The effect of maggots lentera flies (hermetia illucens) growing media as the solution of using organic waste

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Abstract. Waste is not only a complex problem in big cities, but in several villages it can become an environmental problem that must be addressed immediately. Organic waste that has not been managed properly will result in a source of pollution. However, several ways can be done to deal with this problem, including activities to recycle organic waste with the method of decomposing waste using maggot larvae (BSF). This study aims to determine the growth of maggots by treating different types of waste media and containers on maggot growth. The method used was an experimental method with completely randomized design with 3 levels of treatment of the size the container used. The results showed that the highest weight of maggot was produced from container 2, namely a mixture of organic waste and tofu dregs of 4,250 grams with an average of 1,417 grams. The type of waste media had a significant effect on the maggot weight (P=0.001), while the size of container had no significant effect on the maggot weight (P=0.387)

1. Introduction
Currently, waste management is still concentrated in landfills (TPA) without the 3R (Reduce, Recycle, Reuse) process at the source, and without involving community participation. This condition is the main factor in the TPA burden becoming heavy and its use life is getting shorter (Suyatno et al., 2015). Organic waste which is dominated by food waste (animal and vegetable products), vegetables, fruits, fish waste, agricultural waste and plantations, wood waste, leaves, twigs, and animal and human waste. If not handled properly, organic waste can be a source of disease, a source of pollutants that produce leachate waste that can pollute groundwater, and gas produces methane, pollutes the air that causes global warming and can cause a bad smell (Monita et al., 2017).

In general, organic waste is recycled using composting technology to produce compost (Gani, 2007) and anaerobic digestion to produce biogas (Davis et al., 2014) by involving the activity of microorganisms. In addition, there are ways to recycle organic waste using the bioconversion method (Putra and Ariesmayana, 2020). Bioconversion is a breakdown of organic waste into a methane energy source through a fermentation process that involves living things (Newton et al., 2005). Bioconversion carried out by bioconversion agents, namely larvae of Black Soldier Fly (BSF) or commonly known as maggots, can reduce organic waste by up to 56% (Suciati and Faruq, 2017). The final result of bioconversion is a change in the composition of waste organic matter due to the decomposition by BSF larvae into simpler organic compounds. The bioconversion results from BSF larvae produce
stable materials, such as compost. Compost is the final form of waste organic materials after decomposition or conversion.

The use of organic waste using maggot larvae in Kuningan Regency has not been widely used. Some of the obstacles that arise include smelly media, hot media, muddy media, many young maggots that die, pupae don't hatch, the presence of maggot-eating animals, and many more. Hermetia illucens flies like a distinctive aroma, so not all media can be used as a place to lay eggs (Katayane et al., 2014). The purpose of this study was to determine the weight of the maggot with the treatment of different types of waste media and to determine the effect of the type of waste media and the size of the container on the weight of the maggot.

2. Methodology

The research was conducted in the garage area of the Kuningan Regency Environmental Services. The materials used include Helmetia illlucens larvae, organic waste, tofu dregs, and bran. Larvae are obtained from the production of Helmetia illucens insect eggs produced from the waste processing pilot with maggots at the Kuningan Regency Environmental Services. The tools used in this study were plastic containers with sizes respectively 60cm x 25cm x 10cm, and 40cm x 25cm x 10cm, knives, wooden stirrers, gloves, digital scales, kg scales, thermometers, saws, buckets, and filters.

The study used a completely randomized design with 2 factors. The first factor is the type of waste media (S) which consists of 3 levels, namely organic waste (S1), organic waste + tofu dregs (S2), and organic waste + bran (S3). The second factor is the size of the container (B) which consists of 2 levels, namely the size of 60cm x 25cm x 10cm (B1) and the size of 40cm x 25cm x 10cm (B2). The experiment will be repeated 3 times; thus the number of experimental samples is 18 treatments. The processed data were analyzed statistically with two-way ANOVA analysis. Processing of these data is done by computerized methods with the help of Microsoft Office Excel and IBM SPSS Statistics 21.

3. Result and Discussion

3.1 Maggot weight

The initial stage carried out is spreading the eggs in all the containers that have been provided. The growth of BSF begins when the eggs become larvae (Monita et al., 2017), Helmetia illucens eggs hatch after 3 days in all containers except in containers containing a mixture of organic waste and bran. Hermetia illucens eggs will hatch after 3-4 days (Sheppard, 2002), but in a mixture of organic waste and bran Helmetia illucens eggs hatch on the 5th day. The hatching is delayed because the mixture of organic waste media and bran undergoes fermentation. The larval phase lasts 12-13 days, during the feeding phase the larvae experience weight growth until the pupal phase. The quality and quantity of food ingested by BSF larvae have an important influence on the growth and development time of the larvae, survival, mortality and ovarian development of adult insects and determine the physiological and morphological development of adult BSF (Tomberlin et al., 2002).

Temperature plays an important role in the bioconversion process of organic waste by larvae in accelerating composting and supporting larval growth (Monita et al., 2017). Temperature measurements were taken when the larvae were transferred to the treatment container. The temperature in each treatment was observed every day and the results ranged from 25oC - 30oC, this is in accordance with (Dortmans, et al., 2017) who stated that the optimal environmental conditions and food sources for larvae are warm temperatures ranging from 24oC - 30oC, if too hot the larvae will exit their food source in search of a cooler place.

Next, after the BSF larvae hatch, they will eat the feed that has been provided in each container. The type of media is then added again on the fifth day and the eighth day according to the initial weight of the mixed media waste procurement. The total larval feed in each container is 6 kg. After that on the 13th day the larvae that have become maggots are harvested. The quality and quantity of food ingested by BSF larvae have an important influence on the growth and development time of larvae, survival, mortality, and ovarian development of adult insects and determine the physiological and morphological development of adult BSF (Gobbi et al., 2013). In addition, BSF larvae are also
highly resistant and able to withstand environmental conditions, such as drought, lack of food or lack of oxygen (Diener et al., 2011).

Based on the results of the maggot weight found in each treatment medium (organic waste, organic waste and tofu dregs, organic waste and bran) there are different weights. Before weighing, the dirt that sticks to the maggot body is cleaned first. This treatment is intended so that no dirt sticks to the maggot body so that it does not affect the weighing of the maggot body weight (Salman et al., 2020). Following are the results of the average maggot weight for several types of media and containers (Table 1).

Table 1. The results of the average maggot weight

| No | Jenis Media | Bobot Maggot (gr) | Rata-Rata (gr) |
|----|-------------|------------------|---------------|
|    |             | B1    | B2    |               |
| 1  | S1          | 1,200 | 750  |               |
|    |             | 1,100 | 1,000 |               |
|    |             | 1,000 | 1,500 |               |
|    | Total (gr)  | 3,300 | 3,250 |               |
|    | Rata-Rata (gr) | 1,100 | 1,083 |               |
| 2  | S2          | 900   | 750  |               |
|    |             | 1,500 | 1,500 |               |
|    |             | 1,000 | 2,000 |               |
|    | Total (gr)  | 3,400 | 4,250 |               |
|    | Rata-Rata (gr) | 1,133 | 1,417 |               |
| 3  | S3          | 400   | 600  |               |
|    |             | 250   | 500  |               |
|    |             | 200   | 500  |               |
|    | Total (gr)  | 850   | 1,600 |               |
|    | Rata-Rata (gr) | 283   | 533  |               |

Information:

S1 = Organic trash
S2 = Organic waste and tofu dregs
S3 = Organic waste and bran
B1 = Container 1
B2 = Container 2

Based on Table 1 above, it is known that the highest maggot weight is produced from a mixture of organic waste and tofu dregs for both B2 and B1 containers, which weighs 4,250 grams (total) with an average of 1,417 grams and weighs 3,400 grams (total) with an average of 1,133 grams. The second highest maggot weight is produced from organic waste alone for containers B1 and B2, which is 3,300 grams (total) with an average of 1,100 grams and 3,250 grams (total) with an average of 1,083 grams. While the lowest maggot weight is produced from containers B1 and B2, namely a mixture of organic waste and bran weighing 1,600 grams (total) with an average of 533 grams and weighing 850 grams (total) with an average of 283 grams. Viewed as a whole, the mixed media types for organic waste and tofu dregs in containers 1 and 2 obtained a high amount of maggot weight compared to other types of waste media, namely 3,400 grams and 4,250 grams. The difference in weight resulting from each mixture of media according to Silmina et al., (2012) can occur because the composition of tofu dregs is a medium that contains sufficient nutrients (vegetable protein).
The media conditions in each treatment were also different (Table 2). Based on the results of observations between organic waste media alone with a mixture of organic waste and tofu dregs, the condition of the media is wet and the smell is strong. The existence of wet conditions due to the high water content. But even in wet conditions, the growth of maggot in a mixture of organic waste and tofu dregs is very high. This is different from the statement (Tran et al., 2014) which states that BSF larvae can only grow on media with low water content, so that if the water content is high it will only inhibit the reproduction of BSF larvae. High water content is the cause of difficulty for larvae to reduce feed (Hakim, 2017). The mixed condition of organic waste and bran produces a culture medium that is moist and odorless.

Table 2. Media Condition

| No | Jenis Media | Kondisi Media Kultur Maggot |
|----|-------------|-----------------------------|
|    |             | B1                           | B2                           |
| 1   | S1          | Basah                        | Basah                        |
|     |             | Bau                          | Bau                          |
| 2   | S2          | Basah                        | Basah                        |
|     |             | Bau menyengat                | Bau menyengat                |
| 3   | S3          | Lembab                       | Lembab                       |
|     |             | Tidak berbau                 | Tidak berbau                 |

Information:

S1 = Organic trash
S2 = Organic waste and tofu dregs
S3 = Organic waste and bran
B1 = Container 1
B2 = Container 2

3.2 Effect of Treatment Type of Waste Media and Container Size on Maggot Growth

The results of the statistical analysis of the weight value of maggot showed that the treatment of the type of waste had a significant effect on the growth of the maggot ($P = 0.001$). This is because the different types of waste treatment will produce different maggot weights. The highest maggot weight is produced from a mixture of organic waste and tofu dregs with a wet culture medium with high moisture content and a strong odor, this is in accordance with the results of the research of Hakim et al. (2017) on the effect of moisture content in BSF feed. The results of these studies indicate that BSF larvae are able to live on feed containing 20-90% water and the composition of the tofu dregs is a medium with sufficient nutrition (vegetable protein) (Silmina et al., 2012).

The weight of the maggot from a mixture of organic waste and bran with a moist and odorless culture media condition still produces maggot even though it experiences delays in changing to maggot. This is different from the results of research conducted by Suciati and Faruq (2017) which
states that the bran media is not found in BSF maggots, but in this study it does not use bran alone so that it allows maggots to live on organic waste feed even though they are hatched from eggs until the day 5.

Based on the results of statistical analysis, the value of maggot weight on the container size has no significant effect on the maggot weight (P = 0.387), this is in accordance with the research of Suciati and Faruq (2017) which suggests that the use of different containers has no effect on maggot weight.

**Table 3.** The results of the analysis of the effect of the type of waste media and the size of the container on mangos teen growth

| Tests of Between-Subjects Effects | Maggot weight |
|----------------------------------|---------------|
| Source                           | Type III Sum of Squares | df | Mean Square | F  | Sig. |
|----------------------------------|------------------------|----|-------------|----|------|
| Corrected Model                  | 2931111.111*          | 5  | 586222.222  | 5.037 | .010 |
| Intercept                        | 1494222.222          | 1  | 1494222.222 | 128.382 | .000 |
| Container                        | 93888.889            | 1  | 93888.889   | .807  | .387 |
| Type_S                           | 2768611.111         | 2  | 1384305.556 | 11.894 | .001 |
| Container * Type_S               | 68611.111           | 2  | 34305.556   | .295  | .750 |
| Error                            | 1396666.667         | 12 | 116388.889  |       |      |
| Total                            | 19270000.000       | 18 |             |       |      |
| Corrected Total                  | 4327777.778        | 17 |             |       |      |

a. R Squared = .677 (Adjusted R Squared = .543)

4. Conclusion

The highest maggot weight is produced from a mixture of organic waste and tofu dregs, both containers B2 and B1, which weighs 4,250 grams (total) with an average of 1,417 grams and weighs 3,400 grams (total) with an average of 1,133 grams. The second highest maggot weight is produced from organic waste alone for containers B1 and B2, which is 3,300 grams (total) with an average of 1,100 grams and 3,250 grams (total) with an average of 1,083 grams. The type of waste media had a significant effect on the maggot weight (P = 0.001), while the size of the container had no significant effect on the maggot weight (P = 0.387).

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