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Chemical content of waste composting by black soldier fly (*Hermetia illucens*)

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Abstract. Solid food waste from households and restaurants in urban areas currently be a severe problem. Mismanagement of solid food waste can promote disease. Black Soldier Fly larvae were known as new composting technology because they fast in the composting process. To decrease the volume of solid food waste that Black Soldier Fly larvae can be applied. This research aims to study the chemical content of the compost from composting by Black Soldier Fly larvae. The results show that the C-organic compost content is 18,37%, Total Nitrogen is 1.45%, Total Phosphor is 1.58%, and the pH is 6.8, C/N ratio is 12.66. Total Nitrogen, Total Phosphor, C/N ratio, and pH have fulfilled the requirements of the National compost standard of Indonesia (SNI). So, Compost from Black Soldier Fly larvae has high potential as a standard compost.

1. Introduction

One of the global issues currently taking the world community's attention is food waste (FW). Developing countries to developed countries try to develop various methods or approaches to solve this problem. FAO states that around 33% to 50% of the food that has been produced is not appropriately consumed [1;2]. Currently, the method commonly used to manage organic waste uses composting techniques. However, Simanungkalit et al. [3] explained that composting with microorganisms takes 5 weeks to 2 months in composting. Therefore, it is necessary to use organic waste decomposing organisms quickly. One of the organic waste processing uses biological agents in the form of larvae (maggot) from *Hermetia illucens* or better known as the Black Soldier Fly (BSF).

Hermetia illucens, generally well known as black soldier fly, is widely scattered globally, including Asia, Europe, and the southeastern United States [4;5;6]. The larvae of black soldier fly (BSF; *Hermetia illucens*) can grow on very dense populations on organic wastes, transform organic waste into valuable biomass, and produce the compost as residue [7].

The chemical content of compost by black soldier fly larvae still limited reported. The purpose of this research is to investigate the chemical content of compost from black soldier fly larvae.

2. Materials and Methods

The research was conducted from March-July 2020 in Labuhan Maringgai Subdistrict, Lampung Timur Regency, and Soil Science Laboratory, University of Lampung. The feed of black soldier fly larvae is a waste of orange (jeruk) without peel and ambarella fruit (kedondong), which is fermented using EM4.



Compost analysis was conducted in Soil Science Laboratory. The compost parameter was analysis namely: the pH was measured by a pH meter, the Walkley and Black method determined the organic C-organic content, N analysis was done by the Kjeldahl method, P analysis was done by the P Bray-1 method.

The compost's quality data from BSF will be compared with SNI 19-7030-2004 (National Standard of Indonesia for compost), Perhutani Standard, and Who standard. Moreover, the data will also compare to data from compost with aerobic decomposition process reported by Sahwan et al. [8]; Compost A is compost from waste food of Housing Rajawali, and Compost B is waste food of Housing Puspitek.



Figure 1. Broodstock of Black Soldier Fly



Figure 2. Food for Black Soldier Fly

3. Results and discussion

Compost is the product of the biological degradation process from organic matter in aerobic conditions, which has a stable condition. Compost from Organic Fraction of Municipal Solid Waste is becoming very commonly used in agriculture as a soil conditioner and a fertilizer, and it causes the rise of its characterization issue [9]. Some of the compost's high quality even produces high quality for

certain plants rather than the chemical fertilizer. Some plants produce a bigger size of fruits or leaves than the regular fertilizer.

These are because compost has several benefits, such as soil-borne plant pathogen suppression, biological weed control, and plant nutrient availability [10]. The study from Weindorf et al. [11] successfully quantified the positive effects of compost on soil physical properties for the parameter of Coefficient of Linear Extensibility (COLE), water content, infiltration rate, and secondary properties.

One of the methods of the composting process is to take advantage of the Black soldier fly activity. Black soldier fly seems to be one of the best candidates for biodegradation [12]. From the result of this research, it was found that compost from black soldier fly has a larger value of C-Organic is 18.37%, which is higher compare to C-organic in Compost A (9.33%) and Compost B (11.62). Data of N-Total in Compost BSF (1.45%) is higher compare to Compost A (0.71%) and Compost B (1.08%). Linear with C-organic and N-total, P-total in Compost BSF is higher than P-total in Compost A and B.

Table 1. Parameters matching the compost from Black Soldier Fly with SNI standard

No	Parameters	Compost BSF	Compost A	Compost B	Indonesian Standard	Perhutani	WHO 1980
1.	pH	6.8*	7.5	5.8	6.8-7.49	6.6-8.2	6.5-7.5
2.	C-Organic(%)	18.37*	9.33	11.62	9.8-32	14.5-27.1	5-8
3.	N-Total (%)	1.45*	0.71	1,08	0.4 -	0.6-2.1	0.4-3.5
4.	P-Total (%)	1.58*	0.17	0,12	0.10-	0.3-1.8	0.3-3.5
5.	C/N Ratio	12.66*	13	11	10-20	10-20	10-2-
		<i>source: Research data</i>	Source: Sahwan <i>et al.</i> , 2011		<i>SNI 19- 7030- 2004</i>		

Compost A and Compost B, which are from the organic waste from the residential area. For the pH and C/N ratio parameter. Compost BSF is larger than Compost B but still lower than Compost A.

One parameter to assess the level of compost maturity is the C/N ratio. Microbes need carbon as an energy source in the process of decomposing organic matter. At the same time, Nitrogen is needed by microbes as a food source for the formation of body cells. Both of these elements are needed in large quantities in a specific balanced composition. For a good composting process, the raw materials C / N ratio is 30, and the compost is said to be ripe if the C/N ratio drops to less than 20 [13-17]. The compliance of the initial C/N ratio mainly influenced the maturity of the final compost [18].

However, Compost BSF complies with several predetermined standards such as Indonesian Standard (SNI), Perhutani, and WHO 1980. The advantage of using BSF for composting is that the decomposition time only takes 1 week, while conventional composting takes 1 month or more than 1 month. Composting using BSF can remain a lot of C-organic.

4. Conclusion

This research concludes that the C-organic compost content is 18,37%, Total Nitrogen is 1.45%, Total Phosphor is 1.58%, and the pH is 6.8, C/N ratio is 12.66. Total Nitrogen, Total Phosphor, C/N ratio, and pH have fulfilled the requirements of the National compost standard of Indonesia (SNI). So, Compost from Black Soldier Fly larvae has high potential as a standard compost and fast composting process.

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Authorships

The main authors in this article are R A D Widyastuti and Ali Rahmat. Authors co-contributor H A Warganegara, W S Ramadhani, B Prasetyo and M Riantini

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