



# Local Microorganisms from Tomato, EM4, and Cattle Rumen Affect The Production of Organic Fertilizer from Cabbage Waste and Banana Peels

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**Abstract.** The abundance of cabbage waste and banana peels presents an opportunity for their utilization as raw materials in the composting process. Composting is the decomposition of organic matter facilitated by the activity of microorganisms acting as decomposers. Through this process, organic materials are transformed into compost, enriched with essential nutrients, which in turn promote the growth of beneficial soil microorganisms. The acceleration of the composting process can be achieved using bio activators. In this study, bio activators including tomato-based local microorganisms (MOL), EM4, and cattle rumen were used. The research involved varying the raw materials and adding 50 ml of bio activator, resulting in changes in nutrient content and the C/N ratio. Analysis indicated both improvements and reductions in compost quality over the course of the composting period, with fluctuating levels of parameters such as C-Organic, nitrogen (N), phosphorus (P), potassium (K), and the C/N ratio.

**Keywords:** Banana peel, Bio activator, Cabbage, Composting, Organic Material

## 1 Introduction

Waste management poses significant environmental challenges resulting from societal activities that require effective handling. Improper waste management risks compromising ecosystems and environmental health [1]. The waste composition at Segiri Market in Samarinda is predominantly organic, comprising 97.67% organic waste, with 95.45% consisting of vegetable and fruit residues [2]. Cabbage waste and banana peels in particular, hold potential as raw materials for composting. Composting enhances the characteristics of organic waste by reducing its volume and mass [3].

Composting involves the decomposition of organic matter, utilizing microbial activity as decomposers. This process transforms organic materials into nutrient-rich compost, enhancing soil fertility and supporting plant growth [4]. The effectiveness of com-

posting can be enhanced through bio activators, which expedite the decomposition process, resulting in a more consistent product and a relatively straightforward production method [5].

Bio activators, such as Local Microorganisms (MOL), are cultivated microbial communities used as starters to accelerate composting. EM4 is a commonly used bio activator in composting processes and is known to improve compost quality [6]. The addition of EM4 and cattle rumen significantly affect the maturity time and quantity of the resulting compost [7].

Given this background, this study aims to investigate the effect of using a mixture of tomato-based MOL, EM4, and cattle rumen on the composting time of cabbage and banana peel waste. The objective is to evaluate the impact of bio activators on the values of C, N, P, K, and the C/N ratio.

## 2 Materials and Methods

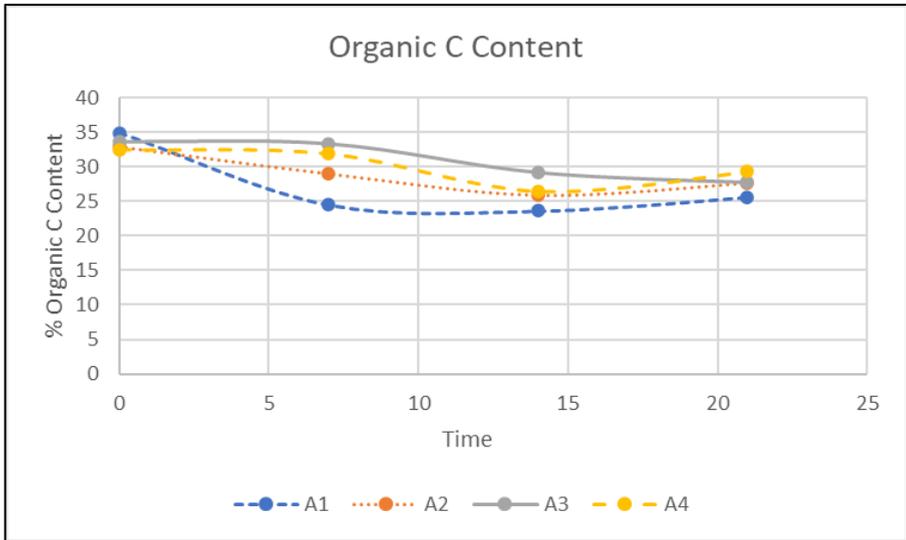
The study utilized cabbage and banana peel waste in a 1:1 ratio, with variations including cabbage peel (A1), cabbage peel + tomato MOL (A2), cabbage peel + EM4 (A3), and cabbage peel + cattle rumen (A4). A volume of 50 ml of bio activator was added to each mixture, and the composting process lasted for 21 days. Analysis of C, N, P, K, and the C/N ratio was conducted every 7 days.

## 3 Results

### 3.1 C-Organic Content

Under ideal conditions, C-Organic levels decrease progressively throughout the composting process. However, this study observed an increase in C-Organic levels toward the end of the composting period across all treatments. The recorded C levels on days 7, 14, and 21 for A1 were 34.85%, 24.49%, 23.60%, and 25.56%, respectively. For A2, C levels were 32.89%, 28.99%, 25.88%, and 27.64%. The analysis indicated that reduced microbial activity might lead to increased C-Organic content, likely due to decreased decomposition efficiency or microbial death [5]. The graph of organic C content can be seen in Fig. 1.

On the 21st day, there was an increase in the C content, which is suspected to have occurred due to a decrease in microbial activity and the presence of dead microorganisms. This increase in organic C was caused by the reduction in microbial activity and the presence of dead microorganisms, as the food reserves had been depleted. The death of composting microorganisms adds to the biomass, thereby increasing organic C, especially at the end of the composting period [8].

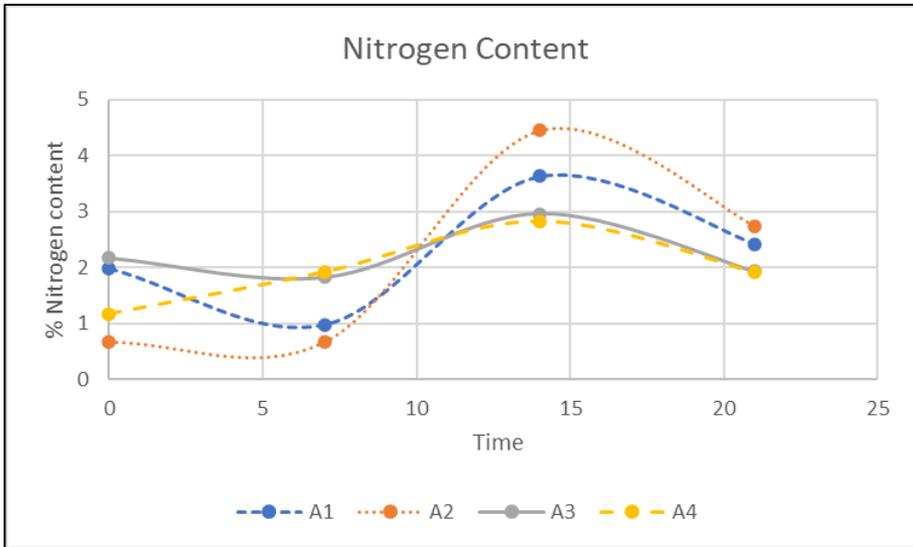


**Fig. 1.** Graph of Organic C Content and Time

### 3.2 Nitrogen (N) Content

Nitrogen (N) plays a crucial role in the decomposition of organic matter, acting as a vital nutrient for microbial growth. Ideally, nitrogen levels increase during composting, yet this study found fluctuations and a decline in nitrogen content towards the end. Nitrogen content varied across treatments, with A1 showing 1.98%, 0.97%, 3.63%, and 2.42%, and similar variations in A2, A3, and A4. Nitrogen is essential for protein formation and plant growth; its deficiency can hinder plant development, causing symptoms like chlorosis (leaf yellowing or pale) [5]. The graph of the nitrogen content in the composting can be seen in Fig. 2.

The nitrogen content in compost is greatly influenced by the composting process and the raw materials used. If composting occurs under optimal conditions, the nitrogen content in the compost will be high because, in these conditions, sufficient  $O_2$  is available for microorganisms to convert proteins into ammonium and nitrate. Additionally, if the nitrogen content of the compost raw materials is high and there is a sufficient amount of carbon, a large amount of ammonium will be released by the bacteria. The increase in nitrogen levels is also caused by the reduction in the weight of compost materials due to the evaporation of  $CO_2$  and  $H_2O$ , as well as the release of certain nutrients through the mineralization process, which results in an increase in the concentration of nitrogen in the compost [9].



**Fig. 2.** Graph of Nitrogen Content and Time

### 3.3 Phosphorus (P) Content

During the composting process, phosphorus (P) is utilized by microorganisms to synthesize cellular proteins. The analysis of phosphorus content in the compost revealed that, for treatment A1, the P levels were 0.16%, 0.35%, 0.05%, and 0.44%. For treatment A2, the P content was 0.30%, 0.37%, 0.38%, and 0.34%. In treatment A3, the values recorded were 0.22%, 0.24%, 0.51%, and 0.33%, while treatment A4 showed phosphorus levels of 0.14%, 0.61%, 0.49%, and 0.37%.

There was an initial increase in phosphorus content at the beginning of the study, followed by a decline between day 14 and day 21 of composting. This initial rise in phosphorus can be attributed to the decomposition of organic matter, during which microorganisms break down the composting material. As the compost matures, microbial death occurs, and the phosphorus within these microorganisms is released into the compost, thereby increasing its phosphorus content. The subsequent decrease in total phosphorus is likely due to its uptake by decomposer microorganisms. Moreover, high phosphorus levels are often correlated with the nitrogen content of the compost; as the nitrogen levels increase, the microbial population also grows, leading to greater phosphorus breakdown and thus an increase in phosphorus content within the compost material [7].

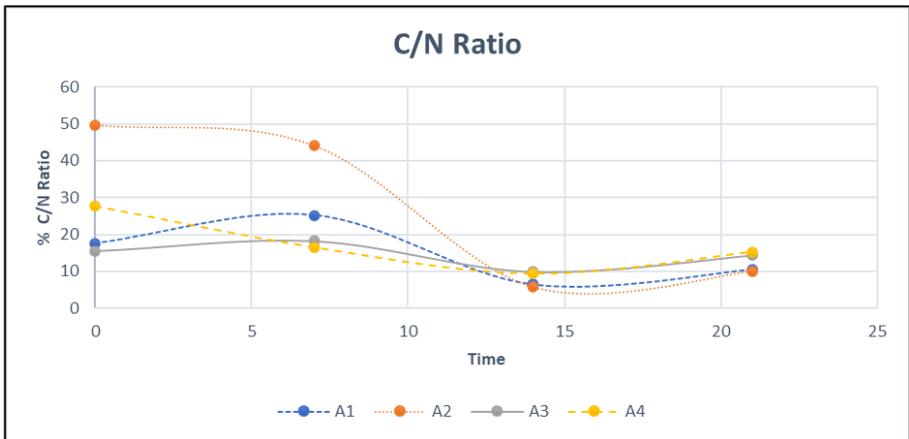
### 3.4 Potassium (K) Content

Potassium (K) is a vital nutrient for photosynthesis, contributing to plant cell structure and strengthening. The potassium content showed variable levels among the treatments,

with an overall trend of slight increases and decreases, reflecting its dynamic role in both soil fertility and plant growth processes [5].

### 3.5 C/N Ratio

The C/N ratio of organic raw materials in compost is a crucial factor influencing the rate of the composting process. The method used to determine the C/N ratio is the calculation method. The C/N ratio is calculated by comparing the content of C-Organic (carbon) and nitrogen (N). Ideally, the C/N ratio should decrease over time as the composting process progresses. However, in this study, the actual conditions showed a fluctuating C/N ratio, with an increase observed towards the end of the process. The C/N ratio values recorded were as follows: for A1 — 17.63, 25.22, 6.5, and 10.57; for A2 — 49.67, 44.13, 5.81, and 10.09; for A3 — 15.51, 18.22, 9.88, and 14.35; and for A4 — 27.77, 16.56, 9.37, and 15.29. Microorganisms require both carbon and nitrogen as energy sources for the decomposition process. Carbon serves as an energy source for microorganisms, while nitrogen is essential for protein synthesis. The C/N ratio in organic compounds indicates the availability of nutrients. If organic matter with a high C/N ratio is directly applied to the soil (without being composted first), the decomposition process will take place in the soil itself [7]. The following is a table of the C/N ratio over 21 days of observation.



**Fig. 3.** Graph of C/N Ratio and Time

The C/N ratio indicates the degree of maturity of an organic material, where a C/N ratio greater than 30 signifies immature material, and a C/N ratio less than 30 indicates mature material [10]. The reduction in the C/N ratio in each compost bin is attributed to the decreasing carbon content, which is utilized as an energy source by microbes to decompose or degrade organic material. During the composting process, organic matter undergoes transformation into CO<sub>2</sub>, H<sub>2</sub>O, nutrients, humus, and energy. Throughout this process, CO<sub>2</sub> evaporates, leading to a decline in carbon (C) levels and an increase

in nitrogen (N) levels, thereby lowering the C/N ratio of the compost. A high C/N ratio can slow down the decomposition process, whereas a low C/N ratio may initially accelerate the decomposition but slow down later due to a lack of carbon as an energy source for microorganisms. The C/N ratio serves as a key parameter for assessing compost quality based on its maturity level. Compost maturity can be measured by the reduction in the C/N ratio, driven by the activity of degradation activators that utilize organic matter [11].

The decomposition process proceeds rapidly but eventually slows down due to a lack of carbon (C) as an energy source for microorganisms. The increase in phosphorus content at the beginning of the composting process is attributed to the decomposition of organic matter. During the maturation stage, microorganisms die, releasing phosphorus (P) into the compost, which subsequently increases its phosphorus content. Conversely, the decline in total phosphorus (P) occurs due to microbial consumption of phosphorus during the decomposition process [12]. High phosphorus levels can also be associated with nitrogen content in the compost. The higher the nitrogen content, the greater the microbial population, resulting in increased phosphorus breakdown and, consequently, elevated phosphorus levels in the compost [13].

Microorganisms not only decompose nitrogen but also utilize potassium for their metabolic activities. During the composting process, microorganisms use potassium within the substrate as a catalyst. The presence and activity of bacteria significantly impact the increase in potassium content. However, the reduction in potassium levels is due to microbial activity in breaking down organic matter, which depletes the potassium content in the liquid organic fertilizer. Additionally, the formation of organic acids during the decomposition process increases the solubility of nutrients such as calcium (Ca), phosphorus (P), and potassium (K). Meanwhile, the microbial decomposition of organic matter reduces the potassium content in liquid organic fertilizer [14].

## 4 Conclusions

The findings of this study reveal that the quality of compost made from cabbage and banana peel waste, using bio activators like tomato MOL, EM4, and cattle rumen over 21 days, exhibited both improvements and declines in nutrient content and C/N ratio. The compost's fluctuating quality was observed in parameters such as C-Organic, nitrogen (N), phosphorus (P), potassium (K), C/N ratio, and moisture content.

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