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Growth Performance of *Hermetiaillucens* and *Tenebriomolitor* in Different Organic Waste Biconversion Process

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Abstract

The amount of organic waste in Indonesia has increased. One solution to reduce the amount of organic waste is to use the concept of bioconversion. Bioconversion can be done using the larvae of insects Hermetiaillucens and Tenebriomolitor. The type of organic waste and the amount of organic waste given affects the change in body weight of the larvae *Hermetiaillucens* and *Tenebriomolitor* (P>0.01). The largest change in the body weight of *Hermetiaillucens* larvae occurs in the market waste media and the largest change in the body weight of *Tenebriomolitor* larvae occurs in chicken manure. The survival rates of *Hermetiaillucens* and *Tenebriomolitor*are highest in the market waste media.

Keywords: *Growth Performance; Hermetiaillucens Larvae; Tenebriomolitor Larvae; Market Waste; Chicken Manure*

Introduction

Garbage is one of the sources of problems experienced by every country, especially in Indonesia. The amount of waste in Indonesia is increasing every year. The increase in the amount of waste is related to the increase in the population, economic growth, and consumption patterns of indonesian people (Indonesia's Environmental Statistics, 2018). Based on data from the Ministry of Environment in the National Waste Management Information System, the composition of Indonesia's waste is the most organic waste type, which is 65.7%. The waste consists of food waste, wood/ twigs/leaves, and paper / cardboard. The most organic waste is produced from households, traditional markets, and food stalls (Trihadiningrum et al., 2015; Windraswara&Prihastuti, 2016).

Organic waste is an easily decomposing waste and contributes to the presence of greenhouse gases (Al-Rumaihi et al., 2020; Pace et al., 2018). In general, people manage waste by burning, hoarding, even dumping into rivers (Dobiki, 2018; Penny et al., 2012). Unmanaged waste may cause environmental pollution (water, air, soil) (Alabi et al., 2019; Wahyudi, 2019) and affect human health (Irianti&Prasetyoputra, 2018).

Some of the usual methods of organic waste management are to use worms, microorganism, and insect larvae (Ayilara et al., 2020; Khair et al., 2015; Sarpong et al., 2019). Bioconversion is one of the concepts of organic waste processing that is widely used today. Bioconversion is the process of converting large molecules into smaller molecules using enzymes found in living organisms (Collins &Kennedy, 1999; Son et al., 2014).

Living organisms commonly used in the current bioconversion process are insect larvae. Insect larvae that can be used in the bioconversion process are *Hermetiaillucens* or black soldier fly (BSF) (Kinasih et al., 2018; Gao et al., 2019) and *Tenebriomolitor* (Bordiean et al., 2020). Bioconversion with

insect larvae has advantages, such as residues from the bioconversion process can be used as organic fertilizer (solid or liquid) (Kahar et al., 2020), insect larvae that grow during the bioconversion process can be used as animal feed (Doper et al., 2020; Madibana et al., 2020; Thevenot et al., 2018), insect larvae can be sold so as to improve the economy of the community (Handayani et al., 2021; Nuryaman et al., 2020), and larvae can be developed as biodiesel (Li et al., 2011; Isaac et al., 2018; Wong et al., 2019).

Insects *Hermetiaillucens* and *Tenebriomolitor* are easy to find in Indonesia. Currently many developed waste processing using larvae *Hermetiaillucens*. In addition, there are several breeders of *Tenebriomolitor* larvae in Indonesia. Larvae of *Tenebriomolitor* are commonly used as feed for birds and chickens. Therefore, in this study used both larvae to process organic waste. The purpose of this study is to find out the growth of both larvae in the bioconversion process of different organic waste.

Materials and Method

The necessary ingredients in the study are *Hermetiaillucens* larvae, *Tenebriomolitor* larvae, and organic waste. Larvae of *Tenebriomolitor* are obtained from the farm. Larvae are developed from eggs and bred in wet bran medium for 5 days. *Tenebriomolitor* larvae are obtained from UD. Bintang Jaya, Yogyakarta. The larvae used are larvae that are 5 weeks old.

Organic waste used is market waste and chicken manure. Market waste is obtained from household waste, vegetable stalls, and traditional markets. Market waste consists of tofu, tempeh, vegetables, and fruit that are no longer worth eating. Market waste consists of tempeh, tofu, *Brassica rapasubsp.chinensis, Brassica rapasubsp.pekinensis, Daucuscarota, Brassica oleraceavar.capitata, Psidiumguajava, Sechiumedule, Solanummelongena, Amaranthus gangeticus*. Chicken manure is obtained from the chicken farm.

The equipment required in this study is containers, scales, and trusses. The preparation of the research is to calculate the number of larvae required, which is as much as 500 heads, then weighed, and measured the length of the larvae. Larvae are put in a container measuring 14.9 cm x 7.6 cm shaped like a bowl. Then the market waste will be weighed with the same weight comparison between each material and put in the container. Litter will be weighed and added water by the same comparison (Katayane et al, 2014). The weight of waste given is as much as 6.25 grams, 12.5 g, and 25 g daily and garbage is given every morning.

This study is an experimental study using a Complete Randomized Design factorial. The data obtained from the research was conducted quantitative descriptive analysis and presented in the form of a bar chart.

Results and Discussion

A. Body Weight Change

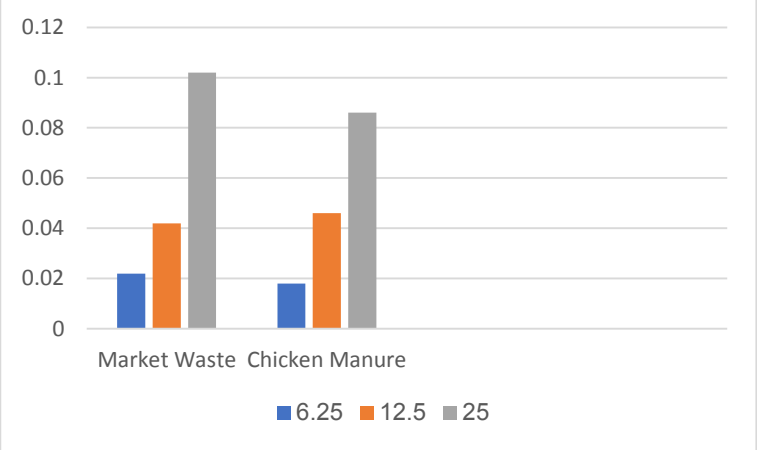

Figure A. Body Weight Change of *Hermetiaillucens* Larvae

Figure A shows a change in the body weight of the larvae *Hermetiaillucens*. Changes in the body weight of larvae in the market waste media increased the same as the amount of media feeding. The increase in body weight of *Hermetiaillucens* larvae in each amount of market waste media feeding is very significant based on the results of the analysis of ANOVA (P>0.01). This indicates that the amount of waste media provided exerts a very significant influence on changes in the body weight of the larvae. The higher the amount of market waste media given, the greater the change in the body weight of the larvae. The highest change in the body weight of larvae is in the provision of market waste media as much as 25 g day^{-1}. Quality feed media will influence the development of larvae (Katayane et al., 2014). The amount of nutrients contained in the medium can affect the weight gain of the body of the larvae. In addition, the moisture content of the media also affects the growth of larvae (Hakim et al., 2017).

Changes in the body weight of larvae in the medium of chicken manure have a very significant difference based on the results of the analysis of ANOVA (P>0.01). This indicates that the amount of chicken manure media given exerts a very significant influence on the weight gain of the larvae of *Hermetiaillucens*. The higher the media amount of chicken manure given, the greater the change in the body weight of the larvae. Changes in the body weight of larvae are strongly influenced by the amount of nutrients contained in the media (Hakim et al., 2017). Changes in the body weight of *Hermetiaillucens* larvae in organic waste media are greater than in chicken manure media. This can be due to the difference in the amount of nutrients and moisture contained in the media.

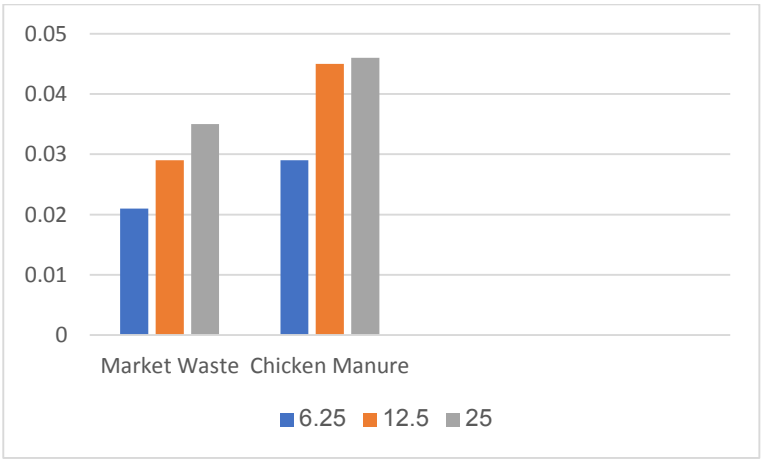

Figure B. Body Weight Change of *Tenebriomolitor* Larvae

Figure B shows the change in the body weight of *Tenebriomolitor* larvae in market waste and chicken manure. The body weight of *Tenebriomolitor* larvae in the market waste media has increased the same as the amount of media provided. The increase in the body weight of larvae in each amount of feeding differs significantly based on the results of the analysis of ANOVA (P>0.01). This indicates that feeding amount affects the change in body weight of larvae. The more amount of market waste media provided, the greater the change in the body weight of the larvae.In general, *Tenebriomolitor* larvae are fed in the form of bran and given additional water sources derived from vegetables or fruits as well as additional proteins derived from soybeans (Riberio, 2017). The amount of soybeans given to the amount of market waste media is 25 g day^{-1} more than others. This causes a change in the body weight of the larvae Tenebriomolitor on the amount of media given 25 g day^{-1} greater than others, which is 0.035 g.

Changes in the body weight of larvae Tenebriomolitor also occur in the medium of chicken manure. The body weight of the larvae increases the same as the amount of chicken manure given. The increase in the length of larvae in each amount of feeding of chicken manure differs very markedly based on the results of the analysis of ANOVA (0.05<P<0.01). This indicates that the amount of chicken manure given greatly affects the body weight of the larvae. The more chicken manure given, the greater the change in the body weight of the larvae (Silva et al., 2021). The largest change in the body weight of larvae is found in the amount of chicken manure media giving as much as 25 g day^{-1}, which is 0.049 g.

The change in the body weight of *Tenebriomolitor* larvae is most high in chicken manure media compared to the market waste media. This can be due to the nutritional needs of larvae found most in

chicken manure. In chicken manure contains other types of proteins and food substances (Katayane et al., 2014). *Tenebriomolitor* larvae showed excellent growth in feed media containing carbohydrates as much as 80%-85% compared to feed media containing carbohydrates by 20% (Ribeiro, 2017).

The change in the body weight of the larva between *Hermetiaillucens* and *Tenebriomolitor* occurs in the larvae of *Hermetiaillucens*, which is 0.104 g. This can be due to the moisture content contained in the media. *Hermetiaillucens* can experience good growth in media that has a water content of 40%-60% (Hakim et al., 2017).

B. Survival Rate

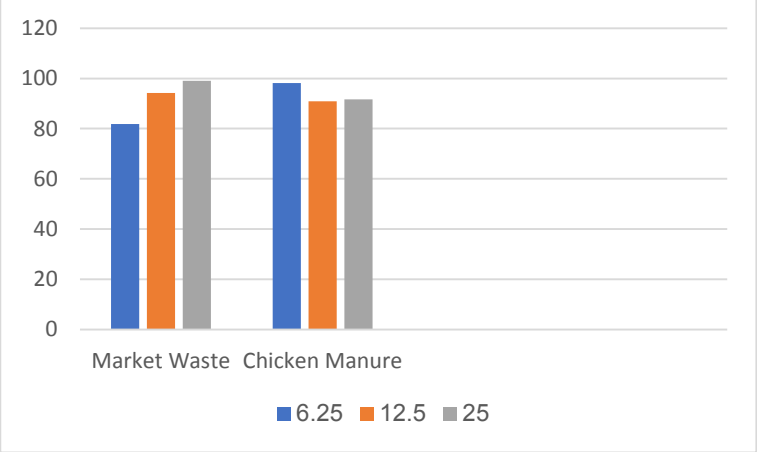

Figure C. Survival Rates of *Hermetiaillucens* Larvae

Figure C shows the survival rate of *Hermetiaillucens* larvae. The survival rate of *Hermetiaillucens* larvae decreased the same as the amount of market waste media provided. Survival in the provision of waste media market 25 g day^{-1} is the highest, which is 99% and the lowest occurs in the provision of waste media market 6.25 g day^{-1}. This can be related to the moisture content contained in the given market waste media (Hakim et al., 2017). The more market media provided, the greater the moisture content contained. This can be seen in the results of the bioconversion process. The bioconversion result in the provision of 25 g day^{-1} market waste media looks wetter compared to others and the water content contained is 25.66%. *Hermetiaillucens* larvae can live on a medium with a water content of 20%-90% and the highest survival rate of larvae is in media with a water content of 40%-60% (Hakim et al., 2017). In this study the highest survival rate of *Hermetiaillucens* larvae was at a water content of 25.66%.

Larvae of *Hermetiaillucens* on the market waste media with a media feeding amount of 25 g day^{-1} indicate a change in larvae. The change is that the larva undergoes a discoloration to black. This indicates that within 14 days with a feeding amount of 25 g day^{-1}, the larvae of *Hermetiaillucens* develop into prepupa. The change of larvae to prepupa occurs more than in the market waste media with the amount of media giving as much as 12.5 g day^{-1}. While in the market waste media with the amount of media administration 6.25 g day^{-1} does not indicate any change of larvae into prepupa. This can be due to the presence of insufficient nutrients for the growth and development of larvae.

The survival rate of *Hermetiaillucens* larvae is lowest in the medium of chicken manure with a feeding amount of 12.5 g day^{-1}. The survival rate in chicken manure media with a feeding of 6.25 g day^{-1} is 98.2% and the lowest larva survival rate is in the medium with a total administration of 12.5 g day^{-1}, which is 90.9%. This can be caused because the feed medium is chicken manure and the medium is added with water before it is given. In chicken manure there are decomposing microorganisms and this affects the media temperature (Atmaja et al., 2017). So the more media provided it will cause the media to become hot and affect oxygen levels in the media (Rofi et al., 2021). The survival rate of *Hermetiaillucens* larvae among the market waste media and chicken manure is highest on the market waste media. This can be due to the influence of moisture content and media temperature.

Larvae of *Hermetiaillucens* in the medium of chicken manure with the amount of media administration as much as 25 g day^{-1} develop into prepupa, namely the change in the color of the larvae to black. While in the media chicken manure with the amount of media giving as much as 12.5 g day^{-1} does not show any change. The change of larvae into prepupa on the market waste media is more than in the medium of chicken manure. This can be due to differences in nutrients contained in the media.

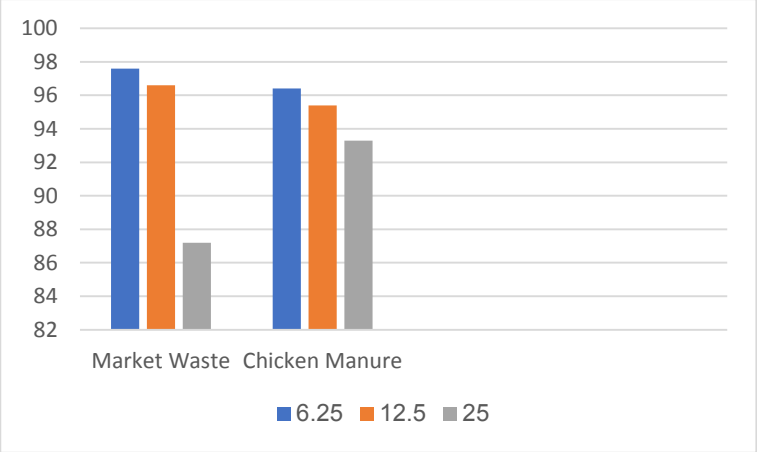

Figure D. Survival Rates of *Tenebriomolitor* Larvae

Figure D shows the survival rate of *Tenebriomolitor* larvae in market waste and chicken manure. The survival rate of larvae in the market waste media is not the same as the amount of market waste media provided. The higher the amount of market waste media given, the lower the survival rate of *Tenebriomolitor* larvae. The direct rate of life in the highest market waste media is 97.6%, namely in media giving as much as 6.25 g day^{-1}. And the lowest survival rate is 87.2%, which is at media feeding as much as 25 g day^{-1}. This can be due to the difference in moisture content in the given media. Market waste media is a wet medium because it consists of vegetables and fruits that have a high water content. Bioconversion results in the provision of market waste media 25 g day^{-1} looks wetter and slightly waterier compared to others and the water content contained is 27.26%. Many market waste media are not consumed by larvae causing decay by microorganisms contained in the market waste. The decay of the market media resulted in the existence of leachate. Leachate can cause limited movement of larvae because the body of the larva attaches to the medium.

The survival rate of *Tenebriomolitor* larvae in chicken manure was highest at 12.5 g day^{-1}, which is 96.4%. While the lowest survival rate occurs in media administration as much as 25 g day^{-1}. Low survival can be due to temperature differences in the media. In the medium of chicken manure there are decomposition microorganisms.The media temperature changes due to bacterial activity as a hint of material degradation activity by bacteria (Suhartini et al, 2020). The more the amount of media giving chicken manure, the state of the media in the container is seen to accumulate. The thickness of the media can affect the temperature inside the media (Li et al., 2020). The optimal temperature for the growth of *Tenebriomolitor* larvae is 25º-28ºC (Ribeiro et al., 2018) and the maximum temperature for larvae to survive is 35ºC.The death of *Tenebriomolitor* larvae in animal feces media is 74%-88% (Castilla et al., 2008). The survival rate in feces media is very low due to aerobic activity by microorganisms causing the amount of oxygen to thin (Rofi et al., 2017). The survival rate of *Tenebriomolitor* larvae among the market waste media and chicken manure is highest in the market waste media. This can be due to differences in water content, temperature, and nutrient content available in the media.

Larvae *Hermetiaillucens* and *Tenebriomolitor* have good growth and survival in the waste media market. This can be due to the content of the amount of nutrients contained in the media. The amount of media administration also has an influence for the growth and survival rate of larvae. In addition to the nutrients contained in the medium, moisture content and media temperature also have an effect in the growth of both larvae.

Conclusion

The largest change in the body weight of *Hermetiaillucens* larvae is in the market waste media with a media feeding amount of 25 g day^{-1}, which is 0.102 g. While the change in the body weight of larvae *Tenebriomolitor* the largest is in the medium of chicken manure with the amount of media administration of 25 g day^{-1}, which is 0.046 g.

The survival rate of *Hermetiaillucens* larvae is highest in the market waste media with a media grant of 25 g day^{-1}, which is 99%. While the survival of larvae *Tenebriomolitor* is the highest in the market waste media with the amount of media delivery as much as 6.25 g day^{-1}, which is 97.6%.

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