The effectiveness of cellulolytic microbes and cow manure consortium for the composting technology of the garbage at the garden in Faculty of Science and Technology Airlangga University

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Abstract. This research aimed to determine the influence of adding a consortium of cellulolytic microbe, cow manure, and mixture of cellulolytic microbe and cow manure towards the composting process of garbage at the garden of the Faculty of Science and Technology Airlangga University. The independent variables used were a microbial cellulolytic consortium, cow manure, and a consortium of microbial cellulolytic and cow manure. The independent variables were the color, moisture content, pH, temperature, C-organic, N-total, and the ratio C/N. The composting technology implemented in this research was windrow composting. The difference between garbage and cow manure added was 3:1, meaning 1.5 kg cow manure for 4.5 kg garbage. For the treatment, the ratio of the addition of microbial cellulolytic consortium to garbage was 20:1, meaning 90 ml microbial cellulolytic consortium for 4.5 kg garbage. The cellulolytic microbial consortium used consisted of Bacillus sp., Lactobacillus sp., Pseudomonas sp., and Cellulomonas sp. From the Microbiology Laboratory of Biology Department at the Faculty of Science and Technology Airlangga University, as much as 20 ml/kg of garbage and 1.5 kg of cow manure for each garbage volume from the Faculty of Veterinary Medicine Airlangga University was processed. The results showed that there was a treatment effect on the composting process, which was indicated by the decrease in the ratio of C/N. The addition of cellulolytic microbial consortium is the most effective because composting can decrease C/N ratio by 80.41%.

1. Introduction

Garbage is a solid waste material from household activities, markets, offices, lodgings, hotels, restaurants, industries, etc. Garbage is also a by-product of human activity that has been used [1]. The management of garbage should be done so as not to adversely affect the environment and other living beings. One way to manage organic waste is to convert it into compost.

In this study, organic waste is converted into compost using the windrow composting method. Windrow composting is a simple composting technique, which is done by stacking compost in rows of piles arranged in parallel. The pile is periodically flipped for air circulation to flatten and lower the temperature and humidity of compost [2]. The starter used in this research was a consortium of cellulolytic microbes and cow manure. The cellulolytic microbial consortium used consists of Bacillus sp., Lactobacillus sp., Pseudomonas sp., and Cellulomonas sp.
2. Research Materials and Methods

The materials used in this research are 180 kg of leaf waste from the Faculty of Science and Technology Airlangga University (FST UNAIR) garden for 24 treatments, 18 kg of fresh cow manure from Faculty of Veterinary Medicine Airlangga University for 12 treatments, 1080 ml of starter in the form of a microbial consortium of Bacillus sp., Lactobacillus sp., Pseudomonas sp., and Cellulomonas sp. from the Laboratory of Microbiology, Department of Biology FST UNAIR for 12 treatments, and water to regulate moisture. The tools used in this research are shovels, buckets, gloves, plastic bags, scales, shredder, masks, thermometer, soil tester, oven, pans, aluminum plates, raffia ropes, drop pipettes, and measuring cups.

2.2 Methods

First, as a control, 4.5 kg of garbage was homogenized, then covered with plastic. As for the second treatment of windrow composting, 4.5 kg of garbage were added with 1.5 kg of cow manure, so the ratio is 3: 1. They were then homogenized and closed. The third treatment of windrow composting was 4.5 kg of garbage added with 90 ml of cellulolytic microbial consortium. After that, it was homogenized and closed. The fourth one was 4.5 kg of garbage added with 1.5 kg of cow manure and 90 ml of cellulolytic microbial consortium, then homogenized and closed with plastic. Periodically, the garbage was stirred and added with water if the condition was less moist.

2.3 Data Analysis

Data analysis was conducted using two methods; descriptive and statistical. The data of color, pH, moisture, and temperature were analyzed descriptively. The data of C-organic, N-total, and C/N ratio data were statistically analyzed using one-way ANOVA and continued with Duncan test of 5% level [3].

3. Results and Discussion

3.1 Effects of Treatment on C-Organic Waste from FST UNAIR Garden

Table 1. Effects of treatment on mean value of C-Organic decrease on compost

| No. | Treatment Addition | Average C-Organic | C-Organic Decrease | C-Organic Decrease (%) |
|-----|--------------------|-------------------|-------------------|-----------------------|
| 1.  | I                  | 15.65             | -                 | -                     |
| 2.  | C                  | 10.36 ± 0.92 b    | 5.29              | 33.80                 |
| 3.  | CMC                | 9.03 ± 1.00 a     | 6.62              | 42.30                 |
| 4.  | CF                 | 10.04 ± 0.57 ab   | 5.61              | 35.84                 |
| 5.  | CFCMC              | 11.20 ± 1.40 b    | 4.45              | 28.43                 |

Description: numbers followed by different letters show a real difference based on Dunca test at 5% level (α = 0.05)

Notes:
A = Initial
C = Control
CMC = Cellulolytic microbial consortium
CF = Cow manure
CFCMC = Mixture of consortium of cellulolytic microbes and cow manure

Based on Table 1, C-organic decline at cellulolytic microbial consortium (CMC) reach 42.30% if that compared by C-organic before the composting. It is suspected as more and more microbes of cellulose degradation which contained on it [4].

Based on Table 2. N-total increase at cellulolytic microbial consortium (CMC) reach 190% if that compared by N-total before the composting. The element N in soil comes from the decomposition of organic matter of crop residues, animal, fertilizer, and rainwater [5].
3.2 Effects of Treatment on N-Total of Waste from FST UNAIR Garden

Table 2. The effects of treatment on the mean value of the decrease of N-total on the compost

| No. | Treatment Addition | Average N-total (g/kg) | Decrease of N-total (g/kg) | Decrease of N-total (%) |
|-----|---------------------|------------------------|---------------------------|-------------------------|
| 1.  | I                   | 0.21                   | -                         | -                       |
| 2.  | C                   | 0.48 ± 0.02 a          | 0.27                      | 128                     |
| 3.  | CMC                 | 0.61 ± 0.06 b          | 0.4                       | 190                     |
| 4.  | CF                  | 0.58 ± 0.03 b          | 0.37                      | 176                     |
| 5.  | CFCMC               | 0.56 ± 0.05 b          | 0.35                      | 166                     |

Description: numbers followed by different letters show a real difference based on Dunca test at 5% level (α = 0.05)

Notes:
A = Initial
C = Control
CMC = Cellulolytic microbial consortium

3.3 Effects of Treatment on C/N Ratio of Waste from FST UNAIR Garden

Table 3. The effects of treatment on the mean value of the C/N ratio decrease on the compost

| No. | Treatment Addition | Average C/N ratio | Decrease C/N ratio (g/kg) | Decrease C/N ratio (%) |
|-----|---------------------|-------------------|---------------------------|-------------------------|
| 1.  | I                   | 74.8              | -                         | -                       |
| 2.  | C                   | 21.38 ± 1.36 d    | 54.42                     | 71.41                   |
| 3.  | CMC                 | 14.65 ± 0.46 a    | 60.15                     | 80.41                   |
| 4.  | CF                  | 17.46 ± 0.73 b    | 57.34                     | 76.66                   |
| 5.  | CFCMC               | 19.92 ± 0.93 c    | 54.88                     | 73.37                   |

Description: numbers followed by different letters show a real difference based on Dunca test at 5% level (α = 0.05)

Notes:
A = Initial
C = Control
CMC = Cellulolytic microbial consortium
CF = Cow manure
CFCMC = Mixture of consortium of cellulolytic microbes and cow manure

Based on Table 3. The most decline C/N ratio is on cellulolytic microbial consortium treatment reach 80.41% if compared by C/N ratio before the composting. More C element wich broken down will make the N element increase and the effect will decreasing the amount of C/N ratio [6].

3.4 Effects of Each Treatment on the pH (Acidity) of Garbage from FST UNAIR Garden

![Graph showing pH levels for different treatments](image-url)
Description:
C = Control
CMC = Cellulolytic microbial consortium
CF = Cow manure
CFCMC = Mixture of consortium of cellulolytic microbes and cow manure

**Figure 1.** Effect of each treatment on the pH (acidity) of garbage from FST Unair garden

The value of pH in the final result is lower than the start. It caused the reaction between CO$_2$ and H$_2$O are generated carbonic acid which produced during the composting process by the microbial cellulolytic [7].

3.5 Effects of Treatment on Temperature (C$^\circ$) of Waste from FST UNAIR Garden

![Figure 2](image2.png)

Description
C = Control
CMC = Cellulolytic microbial consortium
CF = Cow manure
CFCMC = Mixture of consortium of cellulolytic microbes and cow manure

**Figure 2.** Effects of treatment on temperature (C$^\circ$) of waste from FST UNAIR garden

Based on the temperature, the composting process conducted in two phase: thermophilic (45-65$^\circ$C) and mesophilic (23-45$^\circ$C). Early process occurred on mesophilic phase. After a week until last week occurred on thermophilic phase. Actually, the effective condition or composting is on mesophilic phase or 60$^\circ$C approximately because at this temperature, the pathogenic microbes will die [8].

3.6 Effects of Treatment on Percentage of Water Content of waste from FST UNAIR Garden

![Figure 3](image3.png)

Description
C = Control
CMC = Cellulolytic microbial consortium
CF = Cow manure
CFCMC = Mixture of consortium of cellulolytic microbes and cow manure

**Figure 3.** Effects of treatment on percentage of water content of waste from FST UNAIR garden
The great compost has water content below 50%. The result of this research showed that the water content of the compost at all are under 50% [3].

3.7 Effects of Treatment on Color Changes of Waste from FST UNAIR Garden

| Week- | Control       | CMC          | CF            | CFCMC         |
|-------|--------------|--------------|---------------|---------------|
| 0     | Brownish yellow | Brownish yellow | Brownish yellow | Brownish yellow |
| 1     | Light brown | Light brown | Light brown | Light brown |
| 2     | Brown | Brown | Brown | Brown |
| 3     | Dark brown | Dark brown | Dark brown | Dark brown |
| 4     | Blackish brown | Blackish brown | Blackish brown | Blackish brown |

The final result of this composting showed that all of compost has blackish brown color. It showed that the composting process was finished [3].

4. Conclusion

Based on the results of the research, it can be concluded that the control treatment, the addition of consortium of cellulolytic microbes, the addition of cow manure, and the mixture of cellulolytic microbial consortium and cow manure has effects on the composting of waste from FST UNAIR garden. The best composting result was achieved with the treatment of adding cellulolytic microbial consortium, which was able to decrease C/N ratio to 80.41%.

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