Available online at : http://alive.lppm.unand.ac.id/

Andalasian Livestock

ISSN 3063-1912 (Online)

Research Article

The Influence of Fish Oil Supplementation in BSF (Black Soldier Fly) Larvae Growth Medium as an Omega-3 Source through Mixed Fermentation of Blood and Tofu on BSF Maggot Production and Its Nutritional Composition

Muhammad Rido[1]*, Harnentis[2], Montesqrit[2]

[1]Department of Animal Science, Universitas Lambung Mangkurat, Banjarbaru, Souh Kalimantan. 70714. Indonesia

[2]Department of Animal Nutrition and Feed Technology, Faculty of Animal Science, Universitas Andalas, Padang, 25163, Indonesia

*Corresponding author: ridomuhammad@ulm.ac.id

License and copyright: Copyright: © 2025 by the authors. Open-access publication under the terms and conditions of the ***Creative Commons Attribution-NonCommercial-ShareAlike (CC BY-NC-SA)*** license

Article history:
Received: 13-10-2024 | Revised: 01-11-2024 | Accepted: 26-12-2024 | Published: 24-01-2025

ABSTRACT

This study aims to evaluate the effect of incorporating fish oil as an omega-3 source on BSF maggot meal's production and nutritional composition when cultivated in a growth medium based on the mixed fermentation of ruminant blood and tofu. The study utilized BSF eggs, fresh blood, tofu, Probio_FM, and sardine fish oil. An experimental design was implemented, consisting of four treatment groups with three replications, following a completely randomized design (CRD). The treatments involved varying levels of fish oil supplementation in the BSF larvae growth medium: 0 percent (control), 2 percent, 4 percent, and 8 percent. The measured parameters included BSF maggot production and the nutritional content of BSF maggot meal. The analysis of variance (ANOVA) revealed that fish oil supplementation in the fermented blood and tofu growth medium did not significantly affect ($P > 0.05$) BSF maggot production. However, it had a significant effect ($P < 0.05$) on crude ash content and a highly significant effect ($P < 0.01$) on dry matter, crude protein, and crude fat content in BSF maggot meal. Supplementing fish oil at a 4 percent level resulted in a BSF maggot yield of 126.50 grams, with a dry matter content of 96.69 percent, crude protein at 32.35 percent, crude fat at 33.04 percent, and ash content at 6.22 percent.

Keywords: Black Soldier Fly, composition of nutrients, fish oil

INTRODUCTION

The nutrient composition of BSF maggot meal, particularly its crude protein content, is influenced by the composition of the larvae's growth medium. The growth medium must also be protein-rich to produce a high crude protein concentration pupae. Montesqrit et al. (2019a) investigated the use of various protein sources, including fish meal, soybean meal, meat meal, tofu, and coconut cake, as substrates for BSF larvae cultivation. Their findings indicated that BSF maggot meal had the highest crude protein content when larvae were reared in protein-rich media, such as fish, soybean, and meat. However, these media resulted in a slower growth rate compared to tofu. A combination of growth media was explored, incorporating tofu with either fish meal or meat meal to enhance both growth speed and protein content. However, using fish

DOI: 10.25077/alive.v2.n1.p10-15.2025

meal or meat meal as growth substrates poses challenges due to their high cost and the need for commercial procurement.

In response to this issue, Montesqrit et al. (2019b) conducted further research utilizing non-conventional feed ingredients, combining tofu with fish offal meal, chicken offal meal, and fermented blood meal. Their findings revealed that the tofu-blood meal combination yielded a high crude protein content of 53.06%. However, this approach's inefficient processing of blood meal was a drawback. Additionally, the effectiveness of Yakult in the fermentation process remained untested. Subsequently, Rido et al. (2023) examined using a mixture of tofu and fresh blood with varying levels of Probio_FM to optimize the nutritional profile of BSF maggot meal. The study found that a 1:4 ratio of blood to tofu, combined with 75 ml/kg of Probio_FM, resulted in a crude protein content of 50.35%.

High-protein BSF maggot meal is derived from protein-rich growth media and other essential nutrients, including omega-3 fatty acids. Omega-3 fatty acids are crucial in the brain's and human organs' morphological, biochemical, and molecular development (Innis, 2000). Therefore, to produce BSF maggot meal with high omega-3 content, it is necessary to incorporate omega-3-rich ingredients into the growth medium. One potential source of omega-3 fatty acids is fish oil, a byproduct of the fish canning industry. Sardine fish oil, a common byproduct of fish processing, contains 29.68% omega-3 fatty acids, including 15.15% EPA and 11.36% DHA (Dewi, 1996). By adding omega-3-rich materials to the BSF larvae's growth medium, it is expected that BSF maggot meal can serve as both a high-protein feed source and a valuable source of omega-3 fatty acids.

The incorporation of fish oil into the growth medium for BSF larvae aims to produce BSF maggot meal that serves as both a protein-rich feed source and a supplier of omega-3 fatty acids. By adding fish oil to the larvae's growth medium, it is expected that BSF pupae will accumulate omega-3 fatty acids. However, further research is needed to determine the optimal level of fish oil supplementation and its impact on the growth medium, BSF maggot production, and the nutritional composition of BSF maggot meal.

MATERIAL AND METHODS

Research material

The materials used in this study consisted of eggs of black soldier fly (BSF), fresh blood of the ruminants that collected from a slaughterhouse, tofu, Probio_FM, and fish oil. The necessary equipment consisted of BSF larvae-rearing containers (30 × 20 × 12 cm), a jar, a spoon, and a digital scale.

Research procedure

The study was conducted at the Animal Husbandry Department, Universitas Andalas, where the fermentation process was carried out for three days. Sardine fish oil, a byproduct of fish canning, was sourced from Banyuwangi, East Java. BSF eggs were initially placed in an incubator containing a mixture of tofu and fine bran for eight days until the larvae reached a uniform size. The larvae were then separated from the hatching medium. About 0.5 grams of BSF larvae were weighed and introduced into 500 grams of the treatment growth medium. After 28 days, the larvae that developed into prepupae or maggots were harvested, and their production was measured. The harvested maggots were then washed and euthanized using hot water. Finally,

 DOI: 10.25077/alive.v2.n1.p10-15.2025

the BSF maggots were dried to produce a meal, which was later analyzed for their nutrient composition.

Research design

This study employed a completely randomized design of four treatments, each replicated four times. The treatments applied were as follows:

A = No fish oil added (0%)
B = Supplemented with 2% fish oil in the growth medium
C = Supplemented with 4% fish oil in the growth medium
D = Supplemented with 8% fish oil in the growth medium

Data analysis

Data were analyzed statistically using analysis of variance (ANOVA), and differences between treatments were evaluated using Duncan's Multiple Range Test (DMRT) (Steel & Torrie, 1995).

RESULTS AND DISCUSSION

The results of this study demonstrate the effect of adding fish oil to the BSF larva growth medium as a source of omega-3. The observed parameters included BSF maggot production and the nutritional composition of BSF maggot meal, specifically dry matter, crude protein, crude fat, and crude ash, which were analyzed to determine the impact of the treatments. These findings are summarized in Table 1, including statistical differences among treatments.

The Black Soldier Fly (BSF) (Hermetia illucens L.) is a species of fly from the Stratiomyidae family that is commonly found in ground cover plants, particularly in Spagneticola trifoliata grasses and leaves (Rizki et al., 2017). BSF larvae can grow and develop in nutrient-rich media that meet their dietary needs. BSF maggot cultivation can be carried out using growth media containing organic materials, waste-based substances, or byproducts from agro-industrial activities. According to Silmina et al. (2010), materials used as raw ingredients for animal feed must meet several criteria: they should be non-toxic, consistently available, nutritionally suitable for livestock, and not compete with human food sources. BSF maggot meal has a relatively high protein content of approximately 40-50% and a fat content ranging from 29-32%, making it a promising ingredient for protein-rich animal feed (Hadadi et al., 2007; Bosch et al., 2014).

BSF maggot production in this study ranged from 124.25 to 138.25 grams. Statistical analysis indicated that adding fish oil to the growth medium had no significant effect ($P > 0.05$) on BSF maggot production. The highest production was observed in treatment B (2% fish oil addition), while the lowest was in treatment D (8% fish oil addition). Adding fish oil up to 8% in the BSF larvae growth medium did not influence maggot production, likely because it did not alter the texture and structure of the growing medium. One of the key factors affecting BSF maggot production is the type of growth medium used. According to Nugraha et al. (2018), variations in the growth medium can influence the yield of BSF maggots. This study's growth medium consisted of fresh blood and fermented tofu supplemented with fish oil. A higher fish oil concentration may have led to a decline in maggot production due to changes in the medium's smell, color, taste, and nutrient composition. Furthermore, Hem et al. (2008) stated that a high-quality substrate enhances BSF maggot production by providing sufficient nutrients for larvae growth and development, which can be measured through weight production.

Dry matter refers to the constant weight of a material after removing all its water content by heating it to 105°C. There is a negative correlation between water content and dry matter—the higher the water content, the lower the dry matter content. Tran et al. (2014) stated that BSF maggot growth media should have low water content, as larvae cannot develop appropriately in high-moisture environments. In this study, the dry matter content of BSF maggot meal ranged from 93.46% to 96.69%. The highest dry matter content was recorded in treatment C (4% fish oil addition) at 96.69%, while the lowest was in treatment A (0% fish oil addition) at 93.46%. Based on statistical analysis, adding fish oil to the growth medium had a highly significant effect ($P < 0.01$) on the dry matter content of BSF maggot meal. Treatments C (4%) and D (8%) had a significant impact compared to treatment A (0%), while treatment B (2%) also differed significantly in dry matter content. This effect is attributed to the oil content in BSF maggot meal, which helps reduce water content. Suzuki (1991) explained that water content is closely related to fat and protein levels. In this study, higher fish oil supplementation resulted in higher dry matter content and lower water content. However, treatments C (4%) and D (8%) produced the same dry matter content, suggesting that using fish oil by BSF maggots is limited to 4%.

The crude protein content of BSF maggot meal in this study ranged from 31.57% to 49.29%. This falls within the typical 30%–50% protein range reported by Amandanisa & Parayoga (2020) and Bosch et al. (2014). The statistical analysis showed that adding fish oil to the growth medium had a highly significant effect ($P < 0.01$) on the crude protein content of BSF maggot meal. The effect of fish oil supplementation on protein content is linked to an increase in fat content. Buckle et al. (1987) explained that the protein content in BSF maggot meal is influenced by fat and water content. Treatments B (2%), C (4%), and D (8%) showed significantly lower protein content compared to treatment A (0%), indicating a trade-off between fat and protein accumulation. As the fat content increased, the crude protein content decreased—from 49.29% in treatment A (0% fish oil) to 32.35% in treatment C (4%) and 31.57% in treatment D (8%). This decline corresponds with an increase in fat content from 12.62% (A) to 33.04% (C) and 35.32% (D). Furthermore, the crude protein content in treatments C (4%) and D (8%) showed no significant difference, suggesting that BSF larvae can only utilize fish oil up to 4%. Beyond this level, additional fish oil may not further enhance growth, as maggots also require other essential nutrients for body composition.

The crude fat content of BSF maggot meal in this study ranged from 12.62% to 35.32%. Statistical analysis showed that adding fish oil to the growth medium significantly affected crude fat content ($P < 0.01$). The highest fat content was observed in treatment D (8% fish oil), reaching 35.32%, while the lowest was in treatment A (0% fish oil), at 12.62%. Treatments B (2%), C (4%), and D (8%) had significantly higher crude fat content compared to treatment A (0%), confirming that fish oil supplementation increases fat accumulation in BSF maggots. Furthermore, treatments C (4%) and D (8%) had significantly higher fat content than treatment B (2%), indicating that increasing fish oil levels beyond 2% continues to enhance fat deposition. However, no significant difference was found between treatments C (4%) and D (8%), suggesting that BSF larvae can only utilize fish oil up to 4% in the growing medium. Adding more fish oil beyond this level does not increase fat content, making it economically inefficient.

Crude ash refers to the inorganic residue left after the combustion of organic material. In this study, the ash content in BSF maggot meal ranged from 6.14% to 8.53%. Statistical analysis indicated that adding fish oil to the growth medium significantly affected crude ash content ($P < 0.05$). Ash content indicates organic material composition, higher crude ash levels correspond to lower organic matter content, as organic material is composed of crude protein, crude fat, fiber,

 DOI: 10.25077/alive.v2.n1.p10-15.2025

and nitrogen-free extract (BETN). In this study, treatments C (4% fish oil) and D (8% fish oil) significantly differed ($P < 0.05$) from treatment A (0% fish oil), indicating that higher fish oil levels reduced crude ash content while increasing organic matter in BSF maggot meal. However, the addition of 2% fish oil (treatment B) did not significantly affect ($P > 0.05$) crude ash content compared to treatment A, likely because the fish oil level was too low to produce a noticeable effect.

Tabel 1. Research result

Treatment	Maggot production (gr)	Dry matter (%)	Protein (%)	Fat (%)	Ash (%)
A (0%)	131.50	93.46^{a}	49.29^{a}	12.62^{a}	8.53^{a}
B (2%)	138.25	95.24^{b}	37.78^{b}	27.63^{b}	7.69^{ab}
C (4%)	126.50	96.69^{c}	32.35^{c}	33.04^{c}	6.22^{b}
D (8%)	124.25	96.68^{c}	31.57^{c}	35.32^{c}	6.14^{b}

Remarks: Superscript lowercase letters on the same line show a significant difference ($P<0.05$), Uppercase superscript on the same line shows a very significant difference ($P<0.01$)

Overall, increasing fish oil in the BSF larval growth medium led to a decrease in crude ash content and an increase in organic matter. This aligns with Sudarmadji et al. (1996), who stated that crude ash content reflects the mineral composition of a material.

CONCLUSION

The study results indicate that adding fish oil to a blood-based tofu pulp growth medium does not affect BSF maggot production. However, it significantly impacts dry matter content, crude protein, crude fat, and ash composition. The optimal fish oil level was 4%, which resulted in BSF maggot production: 126.50 grams, Dry matter content: 96.69%, Crude protein: 32.35%, Crude fat: 33.04%, Crude ash: 6.22%. This suggests that a 4% fish oil supplementation optimizes nutrient composition in BSF maggot meal, making it a valuable protein and omega-3 fatty acid source for animal feed.

REFERENCES

Amandanisa A., dan Prayoga S. (2020). Kajian Nutrisi dan Budi Daya Maggot (Hermentia illuciens L.) Sebagai Alternatif Pakan Ikan di RT 02 Desa Purwasari, Kecamatan Dramaga, Kabupaten Bogor. *Jurnal Pusat Inovasi Masyarakat*, *2*(5), 796–804.

Bosch G, Zhang S, Dennis GABO, Wouter HH. (2014). Protein quality of insects as potential ingredients for dog and cat foods. *J Nutr Sci. 3*:1-4.

Buckle KA, Edwar RA, Fleet GH, Wooton M. (1987). Ilmu Pangan di Dalam: Purnomo H, Adiono, Penerjemah. Jakarta: Universitas Indonesia Press.

Dewi EN. (1996). Isolasi asam lemak omega-3 dari minyak hasil limbah penepungan dan pengalengan ikan lemuru (*Sardinella Longiceps*). Skripsi. Bogor: Fakultas Teknologi Pertanian, Institut Pertanian Bogor.

Hadadi A, Herry, Setyorini, Surachman A, Rid-wan E. (2007). Pemanfaatan limbah sawit untuk ramuan pakan ikan. *Jurnal Budi daya Air Tawar*, *4*(1), 11-18.

Hem S, Toure S, Sagbla C, Legendre M. (2008). Bioconversion of palm kernel meal for aquaculture: Experiences from the forest region (Republic of Guinea). *African J Biotechnol, 7*(8), 1192– 1198.

Innis SM. (2000). The role of dietary n-6 and n-3 fatty acids in the developing brain. *Developmental Neuroscience, 22*, 474- 480.

Montesqrit, Mahata E.M dan Amizar R. (2019a). Pemanfaatan bahan pakan sumber protein sebagai media tumbuh *black soldier fly* (*hermetia illucens*) guna menghasilkan tepung maggot kaya protein. Prosiding Seminar Nasional Semirata BKS PTN wilayah Barat bidang Ilmu Pertanian. Jambi 27-29 Agustus 2019.

Montesqrit, Mahata E.M, Amizar R, Adrizal dan Efrizon A. (2019b). Pengaruh limbah peternakan sebagai media tumbuh larva BSF (black soldier fly/*Hermetia illucens*) terhadap kandungan bahan kering, protein kasar dan lemak kasar tepung maggot BSF. Prosiding Seminar Nasional Hasil Penelitian dan Pengabdian kepada Masyarakat. "*Membangun Peternakan Berkelanjutan menuju Era Industri 4.0"* Fakultas Peternakan Universitas Jambi.

Nugrahani I. L., Farida Fathul, dan Syahrio Tantalo. (2018). Pengaruh berbagai media terhadap suhu media dan produksi maggot. *Jurnal Riset dan Inovasi Peternakan, 2*(1), 32-37.

Rido, M., dan Erni, N. (2023). Analisis Pendapatan Kandang Closed House (Studi Kasus kandang Closed House Welkin Situmorang) di Bulik Kabupaten Lamandau Provinsi Kalimantan Tengah. *Jurnal Sains dan Teknologi*, *5*(1), 68-74.

Rido, M., Erni N., Firdaus H., dan Dyah T. (2023). Pengaruh Penambahan Minyak Ikan Lemuru Pada Media Tumbuh Larva BSF (Black soldier fly) Berbasis Fermentasi Ampas Tahu Terhadap Produksi Maggot BSF, Kandungan Protein dan Lemak Tepung Maggot BSF. *Jurnal Agriovet. 5*(2). https://doi.org/10.51158/agriovet.v5i2.865

Rizki, S., P, Hartami dan Erlangga. (2017). Tingkat densitas populasi maggot pada media tumbuh yang berbeda. Universitas Malikussaleh, Makassar.

Silmina, D. Edriani, G. Putri, M. (2010). Efektifitas Berbagai Media Budidaya Terhadap Pertumbuhan Maggot (*Hermetia illucens).* Insitut Pertanian Bogor.

Steel, R. G. dan J. H. Torrie. (1995). Prinsip dan Prosedur Statistik Suatu Pendekatan Biometrik. Edisi Ke-2, Diterjemahkan oleh Bambang Sumatri. PT. Gramedia Pustaka Utama, Jakarta.

 DOI: 10.25077/alive.v2.n1.p10-15.2025