Research tower composter bioactivator using buffalo dung

D Anwar*, K Sitorus, R Lumbangaol and E Nainggolan
Faculty of Biotechnology, Del Institute of Technology, North Sumatera, Indonesia

*dedy.anwar@del.ac.id

Abstract. Buffalo dung is buffalo digestive waste, which can cause problems for the environment and health. The buffalo dung waste contains macronutrients such as nitrogen, phosphorus, calcium, and water which have the potential as bioactivator for the composting process. The composting process using bioactivator from buffalo dung is an alternative utilization of buffalo dung solid waste. This study aims to show the potential of buffalo dung solid waste as a bioactivator in the composting process of organic waste and to obtain degradation data of composting organic waste using bioactivator from buffalo dung. The variables observed in this study were pH, TS, TSS, and Moisture Content. This research was started from making bioactivator from buffalo dung, then continued the composting process by putting organic waste into the tower composter while adding bioactivator until the water content reached 55-65%. Results the study found that the pH, TS, and TSS values in the manufacture of liquid fertilizer from buffalo dung were 4.28; 17.68 ppm and 6.9 ppm. Composting carried out for 20 days showed that the bioactivator of buffalo dung was able to influence the composting process, namely moisture content 50.23%.

1. Introduction
The increase in the amount of waste can be caused by several things such as an increase in population and changes in community consumption patterns. Changes in community consumption patterns lead to an increase in the volume, type, and characteristics of increasingly diverse waste [1]. According to the Ministry of Environment and Forestry and the Ministry of Industry in 2016, Indonesia is estimated to produce 65.2 million tons of landfill annually. The composition of waste is dominated by organic waste, which reaches 60% of the total waste. An alternative that can be done to overcome problems in processing organic waste so that organic waste produces higher values is by composting [2]. The composting method can be a solution to reduce land accumulation and reduce air pollution caused by burning garbage and groundwater pollution due to toxic liquids (leachate).

In the composting process, several factors need attention. One of the factors that influence the composting process is bioactivator. The addition of bioactivator serves to help the process of overhauling lignocellulosic compounds contained by organic waste. Bioactivator can come from a variety of organic wastes such as human or animal waste. In this study, an analysis was carried out regarding the use of buffalo dung for use as a bioactivator in the process of composting organic waste using a tower composter. During buffalo life, in addition to producing meat and milk, buffalo also produces waste such as feces and urine [3]. According to Michael et al. [4] about 25-30 kg/day of solid waste in the form of buffalo dung is produced each buffalo tail. While data on the number of buffalo cattle in Indonesia in 2017 recorded 1.4 million head, so it can be estimated that around 35,000 tons of buffalo dung is produced every day [5].
Buffalo dung contains nutrient compositions such as 1.03-2.12% N, 1.30% P, and 2.23-5.54% K [6]. Besides containing nutrients, buffalo dung contains cellulolytic, hemicellulolytic, and amylolytic bacteria that play a role in the hydrolysis of organic matter [7]. Several researchers have researched the composting process using organic waste by adding bioactivator of liquid organic fertilizer from buffalo dung. In this study, in addition to using liquid organic fertilizer bioactivator from buffalo dung, the water content was also maintained at 60%. Bioactivator liquid organic fertilizer from buffalo dung is a product of buffalo dung fermentation and EM 4 for 14 days. The purpose of this study is to show the potential of buffalo dung solid waste as a bioactivator in the processing of organic waste and to obtain data on the degradation of organic waste composting using bioactivator from buffalo dung.

2. Methods

2.1. Organic waste
The raw material of this research is an organic waste obtained from Del Institute of Technology. Before the composting process, organic waste is chopped manually to facilitate the microbial decomposition process of the activator into compost. The characteristics of organic waste are presented in Table 1.

Table 1. Characteristic of organic waste.

| Parameter       | Unit | Value |
|-----------------|------|-------|
| Moisture Content| %    | 65    |
| pH              | -    | 7     |
| C               | %    | 38.17 |
| N               | %    | 1.29  |
| C/N             | -    | 29.58 |

2.2. Liquid organic fertilizer from buffalo dung
The bioactivator used in this study was liquid organic fertilizer from buffalo dung. This liquid organic fertilizer was obtained by researchers from the aerobic fermentation mixture of buffalo dung and EM 4 for 14 days. The characteristics of liquid organic fertilizer from buffalo dung are presented in Table 2.

Table 2. Characteristic of liquid organic fertilizer from buffalo dung.

| Parameter         | Unit | Value |
|-------------------|------|-------|
| pH                | -    | 4.28  |
| Total Solid       | ppm  | 17.68 |
| Total Solid Suspended | ppm  | 6.9   |

2.3. Tower composter
The main equipment used is a drum tower composter with a height of 2.33 m and a diameter of 0.37 m. The composter is equipped with a sampling hole and aeration hole. In drum tower composter given a sampling hole at a height of 90 and 135 cm. The aeration hole has a diameter of 1.27 cm. Scheme and dimension of tower composter can be seen in Figure 1.
3. Results and discussions

3.1. pH

Based on 70/Permentan/SR.140/10/2011, the technical requirements for the pH of liquid organic fertilizer are 4-9. Based on the graph below, the pH has increased at the beginning of the processing, but there pH has been an increase and shows a stable pH at the final stage of 4.8. At the time of the process of making liquid fertilizer, pH is a parameter that needs to be measured to see the time of the maturity of liquid fertilizer. Figure 2 shows the average pH of liquid fertilizer from buffalo dung and EM 4 is 4.166.
The change in pH during the composting process is caused by the activity of microorganisms. The increase in pH occurs due to N changing into NH$_3$ and NH$_4^+$ in the ammonification process. While the pH change which tends to decrease is caused by the ammonium evaporation process and the release of hydrogen ions as a result of the nitrification process.

3.2. **Total Solid (TS) and Total Suspended Solid (TSS)**

The value of TS and TSS is a value representation of solid content in waste. Figure 3 shows a decrease in Total Solid in the process of making liquid organic fertilizer.

Although there was no linear decrease, TS levels decreased throughout the sampling from the value of 28.31 ppm until the end of the process of making liquid fertilizer TS value was 17.68 ppm. This is due to microorganisms breaking down the organic material contained in buffalo dung.

Based on Figure 3 above shows the fluctuation of TSS values. In general, TSS decreased from the first day to the 9th day of making liquid fertilizer, namely 5.51 to 3.17. This is in accordance with the growth phase of microorganisms, which were at the beginning of making liquid fertilizer adaptation or lag phase of microorganisms to logarithms and finally decreased microorganism activity. Decreased microorganism activity due to nutrients in the mixture has thinned, so the TSS value does not decrease again.

3.3. **Analysis of temperature profiles of bioactivator EM 4 and liquid fertilizer buffalo dung**

Temperature is one of the factors that shows that the composting process has taken place. Temperature measurements were carried out at two sampling locations, namely the height of the sample hole 90 cm. Figure 4 shows the temperature changes in the composting process using liquid organic fertilizer bioactivator from buffalo dung and EM 4 bioactivator.

The graph below shows the temperature change in the composting process using liquid organic fertilizer bioactivator from buffalo dung. The resulting compost temperature data can describe the stages of composting and maturity of the compost [8]. Temperature from the first day to the third day of the composting process is a lag phase. Temperature data in the lag phase shows mesophilic stages ranging from 32-36.5°C. The second stage is the active phase with temperature measurement data on day 4 to day 15 the composting process has reached temperatures ranging from 45-54°C. According to Tchobanoglous, an increase in temperature in the composting process indicates the activity of microorganisms to decompose organic matter. The third stage is the maturation phase with temperature measurement data on the 16th day to the 20th day around 35-46°C. The temperature profile tends to decrease during the composting process starting from day 16.
Figure 4. Temperature profile during composting process.

The composting process using bioactivator liquid organic fertilizer from buffalo dung on day 20 has a temperature of 35°C while EM 4 bioactivator on day 18 has a temperature of 39°C. This is following Shen's research, stating that a rapid rise in temperature will slowly decrease. A decrease in temperature indicates that the process of degradation by decomposer microbes slows down as the availability of nutrients decreases. From the above results it can be said that the composting process using liquid organic fertilizer bioactivator from buffalo dung and bioactivator EM 4 affects the temperature during composting which occurs composting through 3 stages namely lag phase, active phase, and maturation phase.

3.4. Analysis of moisture content profiles of bioactivator EM 4 and liquid fertilizer buffalo dung

In Figure 5, we can see the profile of MC with composting time. There is a difference in the value of water content between bioactivators of liquid organic fertilizer from buffalo dung and EM 4.

Figure 5. MC profile during composting process.

The graph shows that bioactivators with liquid fertilizer have an average MC of 60% while bioactivators with EM 4 have an average MC of 48%. That is because the differences in TS and TSS of the two types of bioactivators, where liquid fertilizer bioactivators have TS and TSS values of 17.68 ppm and 6.9 ppm, respectively. This makes it more difficult for bioactivators with liquid fertilizer to flow down compared to EM 4.
4. Conclusion
Changes in pH value during the processing in the range of 4.09 - 4.28 experienced a reduction from the beginning of the processing. The pH value at the end of making liquid fertilizer is 4.28. Measurement of TS (Total Solid) and TSS values (Total Suspended Solid) experienced decrease over time which indicates the bacteria is able to decompose the solids contained in effluent. The quality of mature compost for 3 weeks of composting using bioactivator liquid organic fertilizer from buffalo dung and EM 4 shows changes in the parameters MC 50.23 and 52.36. The quality of compost cooked for 3 weeks of composting using bioactivator liquid organic fertilizer from buffalo dung and EM 4 shows changes in pH parameters 6.5 and 7.5. Fertilizer organic liquid from buffalo dung is suitable for use as a bioactivator for the composting process.

References
[1] Kementerian Pertanian 2015 Direktorat Jenderal Peternakan dan Kesehatan Hewan, 2015,” Pedoman Pengendali. dan Penanggulangan Rabies
[2] Santoso M C, Giriantari I A D and Ariastina W G 2019 Studi Pemanfaatan Kotoran Ternak Untuk Pembangkit Listrik Tenaga Biogas Di Bali J. SPEKTRUM 6
[3] Kadarusno 1979 Peranan peternakan dalam rangka menunjang transmigrasi dalam Bull LPP
[4] Pemerintah Republik Indonesia 2008 Undang-undang republik indonesia nomor 18 tahun 2008 tentang pengelolaan sampah Sekr. Negara, Jakarta
[5] Damanhuri E and Padmi T 2010 Diktat Kuliah Pengelolaan Sampah Bandung Inst. Teknol. Bandung
[6] Cooke G W 1967 The control of soil fertility Control soil Fertil.
[7] T S 2011 Pembuatan pupuk organik cair dengan memanfaatkan limbah padat sayuran kubis (Brassica aleracea L) dan Isi Rumen Sapi (Universitas Sumatera Utara)
[8] Nutongkaew T, Duangsuan W, Prasertsan S and Prasertsan P 2011 Production of compost from palm oil mill biogas sludge mixed with palm oil mill wastes and biogas effluent TIChE Int. Conf. Hatyai, Songkhla Thailand.