Comparative Analysis of Organic composting Processes With And Without Accelerator

Susindiran S[1],Roopa D[2]
[1, 2] Dept of Civil Engineering,
[2]Assistant Professor, Dept of Civil Engineering
[1, 2] Gnanamani College of Technology, Namakkal, India.

Abstract- *Organic waste management through composting presents a sustainable method to reduce landfill dependency, mitigate greenhouse gas emissions, and produce nutrient-rich soil amendments. This study investigates the efficiency of composting processes with and without the use of accelerators by analysing critical parameters such as temperature, moisture content, pH, and carbon-to-nitrogen (C:N) ratio. Over a 55-day period, two compost piles—one with an accelerator and one without—were monitored to evaluate decomposition dynamics. Results demonstrate that the addition of accelerators enhances microbial activity, accelerates decomposition, and produces mature compost more rapidly. This research provides actionable insights into optimizing composting processes in both small-scale and large-scale applications while emphasizing best practices for achieving high-quality compost.*

Keywords- Organic Composting, Accelerator, carbon-to-nitrogen (C:N) ratio, Groundnut shell

I. INTRODUCTION

1.1 Background

The escalating generation of organic waste due to urbanization and population growth presents significant environmental challenges (Bernal et al. 2009). Composting has emerged as a preferred waste management strategy, promoting the biodegradation of organic matter into stable humus while reducing landfill usage and methane emissions (Epstein 1997). Through microbial activity, organic waste is transformed into a valuable soil conditioner, contributing to sustainable agriculture and ecological balance.

1.2 Importance of Composting

Composting mitigates the adverse effects of organic waste accumulation by recycling nutrients back into the soil ecosystem (Carrillo and Monroy 2002). By managing organic waste through composting, communities can reduce greenhouse gas emissions, improve soil health, and contribute to a circular economy. Critical factors such as the C:N ratio, moisture, temperature, and pH govern the efficiency of composting and the quality of the final product (Hogg et al. 2002).

1.3 Scope of the Study

This study compares the performance of composting processes with and without accelerators to assess their impact on decomposition rates, nutrient stabilization, and overall compost quality. Accelerators, often composed of microbial inoculants or nitrogen-rich additives, are designed to expedite the composting process (Smith et al. 2013). By systematically monitoring temperature, moisture content, pH, and C:N ratio, this research aims to identify optimized practices for accelerating composting while ensuring high-quality output. The findings serve as a reference for practitioners seeking efficient and sustainable composting methods.

1.4 Objectives

The primary objectives of this research are:

- To compare the decomposition rates of compost piles with and without accelerators.
- To monitor the variations in temperature, pH, moisture content, and C:N ratio during the composting process.
- To assess the effectiveness of accelerators in enhancing composting efficiency.
- To recommend best practices for organic waste composting based on empirical data.

II. MATERIALS AND METHODS

2.1 Materials

The study was conducted using a variety of organic waste materials commonly available in household and agricultural settings. These materials were selected to create balanced compost piles with appropriate carbon and nitrogen content:

- **Organic Waste**: Food scraps, garden waste, cow dung, and paper.
- **Carbon-Rich Materials (Browns)**: Dry leaves, straw, and groundnut shells.
- **Nitrogen-Rich Materials (Greens)**: Fresh grass clippings, kitchen waste, and manure.
- **Accelerator**: Groundnut shells powder(10%).
- **Water**: Added to maintain optimal moisture levels throughout the composting process.

2.2 Composting Technique

A traditional pile composting method was selected due to its simplicity and widespread use. Organic materials were layered and mixed to maintain a carbon-to-nitrogen (C:N) ratio of approximately **26:1**, which is within the optimal range for efficient composting (Epstein 1997). The piles were periodically turned every 3–5 days to facilitate aeration and heat distribution.

2.3 Experimental Setup

The experiment was conducted over **55 days**, with two identical compost piles prepared under similar conditions:

- **Control Pile (Without Accelerator)**: This pile decomposed naturally without any additional accelerators.
- **Treatment Pile (With Accelerator)**: An accelerator was applied to this pile to enhance microbial activity and expedite decomposition.

Both piles were maintained in a designated outdoor area with adequate drainage and protection from excessive rainfall.

2.4 Monitoring Parameters

To evaluate composting performance, the following parameters were monitored every five days:

Parameter	Instrument/Method	Optimal Range
Temperature	Digital Compost Thermometer	54–71°C (Thermophilic Phase)
Moisture Content	Moisture Meter	40–60%
pH Level	pH Strips and pH Meter	6.0–8.0
C:N Ratio	Kjeldahl Method (N) and Loss on Ignition (C)	20–30:1

2.5 Analytical Methods

- **Nitrogen Measurement**: Conducted using the **Kjeldahl method**, which involves digestion, distillation, and titration to quantify nitrogen content.
- **Carbon Measurement**: Determined through the **Loss on Ignition (LOI)** method, where organic matter is combusted, and weight loss is used to estimate carbon levels.
- **Moisture Determination**: Measured using a digital moisture meter and verified through oven-drying techniques.
- **pH Measurement**: Conducted using pH strips for quick field analysis and a pH meter for laboratory precision.

2.6 Data Analysis

Temperature, moisture, pH, and C:N ratio data were plotted over the 55-day composting period to observe trends, compare decomposition rates, and evaluate the effectiveness of the accelerator. The experiment focused on identifying the following:

- Speed of decomposition.
- Stabilization of key parameters.
- Quality of the final compost product.

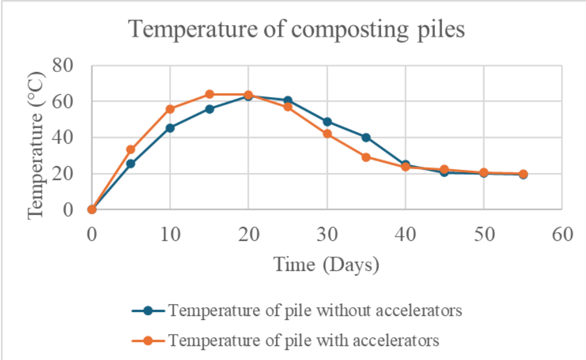
III. RESULTS AND DISCUSSION

The performance of compost piles with and without accelerators was analysed by monitoring temperature, moisture content, pH, and C:N ratio over 55 days. The data reveal significant differences in the efficiency and stability of the composting processes.

3.1 Temperature Monitoring

Temperature is a crucial factor that influences microbial activity during composting. Both compost piles exhibited typical mesophilic and thermophilic phases, but the pile with the accelerator showed faster heating and earlier stabilization.

Graph1. Temperature Progression in Compost Piles



Key Observations:

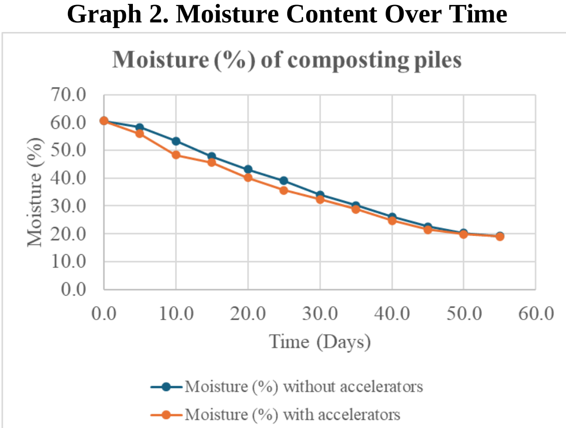
- **Accelerated Pile:** Reached peak temperatures faster, indicating rapid microbial activity.
- **Control Pile:** Slower to heat and prolonged thermophilic phase.
- Both piles achieved pathogen-killing temperatures (>55°C), but the accelerator hastened the process.

This suggests that accelerators enhance microbial metabolism, leading to quicker compost maturation (Bernal et al. 2009).

3.2 Moisture Content

Moisture is vital for microbial activity. An ideal moisture content of 40–60% promotes effective decomposition without waterlogging.

Graph 2. Moisture Content Over Time



Key Observations:

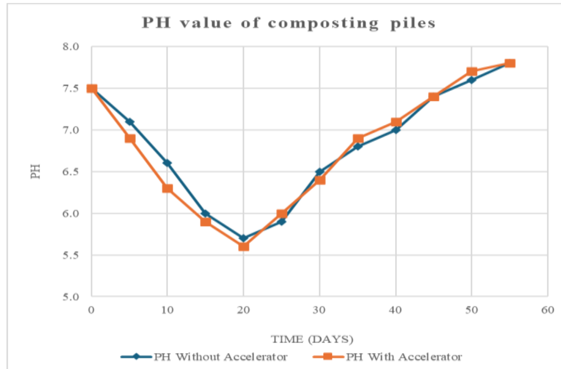
- Moisture content declined steadily due to evaporation and microbial heat production.
- The accelerator pile lost moisture slightly faster, indicating more intense biological activity.
- Both piles stabilized below 20%, suitable for mature compost storage.

This aligns with Carrillo and Monroy (2002), who highlight moisture's role in sustaining microbial processes.

3.3 pH Levels

pH influences microbial diversity and the breakdown of organic matter.

Graph 3. pH Variation in Compost Piles



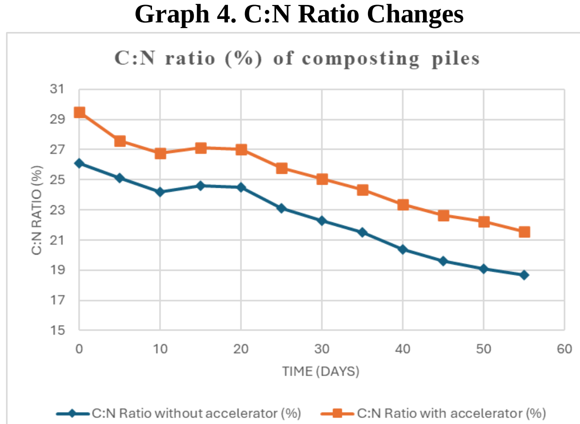
Key Observations:

- Both piles experienced an early drop in pH due to acid formation during initial decomposition.
- Recovery to neutral pH occurred as acids were consumed and ammonia was released.
- Accelerated piles stabilized slightly earlier, which indicates a quicker return to neutral conditions optimal for mature compost (Adams et al. 2002).

3.4 Carbon-to-Nitrogen (C:N) Ratio

The C:N ratio is a primary indicator of compost maturity. A ratio near 20:1 or lower signifies stabilized compost.

Graph 4. C:N Ratio Changes



Key Observations:

- Both piles achieved a significant reduction in C:N ratio, confirming effective decomposition.
- The accelerator pile experienced a faster decline, indicating enhanced microbial processing (Smith et al. 2013).
- Final ratios in both cases were within acceptable ranges for stable, high-quality compost.

3.5 Overall Comparison

Parameter	**Without Accelerator**	**With Accelerator**
Peak Temperature	62.8°C (Day 20)	64.0°C (Day 15)
Final Moisture	19.2%	19.0%
Final pH	7.8	7.8
Final C:N Ratio	18.7	21.5
Maturity Time	~55 days	~48 days

Interpretation:

- Accelerators improved decomposition speed by enhancing microbial activity.
- The final compost quality in both methods was comparable, though the accelerator reduced the processing time.
- Regular turning, optimal moisture, and proper C:N balance were critical across both methods.

These findings support the use of accelerators in composting operations where rapid turnover is desired without compromising compost quality (Hogg et al. 2002).

IV. CONCLUSION

This study demonstrated the comparative effectiveness of organic waste composting with and without the use of accelerators. Through the systematic monitoring of temperature, moisture, pH, and C:N ratio over a 55-day period, several key insights were established:

- The use of accelerators significantly improved the speed of composting, enabling faster attainment of the thermophilic phase and earlier compost maturity.
- Both compost piles, with and without accelerators, produced high-quality, stable compost, with final C:N ratios and pH values within optimal ranges.
- Accelerators enhanced microbial activity, leading to quicker decomposition and a more rapid decline in moisture and C:N ratios.
- Critical factors such as regular aeration, moisture control, and maintaining an optimal C:N ratio played essential roles in composting success, regardless of the presence of accelerators.

Ultimately, while both methods are viable for producing mature compost, the use of accelerators offers a practical advantage in reducing processing time, which is beneficial in settings where rapid waste turnover and compost availability are priorities.

V. RECOMMENDATIONS

Based on the experimental findings, the following recommendations are proposed to optimize composting efficiency and quality:

1. **Use of Accelerators:** Where time constraints exist, adding natural or commercial accelerators can expedite the composting process without compromising the end product.
2. **Maintain Optimal Conditions:** Regular monitoring and management of key parameters (temperature, moisture, pH, and C:N ratio) are critical for efficient composting and high-quality output.
3. **Aeration Practices:** Frequent turning of compost piles (every 3–5 days) ensures sufficient oxygen supply, promoting aerobic microbial activity and preventing odor problems.
4. **Moisture Control:** Maintain moisture content between 40–60% by adding water during dry conditions or integrating dry materials when moisture exceeds the optimal range.
5. **Scale-Up Considerations:** For large-scale composting operations, mechanized aeration and automated monitoring systems can further optimize efficiency and output consistency.
6. **Education and Training:** Compost operators should be trained in managing composting parameters to ensure high-quality production and compliance with environmental standards.

By implementing these recommendations, composting operations—whether at household, community, or industrial levels—can be significantly enhanced, contributing to sustainable waste management and soil health improvement.

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