

# Appropriate Technology of Organic Waste Composting with Activator Bioinokulen Rumen Cow Em4 and Em4

Sunaryo

Lecture, Environmental Health Department of Health Polytechnic of the Ministry of Health, Surabaya

## Abstract

**Intruduction:** The waste problem in Indonesia is the large amount of garbage waste, the lack of landfills and waste processing facilities, resulting in a source of pollution and endangering health. In Ponorogo Regency in the last three years, garbage has accumulated reaching 149 m<sup>3</sup> / day with a percentage of the amount of organic waste amounting to 44.76%. **Methods:** This type of research is True Experimental, Posttest-Only Control design. The study used 80 ml cattle rumen activator, 80 ml EM4 activator, compost mixture activator with 60 ml EM4 + 20 ml livestock rumen activator mixture and 20 ml EM4 + 60 ml cattle rumen activator, and without activator (control) assessed the level of compost maturity and for tested the NPK levels and the C / N ratio. The raw material is 3 kg of organic waste with 5 times replication, so that 25 fruit samples are needed and 75 kg of organic waste material. **Results:** The results showed that the compost concentration was the same as the activator cattle rumen 80 ml, 80 ml EM4, and 60 ml EM4 + 20 ml cattle rumen ripened faster with an average time of 17 days. The results of the measurement of chemical quality compost have the best chemical content of SNI 19-7030-2004 compost activator 60 ml + 20 ml EM4 cattle rumen. **Conclusions:** The conclusion of research on the composting process of waste to be more effective requires an activator material. In addition to the activator material, it is necessary to pay attention to the quality of the activator material.

**Keywords:** Garbage, activator, cattle rumen, composting

## Introduction

Currently, waste is a difficult problem faced by many cities in Indonesia. Big cities with dense population produce waste with a high enough volume. Each individual in the city produces 0.50-0.65 kg of waste per person per day, with a density of 200 kg / m<sup>3</sup><sup>1</sup>. A large city such as Jakarta has a population of 10 million people, the waste produced is around 5000 tons / day. Meanwhile, the potential for waste in other cities such as Bandung is 1,300 tons / day and Surabaya 1,500 tons / day. With such a large number, special handling is needed. If it is not quickly handled properly, these

cities will sink in the heaps of garbage along with all the negative impacts it causes<sup>2</sup>.

The waste problem in urban areas arises as a result of waste management that is not done properly, especially in big cities in Indonesia. At the moment, Ponorogo City is facing the problem of handling waste which is increasingly piling up. Based on data from the Ponorogo Hygiene and Gardening Office, the waste produced in the city of Ponorogo has increased every year for the last three years. In 2013, the amount of waste generated in the city of Ponorogo was 129 m<sup>3</sup> / day, in 2014 as much as 138 m<sup>3</sup> / day, and in 2015 as much as 149 m<sup>3</sup> / day. The waste produced is in the form of organic and inorganic waste from public facility waste, agency waste, and household waste. Of the amount of waste generated, the percentage of organic waste is 44.76%<sup>3</sup>.

As a result of the large amount of waste generated in Ponorogo City, it is necessary to make efforts to

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### Corresponding Author:

Sunaryo,

Lecture, Environmental Health Department of Health Polytechnic of the Ministry of Health, Surabaya, Indonesia, E-mail: naryo82@yahoo.co.id, Telp. (031)5027058, Fax. (031) 5028141

process waste, one of which is composting made from organic waste which aims to reduce waste generation so that waste does not accumulate and does not cause environmental pollution and causes unpleasant odors. At this time, EM4 (Effective Microorganisms 4) was found by Prof. Teruo Higa from Ryukyus University, Japan. EM4 (Effective Microorganisms 4) solution contains fermented microorganisms and can work effectively in accelerating the fermentation process in organic materials<sup>4,5,6</sup>. In fact, EM (Effective Microorganisms) activators can be made by themselves, namely by breeding microorganisms originating from the stomach / rumen (colon, intestine) of ruminant animals, for example cows or buffaloes<sup>7</sup>. Rumen is one part of the stomach of ruminants (ruminant) such as cows, buffaloes, goats and sheep. The rumen contains feed ingredients that are eaten by livestock in the form of grass / other forages and feed reinforcement / concentrate<sup>8</sup>. The contents of the rumen can be used as a starter if they are processed first considering that they are rich in nutrients and microorganisms. The starter contents of the rumen can be used to breed bacteria / microbes in it as a starter for making compost / organic fertilizer and fermentation of agricultural waste such as straw<sup>8,9</sup>.

### Materials and Methods

This type of research is True Experimental in the form of a Posttest-Only Control Design d, where this study aims to determine the length of the process of

making compost made from organic waste which is then assessed the level of compost maturity and testing the levels of NPK and C / N ratio<sup>10</sup>. The research was carried out in the Campus laboratory of the Magetan Environmental Health Diploma 3 Study Program. The sample used was organic waste taken from the Temporary Disposal Site (TPS) in Ponorogo Regency.

This research was conducted by measuring the length of the composting process, by giving 5 treatments, each treatment using 3 kg of organic waste as raw material and each replicating 5 times with varying doses using 80 ml EM4 activator, compost with 80 ml of cow rumen activator, compost. with a mixed activator 60 ml EM4 + 20 ml beef rumen, 20 ml EM4 + 60 ml cow rumen, and without using an activator. The data analysis used descriptive analysis which was used to analyze the composting duration table and to analyze the data about NPK levels and C / N ratio that were examined in the laboratory. One Way Anova statistical test, the error rate was set at  $\alpha$  0.05.

## Results

### Implementation of Compost Making

1. The raw material for making compost uses organic waste in the form of 40% leaves, 30% vegetables, 20% fruit peels, and 10% food scraps.

2. Activators used in composting are as follows:

**Table 1. Activators used in composting**

Material (Trash Organic)	Treatment		Replication
	Activators EM4	Rumen Activators Cow	
3 Kg	80 ml	0 ml	5X (Five times)
3 Kg	60 ml	20 ml	
3 Kg	20 ml	60 ml	
3 Kg	0 ml	80 ml	
3 Kg	0 ml	0 ml	

3. In making compost, each treatment uses organic waste as much as 3 kg of raw material with 5 times of replication, so that a sample of 25 pieces is needed and raw material in the form of organic waste as much as 75 kg.

### Measuring Time of Composting

**Table 2. Data of composting time measurement based on days**

Activators	Replication					Average (Day)
	I	II	III	IV	V	
80 ml EM4	17	19	18	15	17	17.2
60ml EM4 + 20ml beef rumen	17	19	22	22	24	20.8
20ml EM4 + 60ml beef rumen	15	15	17	18	18	18.6
80ml beef rumen	17	20	17	15	17	17.2
Treatment	26	22	26	24	24	24.4

Based on table 2, it is known that compost without using an activator requires the longest ripening time, which is 24 days.

**Table 3. Results of Compost Chemical Analysis**

Aktivator	SNI Quality Standards 19-7030-2004				
	N	P2O5	K2O	C/N	Information
80 ml EM4	1.54	0.93	1.58	13.23	MS
60ml EM4 + 20ml beef rumen	1.75	1.03	1.76	13.69	MS
20ml EM4 + 60ml beef rumen	1.96	1.04	2.34	13.49	MS
80ml beef rumen	1.19	0.98	2.05	23.79	MS
Treatment	1.40	0.81	1.58	12.98	24

## Discussion

### Implementation of Compost Making

1. The first stage in composting is chopping the ingredients using a chopping machine in order to get

a smaller material size. This is in accordance with the opinion of Sudrajad that the smaller the size of the compost raw material used, the faster the decomposition process will be because the surface area of the material in contact with the activator microorganisms is wider<sup>2,5</sup>.

2. During the compost-making process, the physical quality of the compost is controlled, namely temperature, humidity and pH of the compost. According to Sudradjat, generally microorganisms work optimally in the temperature range of 40-60°C, after the organic material is mixed, the optimum humidity for the aerobic composting process is around 50-60%, and the compost pH will work optimally at a neutral pH range of 7<sup>2,5,8</sup>.

### Time of Composting

Based on the results of composting time measurement, it is known that compost using activator EM4, cow rumen activator, and a mixture of activator EM4 and cattle rumen requires a maturation time of 17-20 days, while compost without activator takes the longest time, namely 24 days. Compost with cow rumen activator, EM4 activator, and mixed EM4 + cow rumen activator has a significant difference to compost without using an activator (control) in accelerating composting, this can be strengthened by the results of statistical tests. Based on these results It can be concluded that compost with cow rumen activator, EM4 activator, and mixed EM4 + cow rumen activator ripens faster than compost without using an activator (control) in accelerating the compost ripening time<sup>11,12</sup>.

Based on the results of the statistical test, it is also concluded that there is no difference between the provision of cow rumen activator and EM4 activator on composting time, with an average compost ripening for 17 days. So it is necessary to know that the content of activator EM4 with activator of cattle rumen has similarities in accelerating composting made from organic waste as raw material.

This can occur because the contents of the beef rumen and EM4 contain high enough microbes or bacteria to decompose organic matter. The bacteria contained in the contents of the rumen according to Das and Qin include cellulolytic bacteria, methanogenic bacteria, hemicellulolytic bacteria and amylolytic bacteria, while the bacteria contained in EM4 according to Indriani include photosynthetic bacteria, *Lactobacillus*, sp, *Saccharomyces*, sp. *Actino-mycetes*, sp and fermented mushrooms<sup>9,10</sup>.

### Compost Chemical Quality Analysis

Based on the results of laboratory tests for the chemical quality of compost with the parameters Nitrogen (N) in each activator has met the requirements with a standard laboratory test result of at least 0.40%. From the results of laboratory tests, the activator with the highest Nitrogen (N) content was 20 ml EM4 + 60 ml of beef rumen, which was 1.96%, according to Novizan's<sup>9,11</sup>, opinion, which states that nitrogen is the main component of various important substances in plants. About 40 - 50% of the protoplasm content, which is the living substance of plant cells, consists of nitrogen compounds. Nitrogen compounds are used by plants to form amino acids which will be converted into proteins. Nitrogen is also needed to form important compounds such as chlorophyll, nucleic acids, and enzymes. Therefore, nitrogen is needed in relatively large quantities at each stage of plant growth.

Based on the results of compost chemical analysis on the phosphorus parameter (P<sub>2</sub>O<sub>5</sub>), the value that meets the standards for each activator is obtained, namely the minimum value of phosphorus (P<sub>2</sub>O<sub>5</sub>) of 0.10% according to SNI 19-7030-2004. From the results of laboratory tests, compost with activator 20ml EM4 + 60 ml of beef rumen has the highest phosphorus content (P<sub>2</sub>O<sub>5</sub>) compared to other activators. According to research conducted by Fibria, Ben and Alexander , P element is an important element in compost, because this element is the main nutrient for plant growth. The content of P elements is higher with the weathering of the composted organic matter<sup>11,13,15</sup>.

At the maturation stage the microorganisms will die and the P content in the microorganisms will mix in the compost material which will directly increase the phosphorus content in the compost.

Based on the results of chemical analysis of compost with potassium (K<sub>2</sub>O) parameters, it is known that each activator has met the requirements with a standard laboratory test result of at least 0.20% according to SNI 19-7030-2004. From the results of laboratory tests, the highest potassium content (K<sub>2</sub>O) was found in compost with an activator of 20 ml EM4 + 60 ml of beef rumen. Potassium is needed to make up 1 - 4% of

plant dry matter. This process occurs in the cell solution. Potassium has many functions. Among them activate 60 plant enzymes and play an important role in the synthesis of carbohydrates and proteins.

Potassium also increases water content in plants, thereby increasing plant resistance and ability to stress drought, cold weather, and high salinity (salt content). Plants that are deficient in potassium will be susceptible to disease Agromedia<sup>12,15</sup>. Based on the results of compost chemical analysis with the C/N ratio parameter, it is known that there is an activator that does not meet the standard requirements for compost quality according to SNI 19-7030-2004, namely cattle rumen activator which contains a high C / N ratio of 23.79, while the requirements of SNI 19-7030-2004 minimum C/N value 10-20. According to Fibria, Ben and Alexander, the C / N value of fresh organic matter determines the reaction in the soil, soils with stable organic matter generally have a C / N ratio of about 10. At the C / N ratio, the C element is used as energy for life of microorganisms and element N for protein synthesis<sup>15,16</sup>. If the C / N ratio is too high, microbes will lack N for protein synthesis so that decomposition is slow. Generally, the main problem of composting is at a high C / N ratio, especially if the main material is material that contains high wood content (sawn residue, twigs, bagasse, etc.). The process of decomposing organic matter with a high C / N ratio will have a bad effect on plants because it can cause the availability of other nutrients, such as available nitrogen in the soil. The high number of C / N ratio will cause the growth of microorganisms to be inhibited<sup>13,15</sup>.

### Conclusion

The conclusion of this research is compost making with activator concentration 80 ml of beef rumen, 80 ml EM4, and 60 ml EM4 + 20 ml cow rumen ripens faster than compost without using activator (control) in the composting process, which requires an average maturation. for 17 days. From the results of the measurement of the chemical quality of compost (N, P, K and C / N ratio) the compost that has the best chemical content according to SNI 19-7030-2004 is compost with an activator of 60 ml EM4 + 20 ml from the rumen of the cow. Recommendation research is, garbage is a material that can be used as compost. In making compost, you

must pay attention to the nutrient content contained in the raw materials used. The community can use wasted waste to be processed into compost and can be used as plant compost. The community can use cattle rumen waste as an activator in making compost with wasted waste because it is more efficient, easier and cheaper. The recommendation for further research in making compost made from waste is that it needs development by using a lower activator concentration or dose and by using a different activator and a compost weight reduction test is necessary.

**Conflict of Interest:** None

**Source of Support:** Self

**Ethical Clearance:** Ethical permission is approval from the Health Polytechnic Research Ethics Commission of the Ministry of Health of Surabaya, this research does not use human and animal experiment objects.

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