turning it into solid organic fertilizer. The quality of solid organic fertilizer is determined by various factors, including the raw materials, fermentation methods, and composting time. The aim of this study is to improve the quality of solid organic fertilizer using a decomposer. The production of solid organic fertilizer in this study was carried out in two ways: first, by turning the cow manure every 10 days for 40 days (A), and second, using a decomposer with ratio of 1 Liter/3 tons to the cow manure and then turning it every 10 days for 40 days (B). The results showed an increase in C-organic content by 9.56%, nitrogen by 42.02%, phosphate by 19.00% and potassium by 6.56%. This indicates that the addition of a decomposer in the composting process can improve the quality of solid organic fertilizer.

**Keywords**: *Cow Manure, Decomposer, Organic Fertilizer*

**Abstrak**

Pemanfaatan kotoran sapi dapat mengurangi pencemaran lingkungan di sekitar peternakan. Salah satu cara memanfaatkannya adalah dengan mengubahnya menjadi pupuk organik padat. Kualitas pupuk organik padat ditentukan oleh berbagai faktor, termasuk bahan baku, metode fermentasi, dan waktu pengomposan. Penelitian ini bertujuan untuk meningkatkan kualitas pupuk organik padat menggunakan dekomposer. Produksi pupuk organik padat dilakukan dengan dua cara: pertama, dengan membalik kotoran sapi setiap 10 hari selama 40 hari (A), dan kedua, menggunakan dekomposer dengan dosis 1 liter/3 ton kotoran sapi dan membaliknya setiap 10 hari selama 40 hari (B). Hasil penelitian menunjukkan peningkatan kandungan C-organik sebesar 9,56%, nitrogen sebesar 42,02%, fosfat sebesar 19,00%, dan kalium sebesar 6,56%. Hal ini menunjukkan bahwa penambahan dekomposer dalam proses pengomposan dapat meningkatkan kualitas pupuk organik padat.

**Kata Kunci**: *Kotoran Sapi, Dekomposer, Pupuk Organik*



Correspondence Author :
Universitas Terbuka

p-ISSN 2573-5163
e-ISSN 2579-7085

## INTRODUCTION

In 2018, the worldwide livestock population totaled 1.9 billion animals, including 965 million cattle, 242 million pigs, 237 million chickens, and 226 million sheep and goats. Since 1990, the populations of livestock such as cattle, buffalo, pigs, sheep, and goats have grown by 16% (FAO, 2020). In Indonesia, the livestock population in 2022 was approximately 58 million head (Badan Pusat Statistik, 2024). However, such large numbers of livestock pose significant environmental challenges (Kamilaris, Engelbrecht, Pitsillides, & Prenafeta-Boldú, 2020). In parallel with the global increase in livestock populations, the total production of livestock manure has risen by 23% since 1990, reaching 125 million tons in 2018. Of this total, 88 million tons of manure remain on pastures, 34 million tons are processed in management systems, 7 million tons are lost, 27 million tons are applied to soil, and 3 million tons are utilized for heating and construction (FAO, 2020). The rise in livestock manure volume has become a major concern, contributing to the contamination of soil, air, surface water, and groundwater (Goldan et al., 2023). Excessive manure, in particular, can lead to the pollution of water bodies through nutrient runoff (Kamilaris et al., 2020).

Agricultural production must increase to meet human needs as the global population continues to grow (Penuelas, Coello, & Sardans, 2023). The rising demand for agricultural output has also driven a corresponding increase in the demand for fertilizers, a critical input in agriculture. This has been a central focus of research in the agricultural sector for many years (Danlami, 2014). Fertilizer application is essential to meet the food requirements of a growing population amid diminishing resources. Currently, chemical fertilizers remain relatively expensive, yet they are required in substantial quantities in agricultural production. However, their use negatively impacts soil fertility, leading to an increasing reliance on organic fertilizers (ALnaass, Agil, & Ibrahim, 2021). Livestock manure has emerged as an alternative to chemical fertilizers, contributing to improved soil quality and mitigating the decline in crop productivity (Goldan et al., 2023).

Livestock manure can be utilized as fertilizer, representing one of the most effective methods for managing livestock waste (Goldan et al., 2023), thereby helping to mitigate pollution caused by animal waste (Kamilaris et al., 2020) . Fertilizer derived from livestock manure serves as a valuable source of nutrients and organic matter, playing a critical role in enhancing soil fertility. Its macronutrient and micronutrient content can improve crop yields without adversely affecting soil health or plant growth (Goldan et al., 2023). The addition of decomposers to livestock manure is essential for accelerating the composting process (Said, Hastang, & Isra, 2020). Decomposers are vital in breaking down organic matter, facilitating the fragmentation of litter, and promoting microbial population growth (Hättenschwiler, Tiunov, & Scheu, 2005). Nitrogen (N), phosphorus (P), and potassium (K) are essential macronutrients that play a major role in soil fertility and plant growth, making it important to track their availability (Sanyal et al., 2015). This study aims to analyze the enhancement of solid organic fertilizer quality through the use of decomposers. The application of decomposers is expected to improve fertilizer quality by increasing its organic molecular content.

## METHODS

Time and Place

This research took place in Pulosari Village, Pangalengan District, Bandung Regency, Indonesia as well as at the ICBB Laboratory of PT. Biodiversitas Bioteknologi Indonesia, from January to April 2024.

Materials

The materials used were cow manure obtained from nearby pens and a decomposer purchased from an agricultural store under the brand "EM4." Treatment “A” had no addition of decomposer, while Treatment “B” included the addition of decomposer. The dose of decomposer added was 1 liter for every 3 tons of cow manure.

Preparation of Decomposer Solution

The decomposer to be used was first dissolved in water at a dose of 350 ml of decomposer per 35 liters of water, along with 350 grams of granulated sugar. The resulting solution containing the decomposer was allowed to sit for 24 hours.

Preparation of Compost

The composting process began with the preparation of 1 ton of cow manure for each treatment. The cow manure for Treatment “A” was covered with a tarp, while for Treatment

“B”, the decomposer was sprayed on before covering with a tarp. The cow manure was turned every 10 days. The compost was harvested after 40 days (Ding et al., 2022).

Nutrient Content Analysis

The composting process began with the preparation of 1 ton of cow manure for each treatment. The cow manure for Treatment “A” was covered with a tarp, while for Treatment “B”, the decomposer was sprayed on before covering with a tarp. The cow manure was turned every 10 days. The compost was harvested after 40 days (Ding et al., 2022).

## RESULTS AND DISCUSSION

### Results

The findings of this study are shown in Table 1. The research compares two treatments: compost without decomposers and compost with decomposers. Each treatment was evaluated based on various parameters, including organic carbon (C-organic) content, total nitrogen (N), C/N ratio, total phosphorus (P), and total potassium (K). The results indicate that the addition of EM4 during the composting process led to an increase in the levels of organic carbon (C-organic), nitrogen (N), phosphate (P), and total potassium (K).

**Tabel 1** Table 1. Organic C content, total N, C/N ratio, total P, and total K in compost with decomposers and compost without decomposers.

| No. | Parameters | Without Decomposer | With Decomposer |
|---|---|---|---|
| **1.** | C-Organic | 29% | 31.8 % |
| **2.** | N Total | 2% | 10.6 % |
| **3.** | C/N Ratio | 14 | 3 |
| **4.** | P Total | 2.7 % | 3.29 % |
| **5.** | K Total | 2.4 % | 2.6% |

### Discussion

Carbon (C) Organic

Organic carbon is a vital nutrient that plants require in large amounts, serving as a key component in building organic matter. The results indicated that the percentage of organic carbon in cow manure compost, both with and without EM4, exceeded the minimum threshold of 15%, meeting the standards for organic fertilizer quality set by the Ministry of Agriculture (Kementerian Pertanian, 2011). According to Agustin Olivo (2019), manure can supply essential nutrients, including carbon (C), nitrogen (N), phosphorus (P), potassium (K), and micronutrients, to crops. As the amount of organic matter increases, the availability of these nutrients also rises due to a larger nutrient pool. The benefits of higher soil organic matter extend to improved physical and biological soil properties, such as better nutrient availability, soil aeration, enhanced water infiltration, and greater water retention, ultimately promoting soil health and agricultural sustainability (Bhattacharyya et al., 2022; Pambayun, Purwanto, & Utami, 2023).

The cow manure treated with EM4 exhibited a higher organic carbon content, with a value of 31.8%, compared to 29% without EM4, which can be attributed to the microbial activity in EM4. This results align with findings from Risnawati et al. (2024), which stated that addition of the bioactivator EM4 increases the carbon content in compost. The addition of carbon to the system stimulates microbial respiration, enzyme production, and changes in carbon availability, which in turn alters the microbial community structure. Microorganisms in the compost convert long-chain polysaccharides into shorter saccharides that are more readily absorbed by plants.

The fermentation process relies heavily on organic carbon in compost fertilizers to aid in the decomposition of organic matter. Microorganisms from EM4 break down cellulose into organic carbon, producing fermentative sugars and enhancing the breakdown of lignocellulosic materials. During this process, the microbial community evolves into a highly specialized group that produces 11 enzymes acting together under anaerobic conditions. These enzymes facilitate the release of soluble carbon from high-molecular-weight cellulose, improving heterotrophic metabolism (Bottino, Cunha-Santino, & Bianchini, 2016). Without sufficient organic carbon, microorganisms cannot survive. Organic carbon then released as $CO_2$ into the atmosphere, increasing organic carbon content. The study indicates that the use of microbes for material degradation contributes to the rise in organic carbon levels (Wu et al., 2024).

Nitrogen (N) total

In the composting process, nitrogen (N) content is a crucial factor that must be considered (Risnawati et al., 2024). The results showed that the N-Total levels for all treatments exceeded the 0.4% minimum threshold set by the SNI 19-7030-2004 standards, with values of 2% for compost without EM4 and 10.6% for compost with EM4. Nitrogen is essential for microbial metabolism and growth, as it is a key component of plasma cells and plays an integral role in protein synthesis (Bachtiar et al., 2016). During composting, microorganisms decompose the organic material, converting ammonia into nitrite, which leads to an increase in the N-Total levels throughout the process.

The total nitrogen content in compost with EM4 was significantly higher compared to compost without EM4, increasing from 2% to 10.6%. The addition of EM4 significantly impacted nitrogen levels, as a higher concentration of EM4 accelerated the decomposition process. Microbial activity in EM4 helps break down proteins into amino acids through the ammonification process, leading to the formation of nitrogen in the form of ammonium ($NH_4^+$) compounds (Hidayat, Saptiani, & Agustina, 2023). Ammonia is then converted into nitrate ($NO_3$) and nitrite ($NO_2$), further contributing to nitrogen formation (Vilela et al., 2020). Additionally, the pH level of each treatment was measured, with compost containing EM4 having a pH value of 8.0, which complies with the standards. The pH increases during the composting process due to rising temperatures and the decomposition of nitrogen-rich organic materials by microorganisms, which produce large amounts of ammonium-nitrogen, thereby elevating the pH level (Rahmat et al., 2022). The final pH value of compost is commonly used to assess compost quality, as it influences soil pH and the bioavailability of nutrients to plants (Wang et al., 2015).

C/N Ratio

The carbon-to-nitrogen (C/N) ratio is a key factor in determining the overall nutritional balance of compost. It represents the proportion of carbon (C) to nitrogen (N) in an organic material. The C/N ratio is closely linked to the decomposition and mineralization processes—lower values indicate a faster breakdown of the compost into nutrients that can be utilized by plants. The results of this study revealed that the C/N ratio of cow manure compost without EM4 was higher compared to the compost with EM4. This higher ratio suggests that the cow manure is rich in cellulose. During the composting process, the C/N ratio gradually decreases, signaling the ongoing decomposition (He et al., 2022). The speed of decomposition, whether fast or slow, depends on the compounds present in the organic material. The nutrient content of carbon and nitrogen in the raw material affects how quickly decomposition occurs. Microbial activity is constrained by the availability of nitrogen for protein metabolism. The study found that the C/N ratio for cow manure compost without EM4 was 11, while with EM4, it was reduced to 3. According to Chan et al. (2016), a C/N ratio below 25 indicates that the compost is mature. This is because, during decomposition, microorganisms consume organic compounds, releasing two-thirds of the carbon as carbon dioxide.

The C/N ratio of cow manure compost with EM4 decreased significantly, from 11, due to the action of microorganisms. According to Cheng et al. (2017), the application of EM4 in the composting process contributes to a reduction in the C/N ratio of compost. The low C/N ratio in organic fertilizer is a result of microbial presence and activity. During the incubation phase, the mineralization of organic matter occurs, producing nitrogen in the form of $NH_4^+$ and $NO_3^-$ compounds (Komunikasi dan Pengembangan Teknik Lingkungan et al., 2023). As the fermentation process continues, the C/N ratio decreases further because microorganisms utilize the carbon content from the organic materials as an energy source, leading to a reduction in carbon. Additionally, during anaerobic composting, the carbon in organic compounds is converted into $CO_2$ and $CH_4$ gases, further reducing the carbon content. Despite this, the microbial breakdown of the organic material increases the nitrogen content by generating nitrogen and ammonia in the appropriate proportions.

Phosphorus (P) Total

Phosphorus (P) an important role as one of the elements in fertilizers. Phosphorus is necessary for energy transfer in plants, particularly in the form of adenosine triphosphate (ATP). In the study by Malhotra et al. (2018), ATP energy is used for root development, stem growth, flowering, and seed or fruit production. Phosphorus is crucial in the formation of DNA, RNA, and ATP, which are essential for photosynthesis and the overall metabolism of plants (Khan, Siddique, Shabala, Zhou, & Zhao, 2023). Adequate phosphorus levels enhance the plant's ability to absorb other nutrients, thereby improving overall nutrient efficiency. Mwende Muindi (2019) mentions that phosphorus helps improve soil quality by enhancing soil structure and fertility. Phosphorus can significantly increase crop yields, making it an essential element in fertilizers used in agriculture. Phosphorus is one of the key nutrients that support various developmental and growth processes in plants, thereby enhancing productivity in agriculture.

The study resulting that the addition of decomposers from composting process can increase phosphorus (P) content by 19%. This increase in phosphorus is due to microbial activity in decomposing organic matter. Microbes play a crucial role in enhancing the availability of phosphorus (P) in the soil through several mechanisms. Many soil microbes, as phosphorus solubilizers, secrete organic acids such as formic acid, acetic acid, lactic acid, sulfuric acid, and propionic acid, which could convert insoluble phosphates in the soil, such as those in mineral form, into soluble forms that can be absorbed by plant roots (Dai et al., 2020). These acids lower the pH and convert insoluble phosphates into soluble forms that can be taken up by plants. Microbes found in decomposers can produce phosphatase enzymes that play a critical role in releasing bound P. In soil or media conditions with low pH, P is bound to Al and Fe (Mir & Dar, 2021) . This process releases phosphate ions, making them available for plant absorption. Decomposers, such as bacteria and fungi, break down organic matter, releasing phosphorus in organic forms. This stage enriches and increases the phosphorus content in the soil. Microbes play a role in converting organic phosphorus back into inorganic forms that can be absorbed by plants. The presence of these microbes is crucial in helping make nutrients available for plant uptake. By enhancing phosphorus availability through these mechanisms, microbes contribute to better plant growth and agricultural productivity.

Potassium (K) Total

The third most essential nutrient is Potassium (K), following nitrogen (N) and phosphorus (P), and is the second most abundant nutrient in the photosynthetic tissues of terrestrial plants after nitrogen (SOUMARE, SARR, & DIÉDHIOU, 2023). The results of this study indicate that the total potassium content without the addition of decomposers is 2.4%, while the addition of decomposers can increase the total potassium content to 2.6%. This represents a 6.56% increase in total potassium when decomposers are added. This increase is attributed to the rise in the population of microorganisms that produce organic acids and cellulase enzymes, which help enhance potassium availability. The organic acids produced by microorganisms can dissolve potassium, making it available for direct absorption by plants. Additionally, cellulase enzymes contribute to increasing potassium content through cellulose breakdown activity.

This result is supported by Indrawati (Indrawati et al., 2020) state that the addition of cow dung can also increase potassium levels, as potassium is abundant in cow dung (Chen et al., 2023). However, when added to soil, potassium in fertilizer is easily fixed by soil, making it ineffective or unavailable to plants. This makes it more difficult for the plant to absorb and utilize the potassium directly (Tian et al., 2024) . Potassium-solubilizing microorganisms can convert potassium from soil or minerals into forms that are available to plants (SOUMARE et al., 2023). Several microorganisms have the ability to solubilize potassium in the soil, including species such as Pseudomonas, Burkholderia, Acidithiobacillus ferrooxidans, Bacillus mucilaginosus, Bacillus edaphicus, Bacillus circulans, Paenibacillus sp., Aspergillus niger, and Aspergillus terreus (Liu, Lian, & Dong, 2012). These microorganisms release potassium from mineral forms by producing organic acids, such as acetate, citrate, and oxalate. These acids release protons ($H^+$), which displace potassium from adsorption sites, making it available in solution and easily absorbed by plants (Shanware, Kalkar, & Trivedi, 2014).

Microbes produce several enzymes that play a role in increasing phosphorus, nitrogen, and potassium content (Deepthi, Kathireswari, Rini, Saminathan, & Karmegam, 2021). Several enzymes such as hydrolases, oxidoreductases, transferases, and isomerases play a role in decomposing organic matter through hydrolytic bond cleavage, hydrogen transfer, and conformational changes of substrate molecules. Some enzymes such as arylsulfatase, phosphatase, lipase, peptidase, peptidase, chitinase, cellulase, urease, protease, polyphenol oxidase, and dehydrogenase work by oxidizing or reducing molecules through the addition or subtraction of electrons (Karwal & Kaushik, 2020). During the degradation process into simpler molecules, microorganisms play an important role in providing nutrients. Bacteria are capable of producing organic acids that lower the pH, creating a more acidic environment which encourages fungal growth. In turn, fungi secrete enzymes that degrade the bacterial cell wall, releasing nutrients that promote further bacterial growth (Datta, 2024), which plays a role in releasing potassium content to the soil. Therefore, the increase in potassium with the addition of decomposers in this study indicates high microbial activity in producing organic acids that can dissolve potassium and enzymes that break down molecules into simpler forms, making them easier for plants to absorb.

## CONCLUSION

The composting treatment with added decomposers can improve the quality of organic fertilizer. The addition of decomposers increases the nitrogen, phosphate, and potassium content. Further research is needed to test the efficacy on plant growth and development using compost with added decomposers.

## ACKNOWLEDGEMENT

The author would like to express gratitude to everyone who contributed to the successful completion of this research. A special acknowledgment is extended to PT. Tasawa Herbal Nusantara for providing funding for this study. The author also wishes to thank the Department of Biology, Faculty of Science and Technology, Universitas Terbuka, Indonesia for their support throughout the research process.

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