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Utilization of Household Organic Waste As Solid Fertilizer With Maggot Black Soldier Fly (BSF) As A Degradation Agent

Deffi Ayu Puspito Sari*[1], Darmono Taniwiryono[2], Richa Andreina[1], Prismita Nursetyowati[1], Diki Surya Irawan[1], Aqil Azizi[1], Prima Hadi Putra[3]

[1]Environmental Engineering Universitas Bakrie, 12940, Indonesia

[2]Homebase Innovation Center, Indonesia

[3]PT Duta Danadyaksa Teknologi (DD Tekno), Indonesia

*Corresponding author E-mail: deffiayu@gmail.com

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ABSTRACT

Household waste still becomes a national problem as it causes air, soil and water pollution and disturbs aesthetics. For this reason, comprehensive and integrated waste management from upstream to downstream needs to be carried out in order to provide economic and health benefits for the community and be safe for the environment. Organic waste processing can be performed using black soldier fly (BSF). BSF is a type of fly that can eat household organic waste, making this fly is widely used as an alternative to processing organic waste, especially from households. This research uses an experimental method of cultivation scale and produces a by-product in the form of solid fertilizer which then compared with the Decree of the Minister of Agriculture of the Republic of Indonesia No. 261 of 2019 concerning Organic Fertilizer, Biological Fertilizer and Soil Improvement. From laboratory tests, the parameters of C-organic, C/N, by-products, pH, macronutrients, heavy metals, micronutrients, and biological analysis met the quality standards.

Keywords : Maggot Black Soldier Fly (BSF), Solid Fertilizer, Organic Waste

1. INTRODUCTION

Garbage generally consists of organic and non-organic waste. Organic waste can cause air, soil and water pollution. Organic waste that enters water bodies can cause high turbidity values and result in reduced light intensity entering the water (Irawan, Sari, & Putriahalya, 2021).

Waste management, either by the community or the local government, is still not optimal. One of the waste managements that has a negative impact on public health and the environment is the burning of waste. Organic waste that is burned directly produces several by-products that have an impact on the environment such as carbon dioxide, methane and nitrous oxide (Sari & Falatehan, 2020). Therefore, waste processing needs to get special handling and attention from all parties because waste can create health risks for city workers, community and environment (Fairus, Rohajawati, Nursetyowati, Irawan, & Sari, 2020).

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Organic waste has potential to be used as fertilizer (Ali, Nisak, & Pratiwi, 2020), and the addition of organic fertilizer can improve soil biological fertility which was generally low (Purba et al., 2020), (Purba, J. H., Wahyuni, & Febryan, 2019).

Currently, organic waste can be managed by using the black soldier fly or commonly called the maggot black soldier fly (BSF). Maggot BSF is a type of insect that is very appropriate for processing organic waste (Dortmans, Diener, Verstappen, & Zurbrügg, 2017) and (Sari, Taniwiryono, Andreina, Nursetyowati, & Irawan, 2022). Maggot BSF can decompose organic waste containing 60% to 90% water content. In addition, for the nutritional needs of maggot black soldier fly, the ingredients are high in protein and carbohydrates which are good for larvae. Waste processing with BSF maggot can be an alternative because it does not have a negative impact on the environment. Following good waste management can be done to prevent greenhouse gas (GHG) emissions, therefore its role in mitigating climate change is important (Sari & Falatehan, 2020).

BSF larvae can consume a wide variety of foods. The versatility of the foods makes BSF an ideal insect for protein production. BSF larvae can be fed a variety of foods such as kitchen waste, fruits, vegetables, liver, fish waste, urban waste, human waste, and animal waste (Yuwono & Mentari, 2018), (Sari et al., 2022) and (Siddiqui et al., 2022). Production process waste, such as palm oil production waste, can also be used as food for BSF. Waste from palm oil processing is divided into solid and liquid waste. Solid waste is in the form of empty fruit bunches, fibre, and shells (Sari et al., 2019). Solid waste can also be treated using BSF maggots (Sari et al., 2022).

The nutrient requirements of adult flies are influenced by several factors, one of which is the fat content that is stored during the pupa stage (Makkar, Tran, Heuzé, & Ankers, 2014). Therefore, the fly dies when the fat stores are depleted.

2. RESEARCH METHOD

This study uses primary data obtained from experimental results. The data is then analysed using secondary data from the Decree of the Minister of Agriculture of the Republic of Indonesia No. 261 of 2019 concerning Organic Fertilizer, Biological Fertilizer and Soil Improvement. The results of data analysis are displayed in descriptive form in the form of pictures and tables.

The manufacture of solid fertilizer is done by feeding maggot with home organic waste. After one month, the compost is harvested and samples of solid organic fertilizer are made. Organic solid fertilizer that has become a product is then tested in the laboratory. The

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results of sample testing were analysed based on the Decree of the Minister of Agriculture of the Republic of Indonesia No. 261 of 2019 concerning Organic Fertilizer, Biological Fertilizer and Soil Improvement.

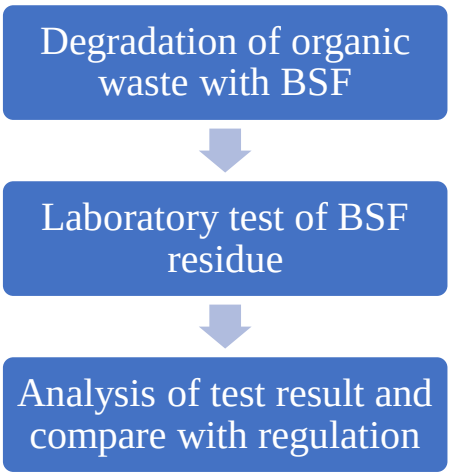

Figure 1. Research Flow Diagram, The Production of Solid Fertilizer from BSF Residue (*Kasgot*)

Parameters to be tested to determine the quality of solid organic fertilizer include C-Organic, C/N, by-products, moisture content, pH, heavy metal values (As, Hg, Pb, and Cd), macronutrient values (N, P, and Cd). K), micronutrient values (total Fe, available Fe, total Mn, and total Zn), as well as biological analysis in the form of (E.coli, and Salmonella sp.). In this study, the quality standard of solid fertilizer was used with enriched microbes. The quality standards for solid fertilizers used are as follows:

Table 1. Solid Fertilizer Quality Standard

No.	Parameter	Unit	Quality Standard	
			Pure	Enriched with Microbes
1.	C- organic	%	Min 15	Min 15
2.	C/N Ratio	-	≤ 25	≤ 25
3.	Associated Materials (Plastic, glass, gravel)	%	Maximum 2	Maximum 2

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No.	Parameter	Unit	Quality Standard	
			Pure	Enriched with Microbes
4.	Water content	%	8 - 20	10 - 25
5.	**Heavy metal**			
	As	ppm	max 10	max 10
	Hg	ppm	max 1	max 1
	Pb	ppm	max 50	max 50
	Cd	ppm	max 2	max 2
	Cr	ppm	max 180	max 180
	Ni	ppm	max 50	max 50
6.	pH	-	4 - 9	4 - 9
7.	**Hara Macro** ($N+P_2O_5+K_2O$)	%	min 2	
8.	**Contaminant Microbes:**			
	- *E.coli*	MPN/gr	$< 1 \times 10^2$	$< 1 \times 10^2$
	- *Salmonella*	MPN/gr	$< 1 \times 10^2$	$< 1 \times 10^2$
9.	Functional Microbes:	Cfu/ gr	-	$\geq 1 \times 10^5$
10.	Granule Size 2 - 5 mm	%	min 75	min 75
11.	**Micro Nutrients:**			
	- Fe total	ppm	max 15.000	max 15.000
	- Fe available	ppm	max 500	max 500
	- Zn	ppm	max 5000	max 5000
12	**Other Elements**			
	- La	ppm	max 2000	max 2000
	- Ce			

Source: Ministry of Agriculture of the Republic of Indonesia No. 261 of 2019

3. RESULT AND DISCUSSION

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Solid organic fertilizer comes from residual waste from processing with BSF maggot. Waste processing using this method reduces the negative impact of waste on the environment such as water and air pollution. By utilizing organic waste into solid fertilizer, water pollution can be avoided because waste from people's domestic activities in the form of food waste causes high COD values and reduces oxygen if it enters water bodies (Irawan et al., 2021). On the other hand, the direct method of burning waste can produce emissions (Sari & Falatehan, 2020).

In this study, samples of solid fertilizer were taken from 3 points but still in the same reactor. A sample of 1 kg was used for laboratory tests. According to (Simanungkalit, Suriadikarta, Setyorini, Saraswati, & Hartatik, 2006), decomposition products in solid form can be referred to as solid compost or organic solid fertilizer. The manufacture of products from organic waste can help reduce greenhouse gas emissions because the process of degradation of residual production waste can produce emissions (Sari, Fadiilah, & Azizi, 2019).

The use of organic solid fertilizers can increase the content of organic matter in the soil so that it can maintain and increase the fertility of agricultural soil. Solid organic fertilizers can have a function in improving the quality of physical, chemical and biological fertility of the soil.

From the results of laboratory tests for solid organic fertilizers, the value of heavy metal content, 2 samples with microbial contaminants in the form of E.coli and 10 samples with microbial contaminants in the form of Salmonella sp. are according to quality standards. However, the value of macronutrients, micronutrients and E.Coli bacteria from 7 samples did not meet the quality standards. The high content of heavy metals can harm the community (Fairus et al., 2020). The results of laboratory tests are as follows:

Table 2. Solid Fertilizer Test Results

Test Parameters	Unit	Quality standards	Unit	Result	Note
C- Organic	%	min 15	%	45,65	Meet Quality Standards
C/N	-	≤ 25	-	15	Meet Quality Standards
Additional material	%	max 2	%	0	Meet Quality Standards
Water content	%	10 - 25	%	75,5	Does not Meet Quality Standards

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pH	-	4 - 9	-	8,4	Meet Quality Standards
Macro Nutrient					
N	%	min 2	%	3,05	Meet Quality Standards
P_2O_5	%	min 2	%	3,18	Meet Quality Standards
K_2O	%	min 2	%	1,39	Does not Meet Quality Standards
Heavy metal					
Hg	ppm	max 1	ppm	Td	Meet Quality Standards
Pb	ppm	max 50	ppm	6	Meet Quality Standards
Cd	ppm	max 2	ppm	0,4	Meet Quality Standards
As	ppm	max 10	ppm	Td	Meet Quality Standards
Micro Nutrient					
Fe Total	ppm	max 15.000	ppm	1.985	Meet Quality Standards
Fe available	ppm	max 500	ppm	438	Meet Quality Standards
Zn Total	ppm	Max 5000	ppm	410	Meet Quality Standards
Biological Analysis					
E.coli	MPN/gr	< 1 x 10^2	MPN/gr	<30	Meet Quality Standards
Salmonella sp	MPN/gr	< 1 x 10^2	MPN/gr	92	Meet Quality Standards

Source: Laboratory Test Results

In Table 2, the value of the water content in the sample is 75.5%. When compared with the quality standard used by 10 -25%, the value of the water content in the sample is very high and does not match the quality standard. The water content resulting from the decomposition of BSF maggots had higher yields (Eka Kusumawati, Sapta Dewi, & Sunaryanto, 2018). This can happen because in the decomposition process, BSF maggot also metabolizes and releases its excretion products in the form of solid and liquid residues in a more humid condition. In addition, high water content can be caused by organic waste. According to researchers, to reduce water content, organic waste should not have high-water content.

Still from Table 2, the value of macronutrients in the form of nitrogen (N), phosphorus (P), and potassium (K), when compared with the quality standard used for a minimum macronutrient content of 2%, is in accordance with the quality standard used. However, the value of potassium (K) is not in accordance with the quality standard. The high value of

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potassium can be caused by the formation of organic acids during the faster decomposition process (Hidayati, Benito, Kurnani, Marlina, & Harlia, 2011). The low value of macronutrients in the form of potassium (K) can be caused by the composting process that is too fast or the harvesting of leachate too early.

Figure 2. The Harvest of Organic Waste Residues

Figure 3. Organic Waste Residue as Solid Fertilizer

4. CONCLUSION

From the laboratory test for the manufacture of solid fertilizer, the value of C-organic, C/N, by-products, pH, heavy metals, micro nutrients, E.coli, Salmonella sp., and F-solvent bacteria met the quality standards. However, the value of water content, micro nutrients in the form of potassium values did not meet the quality standards.

Suggestion

Suggestions proposed following this research are as follows:

1. It is necessary to do further research using a dry type reactor or biopond considering the reactor used in this research was a continuous and wet type bioreactor so that the water content in solid fertilizer exceeds the quality standard;
2. Composting needs to be done longer so that the results obtained can meet the quality standards.

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