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Research Paper

The Effect Addition of Fish Oil to BSF (Black soldier fly) Larvae Growth Media as a Source of Omega-3 Based on Mixed Fermentation of Blood and Tofu on the Production BSF Maggot and Nutrients Content of BSF Maggot Meal

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ABSTRACT: *This study aims to determine the impact of adding fish oil as a source of omega-3 on the production and nutrients content of BSF maggot meal in the growth media BSF larvae based on mixed fermentation of ruminant blood and tofu. This research used BSF eggs, fresh blood, tofu, probio_ FM, and sardines fish oil. This research used an experimental approach of 4 treatments with three replications planned with a fully randomized design (CRD). The treatment in this study was the amount of fish oil in the growth of BSF larvae based on mixed blood and tofu fermentation. The treatments were without fish oil (0 percent), fish oil gives 2 percent, fish oil gives 4 percent, and fish oil 8 percent. The calculated parameters were BSF maggot production and the nutrients content of the BSF maggot meal. The results of the diversity analysis showed that the production of fish oil in BSF larvae growth media based on mixed blood and tofu fermentation had no significant effect (P> 0.05) on the production of BSF maggot, had a significant impact (P <0.05) on the crude ash content and had a very significant effect (P <0.01) on the dry matter, crude protein and crude fat content of BSF maggot meal. Providing fish oil at the 4 percent level resulted in the production of 126.50 grams BSF maggot, 96.69 percent dry matter content, 32.35 percent crude protein, 33.04 percent crude fat, and 6.22 percent ash.*

KEYWORDS: *Black Soldier Fly, Composition of Nutrients, Fish Oil*

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I. INTRODUCTION

The nutrients contens in BSF maggot meal especially crude protein depends on the growing medium for BSF larvae. To obtain pupae with high crude protein content, the growing media material is also high in crude protein. Montesqrit et al. (2019a) conducted a study to obtain use of growing media with protein sources of fish meal, soybean meal, meat meal, tofu and coconut cake as a medium for growing BSF larvae. The results showed that the crude protein of BSF maggot meal was the highest in growing media with high crude protein content such as fish meal, soybean meal and meat meal but had a low growth rate compared to tofu. In this study, a combination of growing media also carried out, namely tofu mixed with fish meal or meat meal to produce fast growth and high protein. The provision of fish meal or meat meal in the BSF larva growing medium is contradictory because the materials used have to be purchased and are expensive.

Based on this, Montesqrit et al. (2019b) conducted research based on non-conservative feed ingredients, consisting of a combination of tofu with the meal of fish offal, the feast of chicken offal, and fermented blood meal. The results obtained were the combination of tofu and blood meal produced high crude protein, namely 53.06%. The weakness of this research is the use of blood meal which is ineffective in its manufacture. Besides, the use of Yakult in the fermentation process has not yet been tested for its effectiveness. Then Rido (2021) conducted a study using a mixture of tofu and fresh blood with probio_ FM levels to produce optimal BSF maggot meal content. The results obtained by the ratio of blood and tofu 1:4 with 75ml/kg of probio_ FM level get crude protein 50.35%.

High protein BSF maggot meal comes from protein growth media and other nutrients such as omega-3 fatty acids. Omega-3 fatty acids play an essential role in the morphological, biochemical, and molecular

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development of the brain and human organs (Innis, 2000). Thus, to get a BSF-rich omega-3 maggot meal, it is necessary to add omega-3 source materials. One of the ingredients that contain omega-3 fatty acids, namely waste from fish canning, is fish oil. Sardines fish oil, which is the result of fish canning, includes 29.68% of omega-3 fatty acids, with EPA 15.15% and DHA 11.36% (Dewi, 1996). The addition of source media for omega-3 fatty acid and, expected to make of BSF maggot meal and a protein source feed and a source of omega-3 fatty acids.

The addition of fish oil to the growth media for BSF larvae needs to get a meal of BSF maggot and protein source feed and feed sources of omega-3 fatty acids. The addition of fish oil to the BSF larva growing medium expect to make BSF pupae contain omega-3 fatty acids. The level of adding fish oil and how it affects the growing media needs to study BSF maggot production and the nutrient content of BSF maggot meal.

II. MATERIALS AND METHODS

Research Materials

The materials used in this study were BSF eggs, fresh ruminant blood obtained from the slaughterhouse, tofu, probio_ FM, and fish oil. The equipment needed is a container for BSF larvae rearing measuring 30 x 20 x 12 cm, a jar, a spoon, and a digital scale.

Research procedure

Animal Husbandry, Jambi University, and carried out fermentation for three days. Furthermore, sardines fish oil is the result of fish canning processing and obtained from Banyuwangi, East Java. BSF eggs are first place in an incubator consisting of tofu and fine bran for eight days until the BSF larvae are uniform in size, then separate the BSF larvae with the hatching medium. BSF larvae were weighed as much as 0.5 grams and put into the treatment growth medium 500 grams. After 28 days of age, the larvae that develop into prepupae or maggots harvest, and production measurements take, after which they are washed and turned off using hot water. The BSF maggot is dried to make the meal and ready to be analyzed for its nutrients content.

Research design

This study used a completely randomized design (CRD) with four treatments and four replications. The treatments given are:

A = Without adding fish oil (0%)
B = The addition of 2% fish oil from the growing media.
C = The addition of 4% fish oil from the growing media.
D = The addition of 8% fish oil from the growing media.

Observed Parameters

The parameters observed in this study were the production of BSF maggots, the nutritional content meal of BSF maggot (dry matter, crude protein, crude fat, and crude ash).

Data analysis

We analyzed data statistically with analysis of variance, differences between treatments, tested with Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1995).

III. RESULTS AND DISCUSSION

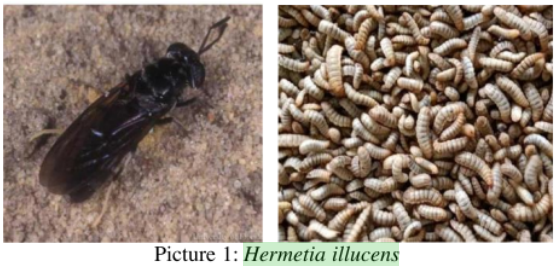
Table 1: Research Results

Treatment	Maggot production (gr)	Dry matter (%)	Crude protein (%)	Crude Fat (%)	Crude ash (%)
A	131.50	93, 46^{a}	49.29^{a}	12.62^{a}	8.53^{a}
B	138.25	95, 24^{b}	37.78^{b}	27.63^{b}	7.69^{ab}
C	126.50	96.69^{c}	32.35^{c}	33.04^{c}	6.22^{b}
D	124.25	96.68^{c}	31.57^{c}	35.32^{c}	6.14^{b}

Information: A = without the addition of fish oil (0%)
B = addition of 2% fish oil
C = addition of 4% fish oil
D = addition of 8% fish oil

Black soldier fly or in the scientific name *Hermetia illucens Linnaeus*, 1758 has the following taxonomic classifications:

Kingdom	: Animalia
Filum	: Arthropoda
Kelas	: Insecta
Ordo	: Diptera
Famili	: Stratiomyidae
Subfamili	: Hermetiinae
Genus	: *Hermetia*



Picture 1: *Hermetia illucens*

Black soldier fly (BSF) or Hermatia ilucens L. is a type of fly from the Stratiomydae family common and can be found widely in ground cover plants, significantly often found in Spagneticola trifoliata grasses and leaves (Rizki et al., 2017). BSF larvae can grow and develop in media that contain nutrients that match their needs. BSF maggot cultivation can carry out using growing media containing organic and waste-based materials or by-products of agro-industrial activities. Silmina et al. (2010) explained that the requirements for a material to be used as raw material for animal feed are: harmless, available at all times, contains nutrients according to livestock needs, and these materials do not compete with human needs. The protein content of maggot meal is relatively high, which is around around 40-50% with a fat content ranging from 29-32% so that it has good potential as a protein source feed ingredient (Hadadi et al., 2007; Bosch et al., 2014).

BSF maggot production in this study ranged from 124.25 grams - 138.25 grams. Based on the analysis of the diversity of adding fish oil to the growth media, it has no significant impact (P> 0.05) on BSF maggot production. The highest BSF maggot production was in treatment B (adding 2% fish oil), and the lowest maggot production was in treatment D (adding 8% fish oil). Giving fish oil in the BSF larvae growth medium up to 8% does not affect maggot production. The problem is because there is no change in the texture and shape of the growing medium. The factors that affect the differences in BSF maggot production are the differences in the growth media used. The medium explained by Nugraha et al. (2018), differences in growing media will affect the output of the resulting BSF maggot. In this research, the growth media used were fresh blood and fermented tofu, which treat fish oil. With the addition of larger fish oil, there may be a decrease in the production of BSF maggots due to changes in the quality of the media in the form of smell, color, taste, and nutrient content of the growing media. Furthermore, Hem et al. (2008) explained that a quality substrate would produce more BSF maggots because it can provide sufficient nutrients for the growth and development of BSF larvae, whose results can be measure through weight production.

Dry matter is the constant weight of a material that does not contain water in the material or material heated to a temperature of 1050 C. Its water content lose. Water content a negative correlation with dry matter content. The higher the water content, the lower the dry weight. Tran. et al. (2014) explained that the BSF maggot growing media must lack water content because the larvae cannot develop properly and cannot grow on media with high water content. The dry matter content contained in BSF maggot meal ranges from 93.46% - 96.69%. The highest dry matter content was in treatment C (4%), namely 96.69%, and the lowest was in treatment A (0%), namely 93.46%. Based on the analysis of diversity, adding fish oil to the growing medium had a very significant effect ($p < 0.01$) on the dry matter content of the BSF maggot meal. Treatment C and D had a considerable impact on treatment A (without the addition of fish oil) and a significantly impacted treatment B (addition of 2% fish oil) on dry matter content. This problem is due to the oil content in the BSF maggot meal, which can suppress the water content in the BSF maggot meal. Suzuki (1991) explains that water content has a close relationship with fat and protein levels. In this study, the higher the addition of fish oil, the higher the dry matter and the lower the water content. C (4%) and D (8%) produced the same dry matter content. This problem is due to the addition of fish oil used by the BSF maggot body, which is limited to 4%.

The crude protein content of BSF maggot meal in this study ranged from 31.57% - 49.29%. The protein content of BSF maggot meal ranges from 30% - 50% (Amandanisa and Parayoga, S., 2020; Bosch et al., 2014). The average crude protein content in this study is still within a reasonable value. The analysis of adding fish oil to the growing medium had a very significant effect ($p < 0.01$) on the crude protein content of the BSF maggot meal. It has an authentic effect on the addition of fish oil to a crude protein content of BSF maggot meal due to an increase in maggot meal fat content. Buckle et al. (1987) explained that the protein content of BSF maggot meal influences fat content and water content. The addition of 2% (B), 4% (C), and 8% (D) fish oil in the BSF larva growing medium was very significantly different than without the addition of fish oil (A) to the crude protein content of BSF maggot meal. The addition of 2% (B), 4% (C) and 8% (D) fish oil to the BSF larva growing medium was very significantly different than without the addition of fish oil (A) to the crude protein content of BSF maggot meal. The low protein content from 49.29% (A) to 32.35 (C) and 31.57% (D) was

caused by the increase in the fat content of BSF maggot meal from 12.62% (A) to 33.04% (C) and 35.32% (D). Crude protein content between treatments C and D showed the same results, this indicates that the addition of fish oil in the growing medium is limited to 4% because maggots also need other nutrients in the preparation of their body composition.

The crude fat content of BSF maggot meal in this study ranged from 12.62% - 35.32%. Based on the analysis of the diversity of adding fish oil to the growing media, it has a very significant impact ($p < 0.01$) on the crude fat content of BSF maggot meal. The highest fat content in treatment D, namely 35.32% with the addition of fish oil by 8%, and the lowest in treatment A, namely 12.62% without fish oil. The addition of 2% (B), 4% (C), and 8% (D) fish oil in the BSF larva growing medium was very significantly different than without the addition of fish oil (A) to the crude fat content of BSF maggot meal. Whereas treatment C and D had a very significant effect compared to treatment B on fat content, the provision of fish oil was 2% smaller than 4% and 8%. However, between treatments, C and D produced the same crude fat. This problem is because the utilization of fish oil by BSF larvae is limited to 4% in the growing medium. The addition of larger fish oil will only increase costs and will not utilize the BSF maggot body.

Crude ash is an inorganic substance leftover from the combustion of organic material. The ash content in the meal of BSF maggot in this study ranged from 6.14% - 8.53%. The analysis of adding fish oil to the growing medium had a significant effect ($p < 0.05$) on the crude ash content of the BSF maggot meal. The ash on the material indicates the organic material content of the material. The higher the crude ash content of a material, the lower the organic matter. Organic material itself is dry matter content which reduces ash content. Organic material consists of crude protein, crude fat, fiber, and BETN (extract material without nitrogen). In this study, treatment C and D had a significant effect ($p < 0.05$) on treatment A. This problem is due to the addition of fish oil in causing a decrease in coarse ash content or an increase in the organic matter of BSF maggot meal. However, the addition of 2% fish oil (treatment B) had no significant effect ($p > 0.05$) on treatment A. This problem was because the addition of 2% fish oil was still small, so the crude ash content did not affect. The addition of fish oil to the growth media for BSF larvae resulted in a decrease in ash and an increase in the organic matter of the BSF maggot meal. Furthermore, Sudarmadji et al. (1996) explained that the crude ash content determines the number of minerals in the material.

IV. CONCLUSION

Study results can conclude that giving fish oil to the blood-based growth media and tofu pulp does not affect the production of BSF maggot but affects the dry matter content, crude protein, crude fat, and crude ash. Providing fish oil at the 4% level resulted in the production of BSF maggot of 126.50 grams, dry matter content of 96.69%, crude protein 32.35%, fat 33.04, and crude ash 6.22%.

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