A Method of Determining the C/N Ratio from Aerobically Treated Brem Compost Waste

by Nur Aini Fauziyah

Submission date: 06-Jun-2022 01:41PM (UTC+0700)
Submission ID: 1851352873
File name: 12670-45798-1-PB-publish.pdf (317.41K)
Word count: 2679
Character count: 13678

ALCHEMY : JOURNAL OF CHEMISTRY

Research Article

A Method of Determining the C/N Ratio from Aerobically Treated *Brem* Compost Waste

Kindriari Nurma Wahyusi, Nur Aini Fauziyah*

Department of Chemical Engineering, Faculty of Engineering, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Gunung Anyar, Surabaya, East Java, Indonesia, 60294

ARTICLE INFO

Article History
Accepted 8 September 2021
Revised 12 February 2022
Available online 27 May 2022

* Author Corresponding:
aini.zierra@gmail.com

ABSTRACT

Composting of *brem* wastes was one of the ways to optimize them into useful materials. This research aimed to determine the C/N ratio and temperature of compost correlating to composting time. *Brem* waste compost was processed by the aerobic method after adding eggshell powder and an M-Bio activator. The M-Bio activator was added with five varied volumes such as 50 mL (CM50), 75 mL (CM 75), 100 mL (CM100), 125 mL (CM125), and 150 mL (CM150). Composting process was conducted for 10 days. The measurement of the C/N ratio and temperature was carried out in the intervals of 2 days. The properties of *brem* waste compost were suitable with SNI Standard 19-7030-2004. The optimal volume of the M-Bio activator was 100 mL (CM100) for 10 days of composting time with an 11.42 C/N ratio. This compost has no odor at the end of the composting process.

Keywords: *brem* waste, compost, C/N ratio, temperature

1. Introduction

The long-term option to utilize organic waste is composting technology. Several composting techniques have been developed previously. Vermicomposting had been found to compost agricultural and industrial waste with the help of earthworms [1]. Composting with the Takakura technique had also been developed to treat household organic waste [2]. Some of the studies mentioned above only treated organic waste on a household scale.

The different circumstances occurred in the Caruban, Madiun (East Java) as central *brem* industry. *Brem* waste is enormous every day, which was around 50-100 kg or about 1.5-3 tons per month. Currently, *brem* waste is only used as animal feed and most of it is still disposed of without further processing. Moreover, *brem* waste can cause problems in the environment. Water was the main content in the *brem* waste, which was 16 wt.%, followed by the acid of 15 wt.% in the 100 grams of *brem* [3]. Water and acid content which was quite high in this *brem* waste can cause the decomposition process of the waste faster and become a comfortable microbial growth area. Therefore, the *brem* waste can be further processed as organic compost.

The composting process needs to pay attention to several conditions so that the composting process of material can reach optimum conditions [4]. Several factors that can affect a composting process of an organic material include the ratio of C/N, aeration, pH, humidity, and composting time [1, 5]. In the previous research, a material has different C/N ratio values and there was an effective C/N ratio for composting [6]. This compound was prepared by adapting the C/N ratio of 30:1 to 40:1. Furthermore, in this condition, the microbes required more nitrogen to undergo decomposition of organic matter if the C/N ratio was excessive and the decomposition will be slower.

The parameters of mature compost are generally blackish-brown color, C/N ratio <20, soil-like smell, and close to neutral pH [7-9]. A composting process can take a long process (40-60 days) with the aerobic method and without an activator. The addition of a bioactivator will accelerate the composting process. The mixture of bioactivator and microorganisms can speed up the decomposition process of organic matter found in the soil and in nature. Eggshell can

be used as a bioactivator which consists of 98.2% $CaCO_3$ [10]. The high content of calcium in the eggshell was potent to use as fertilizer and as an ingredient to neutralize the acidity of a fertilizer [11-13].

In this work, we focused to study the C/N ratio and the addition of a M-Bio activator on the effect of time in the composting of *brem* waste in UD. Tongkat Mas by aerobic method. By knowing the C/N ratio in the compost formed, the optimum time and temperature will be obtained.

2. Materials and Methods

2.1. Materials

The sample in this research was *brem* waste from UD. Tongkat Mas, Caruban, Madiun, East Java. The other materials used were granulated sugar, eggshell flour, potassium dichromate ($K_2Cr_2O_7$) 1 N, sulphuric acid (H_2SO_4) 0.1 N, phosphoric acid (H_3PO_4) 0.1 N, diphenylamine indicator 0.2 N, iron(II) sulfate ($FeSO_4$), $Fe(NH_4)$ and potassium sulfate (K_2SO_4).

2.2. Preparation of Brem Waste for Composting

A 10 mL M-Bio activator was prepared by dissolving 15 g of granulated sugar in the distilled water at 45°C with various volumes of 50, 75, 100, 125, and 150 mL, respectively. The prepared M-Bio solution was cooled for 2 hours and ready to use. Then, compost from the *brem* waste was prepared. A 1000 g of *brem* waste was mixed with 300 g of eggshell flour. The mixing was done using an aerobic composter with air cavities on the bottom and middle of the composter tube. The hole made was intended for oxygen circulation [14].

The M-Bio activator solution was added to the mixture of *brem* waste and eggshell flour. The addition of M-Bio activator and sugar solutions was named as follows, CM50, CM75, CM100, CM125, and CM150, respectively for the M-Bio activator and sugar solution volumes of 50; 75; 100; 125; and 150 mL. The aerator was turned on at an aeration speed of 50 mL/second. The composting process was conducted for 2; 4; 6; 8; and 10 days on each composter. Then, the C/N ratio of the composts was observed and analyzed [14].

2.3. Physicochemical Analysis of Brem Waste Compost

The physicochemical composition was carried out to determine the organic components present in the *brem* waste compost. The compost samples were calculated for carbon (C) and nitrogen (N) content. Carbon in the sample was analyzed by Walkley and Black methods [15], while total nitrogen was analyzed by Kjeldahl method [16].

A 0.5 g of compost sample in the 250 mL erlenmeyer was added to 10 mL of $K_2Cr_2O_7$ 1 N and the mixture was shaken. Afterward, 7.5 mL of H_2SO_4 0.1 N was added through the erlenmeyer wall and the sample was shaken by rotating for 1 minute. The sample was allowed to stand for 30 minutes and then was diluted with distilled water to 200 mL. The diluted sample was added with 10 mL of phosphoric acid 0.1 N and 10 drops of diphenylamine indicator 0.2 N. A blank sample was prepared in the same way as the sample. Then, the samples were titrated with $FeSO_4$/$Fe(NH_4)$ 0.1 N from a faded green to a cloudy blue color. The titration was continued until the color of the solution turned bright green. The percentage of carbon of *brem* waste compost can be calculated following **Equations 1** and **2** [15].

$$\text{Correction Factor} = \frac{100}{100 - \text{Water Content}} \quad (1)$$

$$\text{Percentage of Carbon} = \frac{[\text{Blank Volume (mL)} - \text{Sample Volume (mL)}] \times \text{Normality} \times 3 \times 1.33}{\text{Sample Mass (mg)} \times \text{Correction Factor}} \text{ x } 100\% \quad (2)$$

Kjledahl method was carried out by adding 25 mL of sulfuric acid 0.1 N and 1.5 g K_2SO_4 to of the compost sample. The nitrogen percentage was determined by **Equation 3** [16]. The percentage of carbon to nitrogen ratio (C/N ratio) was calculated by dividing the expected carbon percentage for the sample by the percentage of nitrogen was expected for the same sample.

$$\text{Percentage of Nitrogen} = \frac{[\text{Acid Volume(mL)} - \text{Blank Volume (mL)}] \times \text{Acid [N]} \times \text{Correction Factor} \times 14.008}{\text{Sample Mass (g)} \times 1000} \text{ x } 100\% \quad (3)$$

3. Result and Discussion

Composing time and addition activator affected the C/N ratio. **Figure 1** showed that the longer the composting process and the more addition of M-Bio activators in the composting process, the more decline the C/N ratio in the compost. The

value of the C/N ratio in the compost gradually declined from day 2 to 10 in the composting process. The decomposition process of organic matter caused a decrease in the value of the C/N ratio in the compost during the composting process. During the composting process, carbon in the compost was converted into carbon dioxide, while nitrogen in the compost was converted into nitrate and ammonia. As a result, carbon, and nitrogen in the compost decreased and increased respectively.

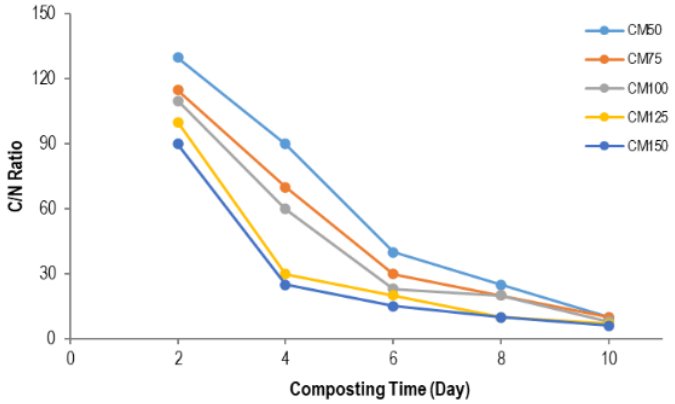

Figure 1. The ratio of C/N to the composting time of *brem* waste compost.

The principle of composting was to reduce the C/N ratio of an organic compound to reach the C/N ratio of the soil (10-20). The maturity indicator of compost was based on the value of the C/N ratio around 10-20 [17]. In this study, the composting time of CM100 (10 days) showed the optimum C/N ratio of 11.42 which was the color and odor suitable to the SNI 19-7030-2004 Standard. The use of carbon and nitrogen elements during the composting process caused a change in the C/N ratio in the compost. The carbon and nitrogen in organic compounds are needed for the growth of microorganisms. The utilization of nitrogen is less when compared to carbon for microorganisms during the composting process. Carbon is a source of energy in the metabolic process of a microorganism, while nitrogen is used for protein synthesis in the composting process.

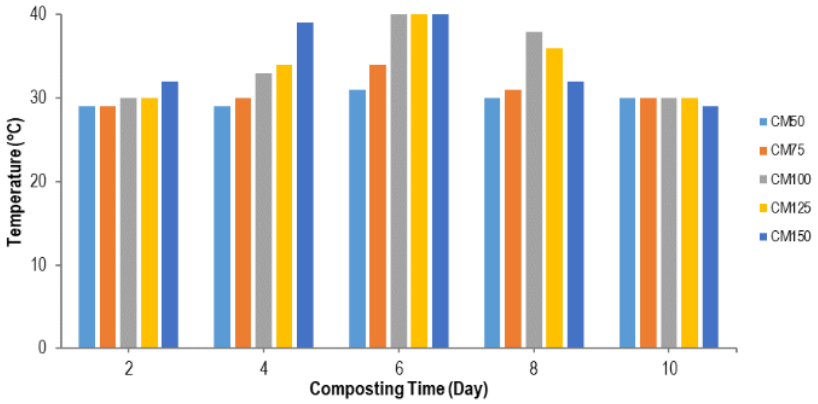

Figure 2. The temperature of *brem* waste compost to the composting time.

In this study, the C/N ratio was related to the temperature of *brem* waste compost. The C/N ratio decreased with the length of composting (**Figure 1**) and the optimal temperature was on day 6 of the composting process (**Figure 2**). Based on **Figure 2**, the temperature of the compost increased during the composting process from day 2 to 6. The more volume of M-Bio activator was added, the temperature of the compost also increased. This increasing temperature was caused by the activity of microorganisms that produce carbon dioxide, heat, and water. In the early stage of the composing process, microorganisms involved in the composting process are mesophilic organisms that grow at 25-40°C [18]. The compost temperature on each composter on the sixth day reached the thermophilic phase (40-65°C) in the decomposing organic

matter. The fermentation process involved thermophilic microorganisms and the impact was the temperature of the compost pile increased. However, the temperature in the compost decreased close to room temperature from day 6 to 10. This decreasing temperature can activate mesophilic microorganisms. Releasing energy in the form of heat causes rising and falling of the temperature. It was important to observe the temperature to determine changes in microorganisms' activity because the temperature was one of the indicators in breaking down organic matter. A good aeration process can assist in the decomposition of microorganisms in the compost.

The addition of the M-Bio activator in the composting process affects the development of microorganisms and nutrients in the soil. The cultures of these various microorganisms are synergistic and mutually beneficial. The roles of microorganisms contained in the M-Bio biofertilizer are (a) to assist decomposition of organic matter by aerobic and anaerobic fermentation, (b) to improve the properties and characteristics of soil by humus enrichment, and (c) to suppress pathogenic microorganisms in the plants by forming a certain compound [19]. The addition of the M-Bio bioactivator in the composting process accelerates the decomposition process of complex compounds contained in organic matter. Thus, the composting process of organic material is relatively faster compared to without using the addition of a bioactivator.

4. Conclusion

This study showed that *brem* waste compost has been prepared by the aerobic method. The C/N ratio of compost was around 10-20 as the maturity indicator of compost. The optimum C/N ratio (11.42) was obtained for 10 days with 100 mL addition of M-Bio activator. The composting time and bioactivator addition were needed for preparing the optimum compost.

References

[1] Y.-K. Jeong & J.-S. Kim, "A New Method for Conservation of Nitrogen in Aerobic Composting Processes," *Biosource Technology*, vol. 79, no. 2, pp. 129–133, 2001.

[2] Y. Astuti, T. Tafiprios, & C. C. Widayati, "Takakura Compost Making Training Joglo Village, West Jakarta," *International Conference on Community Development (ICDD)*, vol. 1, no. 1, pp. 692–699, 2018.

[3] R. Purwasih, "Pemanfaatan Limbah Pabrik Brem Sebagai Bahan Baku Bioetanol Untuk Bahan Bakar Alternatif," *Jurnal Pendidikan Teknik Mesin*, vol. 6, no. 1, pp. 25-36, 2017.

[4] N. Ekawandani & A. A. Kusuma, "Pengomposan Sampah Organik (Kubis dan Kulit Pisang) dengan Menggunakan EM4," *Jurnal TEDC*, vol. 12, no. 1, pp. 38–43, 2019.

[5] J. I. Boulter, G. J. Boland, & J. T. Trevors, "Compost: A Study of the Development Process and End-Product Potential for Suppression of Turfgrass Disease," *World Journal of Microbiology and Biotechnology*, vol. 16, no. 2, pp. 115–134, 2000.

[6] T. Nolan, S. M. Troy, M. G. Healy, W. Kwapinski, J. J. Leahy, & P. G. Lawlor, "Characterization of Compost Produced from Separated Pig Manure and a Variety of Bulking Agents at Low Initial C/N Ratios," *Bioresource Technology*, vol. 102, no. 14, pp. 7131–7138, 2011.

[7] S. Sadaka & A. El-Taweel, "Effects of Aeration and C:N Ratio on Household Waste Composting in Egypt," *Compost Science & Utilization*, vol. 11, no. 1, pp. 36–40, 2003.

[8] S. Goyal, S. K. Dhull, & K. K. Kapoor, "Chemical and Biological Changes during Composting of Different Organic Wastes and Assessment of Compost Maturity," *Bioresource Technology*, vol. 96, no. 14, pp. 1584–1591, 2005.

[9] E. I. Jiménez & V. P. García, "Composting of Domestic Refuse and Sewage Sludge. I. Evolution of Temperature, pH, C/N Ratio and Cation-Exchange Capacity," *Resources, Conservation and Recycling*, vol. 6, no. 1, pp. 45–60, 1991.

[10] I. Putra, N. Ariska, & Y. Muslimah, "Aplikasi Serbuk Cangkang Telur dan Pupuk Kandang terhadap Pertumbuhan dan Produksi Semangka (*Citrullus vulgaris* Schard) pada Tanah Gambut Meulaboh," *Jurnal Agrotek Lestari*, vol. 5, no. 1, pp. 8–21, 2019.

[11] M. Kumar, Y.-L. Ou, & J.-G. Lin, "Co-composting of Green Waste and Food Waste at Low C/N Ratio," *Waste Management*, vol. 30, no. 4, pp. 602–609, 2010.

[12] F. Kaswinarni, B. Suharno, & O. A. Winarta, "Berbagai Fenomena Kacang Panjang (*Vigna sinensis*) terhadap Penambahan Kompos Organik pada Pemupukan Batuan Fosfat," *Bioma: Jurnal Ilmiah Biologi*, vol. 3, no. 1, pp. 16-26, 2014.

[13] E. Surya, H. Hanum, C. Hanum, & F. S. Harahap, "Pengaruh Pemberian Kompos Bunker Diperkaya dengan Limbah Cair Pabrik Kelapa Sawit pada Pertumbuhan Bibit Kelapa Sawit di Bibitan Utama," *Jurnal Tanah dan Sumberdaya Lahan*, vol. 6, no. 2, pp. 1281–1289, 2019.

[14] K. N. Wahyusi, U. Muashomah, A. Bella, & N. A. Fauziyah, "The Time Effect on Aerobic Composting Method for Temperature and pH from Brem Waste," *International Journal of Eco-Innovation in Science and Engineering*, vol. 2, no. 2, pp. 9-13, 2021.

[15] F. Gelman, R. Binstock, & L. Halicz, "Application of the Walkley–Black Titration for the Organic Carbon Quantification Organic Rich Sedimentary Rocks," *Fuel*, vol. 96, pp. 608–610, 2012.
[16] P. Sáez-Plaza, M. J. Navas, S. Wybraniec, T. Michalowski, & A. G. Asuero, "An Overview of the Kjeldahl Method of Nitrogen Determination. Part II. Sample Preparation, Working Scale, Instrumental Finish, and Quality Control," *Critical Reviews in Analytical Chemistry*, vol. 43, no. 4, pp. 224–272, 2013.
[17] F. Eiland, M. Klamer, A.-M. Lind, M. Leth, & E. Bååth, "Influence of Initial C/N Ratio on Chemical and Microbial mposition during Long Term Composting of Straw," *Microbial Ecology*, vol. 41, no. 3, pp. 272–280, 2001.
[18] M. S. Alam, P. R. Sarjono, & A. L. Aminin, "Isolasi dan Karakterisasi Selulase dari Bakteri Selulolitik Termofilik Kompos Pertanian Desa Bayat, Klaten, Jawa Tengah," *Jurnal Sains dan Matematika*, vol. 21, no. 2, pp. 48–53, 2013.
[19] E. Surahman, M. Ali, & R. Fitriani, "Pengaruh Konsentrasi M-Bio terhadap Kecepatan Pengomposan Sampah Organik Pasar," *Bioedusiana: Jurnal Pendidikan Biologi*, vol. 2, no. 1, pp. 82-93, 2017

A Method of Determining the C/N Ratio from Aerobically Treated Brem Compost Waste

ORIGINALITY REPORT

16%	%	%	16%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Monash University Student Paper	2%
2	Submitted to University of Brighton Student Paper	1%
3	Submitted to University of Mauritius Student Paper	1%
4	Submitted to Utah Valley State College Student Paper	1%
5	Submitted to Swinburne University of Technology Student Paper	1%
6	Submitted to University of Wales, Bangor Student Paper	1%
7	Submitted to Universitas Sumatera Utara Student Paper	1%
8	Submitted to Yeungnam University Student Paper	1%
	Submitted to Charles Sturt University	

9	Student Paper	1%
10	Submitted to University Tun Hussein Onn Malaysia Student Paper	1%
11	Submitted to Bogazici University Student Paper	1%
12	Submitted to Universitas Teuku Umar Student Paper	1%
13	Submitted to Syiah Kuala University Student Paper	1%
14	Submitted to UC, Irvine Student Paper	1%
15	Submitted to Universitas Raharja Student Paper	1%
16	Submitted to Universitas Negeri Surabaya The State University of Surabaya Student Paper	<1%
17	Submitted to Chulalongkorn University Student Paper	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		