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THE EFFECT OF MOLASSES AND TOFU DREGS ON THE GROWTH OF *BLACK SOLDIER FLY MAGGOTS* *(Hermetia illucens)*

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ABSTRACT

The utilization of organic waste in Indonesia has not been fully optimized, but one technique that can be used is bioconversion, which involves the use of organisms such as the maggot black soldier fly (*Hermetia illucens*) to convert the waste. Organic waste sources, such as molasses and tofu dregs, can be used for this purpose. The aim of this study was to investigate the growth of BSF maggots using molasses and tofu dregs media. A completely randomized design (CRD) with four treatments and six replications was used, including a control treatment using fruit and vegetable waste (P0), 100% molasses (P1), 50% molasses and 50% tofu dregs (P2), and 100% tofu dregs (P3). The data were analyzed using the SPSS program, and the results indicated that the P0 treatment produced the highest weight and length of 0.13 grams and 17 millimeters, respectively. Further analysis using DMRT showed that P0 was the best medium for maggot growth. The treatment with the highest maggot nutritional content was P0, with 9.57% protein and 5.99% fat. The treatment with the highest carbohydrate content was P2, at 22.04%. Future research can investigate other media and ratios to further optimize the growth of the maggot black soldier fly *(Hermetia illucens).*

Keywords: growth, fruit and vegetable waste, maggot, molasses, tofu dregs

INTRODUCTION

Waste pollution has been identified as a significant contributor to environmental pollution, and a lack of balance in waste management is a key factor in waste-related issues. The production of waste is a common by-product of many activities. When inorganic and organic waste is not properly utilized, it can trigger environmental problems. One example of organic waste generated in the industrial sector is tofu dregs and molasses. Despite their potential value, the management of these waste products remains suboptimal. Organic waste management techniques offer potential solutions, and bioconversion is one such approach. This technique involves the use of living organisms, such as insects, to convert organic waste into simpler biomass and organic matter (1). One promising bioconversion agent is the Maggot Black Soldier Fly (*Hermetia illucens*).

The Maggot Black Soldier Fly (BSF) is the larval or pupal stage of the Black Soldier Fly (*Hermetia illucens*) that eventually develops into an adult BSF fly (2). According to (3), BSF Maggot is rich in protein, with a content of 44.26%, and contains 29.65% fat. Given its high protein content, there is an opportunity to use BSF Maggot as a supplementary feed for fish and poultry. Furthermore, BSF maggot flour has the potential to fully replace a fish meal as a component of mixed feed for broiler chickens without any negative effects. Insect farming, including the farming of BSF Maggot, has the potential to effectively reduce the amount of organic waste that could otherwise pollute the environment.

According to (4), media with appropriate nutrient content can serve as a conducive breeding and growth environment for BSF maggots. Tofu dregs and molasses, two forms of organic waste,

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are potential substrates for BSF maggot growth. (5) reported that 8.69 grams of tofu dregs have a crude protein content of 18.67%, crude fat content of 9.43%, and ash content of 3.42%. On the other hand, (6) found that molasses contains 3.1% crude protein, 0.9% crude fat, and 60% crude fiber, with a sugar content of 50.23% (7). These nutrient profiles suggest that tofu dregs and molasses hold great promise as a substrate for the development of BSF maggots.

The substrate for BSF larvae, which is abundant in protein and carbohydrates, can support their optimal growth. Tofu dregs and molasses, as a substrate component, offer a favorable medium for the growth of BSF Maggot. Using 0.5 kg of tofu dregs media resulted in a fresh weight of Maggot at 380.67 ± 43.11 grams. On the other hand, (8) demonstrated that 50.65% protein can be produced from Maggot BSF by using 15 kg of pineapple skin medium and 50 ml of molasses/5 bottle caps.

METHODS AND MATERIALS

Time and Place

The present study was conducted at the Ecology Laboratory, Faculty of Mathematics and Natural Sciences, Islamic University of Malang, during the period spanning from December 2022 to January 2023. The growth of BSF Maggot was closely monitored for a duration of 15 days.

Tools and Materials

In this study, a set of tools were employed, including a 750 ml thin-wall container, black gauze with a pore diameter of 1 mm, styrofoam, digital analytical balance, thermometer, tweezers, filter cloth, millimeter block, stationary, and camera. The materials used included 2400 seven-day-old maggot black soldier fly (*Hermetia illucens*), magic chalk, tissue, molasses, and tofu dregs.

Research Procedure

This study employed a completely randomized design (CRD) with 4 treatments and 6 replications. The treatments comprised of P0: a control using vegetable and fruit waste media, P1: 100% molasses, P2: a mixture of 50% molasses and 50% tofu dregs, and P3: 100% tofu dregs. The study utilized 2,400 individuals of 7-day-old BSF maggots, which were obtained from BSF bumdes arumasri, malang. Each experimental unit was composed of 100 BSF maggots that were carefully selected using tweezers and placed in a thinwall container. The feeding media was provided every 3 days while observational data was collected. The treatment media was weighed according to the feeding rate of 100 mg/larvae/day for a portion of food once a day to provide each experimental unit with 3000 mg/30 g of media for 3 days. To prevent oviposition from other insects, the thinwall container containing BSF maggots that had been given the treatment media was covered with black gauze.

Research Parameters

The study monitored several factors, such as the weight and length of the BSF Maggot, as well as its proximate analysis, which included assessing its protein, fat, and carbohydrate content.

Maggot Weight

The weight of the BSF Maggot was measured in this study by sampling 10 individuals every 3 days and calculating their weight using a digital analytical balance. The maggots were first separated from the media and cleaned before the weight measurement. The average weight of the BSF Maggot was calculated in accordance with the formula:

$$\text{Average Weight} = \frac{\text{Total Larva Weight}}{\text{Total Number of Larva}}$$

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Maggot Length

In order to collect data on the length of the BSF Maggot, a sampling method was employed wherein ten specimens were taken every three days. The length of the Maggot was measured in millimeter blocks. The average length of the BSF Maggot was computed using the formula below:

$$\text{Average Length} = \frac{\text{Total Larva Length}}{\text{Total Number of Larva}}$$

Maggot Proximate Analysis

A proximate analysis of fresh BSF Maggot, including the determination of protein content using the Kjeldahl method (9), fat content by the Soxhlet method (9), and carbohydrate content by a distinct method (9), was conducted at the food quality and safety testing laboratory of Brawijaya University.

Data Analysis

After conducting the research, the collected data underwent ANOVA analysis using the SPSS 25 program. If a significant difference was observed, further analysis was conducted using the Duncan Multiple Range Test at a significance level of 5%.

RESULTS AND DISCUSSION

The Effect of Molasses and Tofu Dregs on the Growth of BSF Maggot

Maggot Black Soldier Fly (Hermetia Illucens) Weight

The maggot black soldier fly exhibited the highest weight growth in treatment P0, which served as the control with fruit and vegetable waste media, with a weight of 1258.2 ± 67.6. On the other hand, the lowest weight was recorded in treatment P1, where 100% media molasses was used, resulting in the death of the bsf maggot (figure 1). The Anova statistical analysis showed a significant difference between the media and maggot weights, as evidenced by the f count of 261.52 > f table 5% (3.10).

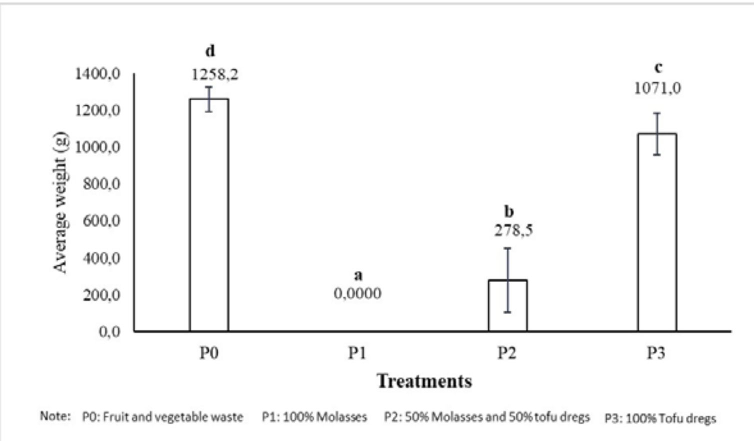

Figure 1. Diagram of Maggot *Black Soldier Fly* (*Hermetia illucens*) Weight

The highest weight was obtained in treatment P0 (control) with fruit and vegetable waste media due to the utilization of various types of fruits and vegetables, which promoted better growth of the BSF Maggot. In their study, (10) reported an average Maggot weight of 383 g using vegetable and fruit media. Vegetables and fruits are rich in carbohydrates but low in protein (11), leading to higher fat accumulation in BSF Maggots that consume more carbohydrates than protein (12). The greater the amount of fat in the Maggot's body, the higher the growth rate. Macromolecules such as

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proteins and fats will be converted into larval biomass (13). Moreover, the weight of the BSF Maggot is affected by the amount of organic matter in the media used (14).

The next highest weight was observed in P3, where 100% tofu dregs media was used. Tofu dregs are known to have good nutrition, containing 21% protein and 3.79% fat, as reported by (15). However, tofu dregs have a high water content, resulting in a wet and slightly slimy texture that is unfavorable for BSF Maggot growth, as stated by (16). Feeds with high water content create anaerobic conditions that lead to the production of ammonia and methane, which can affect feed quality and growth rate, according to (13).

Media P2, which consists of 50% molasses and 50% tofu dregs, resulted in a relatively low weight for BSF Maggot. According to (17), adding molasses with a dry matter content of more than 20% to the basal feed will compete with the basal feed as a substrate for microorganisms. The lowest weight of BSF Maggot was observed in P1, which used 100% molasses media. The high sugar content in molasses can disturb the metabolic system of larvae, causing obesity and slowing down the growth rate (18). The BSF Maggot in P1 also died due to the excessively wet media, which hindered the process of media decomposition by the BSF Maggot. High sugar content in molasses can reduce the digestive capacity of fiber and alter the utilization of nitrogen and the pattern of microbial synthesis (19). The Duncan test (DMRT) with a 5% significance level showed that all media were significantly different ($P<0.05$). Based on the results, the best medium for the growth of BSF Maggot weight was P0, which used fruit and vegetable waste media.

Maggot Black Soldier Fly (Hermetia illucens) Length

The study observed a variation in the length growth of the Maggot Black Soldier Fly (*Hermetia illucens*). As shown in Figure 2, treatment P0 with fruit and vegetable waste media had the longest maggot size (170.0 ± 2.7), while treatment P1 with 100% media molasses had the smallest maggot size (0.0 ± 0.0). The ANOVA statistical analysis revealed that there is a significant difference (F count = 952.18) between the media and the length of the BSF Maggot at a 5% level of significance (F table = 3.10).

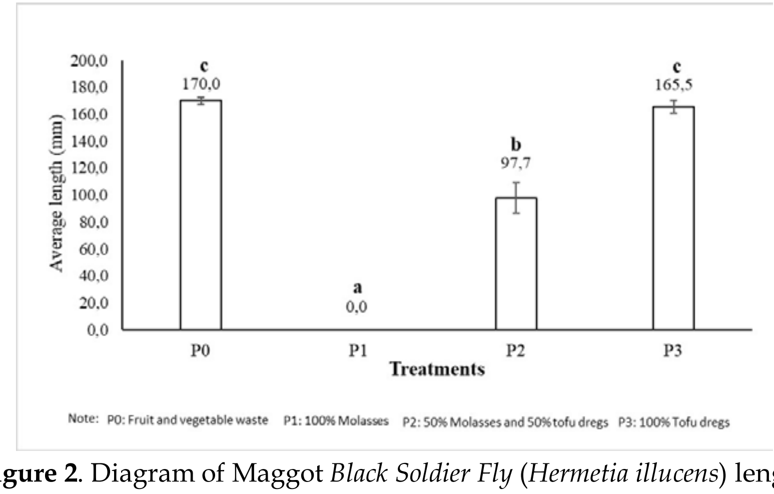

Figure 2. Diagram of Maggot *Black Soldier Fly* (*Hermetia illucens*) length

The length of the BSF Maggot varies depending on the growth medium. The energy and protein derived from the growth medium contribute to the growth of the BSF Maggot (20). In a previous study, (21) reported an average larva length of 8 mm with the use of vegetable and fruit media. The quality and quantity of the ingested media significantly influence the growth, larval development time, survival, and mortality of the BSF Maggot (22). The variation in vegetables and fruit used in the growth medium serves as an essential growth factor for the Maggot.

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The Duncan test results (DMRT) at 5% in P3, with tofu dregs media, were not significantly different (P>0.05) from the control media (P0). Tofu dregs contain 26.6% protein, 18.3% fat, and 41.3% carbohydrates, which are beneficial for the growth of the BSF Maggot. However, environmental factors such as air temperature, media humidity, and pH levels also play a role in the growth process. The dense and runny texture of tofu dregs hampers the absorption of food by the BSF Maggot (23).

The length of the BSF Maggot in P2 media is superior to that in P1 media, where the average length is 0 mm, indicating that the Maggot does not survive. The texture of P2 media is relatively dry. Mixed waste has a low moisture content that hinders larval growth (24). The Maggot's mass mortality in P1 was also influenced by media conditions. Excessive wet feed has an impact on the death of BSF Maggots (25).

According to the results of the 5% Duncan test (DMRT), it was found that there was no significant difference (P>0.05) between the P0 and P3 media. However, media P1 and P2 showed a significant difference (P<0.05) compared to P0 and P3. In general, all media were significantly different (P<0.05). The fruit and vegetable waste media (P0) and 100% tofu dregs (P3) were the best media for achieving the long growth of the BSF Maggot.

Effect of Molasses and Tofu Dregs on Protein, Fat, and Carbohydrate Content of Maggot Black Soldier Fly (Hermetia illucens) Using Proximate Analysis

Table 1 displays the results of proximate analysis, indicating that there are differences among the treatment media. P1, which used 100% molasses, could not be analyzed for protein, fat, and carbohydrate levels as the BSF Maggot did not survive. The highest protein content was observed in P0, which used fruit and vegetable waste media. In their study on organic vegetable and fruit media, (26) produced 7.45% protein. The high protein content in P0 was influenced by the presence of nitrogen in the fruit and vegetable waste media. Atmospheric nitrogen is transformed by the bacteria Azotobacter sp. into ammonia, which will then become the protein that is required by plants (27). The protein level analysis is expressed by total nitrogen (28). Nitrogen is an essential component of cell proteins, so its consumption affects the course of protein synthesis (29). The nutritional and environmental content of the growing media significantly affects the nutritional content of BSF Maggot (30).

Table 1. Proximate analysis results of the Maggot *Black Soldier Fly (Hermetia illucens)*

Composition	**Treatments**			
	P0	**P1**	**P2**	**P3**
Protein	9,57%	0,00%	3,84%	4,07%
Fat	5,99%	0,00%	1,24%	4,35%
Carbohydrate	5,40%	0,00%	22,04%	7,76%

To obtain the BSF Maggot with the highest fat content, vegetable, and fruit waste media should be used due to the variation of waste that accumulates fat content. P0 media was found to have the highest BSF Maggot Biomass, and it also contained the highest levels of protein and fat. The conversion of nutrient composition in the feed, especially protein and fat, into larval biomass was also highlighted in (13) research. Therefore, the growth of larval biomass and macromolecules, such as proteins and fats, are closely related, and good substrate content can provide greater larval growth, according to (31). This also suggests that the nutrient substrate affects the weight of the larvae.

P2 had a high carbohydrate content because molasses was present in the media, which is known to be rich in carbohydrates (32). However, for the successful productivity of BSF Maggot, carbohydrate content alone is not enough. The body requires a balanced nutritional intake of water, protein, fat, crude fiber, and energy, as emphasized by (33).

CONCLUSIONS

The growth of the Maggot Black Soldier Fly (Hermetia illucens) was significantly influenced by the growth media of molasses and tofu dregs. However, the addition of molasses did not result in significant growth of the Maggot. Fruit and vegetable waste media yielded the highest weight of 0.13 grams and an average length of 17 mm, making it the best medium for growing BSF Maggot. Based on these findings, further research is required to explore the effects of different media types and ratios on the growth of the Maggot Black Soldier Fly (Hermetia illucens).

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