Exploration of Maggot Utilization as Protein Source in Fish Feed

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ABSTRACT

Through a process known as bioconversion, organic waste can still be used as a medium for growing larvae which can subsequently be used as feed materials for animal protein sources in fish and livestock feed. Maggot bioconversion can reduce organic waste by up to 56%. Utilizing maggots as a natural decomposer will result in the production of three major products: dry organic waste residue as fertilizer, liquid created by larval activity, and larvae as animal feed. The larva of the Black Soldier Fly (BSF) is called a maggot of Hermetia illucens. Maggots have the ability to degrade organic material. This BSF maggot can be fed to animals and fish. Because it is simple to breed and has a high protein content, the H. illucens maggot can be utilized as a feed alternative. A search on nutritional value and abundance revealed that maggots have a lot of potential as an alternative feed item for protein sources in fish feed. An improvement in the health status of many fish is another effect of utilizing maggot.

Keyword: *black soldier fly, fish feed, maggot, protein, waste*

1. INTRODUCTION

Organic waste is one of the wastes that is abundant and has the potential to pollute the environment. Therefore, there is a need for professional management efforts so that organic waste can become something that is productive, useful and has economic value. On the other hand, the type of organic waste can still be used as a medium for growing larvae which can then be used as feed ingredients for animal protein sources in fish and livestock feed, through a process called bioconversion.

Bioconversion is the overhaul of organic waste that involves living things, such as fungi, bacteria, and larvae. Black Soldier Fly (BSF) in Latin *Hermetia illucens* is a fly native to the Americas, and has been found in Indonesia, precisely in Maluku and Irian Jaya. When in the form of larvae, this type of Black Soldier Fly (BSF) larvae has advantages in converting organic waste where the final product contains microbial, anti-fungal and cellulosic activity in the presence of bacteria in the intestines [1].

Bioconversion by maggot is able to reduce organic waste by up to 56%. Utilization of maggot as a natural decomposer will produce three main products, namely larvae as animal feed, liquid produced by larval activity as liquid fertilizer, and dry organic waste residue as fertilizer. The advantage of cultivating BSF maggot compared to processing waste into compost is that maggot cultivation requires a shorter time and every day BSF maggot requires food from organic waste.

This BSF maggot can be used as fish and livestock feed. [2] explained that (*H. illucens*) can be used as an option for providing feed because it is easy to breed, and has a high protein of 61.42%. Protein components have an important role in a feed formula because they function in the formation of body tissues and play an active role in vital metabolism such as enzymes, hormones, antibodies and so on. The high nutrient content of maggot, its abundant availability, and its easy-to-make growth media show good potential as an alternative to fish feed combinations [3].

2. BIOLOGICAL CHARACTERISTICS OF MAGGOT

Maggot (*Hermetia illucens*) is the larva of the Black Soldier Fly (BSF). Maggot is a decomposer that can break down organic matter. According to [4], Maggot BSF can digest organic waste with a reduction of organic matter by 65.5% to 78.9% per day. In addition to being able to properly decompose organic waste, BSF maggots are safe for cultivation because they do not cause disease and have high enough nutrients, namely protein by 30-45% and fat by 24-30% [5], hence that they can be used as feed sources of high protein for both poultry and fish. According to [6] the classification of *Hermetia illucens* is as follows:

Kingdom : Animalia
Phylum : Arthropoda
Class : Insecta
Order : Diptera
Family : Stratiomyidae
Genus : Hermetia
Species : *Hermetia illucens*

Figure 1. Adult BSF maggots for alternative feed

Maggot can grow on decaying organic matter in the tropics. The maggot life cycle starts from the maggot egg. The eggs will hatch within 3-4 days, then they will become larvae or baby maggots. Maggot was developed in a bio-pond (maggot rearing site) for 21 days and fed with organic waste. Next, the maggot will enter the prepupa phase. For 14 days the maggot does not eat to become a pupa. After entering the pupa stage, maggots take seven days to a month to metamorphose into BSF flies. When they become BSF flies, the males only have three days to breed with the female flies. The factor that plays an important role in the BSF life cycle is temperature, at a temperature of 30^{o} adult flies will be more active and productive. After carrying out the breeding process, the male fly will die and the female fly will enter the breeding phase or lay eggs for the next three days. Female flies will follow in the footsteps of the males after completing the egg-laying process. Likewise, the cycle will repeats itself.

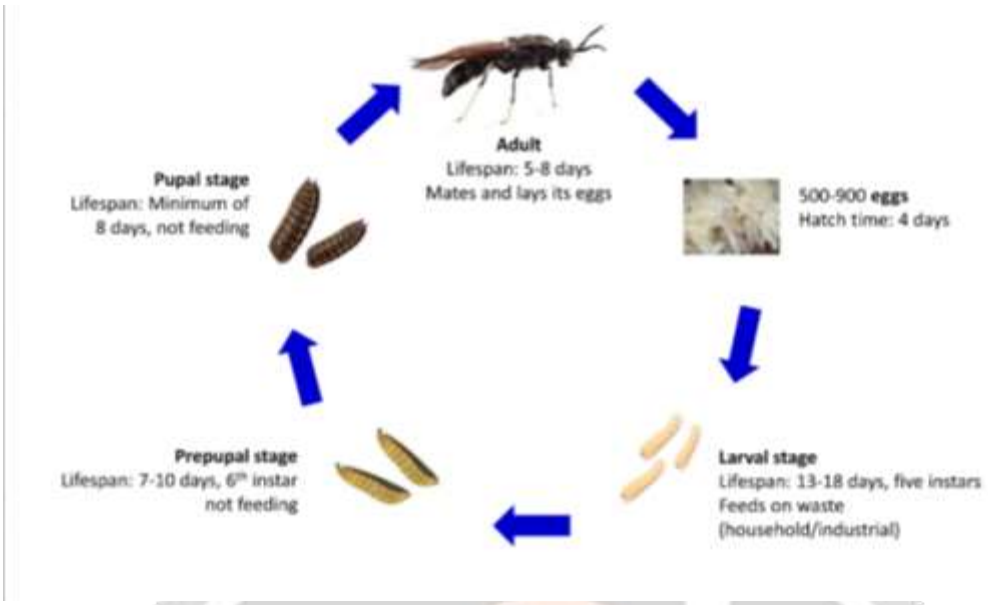

Figure 2. Maggot Life Cycle[1]

Maggot *Hermetia illucens* measures about 1.8 mm when newly hatched. The surface of the rough and hard maggot skin is yellowish with a black head. Adult larvae are about 18 mm long and 6 mm wide, some individuals can reach a length of 27 mm [7].

3. MAGGOT NUTRITIONAL CONTENT

Magot is used as an alternative to fish feed because it has a high protein content. Materials containing more than 19% crude protein are considered as good protein sources [8]. Maggot *Hermetia illucens* has the ability to produce enzymes that can increase the digestibility of fish to feed. The nutritional value of maggot can be seen in Table 1.

Table 1. Maggot Nutritional Value

Amino Acid		**Minerals and others**	
Methionine	0.83	P	0.88%
Lysine	2.21	K	1.16%
Leucine	2.61	Ca	5.36%
Isoleucine	1.51	Mg	0.44%
Histidine	0.96	Mn	348 ppm
Phenylalanine	1.49	Fe	776 ppm
Valine	2.23	Zn	271 ppm
I-Arginine	1.77	Crude Protein	43.2%
Threonine	1.41	Crude Fat	28.8%
Tryptophan	0.59	Ash	16.6%

Source: [9]

Maggot has a different percentage of nutritional components at each age difference. Maggot fat content tends to be positively correlated with increasing age, namely, by 13.37% at the age of 5 days and increasing to 27.50% at the age of 25 days. Meanwhile, the crude protein content in maggot will decrease with increasing age. According to [10], larger larvae are ideal when used for feed mixtures or pellet raw materials because they are able to meet the production quantity.

[1] https://encyclopedia.mdpi.cn/Fmv3k9NZ3qq5UV8BYtuzDsjzqbIL

4. UTILIZATION OF MAGGOT AS FEED IN FISH CULTIVATION ACTIVITIES

Research on the use of maggot as a fish feed supplement has been widely carried out. Among them is the research conducted by [11] regarding the growth in length and weight of *Sangkuriang* catfish (*Clarias gariepinus*) in the feeding treatment using maggot showed better results than other treatments with an average length of 7.87 cm, and a weight of 7.83 grams. The survival of *Sangkuriang* catfish (*Claris gariepinus*) reached 100% in all treatments. The research by [12] regarding the use of maggot as fish feed showed a significant effect on the growth of Black shark fish with an SGR value of 6.51 ± 0.32. The impact of using maggot is also seen in an increase in the health status of fish. This can be seen from the increase in the number of red blood cells, white blood cells, and the number of cells that carry out phagocytic activity. More complete research results are presented in Table 2.

Table 2. Utilization of Maggot as Feed

Aquaculture Commodity Type	Treatments	Results	Reference
Gouramy seeds *(Osphronemus gourami)*	Combination of Pellet and Maggot feed with 4 treatments, 100% Pellet, 70% Pellet+30% Maggot, 65% Pellet+35% Maggot, 60% Pellet+40%	Maggot Treatment 70% Pellet+30% Maggot is superior in Absolute Weight, Length, Survival Rate (SR), and Food Conversion Rate (FCR)	[13]
Sangkuriang catfish *(Clarias gariepinus)*	2 Treatment of different pellet and maggot combinations. 50% Maggot (BSF)+50% Commercial Pellet, and 100% Commercial Pellet	The best treatment is 50% Maggot+50% Commercial Pellet. With parameters Absolute Weight, Length, Survival Rate (SR), Feed Efficiency (EP), Food Conversion Rate (FCR)	[14]
Siamese catfish (*Pangasius hypophthalmus*)	5 Combined treatments of Pellet and Maggot. 100% Pellet, 75% Pellet + 25% Maggot, 50% Pellet + 50% Maggot, 25% Pellet + 75% Maggot, 100% Maggot.	In the length and weight parameters the best treatment was 25% Pellet + 75% Maggot, the Survival Rate (SR) parameter and the best feed cost were obtained in the 100% Maggot treatment with an SR of 90% at a price of Rp. 4,200	[15]
Rainbow Kurumoi fish (*Melanotaenia parva*)	2 Treatments with different feeds, namely Maggot and Maggot with a pellet mixture of 1:1	Based on the parameters of the weight and total length of the best fish obtained by the Maggot Pellet feed treatment.	[16]
Siberian Sturgeon (*Acipenser baerii*)	6 treatments with feed (Fish Meal and Fish Oil) mixed with Black Soldier Fly (BSF/Maggot) with a dose: – Control 26.1% FM+0%BSF – H5 23.4%FM+5% BSF – H10 20.8%FM+10% BSF – H15 18.1%FM+15% BSF – H20 15.5%FM+20% BSF – H25 12.8%FM+25% BSF – H30 10.1%FM+30% BSF	Based on Growth Performance, Feed Utilization, Acceptance obtained Survival Rate (SR) is 100% in all treatments. Body weight and body weight gain specific growth rate, as well as relative growth rate, increased significantly with the use of BSFL foods. There was no difference in feed consumption between treatments. The FCR was highest in the H5 treatment, and there was no difference between the higher doses of BSFL. In terms of PER, the lowest values were observed in the control treatment, with a significant increase at H5, while H10, H15, H20, H25, and H30 showed higher values.	[17]
Snapper (*Sparus aurata*)	6 treatments with Fish Meal content in the feed replaced with BSF/Maggot without fat with a	*Hermetia illucens* (BSF/ Maggot) has a positive effect on the ratio of hypocholesterolemia/hypercholesterolemia	[18]

	dose: – H25 25% BSF – H30 30% BSF – H50 50% BSF	and the content of amino acids and microelements that are needed by snapper.	
Sangkuriang catfish (*Clarias gariepinus*)	A mixture of fish meal and BSF/Maggot flour with 5 treatments, 100% fish meal, 75% fish meal + 25% Maggot flour, 50% fish meal + 50% Maggot flour, and 100% Maggot flour.	Treatment with 50% fish meal + 50% Maggot flour gave the best performance with a normal liver, optimal blood cells, and good digestion.	[19]
Common carp (*Cyprinus carpio L.*)	3 different treatments for maggot culture used as carp feed. – Organic Waste – Tofu dregs trash – Wheat Flour	The treatment of Maggot cultivation using wheat flour was the best with 50.88% protein, followed by 43.87% organic waste, and 39.87% tofu dregs.	[20]
Catfish (*Clarias gariepinus*)	Fermentation on pellet feed containing BSF/Maggot flour with 4 treatments. – F1: (non-fermented, 60% BSFLM) – F2: (fermented, 60% BSFLM) – F3: (non-fermented, 50% BSFLM) – F4 (fermented, 50% BSFLM).	Specific growth rate (SGR) and body weight gain (WG) for fermented feed F2 and F4 were higher than non-fermented feed F1 and F3, respectively. F4 gives the best feed conversion ratio (FCR) of 1.78, which is 15–25% more efficient than F1, F2, and F3. Compared with commercial feeds, the four formulated feeds had poor performance of about 50% in all growth parameters except survival rate (SR) which was not significantly different (93-100%).	[21]

5. CONCLUSIONS

Based on the results of a search on nutritional quality and abundance, maggot has great potential to be utilized as an alternative feed ingredient for protein sources in fish feed. These considerations become a strong recommendation for cultivators to use maggot according to the needs of the fish being cultivated.

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