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# EVALUATING THE FEASIBILITY OF COMPOSTING BANANA PLANT WASTE

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## ABSTRACT
The study based on composting banana peels together with leaves and stems using a wooden bin system. Six composting bins were utilized, each measuring 64 cm in length and 31 cm in width. Among of these, three bins were loaded with 6 kg of material each, while the remaining three held 9 kg, giving a combined total weight of 45 kg. Different mixture ratios of materials were applied across the bins: B-1 (0:0:1), B-2 (0:1:0), B-3 (1:0:0), B-4 (0.25:0.5:0.75), B-5 (0.5:0.75:0.25), and B-6 (0.5:0.25:0.75). Throughout the composting process, parameters including temperature, pH, moisture content, total organic carbon, total nitrogen, and the carbon-to-nitrogen (C:N) ratio were monitored. The highest temperatures were recorded in B-5 (40 ºC) and B-6 (46 ºC), sufficient for eliminating harmful bacteria and pathogens, thereby ensuring safe compost. Lower temperatures were observed in B-1 (37 ºC), B-2 (36 ºC), B-3 (37 ºC), and B-4 (36 ºC), which were inadequate for complete pathogen destruction. In terms of organic carbon, B-4 produced the highest value (42.91%), likely due to resistant organic compounds such as cellulose and lignin, while the lowest was in B-5 (36.52%). Nitrogen content peaked in B-2 (1.92%), possibly influenced by nitrogen-fixing microbial activity, whereas the lowest was recorded in B-6 (0.92%). The C:N ratio was highest in B-4 (43.8), again linked to unmanageable organic matter, while B-5 had the lowest ratio (19.4), falling within the recommended range (20:1) for mature compost. Moisture content ranged between 52% and 92%, with notable losses attributed to increased aeration that enhanced aerobic conditions. Overall, the study demonstrates that composting is an effective waste management strategy for organic residues, with bin B-5 producing the most balanced and mature compost suitable for use.

**Keywords:** Banana Plant Waste, Banana Peels, Banana Leaves, Banana Stems, Composting.

## 1. INTRODUCTION
Banana is one of the most important staple food crops in the East African Great Lakes region, where it serves not only as a source of food security but also as a foundation of rural livelihoods and cultural identity. In Tanzania, the Kilimanjaro and Kagera regions are particularly recognized for their banana production, with annual outputs reaching an estimated 2.5 million metric tons. Nationally, bananas are ranked as the fourth most important crop, and approximately 30% of the Tanzanian population equivalent to about 11 million people derive their daily carbohydrate intake from green bananas (Kilimo Trust, 2012). Within Kagera Region, often referred to as “banana culture” or “banana land,” bananas are the primary staple food for more than two million people (URT, 2005; Rugalema & Mathieson, 2009). The region alone

contributes over one-third of the total national banana production, highlighting its central role in household food security and income generation (Bosch & Shwagala, 1994).

Despite their economic and nutritional significance, banana production in Tanzania has faced steady decline over the past decades due to declining soil fertility, increased pest infestations, and diseases such as banana bacterial wilt and nematode infestations (Weerdt, 2003). This has directly threatened food security and household incomes in bananan dependent regions. Moreover, while bananas serve ecological functions by reducing soil erosion and nutrient loss, their processing and consumption generate large volumes of organic waste particularly peels, leaves, and stems. These residues are often discarded in open spaces or landfills without proper management, leading to adverse environmental consequences.

The improper disposal of banana residues contributes significantly to land, water, and air pollution, decomposition in unmanaged environments generates leachates that infiltrate soils and water bodies, introducing toxins and degrading water quality (Moqsud et al., 2011). Furthermore, the anaerobic breakdown of these residues produces methane and other volatile organic compounds, both of which are recognized as potent greenhouse gases that contribute disproportionately to climate change (Kumar et al., 2020). Beyond environmental degradation, poor management of organic waste creates breeding grounds for microbial pathogens, increasing the risks of disease outbreaks in communities where banana cultivation and consumption are widespread (Gupta & Yadav, 2019).

Given the scale of banana production and consumption in Tanzania, sustainable waste management strategies are urgently required. Composting has emerged as a viable and environmentally friendly alternative, offering multiple benefits for both waste reduction and soil fertility restoration. Composting accelerates the natural decomposition process using microorganisms to break down organic matter into stable, nutrient rich compost that can be applied to soils. Key parameters influencing this process include carbon to nitrogen (C:N) ratio, oxygen availability, pH, moisture content, and temperature, all of which must be managed to ensure optimal microbial activity and decomposition (Martinson et al., 2011).

The scope of this study focuses on the assessment of compost produced from banana peels, stems, and leaves, exploring its potential as an effective waste management strategy and as a resource for soil fertility enhancement. By evaluating the physico-chemical properties of compost generated under controlled conditions, this research seeks to demonstrate the feasibility of composting banana residues as a sustainable practice for farmers in banana growing regions. The study further explores the environmental benefits of diverting banana waste from landfills, where its decomposition contributes to greenhouse gas emissions, to composting systems that recycle nutrients back into agricultural soils (El-Hoz, M. (2015).

Previous research has highlighted the growing global recognition of composting as a circular economy practice that simultaneously addresses waste management challenges and agricultural sustainability (Bernal et al., 2017). Composting has been successfully applied to various organic residues, including food scraps, crop residues, and livestock manure, with proven benefits such as soil organic matter enhancement, improved soil structure, and increased nutrient availability (Zhu, 2007). However, studies specific to banana residues remain limited, particularly in East Africa, despite the crop's central role in food systems. This research is therefore positioned at the intersection of agricultural productivity, environmental sustainability, and climate change mitigation, responding directly to calls for innovative approaches to organic waste management in developing countries.

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The relevance of this study lies in its potential to inform both policy and practice, for smallholder farmers in Kagera and other banana growing regions, composting banana residues could provide a low cost and sustainable means of improving soil fertility, thereby enhancing yields and reducing reliance on expensive chemical fertilizers that often degrade soils over time. On a broader scale, promoting composting practices could contribute to national climate change mitigation strategies by reducing methane emissions from unmanaged organic waste. The study also aligns with global sustainable development goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action).
In generally, this research extends beyond the technical assessment of composting banana residues, it highlights the broader socio economic and environmental relevance of adopting composting as a sustainable agricultural and waste management strategy. Building upon previous advancements in organic waste utilization, the study emphasizes composting as a critical intervention for improving soil fertility, reducing environmental pollution, and contributing to climate change mitigation in banana producing regions of Tanzania.

## 2. MATERIAL AND METHODS

The study objectives were addressed using banana peels, leaves, and stems, applying laboratory analysis, field measurements, and experimental design. Experiments, conducted over 40 days at Ardhi University's experimental facility, generated essential data for achieving the study's aims.

### 2.1 Methods Employed

The study employed a combination of experimental, field, and laboratory-based approaches to evaluate the composting of banana residues, including peels, leaves, and stems, and to determine the optimal mixture for producing high-quality compost.

Laboratory analyses were conducted to evaluate the physical and chemical characteristics of the banana residues and the matured compost. Parameters measured included moisture content, pH, electrical conductivity, carbon-to-nitrogen (C:N) ratio, total organic carbon, and total nitrogen, following standard analytical protocols. The quality of the final compost was determined by comparing these parameters across different mixture ratios.

Data collected from laboratory and field measurements were subjected to statistical analysis using descriptive statistics to summarize trends, while analysis of variance (ANOVA) was employed to compare differences among treatment bins. Post-hoc test, particularly Tukey's Honest Significance Differences (Tukey's HSD), was conducted to identify statistically significant differences in compost quality indicators across mixture ratios. This methodological framework ensured rigorous assessment of composting efficiency, material decomposition, and nutrient recovery, enabling identification of the optimal banana residue mixture for producing nutrient-rich compost.

### 3.2 Materials Used

The materials utilized in this study included banana peels, banana plant leaves, and banana plant stems, which served as primary inputs. Additional materials, such as timber and protective gloves, were employed to facilitate the experimental procedures and ensure safety.

**2.2.1 Banana peels**

A total of 50 kg of banana peels was collected from Ardhi University cafeterias and shredded into small pieces measuring less than 1.5 cm to facilitate decomposition. From this process, 15 kg of shredded material was obtained and subsequently placed in composting bins for experimentation.

Plate 1: (Banana peels and shreded ones, 2025)

**2.2.2 Banana plant leaves**

A total of 30 kg of banana plant leaves was collected from Kituda Ward and chopped into pieces smaller than 1.5 cm to increase surface area for microbial activity and enhance decomposition. This process yielded 13.5 kg of shredded material, which was subsequently placed in composting bins.

Plate 2: (Banana plant leaves and chopped ones, 2025)

### 2.2.3 Banana plant stems

A total of 50 kg of banana plant stems was collected from Kitunda Ward and shredded into pieces smaller than 1.5 cm to facilitate decomposition. This process produced 16.5 kg of shredded material, which was then placed in composting bins for further experimental analysis.

Plate 3 (Banana plant stems, 2025)

### 2.3 Experimental Design

In this study, composting wooden bin was used, where by banana peels, banana plant leaves and banana plant stems were introduced in wooden bins of length 64cm and width 31cm, turning the composting materials after some time was achieved to enhance mixing of materials. Composting bins were covered with polyethene bags at the top in order to regulate temperature in the bins. Few openings were left at the top of polyethene materials in order to allow oxygen to enter in the bins so as to facilitate aerobic decomposition which is the best because the heat that is produced during the aerobic decomposition process is great enough that it kills harmful bacteria and pathogens within the reactors, while this heat is killing the harmful bacteria, it is also facilitating the growth of beneficial bacteria species including psychrophilic, mesophilic and thermophilic bacteria which thrive at the higher temperature levels. These bacteria facilitate healthy compost that plants feed on and thrive in. The experiment was set and operated for 5 weeks, it consisted of 6 bins. There were three bins where by each contained a total weight of 6kg and the remaining 3 bins each contained a total weight of 9kg. All bins made a total weight of 45kg and the materials were introduced in the bins at different ratios as shown in the table 3.2 below.

In this study, composting was conducted using wooden bins measuring 64 cm in length and 31 cm in width. Banana peels, leaves, and stems were introduced into the bins, and the materials were periodically turned to enhance mixing and uniform decomposition. The bins were covered with polyethylene sheets to help regulate internal temperature, with small openings left at the top to allow oxygen penetration, facilitating aerobic decomposition. Aerobic conditions generate sufficient heat to destroy harmful bacteria and pathogens while promoting the growth of beneficial microorganisms, including psychrophilic, mesophilic, and thermophilic bacteria, which are essential for producing nutrient-rich compost suitable for plant growth. The experiment was conducted over five weeks using six composting bins. Three bins contained 6 kg of material each, while the remaining three contained 9 kg each, totaling 45 kg across all bins. The materials were introduced in varying ratios, as detailed in Table 1, to evaluate the effects of different mixture compositions on composting efficiency and quality of the materials loaded.

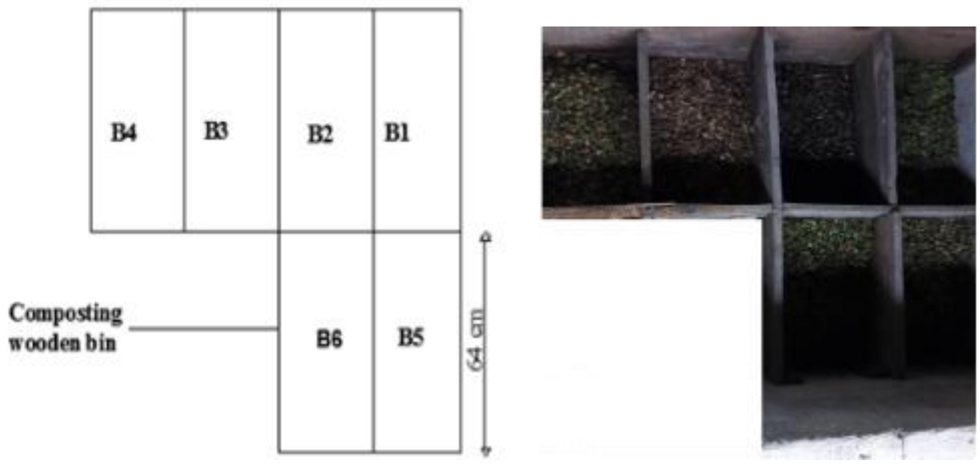


Plate 4: (Experimental setup, 2025)

**Table 1: Showcase of feeding ratios in the composting bins**

| COMPOSTING BIN | BANANA PLANT LEAVES (A) (kg) | BANANA PEELS (B) (kg) | BANANA PLANT STEMS(C) (kg) | RATIO (A:B:C) |
|---|---|---|---|---|
| B-1 | 0 | 0 | 6 | 0:0:1 |
| B-2 | 0 | 6 | 0 | 0:1:0 |
| B-3 | 6 | 0 | 0 | 1:0:0 |
| B-4 | 1.5 | 3 | 4.5 | 0.25:0.5:0.75 |
| B-5 | 3 | 4.5 | 1.5 | 0.5:0.75:0.25 |
| B-6 | 3 | 1.5 | 4.5 | 0.5:0.25:0.75 |
| Total | 13.5 | 15 | 16.5 | |

## 3.RESULTS AND DISCUSSION

### 3.1 Physical and Chemical Characteristics of Composting Materials

Assessing the chemical and physical properties of composting materials was essential to evaluate the feasibility of the study. Table 4.1 presents the measured physical and chemical characteristics, providing critical information for determining the suitability of the materials.

**Table 2: Indicates the measured characteristics of composting materials**

| PARAMETERS | BANANA PLANT LEAVES | BANANA PEELS | BANANA PLANT STEM | RECOMMENDED |
|---|---|---|---|---|
| Moisture content (%) | 85.81 | 89.26 | 91.55 | 40-60% (source: Chen *et al*., 2011) |
| pH | 6.68 | 6.74 | 5.99 | 5.5-8.0 (source: Cooperband, 2002) |
| Electrical conductivity (mS/cm) | 7.585 | 7.375 | 4.91 | 2-10 (source: Golueke, 1972). |
| Total organic carbon (%) | 57.99 | 57.95 | 57.80 | |
| Total Nitrogen (%) | 0.74 | 1.47 | 0.96 | |
| C:N | 78.4 | 39.4 | 60.2 | 20:1-40:1 (source: Herbert, 2011) |

### 3.1.1Moisture Content

The composting materials used in this study exhibited moisture content above the recommended range of 40–60%, as indicated in Table 4.1. Elevated moisture levels can reduce the air-filled pore space in the compost pile, creating anaerobic conditions that slow the decomposition process (Bernal et al., 2009). Excess moisture in composting systems is typically managed by increasing aeration, either through turning or ventilation, which enhances oxygen penetration and facilitates the removal of surplus water, thereby promoting aerobic microbial activity essential for efficient composting (Diaz et al., 2007).

### 3.1.2 pH

The pH values of the composting materials ranged within the optimal range of 5.5–8.0, which supports the growth and activity of microorganisms responsible for organic matter decomposition (Adani et al., 2006). Maintaining an appropriate pH ensures that microbial populations, including bacteria and fungi, remain active, accelerating the composting process and enhancing nutrient cycling.

### 3.1.3 Total Organic Carbon

Total organic carbon was highest in banana peels compared to leaves and stems, as shown in Table 4.1. The inclusion of banana peels in the compost mixture provides an adequate carbon source, which is crucial for microbial metabolism and energy generation during decomposition (Haug, 2018). A balanced carbon content supports sustained microbial activity and contributes to the formation of stable, nutrient-rich compost.

### 3.1.4 Total Nitrogen

Total nitrogen content was also higher in banana peels relative to leaves and stems. Combining banana peels with leaves and stems helps achieve an appropriate carbon-to-nitrogen (C:N) ratio, which is essential for optimizing microbial growth and accelerating decomposition (Diaz et al., 2007).

### 3.1.5 Carbon to Nitrogen Ratio

The C:N ratio of banana stems and leaves exceeded recommended levels, whereas banana peels were within the optimal range. During composting, the C:N ratio decreased due to microbial utilization of carbon for energy and nitrogen for protein synthesis, indicating active microbial activity and progressive organic matter stabilization. Monitoring the C:N ratio is critical for assessing compost maturity and ensuring the production of nutrient-rich, stable compost suitable for agricultural applications.

### 3.2 Compost Production Time

Production of compost with time was determined through measurement of the following parameters;

### 3.2.1 Temperature

Temperature is a critical parameter in composting as it reflects the microbial activity and the progression of organic matter decomposition. Optimal decomposition typically occurs within the range of 40 to 66 ºC, which also facilitates the elimination of pathogens while retaining beneficial microorganisms, thereby enhancing the quality of the final compost product. Monitoring temperature throughout the composting process allows for the assessment of material stability and the overall efficiency of the composting operation.

In this study, temperature variations were monitored in six composting bins (B-1 to B-6) over a 40-day period (Figure 1). In bin B-1, the temperature increased from 30 ºC on day 1 to 37 ºC by day 7, remained at 37 ºC for one day (day 7–8), and subsequently declined from 36 ºC to ambient levels by day 40. Bin B-2 exhibited a temperature rise from 27 ºC to 36 ºC over the first seven days, followed by a gradual decrease from 34 ºC to ambient temperature until day 40. Similarly, bin B-3 showed an increase from 25 ºC to 37 ºC during the first seven days, with a subsequent reduction from 35 ºC to ambient temperature over the remainder of the period.

Bins B-4 and B-5 displayed slightly delayed temperature peaks. In B-4, the temperature rose from 27 ºC to 36 ºC over ten days, remained stable for one day (day 10–11), and then declined from 33 ºC to ambient by day 40. Bin B-5's temperature increased from 27 ºC to 40 ºC within ten days, maintained at 40 ºC for one day (day 10–11), and then gradually decreased to ambient temperature from day 12 onward. Notably, B-6 reached the highest temperature of 46 ºC by day 13, maintained this level for two days (day 13–15), before declining from 39 ºC to ambient temperature until day 40.

These observations indicate that temperature dynamics varied among the composting bins due to differences in material composition, microbial activity, and possibly aeration conditions, all of which influence the rate and efficiency of organic matter decomposition.

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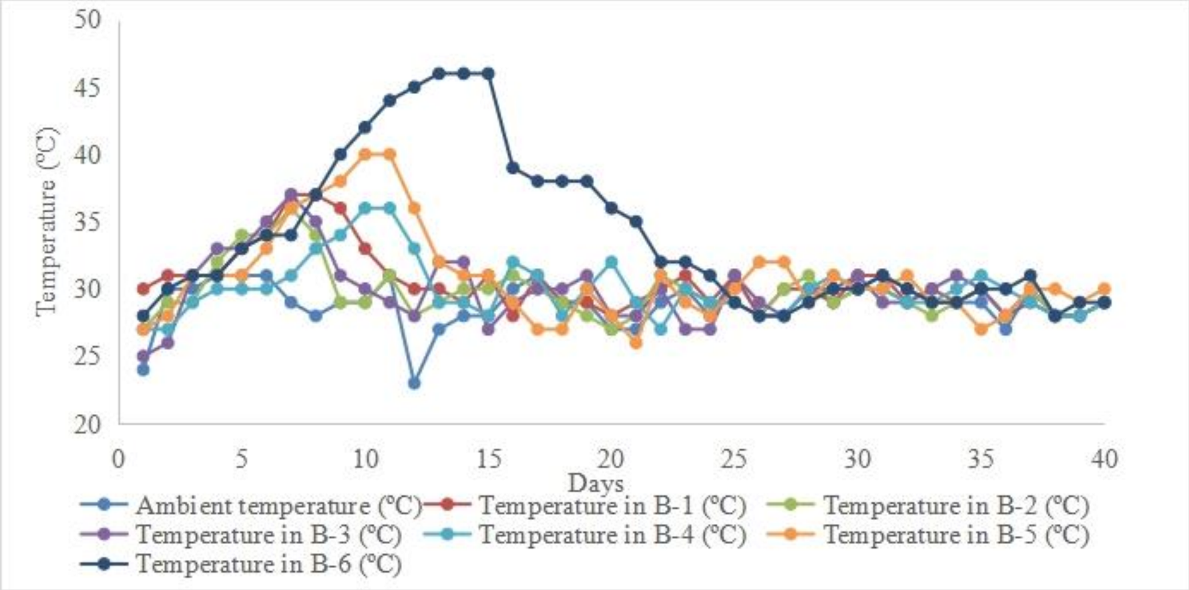


**Figure 1:** (Temperature variations over time in composting bin 1, bin 2, bin 3, bin 4, bin 5 and bin 6)

Temperatures in all composting bins (B-1 to B-6) gradually decreased to ambient levels, indicating that the materials had reached the maturity stage. The decline in temperature after the active composting phase was attributed to substrate depletion and reduced microbial activity. Bins B-5 and B-6 recorded higher peak temperatures, reaching 40 ºC on day 10 and 46 ºC on day 13, respectively, reflecting accelerated microbial decomposition. Optimal decomposition occurs between 40 to 66 ºC, which eliminates pathogens while supporting beneficial psychrophilic, mesophilic, and thermophilic bacteria, ultimately enhancing compost quality (Beirut, 2011).

### 3.2.2 pH

The pH of composting materials was measured at six-day intervals throughout the process to monitor microbial activity and material stability. Initial reductions in pH across the composting bins reflected the accumulation of organic acids, which created acidic conditions. Such conditions are favorable for fungal growth and the breakdown of complex organic compounds such as lignin and cellulose. As composting progressed, these organic acids were gradually neutralized, leading to an increase in pH toward neutrality, a stage commonly associated with compost maturation.

In bin B-1, pH decreased from 6.68 on day 1 to 5.94 on day 12, before rising to 8.16 by day 40. Similarly, bin B-2 exhibited a decline from 6.74 to 6.58 by day 18, followed by an increase to 8.23 on day 40. In bin B-3, pH rose consistently from 5.99 at the start to 7.08 by day 40. Bin B-4 showed a decline from 6.11 to 5.98 within the first 12 days, then increased steadily to 7.22 by day 40. In bin B-5, pH decreased from 6.34 to 5.99 on day 12, then increased to 7.81 by the end of composting. Bin B-6 recorded the lowest initial pH of 5.94, which dropped further to 5.37 by day 12, before rising gradually to 7.32 on day 40.

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Overall, the observed pH dynamics across all bins highlight a common composting trend, an initial acidification phase, followed by a neutralization and stabilization phase, which reflects microbial succession and material maturation.

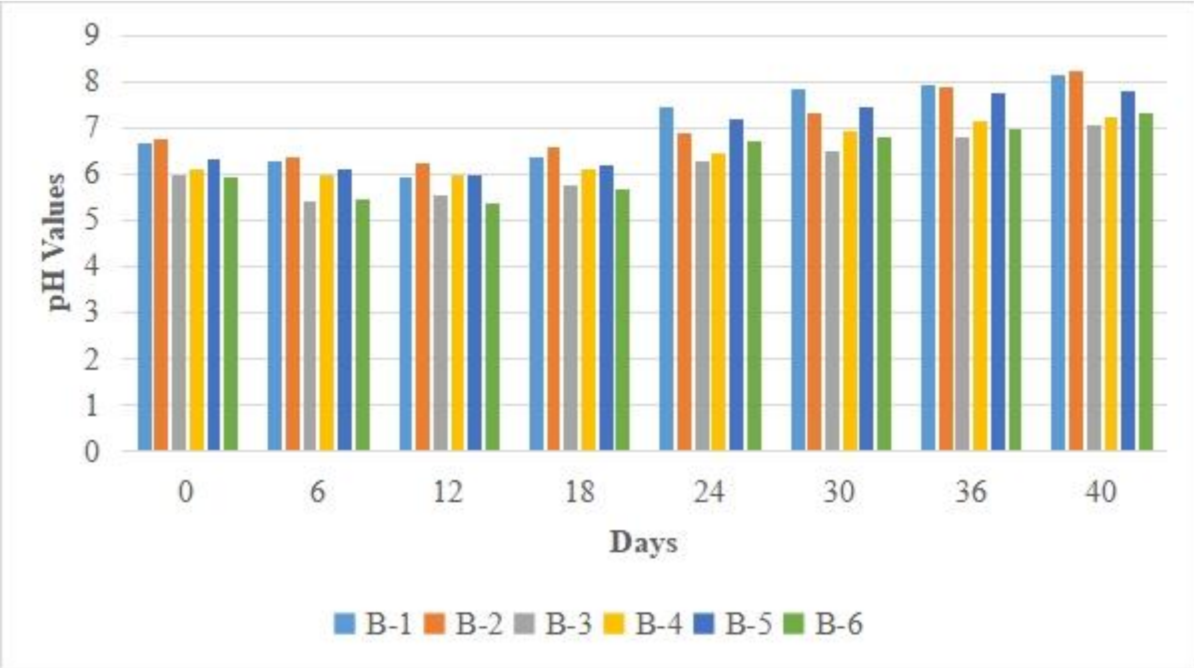


**Figure 2:** (pH Variations over time in all composting bins)

The initial decline in pH observed in the composting bins can be attributed to the degradation of organic carbon into organic acids by acid-forming bacteria, as well as the mineralization of organic nitrogen compounds into inorganic forms such as ammonium and nitrate. Mineralization occurs through microbial activity that converts proteins and other nitrogenous materials into simpler inorganic compounds. The subsequent rise in pH during the composting process is largely associated with ammonification, whereby ammonium is released, increasing alkalinity within the composting environment.

### 3.2.3 Moisture content

Moisture content varied across the composting bins, ranging between 55.75 to 85.81% in B-1, 52.59 to 89.26% in B-2, 55.62 to 91.55% in B-3, 57.64 to 89.29% in B-4, 52.33 to 88.76% in B-5, and 58.27 to 84.54% in B-6, as illustrated in Figure 3.

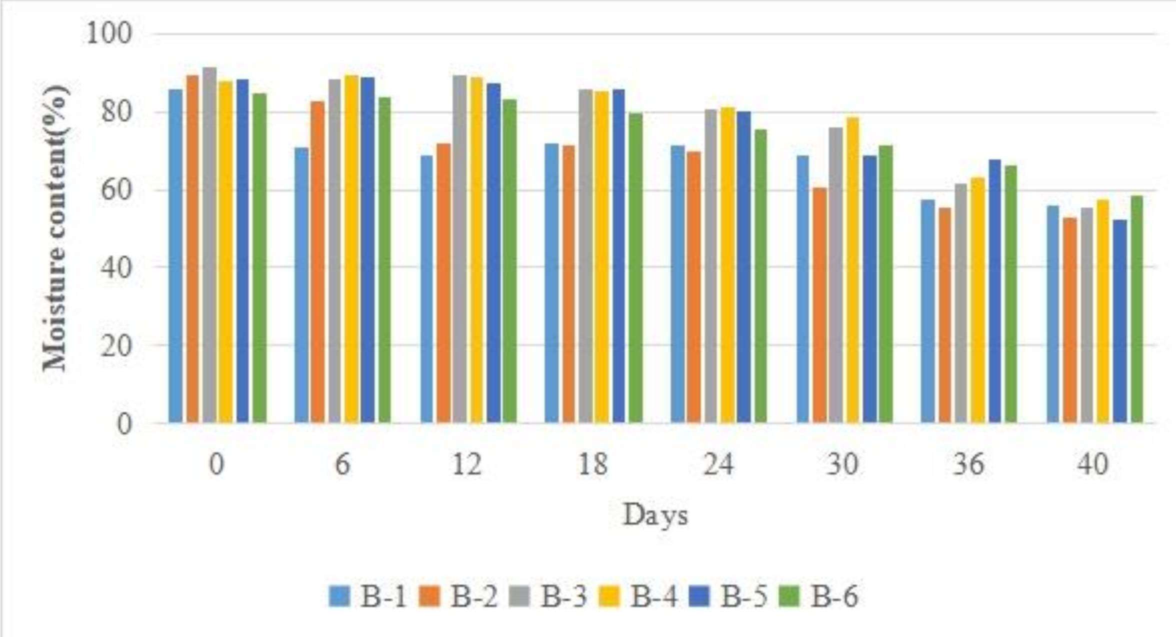


**Figure 3:** (Moisture content variation in different composting bins)

Overall, moisture content in the composting bins ranged between 52 to 92% during the composting process (Figure 3). The gradual decrease in moisture was facilitated by enhanced aeration, which promoted evaporation and improved oxygen availability, thereby preventing excess water accumulation.

### 3.3 The Quality of Compost Generated

The quality of the compost produced was assessed by evaluating specific physicochemical parameters, which serve as reliable indicators of compost stability and maturity (Bernal et al., 2009; Haug, 2018).

#### 3.3.1 Total organic Carbon

The total organic carbon (TOC) content in composting bins showed a gradual decline throughout the composting period. Specifically, TOC in bin B-1 decreased from 49.21% to 42.72%, B-2 from 45.78% to 38.82%, B-3 from 47.41% to 39.45%, B-4 from 48.83% to 42.91%, B-5 from 42.37% to 36.52%, and B-6 from 46.18% to 40.11%, as illustrated in Figure 4. The progressive reduction in TOC across all bins indicates microbial activity, where carbon was utilized as a primary energy source during organic matter decomposition (Bernal et al., 2009; Haug, 2018).

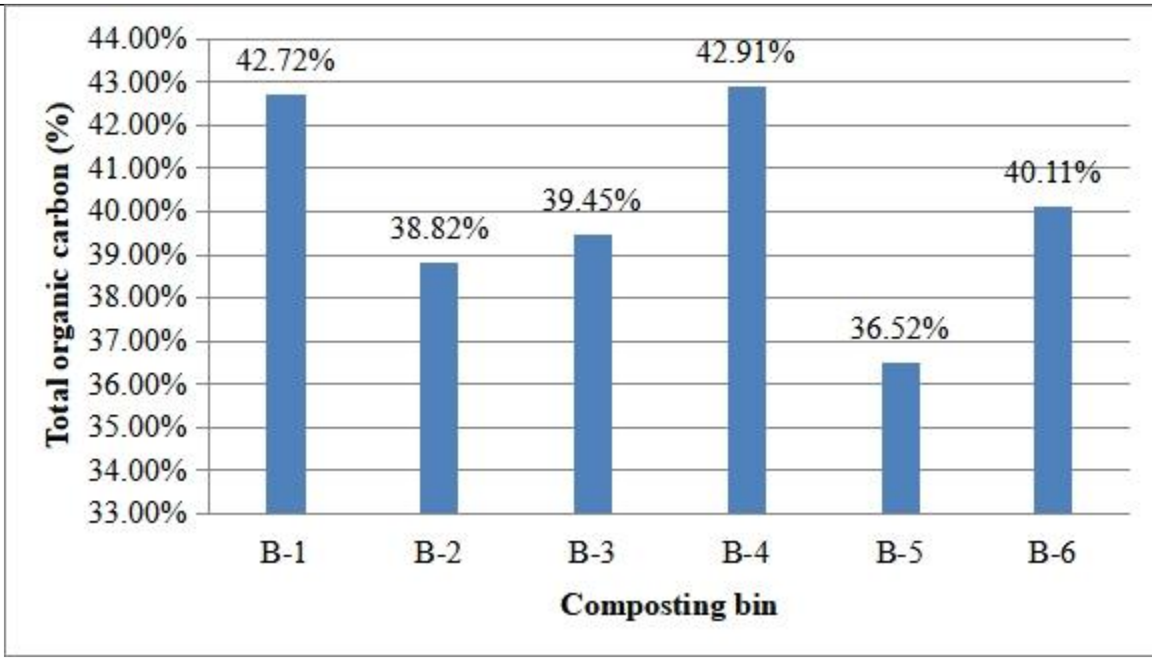


**Figure 4:** ( Indicates a total organic carbon of matured compost in all composting bins)

The highest total organic carbon (42.91%) was recorded in B-4, likely due to recalcitrant compounds such as cellulose and lignin limiting decomposition. Conversely, the lowest value (36.52%) in B-5 resulted from microbial oxidation of carbon into carbon dioxide (Bernal et al., 2009; Haug, 2018).

### 3.3.2 Total Nitrogen

The total nitrogen (TN) content in composting bins showed progressive variation during the composting process. In bin B-1, TN increased from 0.91% to 1.12%, while in B-2 it ranged between 1.72% and 1.92%. Similarly, B-3 recorded values from 1.27% to 1.56%, B-4 from 0.69% to 0.98%, B-5 from 1.63% to 1.88%, and B-6 from 0.67% to 0.92%, as illustrated in Figure 5. These fluctuations indicate nitrogen mineralization and microbial assimilation, processes that typically enhance nitrogen retention within compost matrices (Mazzà et al., 2020).

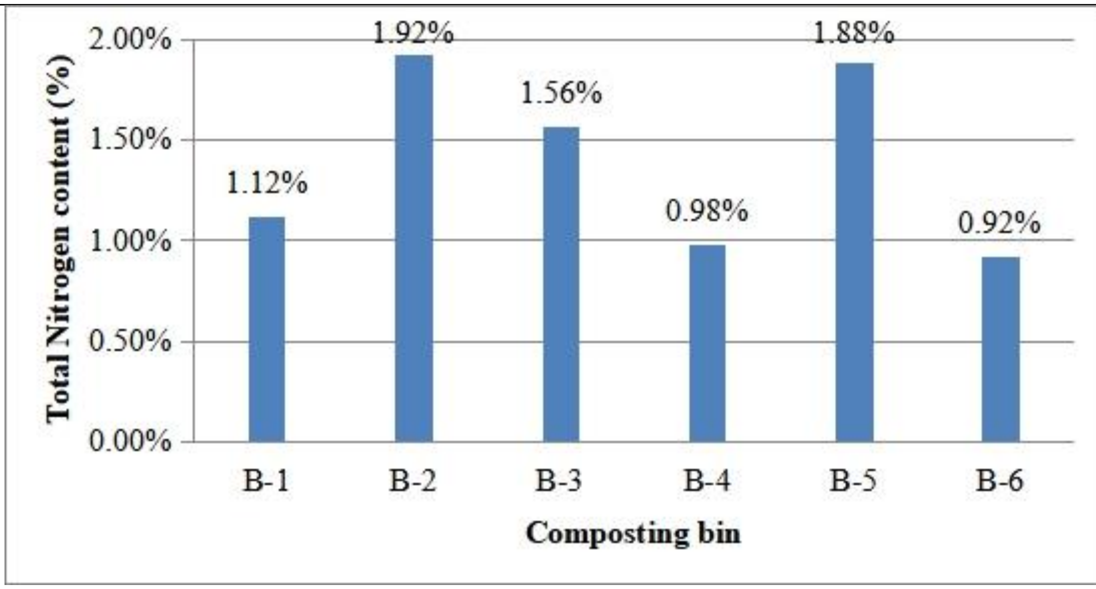


**Figure: 5** (Nitrogen content of matured compost in all composting bins)

Total nitrogen (TN) content exhibited an increasing trend across all composting bins throughout the composting period. The highest TN concentration was observed in B-2 (1.92%), which may be attributed to enhanced activity of nitrogen-fixing microorganisms commonly present in composting systems, facilitating greater nitrogen accumulation. In contrast, the lowest TN value was recorded in B-6 (0.92%), likely resulting from limited microbial activity and reduced efficiency of nitrogen fixation within the compost matrix. Such variations highlight the influence of microbial dynamics on nutrient composition during composting (Sawaya et al., 2024).

### 3.3.3 Carbon to Nitrogen ratio

The carbon-to-nitrogen (C/N) ratio, a critical indicator of compost maturity, was assessed simultaneously across all composting bins. In B-1, the ratio declined from 54.1 to 38.1, while in B-2 it ranged from 26.6 to 20.2. Similarly, B-3 decreased from 37.3 to 25.3, B-4 from 70.8 to 43.8, B-5 from 25.9 to 19.4, and B-6 from 68.9 to 43.6, as illustrated in Figure 6. The declining C/N ratios reflect microbial decomposition of organic matter, where carbon was oxidized and nitrogen retained, thereby enhancing compost stability and quality.

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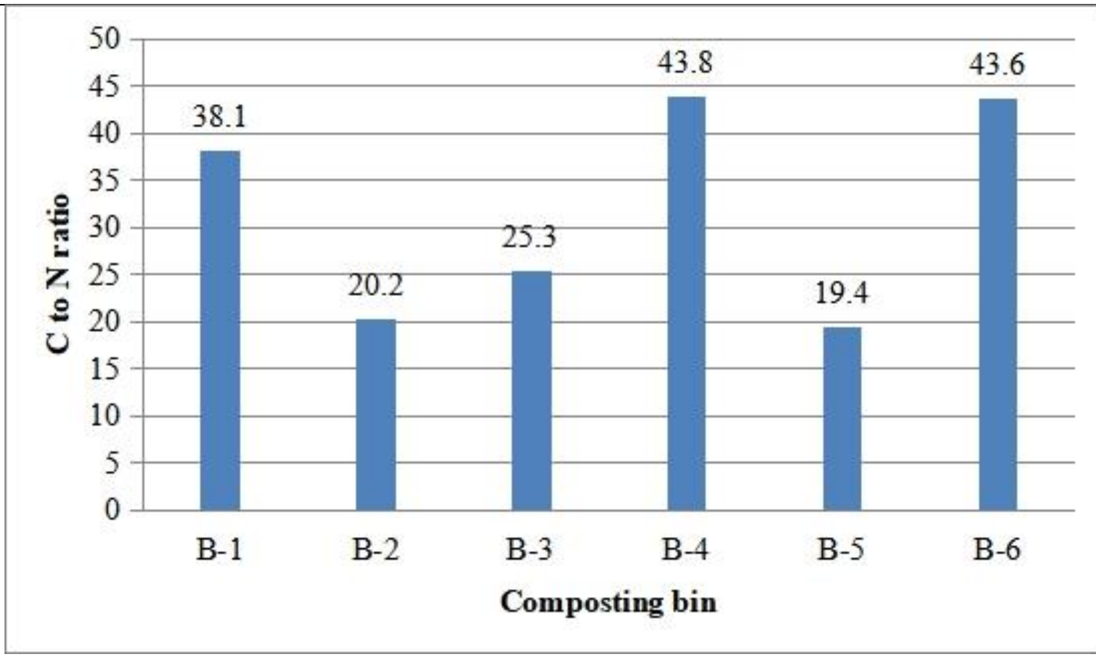


**Figure: 6** (Carbon to Nitrogen ratio of matured compost in all composting bins)

Across all composting bins, the carbon-to-nitrogen (C/N) ratio declined over time, reflecting progressive organic matter decomposition. Matured compost in B-4 exhibited the highest C/N ratio (43.8), likely due to the persistence of recalcitrant compounds such as lignin and cellulose, which slow carbon loss as carbon dioxide. Conversely, B-5 showed the lowest C/N ratio (19.4), as microbial consumption of organic compounds typically results in two-thirds of carbon being released as $CO_2$, while the remaining third is temporarily incorporated into microbial biomass and subsequently recycled upon microbial cell death. These dynamics highlight the interplay between carbon degradation and nitrogen retention (Hussein et al., 2022).

### 3.4 Best Ratio of Mixture for Production of Good Quality Compost.

During the composting experiment, composting bin B-5 produced the highest quality compost, attributed to its higher proportion of banana peels relative to banana leaves and stems. The mixture in B-5 was prepared in a ratio of 0.5:0.75:0.25 (banana peels: leaves: stems), resulting in a matured compost C/N ratio of 19.4:1, which falls within the recommended range for stable compost (below 20:1) (Jashni et al., 2016). The C/N ratio in B-5 declined from 25.9:1 to 19.4:1 over the composting period. This reduction can be explained by microbial activity during decomposition, approximately two-thirds of the carbon in organic compounds is released as carbon dioxide, while the remaining third is temporarily incorporated into microbial biomass along with nitrogen. Upon microbial cell death, nitrogen is released back into the compost matrix, enhancing nutrient content.

Additionally, the temperature in B-5 increased from 27 °C on the first day to 40 °C by the tenth day during the active composting stage. This elevated temperature likely contributed to pathogen reduction and the elimination of harmful bacteria while promoting the proliferation of beneficial microorganisms, thereby improving compost quality and stability. The synergy between substrate composition, microbial activity, and thermophilic conditions was crucial for producing nutrient rich, mature compost.

### 3.5 Statistical Analysis

The study reported the mean and variance of measured carbon to nitrogen (C/N) ratios to evaluate changes during the composting process and after maturation. A statistical comparison was performed using a t-test to determine whether the differences in C/N ratios between the active composting phase and the matured compost were significant. The t-test results yielded a p-value of 0.00825, which is below the conventional significance threshold of 0.05 ($p < 0.05$), as presented in Table 3. This indicates that the observed differences in C/N ratios were statistically significant, reflecting meaningful changes in the composting materials over time (Kim, T. K. 2015). The reduction in the C/N ratio from the initial to the matured compost highlights the effective decomposition of organic matter and the stabilization of compost. These findings suggest that microbial activity and material composition during the composting process substantially influenced nutrient dynamics, and the measured parameters can be considered highly reliable indicators of compost maturity and quality

**Table 3: T-test, Paired two sample for means**

| Values | Day 20 | Day 40 |
|---|---|---|
| Mean | 47.26666667 | 31.73333333 |
| Variance | 410.2986667 | 130.6946667 |
| Observations | 6 | 6 |
| Pearson Correlation | 0.993388982 | |
| Hypothesized Mean Difference | 0 | |
| df | 5 | |
| t Stat | 4.22976197 | |
| P(T<=t) one-tail | 0.004125075 | |
| t Critical one-tail | 2.015048372 | |
| P(T<=t) two-tail | 0.008250149 | |
| t Critical two-tail | 2.570581835 | |

## 4. CONCLUSION

The composting experiment demonstrated that the composition of organic materials significantly influences compost quality. Composting bin B-5, with a higher proportion of banana peels (0.5:0.75:0.25), produced the best-quality compost, as indicated by a matured C/N ratio of 19.4:1, which falls within the recommended range for stable compost. In contrast, B-4 exhibited the highest C/N ratio (43.8:1), likely due to recalcitrant compounds such as cellulose and lignin slowing carbon loss. Temperature monitoring revealed that B-5 and B-6 reached 27 to 46 °C, facilitating pathogen reduction and promoting beneficial microbial activity, whereas B-1 to B-4 remained below 40 °C, which may compromise compost hygiene. Organic carbon was highest in B-4, B-1, and B-6, while nitrogen content peaked in B-2 and B-5, reflecting microbial activity. Moisture (52 to 92%) and increasing pH supported aerobic decomposition. Future research should explore optimized ratios of peel to stem materials, enhanced aeration strategies, and

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microbial inoculants to improve compost quality and reduce maturation time, ensuring consistent production of nutrient rich, pathogen free compost.

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## REFERENCES

*Bernal, M. P., Alburquerque, J. A., & Moral, R. (2009). Composting of animal manures and chemical criteria for compost maturity assessment. Bioresource Technology, 100(22), 5444–5453.*

*Bosch, Ch. H. and Shwagala, D. H. (1994). Kibanja size and coffee production in Bukoba Rural District. Farming Systems Research Programme, Field Note No. 39. Bukoba, Tanzania, Lake Zone ARI-Maruku.*

*Diaz, L. F., de Bertoldi, M., Bidlingmaier, W., & Stentiford, E. (2007). Compost Science and Technology. Elsevier.*

*El-Hoz, M. (2015). Market-based system of municipal solid waste composting. The Journal of Solid Waste Technology and Management, 41(3), 239-248.*

*Farah, J., Ghaddar, R., Nasr, E., Nasr, R., Wehbe, H., & Verdeil, É. (2020). Solid waste management in Lebanon: Lessons for decentralisation (Doctoral dissertation, Democracy Reporting International).*

*Gupta, N., & Yadav, K. K. (2019). Sustainable management of solid waste: Challenges and prospects. Environmental Chemistry Letters, 17(3), 783–806.*

*Haug, R. T. (1993). The practical Handbook of Compost Engineering. Boca Raton:Lewis Publishers.*

*Hussein, L., Uren, C., Rekik, F., & Hammami, Z. (2022). A review on waste management and compost production in the Middle East–North Africa region. Waste Management & Research, 40(8), 1110-1128.*

*Karimi-Jashni, A., Talebbeydokhti, N., Azadi, S., & Binaei, A. (2016). Assessment of compost production from mixed municipal solid waste: A case study in Shiraz city, Iran.*

*Kilimo Trust (2012). Banana Value Chain(s) in the EAC. Consumption, productivity and challenges*

Vol. 10, No. 04; 2025

ISSN: 2456-8643

*Kim, T. K. (2015). T test as a parametric statistic. Korean journal of anesthesiology, 68(6), 540-546.*

*Kumar, A., Samadder, S. R., Kumar, N., & Singh, C. (2020). Estimation of the environmental impact of landfill disposal of municipal solid waste in Indian cities. Waste Management, 103, 22–32.*

*Martinson, S., van de Kamp, M., & Tso, S. (2011). Guide to Agricultural Composting. Commonwealth of Massachusetts, 1.*

*Mazzà, G., Malek, R., Raguzzoni, K., Ragazzi, M., & Ciolli, M. (2020). The Usage of Compost-Like Outputs in Lebanon: regulatory framework, opportunities and threats. A Survey.*

*Moqsud, M. A., Rahman, M. A., & Mahmud, K. (2011). Landfill leachate treatment: Review and opportunity. Asian Journal of Water, Environment and Pollution, 8(2), 27–34.*

*Rugalema, G. and Mathieson, K. (2009). Disease, Vulnerability and Livelihoods on the Tanzania-Uganda Interface Ecosystem to the West of Lake*

*Victoria.Rynk*

*Sawaya, R., Halwani, J., Nehme, N., Alawiye, H., & Diab, W. (2024). Assessment of the Characteristics of the Municipal Solid Waste Compost in Lebanon. Journal of Geoscience and Environment Protection, 12(5), 17-39.*

*United Nations. (n.d.). Goal 2: Zero Hunger. United Nations Sustainable Development. Retrieved August 16, 2025, from https://www.un.org/sustainabledevelopment/hunger/*

*United Nations*

*United Nations. (n.d.). Goal 12: Ensure sustainable consumption and production patterns. United Nations Sustainable Development. Retrieved August 16, 2025, from*

*https://www.un.org/sustainabledevelopment/sustainable-consumption-production/*

*United Nations +1*

*United Nations. (n.d.). Goal 13: Take urgent action to combat climate change and its impacts. United Nations Sustainable Development. Retrieved August 16, 2025, from https://sdgs.un.org/goals/goal13*

*URT. (2005). Kagera Regional Socio-Economic Profile. Dar es Salaam: United Republic of Tanzania, Ministry of Planning.*

*Weerdt, J. (2003). Banana production systems in the Great Lakes Region of East Africa. International Food Policy Research Institute.*