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# KINETICS OF VEGETABLE WASTE DECOMPOSITION USING FISH VISCERA EXTRACT AND BANANA PSEUDOSTEM IN THE COMPOSTING PROCESS

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## Abstract

*This study investigated the effectiveness of the Takakura bin method for composting household vegetable waste using Fish Offal MOL and Banana Stem MOL as bioactivators. The Takakura method is a simple, aerobic composting technique that utilizes locally available materials—such as fermented microbial solutions and organic matter—to accelerate decomposition under controlled conditions, producing compost safely within a confined bin. The Carbon-to-Nitrogen ratio (C/N), a key indicator of compost maturity, represents the balance between carbon (energy source for microbes) and nitrogen (essential for microbial growth). Optimal composting typically occurs when the C/N ratio decreases from around 25–30:1 to below 20:1, indicating efficient organic matter breakdown. Results showed that compost pH remained between 6.0–7.5 and temperature between 25–30°C, ideal for mesophilic microbial activity. Both MOL treatments enhanced microbial diversity—Bacillus spp. dominated as primary decomposers, while Lactobacillus spp. in Fish Offal MOL helped lower pH and inhibit pathogens. The composting efficiency improved significantly, with faster C/N reduction, greater weight loss, and shorter maturation time. The Fish Offal and Banana Stem MOL bioactivators achieved over 80–90% efficiency in accelerating decomposition, producing mature compost with dark color, earthy odor, and fine texture. These findings confirm that the Takakura bin method, enhanced with MOL bioactivators, provides a highly efficient and eco-friendly solution for household organic waste management.*

**Keywords***: Composting, Household Waste, MOL, Fish Offal, Banana Stem, Decomposition Rate, Bacillus Spp., Lactobacillus Spp.*

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## 1. Introduction


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Waste is one of the main challenges in urban management. As human activity increases, the amount of waste generated continues to grow and can become a source of various diseases. The impacts of waste are not limited to health aspects but also affect various aspects of life (Gafur and Sangadji 2023) The volume of waste in urban areas, particularly in Surabaya, has been increasing rapidly due to population growth, changes in consumption patterns, and low public awareness and knowledge regarding waste management. This situation poses a significant challenge that must be addressed in the future (Simbolon and Diansafitri 2021).

Organic waste can decompose naturally, but its presence in residential areas still poses problems. Piles of untreated waste produce unpleasant odors and attract disease-carrying animals (Mahmudah, Sumiwi, and Hartini 2016) Common types of organic waste include household and market vegetable waste. These wastes usually come from parts of vegetables discarded to improve the appearance of food and goods before sale. The high water content in vegetable waste causes rapid decomposition, unpleasant odors, and potential environmental contamination (Sukiman et al. 2021).

To reduce the amount of organic waste generated by households, composting is an appropriate solution. In addition to reducing waste volume, this process aims to prevent environmental pollution caused by household organic waste. One method considered effective for household-scale application is the Takakura bin method. The Takakura method has several advantages, including suitability for limited space, odorless operation, and ease of use. Organic waste that has been chopped into small pieces can simply be placed in the bin (Prayekti et al. 2023).

In addition to the Takakura method, this study utilizes Local Microorganisms (MOL) derived from banana stems and fish viscera as activators in the composting process of vegetable waste. Fish viscera MOL contains 35%–57% protein, 0.05%–2.38% crude fiber, 24%–63% water, 5%–17% ash, 0.9%–5% calcium, and 1.1%–1.9% phosphorus, which are essential components in organic fertilizers (Safitri, Novalina, and Apriandi 2023) Meanwhile, banana stem MOL is rich in cellulose- and lignin-degrading bacteria that accelerate the decomposition of organic matter. The addition of MOL allows the decomposition of vegetable waste to proceed faster, producing mature compost in a relatively short time while reducing odors during the process.

Several previous studies have demonstrated the effectiveness of using MOL and bioactivators in composting. Research by (Rahayu, Fitrianingsih, and Sulastri 2024) showed that the combination of EM4 + fish viscera MOL produced the best compost quality based on macronutrient content (N, P, K), followed by EM4 + banana stem MOL. (Setyawati 2023)demonstrated that using EM4 at the appropriate concentration can increase the N, P, and K content in compost from vegetable waste.(Kasim et al. 2021)showed that soil microbial populations vary depending on land type and management, while(Suanda et al. 2025) highlighted that finer materials promote microorganism growth in eco-enzymes. (Cahyani et al. 2024)added that aerobic bioactivators from local waste accelerate cellulose degradation and reduce dependence on chemical fertilizers. Based on these findings, the use of MOL and local bioactivators has been proven to significantly improve compost quality and accelerate organic waste decomposition.


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Based on the background and previous studies, this research is designed to explore the use of fish viscera MOL and banana stem MOL in household waste composting. It is expected to provide an environmentally friendly and easy-to-use alternative for organic waste management while producing high-quality compost. This study aims to compare the effectiveness of fish viscera MOL and banana stem MOL on compost quality, identify the microorganisms and their populations involved in the composting process, and analyze the decomposition rate with the addition of MOL.

## 2. Method

The research framework provides an overview of the study, illustrating the flow from the preparation of materials and tools to composting processes and analysis of results. This study is a descriptive qualitative observation focusing on the identification of morphology and population of microorganisms in fish viscera MOL and banana stem MOL, along with chemical and physical analysis of the resulting compost. The research procedures began with preparing materials, including collecting vegetable waste and MOL ingredients. Tools were sterilized using dry heat, flaming, or autoclaving, and Nutrient Agar (NA) media was prepared by dissolving 2.8 g NA in 100 mL aquades, boiling, and autoclaving. Fish viscera MOL was made by blending 1 kg of fish intestines and gills with 125 mL sugar solution and water, then fermenting for 8 days, while banana stem MOL was prepared from 2 kg banana stems, 100 g melted brown sugar, and 2 L rice washing water, fermented for 10 days. Vegetable waste (cabbage, lettuce, mustard greens) was chopped (~1 cm) and weighed 500 g per type, then mixed with MOL at 15, 25, and 50 mL doses and placed in Takakura bins lined with cardboard and rice husk. Composting lasted 30 days with aeration and turning every 3–5 days, while moisture (50–60%) and temperature were monitored.

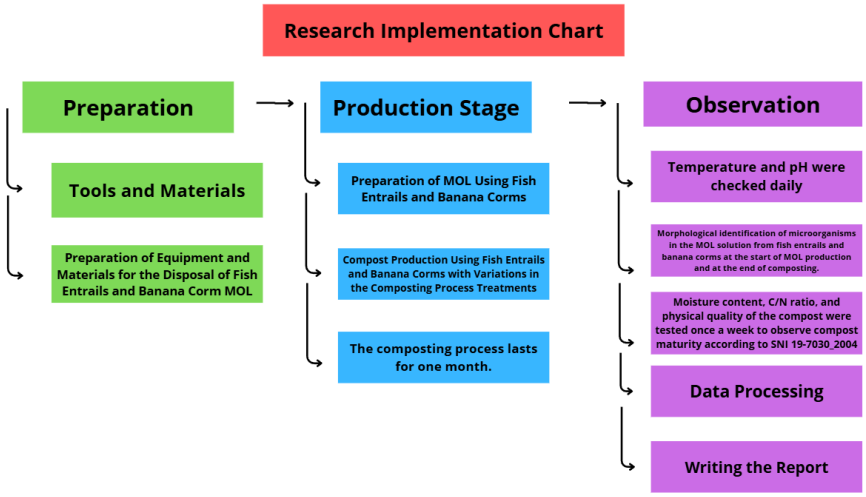


Figure 1: Research Method Flowchart

Observations included Gram staining, serial dilution, colony counting, and biochemical tests to identify microorganisms, with decomposition rates analyzed using zero, first, and second-order kinetics based on C/N ratio. Weekly measurements of


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organic carbon and total nitrogen were used to calculate C/N ratio, and physical compost parameters such as pH, temperature, moisture, color, odor, and texture were recorded. Fixed variables were 500 g vegetable waste, ambient conditions, Takakura aerobic composting for 30 days, and rice husk bedding; independent variables included activator type (fish viscera MOL, banana stem MOL), dose, composting material, and duration (0, 10, 20, 30 days); dependent variables included microorganism population, decomposition rate, C/N ratio, pH, temperature, moisture, and compost quality. The research matrix summarizing materials, time, and parameter tests is presented in :

Table 1**.** Research Matrix

| Compost Material | Composting Time | Parameter Tests (pH, Temp, Moisture, C/N, Color, Odor, Texture) |
|---|---|---|
| Banana Stem MOL | Day 0, 10, 20, 30 | Control, 15 mL, 25 mL, 50 mL for each vegetable type |
| Fish Viscera MOL | Day 0, 10, 20, 30 | 15 mL, 25 mL, 50 mL for each vegetable type |

## 3. Result and Discussion

During the composting process, the pH of compost from various types of vegetable waste tended to range between 6.0 and 7.5, indicating stability toward neutrality. At the beginning of the process, the pH was relatively lower, especially without an activator, whereas with the addition of an activator, the pH increased more rapidly. Variations among waste types such as cabbage, mustard greens, and lettuce caused minor fluctuations in pH, but it remained ideal for the activity of composting microorganisms. Measurements on day 30 showed a relatively neutral pH across all treatments, and analysis indicated that neither the type of activator nor the type of waste had a significant effect on compost pH.


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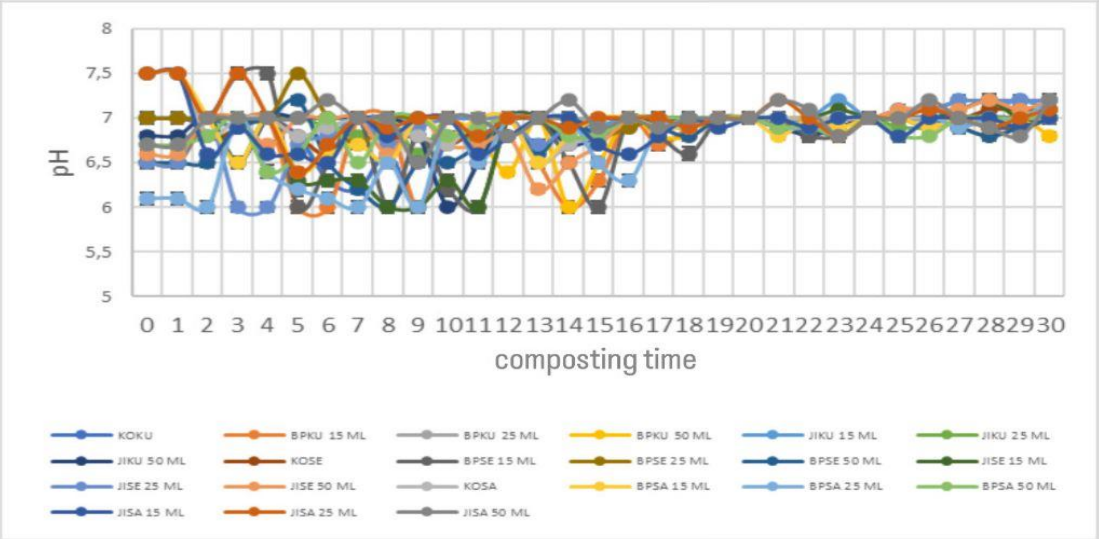


Figure 2: Results of Compost pH Analysis During the Composting Process

Compost temperature during the process remained stable within the range of 25–30°C, with no significant differences between treatments with or without activators. The initial phase showed a slight temperature increase due to mesophilic microbial activity, but it did not reach the thermophilic phase, indicating that the organic material stabilized relatively quickly. Moisture content of the compost decreased from day 0 to day 30 for all types of waste, with significant effects from both the type of activator and waste on the final moisture content. The C/N ratio decreased significantly in all treatments, indicating efficient decomposition, where the type of activator played a crucial role in C/N ratio changes, while the type of waste had minimal effect.

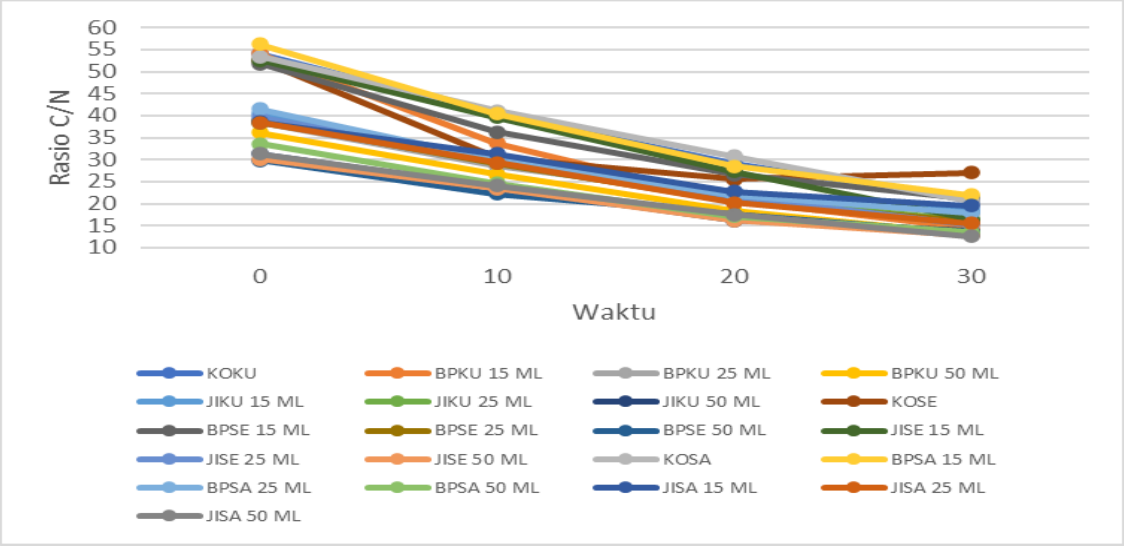


Figure 3: Results of C/N Ratio Analysis During the Composting Process


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The final characteristics of the compost showed changes in color to dark brown to black, odor transforming to an earthy scent, and texture reaching its maximum on day.


Figure 4**:** Samples on Days 0, 10, 20, and 30

Analysis indicated that variations in activator type or waste type did not significantly affect the quality of compost color, odor, or texture. This confirms that the duration and process of composting are more dominant in determining final compost quality than differences in activator or waste type.

Table 2. Type of Microorganisms and Microorganism Population for both MOL Banana

Table 2**.** Stem and MOL Fish Offal

| Researcher | Type of MOL | Type of Microorganisms | Microorganism Population |
|---|---|---|---|
| Safitri, W., Novalina A., & Apriandi, A. (2023). *Pembuatan Mikroorganisme Lokal (Mol) Dari Jeroan Ikan*. *Marinade*, 6(01), 01–07. https://doi.org/10.31629/marinade.v6i01.5481 | MOL Fish Offal | Small and medium round colonies, with entire and wavy edges, convex, shiny surface, and milky white colony color | $10^{-1}$ = $7010^{-2}$ = $5710^{-3}$ = $4610^{-4}$ = $2510^{-5}$ = 16 |
| Manullang, R. R., & Daryono, R. (2019). *Combination of Local Microorganism as Compost Bioactivators*. *Jurnal Hutan Tropis*, 5(3), 259–266. | MOL Banana Stem | Clavibacter, Agrobacterium, Clostridium, and Pseudomonas | No population results reported |


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Based on Table 2 , the dominant microorganisms involved are Bacillus spp. In MOL banana stems, Bacillus spp. functions as a decomposer of organic materials. Bacillus spp. is one of the dominant microbes that helps break down organic matter during fermentation and composting processes, thereby accelerating the breakdown and decomposition of organic materials in banana stems. Additionally, Bacillus spp. in MOL banana stems contributes to improving compost quality by facilitating efficient decomposition, allowing organic materials to be more quickly converted into nutrients that can be absorbed by plants.

According to (Safitri, Novalina, and Apriandi 2023), the bacteria found in MOL fish offal are small and medium round-shaped, with entire and wavy edges, convex, shiny surfaces, and milky white colony color; however, the specific bacterial species were not mentioned. Based on this study, Table 2 indicates that the microorganisms active in MOL fish offal are Bacillus spp., with rough, mucous-centered, wavy-edged colonies, and Lactobacillus spp., with smooth, oval-rounded colonies, flat edges, and convex shapes. Lactobacillus spp. functions to lower pH, maintain microbial balance, and inhibit pathogenic microbes, ensuring optimal fermentation of MOL fish offal. Together, these microorganisms make MOL effective as a bioactivator for fertilizer.

Based on the study, the compost pH was not significantly affected by either Fish Offal MOL or Banana Stem MOL, although a significant interaction between activator type and time was observed, indicating that the effect of the activator on pH depends on the composting duration. Compost temperature remained stable between 25–30°C, showing mesophilic microbial activity without reaching a high thermophilic phase. Moisture content was significantly influenced by the type of activator, with Fish Offal MOL tending to produce higher moisture compared to Banana Stem MOL, and decreased gradually over time. The C/N ratio declined faster with both types of MOL, especially at higher doses, approaching the ideal range for mature compost (10–20). Compost color darkened over time, indicating maturity, while odor transformed into an earthy smell, and texture became finer with time; the type of activator and waste did not significantly affect odor or texture.


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Microbial identification showed that Bacillus spp. dominated both MOLs, while Fish Offal MOL also contained Lactobacillus spp. Bacillus spp. acted as the main decomposer, whereas Lactobacillus spp. lowered initial pH and inhibited pathogenic microbes. Microbial populations grew actively, with Fish Offal MOL showing higher colony counts at $10^{-2}$ dilution. The decomposition rate of vegetable waste, measured by weight reduction, indicated that adding MOL accelerated decomposition compared to the control, especially at a 50 mL dose. Kinetic analysis showed that the first-order model best described the C/N decomposition rate, with a high $R^2$ value confirming good agreement between the model and experimental data.

## 4. Conclusion

Based on the study, it can be concluded that the use of Fish Offal MOL and Banana Stem MOL effectively supported the composting of vegetable waste by maintaining pH stability between 6.0–7.5 and compost temperatures within 25–30°C, suitable for mesophilic microbial activity. Both types of MOL significantly influenced moisture content and accelerated the reduction of the C/N ratio, especially at higher doses, producing mature compost with darkened color, earthy odor, and finer texture over time. Microbial analysis revealed that Bacillus spp. dominated both MOLs, acting as the main decomposer, while Fish Offal MOL also contained Lactobacillus spp., which lowered initial pH and inhibited pathogenic microbes. The decomposition rate, measured by weight reduction, showed that MOL addition enhanced composting efficiency, particularly at 50 mL doses, with kinetic analysis confirming that the first-order model accurately described the C/N decomposition, demonstrating the effectiveness of MOL as a bioactivator for high-quality compost production.

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