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Organic Waste Bioconversion Technology Using Black Soldier Fly (Hermetia Illucens Linnaeus, 1758)

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Abstract – The problem of waste is still not handled so another alternative is needed, namely with the help of the Black soldier fly insect to process organic waste from restaurants and pineapple skin waste. BSF is an insect that is widely used as an agent for the bioconversion of organic waste and can convert organic waste into high-value products. This study aims to determine the ratio of bioconversion of restaurant organic waste to pineapple peel waste. This study uses an experimental method with data collection techniques using quantitative descriptive methods. The results showed that the highest larval wet weight calculation was found in the treatment of restaurant waste while environmental factors for BSF larvae were found in optimal environmental conditions with ideal temperatures.

Keywords – bioconversion, black soldier fly, waste

I. INTRODUCTION

Garbage is something that is not used, not liked, or something that must be thrown away. The problem of waste in Indonesia is a serious problem due to the accumulation of waste. According to [1], Padang City Waste, the daily waste generation of Padang City is 681.21 tons per day with a total annual waste generation of 248.640.34 tons/year. The lack of support from government policies makes this waste problem serious and is still a common concern because it can cause a bad smell and even become a source of disease. For this reason, more serious efforts are needed in handling the waste.

The organic waste processing technology is generally used for composting because the waste is easily degraded. This study uses a bioconversion method that involves microorganisms to convert organic waste into high-value products with the help of Black soldier fly insects to process organic waste. BSF larvae can convert organic waste such as market waste, vegetables, fruit [2], food waste, soft bones [3], animal waste, and expired milk [4]. BSF larvae can survive at extreme pH in the pH range of 7-13 [5]. The advantage of using bioconversion technology with the help of BSF larvae is that it can help reduce the amount of organic waste by up to 58% [6] because organic waste is food for the larvae themselves. BSF larvae can decompose organic waste quickly. BSF larvae can be used to convert organic matter so that it has economic potential [7]. The ability to degrade waste BSF larvae is better than that of other insects [8].

This study is very much needed and expected because BSF larvae can reduce the number and unpleasant odors in restaurant waste and pineapple peel waste. The purpose of this study was to compare the bioconversion of restaurant waste and fruit waste using BSF larvae.

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II. RESEARCH METHODS

This study uses the treatment of organic restaurant waste taken from the biology campus canteen and pineapple waste. The weight measurement technique uses digital analytical scales in grams, while the measurement of environmental temperature and humidity uses a digital thermometer. The tools and materials used are a 19x16x20 cm biopond, wire, analytical scales, cloth cover, and digital thermometer. The materials used are restaurant waste and pineapple waste, chicken feed, and BSF larvae eggs.

a. Preparation process for hatching larvae eggs and rearing BSF larvae

Preparation The hatching media used as the initial feed for BSF baby larvae was chicken feed. Put 50 g of hatching feed mixed with water (±100 ml) until the feed has a soft texture like porridge. Then 0.5 g eggs are placed on a wire on a tissue so that the eggs are not exposed to the media. After the larvae were 7 days old, the rearing feed given was restaurant waste and pineapple skin and flesh waste. Feed was given every day for 21 days of observation as much as 300 g. Then the weight of 50 larvae was weighed with 3 replications after 21 days of observation.

Data analysis

This study uses an experimental method with data collection techniques using quantitative descriptive methods.

III. RESULT AND DISCUSSION

1. Growth of BSF larvae with different rearing media

Growing media is generally used by researchers as a place for laying newly hatched larvae to be able to grow and develop in the media which is then ready to convert coarser organic waste (Figure 1).

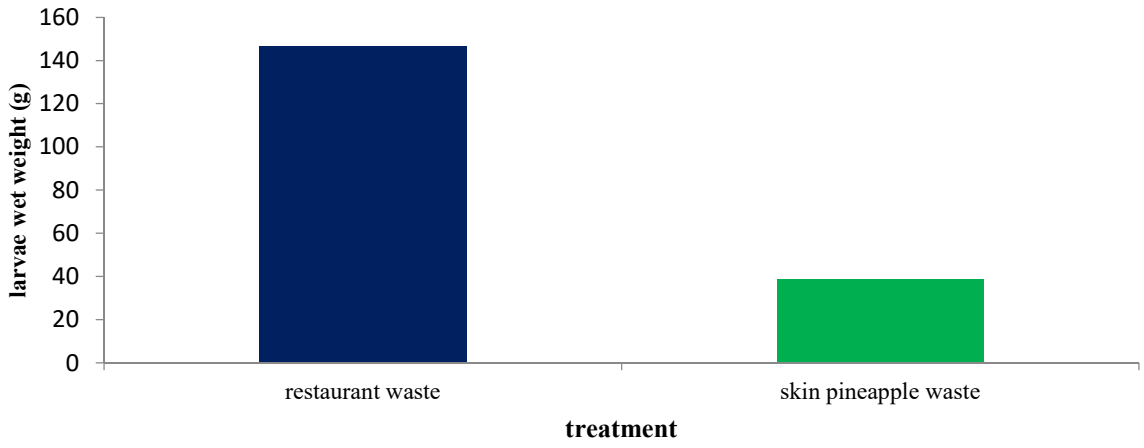

Figure 1. The average increase in larval weight (g) was fed with different feeds during observations.

Growing media is generally used by researchers as a place for laying newly hatched larvae to be able to grow and develop in the media which is then ready to convert coarser organic waste. Based on the calculation of the wet weight of BSF larvae, it was found that the highest larval weight was found in the treatment of restaurant waste at 146.46 g during observation. This is because the ability of larvae to reduce waste also increases. Restaurant waste is an excellent feed medium to support the growth of BSF larvae because it has very diverse types of waste rich in protein and carbohydrates. The more fulfilled the nutrients needed by the larvae, the more optimal the growth of the larvae. According to [5] that restaurant waste, household waste, or restaurant waste has a high-calorie content, resulting in heavier larvae. According to [9], the quality and quantity of food ingested by BSF larvae have an important influence on the growth and development time of larvae.

In contrast to the treatment of pineapple waste feeding, it was found that the larvae weight was low at 38.53 g. It is suspected that pineapple peel has a high fiber content so the larvae need a long time to consume the feed. Pineapple skin contains 81.72% water, 20.87% crude fiber, 17.53% carbohydrates, 4.41% protein, and 13.65% reducing sugar [10]. The high water content in pineapple skin makes BSF larvae tend to leave the breeding grounds to look for drier places. According to [11] the water content

in the feed should be sufficiently moist with a water content of 60% to 90%. However, when the water content is too little or less, it will cause BSF larvae to digest food, which takes longer and is inefficient.

2. Comparison of growing media for larvae fed with different feeds

Table 1. Comparison of larval growth media fed different feeds that have the potential to produce high biomass

References	Massa Total	Biomassa	Sumber Makanan
Darmawan *et al*., 2017 [12]	200 mg/larvae/day	0,1252 gram/larvae	Cassava leaves
Bokau *et al*., 2018 [13]	1 kg	-	Palm kernel meal
Suciati, 2017 [14]	500 gram	-	Coconut pulp
Supriyatna *et al*., 2017 [15]	3.300 mg	13,86 mg	Rice straw
Fahmi, 2015 [16]	10 gram	1864,6 mg	Dregs tofu + PKM fermentation
Salman *et al*., 2019 [17]	1 kg	8,123 gram	Organic waste+ quail poop
Muhayyat *et al*., 2016 [18]	60 mg/larvae/day	10 gram	Cassava leaves
Perkasa, 2019 [19]	300 gram	4,68 gram	Market organic waste
Arthur *et al*., 2019 [20]	15 kg	0,19 gram/larvae	Kitchen waste
Lalander *et al*., 2019 [21]	1 kg	251 mg	Poultry feed
Sprangers *et al*., 2017 [3]	600 gram	930 gram	Chicken food
Ibadurrohman et al., 2020 [22]	4 kg	0,8 kg	Food waste
Monita *et al*., 2017 [5]	300 kg	0,11 g	palm kernel meal (PKM)
Mahardika, 2016 [23]	400 gram	19,89 gram	Fruit waste + cast-offs
Saragi, 2015 [24]	20 mg/larvae/day	0,25 mg	Vegetable waste + fruit

Source: the result of the review paper

Based on several comparison studies of larval growth media that have the potential and have high biomass which is very good for the growth of BSF larvae as follows. BSF has been investigated to be able to degrade organic waste by utilizing its larvae which extract energy and nutrients from vegetable waste, food waste, animal carcasses, and feces as food ingredients. It was also stated by [25] that BSF larvae can degrade both solid and liquid waste. BSF larvae can degrade food waste in large quantities, faster and more efficiently than other species. This is influenced by the mouth part contains digestive enzymes that are more active.

3. Environmental factors of BSF larvae

Table 2. Temperature and humidity of the hatching environment and rearing of BSF larvae during observation

Parameter	Treatment	
	Egg Hatching	Enlargement larvae
Temperature (˚C)	29.97	30,21
Humidity (%)	68	67

Temperature is one of the factors that play a role in the breeding of BSF larvae. Temperature is one of the factors that play an important role in the growth and reproduction of BSF larvae. The temperature in this study was found in the hatching of BSF fly eggs, namely 29.97˚C and 68% humidity, while the temperature at larval rearing was 30.21˚C and humidity was 67%. According to [12] Optimal environmental conditions for BSF larvae are warm climates with ideal temperatures ranging from 24˚C to 30˚C, if it's too hot the larvae will come out of their food source to find a cooler place. If it's too cold, the larvae's metabolism will be slow as a result the larvae will eat less so that their growth will slow down. But according to [26], BSF larvae cannot survive at temperatures less than 7˚C and temperatures more than 45˚C but optimal environmental conditions with ideal temperatures range from 30-36˚C. Then the shaded environment is also good for the development of BSF larvae. BSF larvae will avoid light and always seek a shady environment away from sunlight. If the food source is exposed to light, the larvae will move to a deeper layer of the food source to avoid the light.

BSF flies can live in quite extreme environments such as waste media which contains a lot of salt, alcohol, acid, and ammonia. According to [5] BSF larvae can live in various media because they have a high tolerance for extreme pH in the pH range of 7-13. The ability of BSF larvae to tolerate poor environmental conditions makes the application of reduction with BSF larvae have more potential than other organisms.

IV. Conclusion

Based on the research that has been carried out, the highest average larval weight is found in the treatment of restaurant waste 146.46 g, while the temperature and humidity of environmental factors for BSF larvae are found in optimal environmental conditions with an ideal temperature of 30-36 C and good humidity for BSF larval development is 60-90%

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