The Effect of Feeding Maggot Fluor (Hermetia illucens) on Fish Feed for Growth of Sangkuriang Catfish (Clarias sp)

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Abstract. One of the problems among breeders is the high need for food. An effort to reduce the cost of catfish feed is to provide maggot flour (Hermetia illucens L.) as a basic material for making food. Our study attempted to measure the effect of maggot flour (Hermetia illucens L.) on the growth of 2 month old Sangkuriang catfish (Clarias sp.). The data were compiled using a completely randomized design technique (CRD) with 4 replications and 6 treatments for catfish, namely the provision of maggot concentrations of 10% (P1), 20% (P2), 30% (P3), 40% (P4), 50% (P5), control treatment (without maggot) and calculated using ANOVA. The 50% and 40% maggot percentages provided an increase in all growth parameters. The statistical test at a significant level of 1% showed that feeding maggot flour had a significant effect (P> 0.05) on absolute length and relative length, but had no significant effect on absolute weight, relative weight and feed efficiency ratio. Provision of maggot flour could increase the growth of 2 month old Sangkuriang catfish (Clarias sp.) on growth parameters and provide solutions in reducing feed costs.

1. Introduction

People who are aware of their protein needs are characterized by the high consumption of fish. Aquaculture is one of the government's efforts to develop fish production (Renita & Suriana, 2016). The community has contributed to increasing fish production by conducting freshwater fish farming. One of the reasons is because freshwater fish farming is easier to do, such as making tarpaulin ponds, above-ground ponds and underground ponds (Gomez & Arturo, 2015). One of the freshwater fish farming businesses that are popular within the community is catfish farming (Xiao et al., 2018).

Catfish is one of the contributors to aquaculture with a growth rate of 17-18% per year (Rahayu, 2013). The advantages of catfish farming are being able to live in a high stocking density, being resistant to disease, having a good feeding ratio vis-a-vis meat growth, and fast harvesting time. This is the reason why Sangkuriang catfish (*Clarias* sp.) is widely cultivated by the community. Catfish is a freshwater aquaculture fishery commodity that has a fairly high level of marketing, both in domestic and foreign markets (Wijaya, Rahardja & Prayogo, 2014) However, the increasing need for catfish is not matched by high productivity. Feed is the largest contributor to production costs, namely 50 - 70% of operational costs (Handajani, Hastuti, & Wirawan, 2014).

The difficulty experienced by fish cultivators is the use of basic ingredients for fish meal to make pellets whose availability is inconsistent with high prices and it is imported (Meitiyani, et al, 2018). The price of pellets made from fish meal is relatively high, making fish production costs more expensive. This gives catfish farmers a difficulty in saving production costs, making catfish production to decrease.

Overcoming this problem requires creativity to minimize the use of pellets made from fish meal with large scale production compositions. Sources of feed can come from natural feed or artificial feed. Artificial feed is feed produced by factories, while one of the natural feeds sourced from nature as an alternative to artificial feed is highly nutritious maggot.

The *black soldier* fly maggot is a protein source that can be an alternative fish feed. Materials that contain crude protein of more than 19% are considered to be good protein sources (Murtidjo, 2001; Fauzi & Sari, 2018). Maggot is one of the decomposing organisms because it consumes organic materials to grow (Silmina, Edriani, & Putri, 2011; Fauzi & Sari, 2018). The results of the amino acid sample test from the IPB Integrated Science Laboratory stated that maggot had 13.67% amino acid content, while the proximate sample test results from the Indonesian Spice and Medicinal Research Institute stated that maggot had a protein content of 17.94%. The protein requirement for catfish is 17.09% (Listiarini, Asriani & Santoso, 2018), which means that maggot meets the requirements as a protein source (Hu et al., 2017). Maggot can be used directly as feed in fresh form or mixed with other ingredients such as bran to make pellets (Dudusola & Temenu, 2013). This will make it easier for catfish farmers to produce their own feed and to save production costs and be more effective in using feed.

Hariadi, Irsan & Wijayati (2014) discover that the highest growth rate and protein efficiency and the lowest feed conversion for catfish jambal are in P2 treatment with a combination of 75% pellets and 25% flower fly larvae (*Hermetia illucens* L.). This study used *Hermetia illucens* L. fly maggot flour and fish meal to be used as artificial pellets in various compositions to measure the growth of 2 month old Sangkuriang catfish (*Clarias* sp.). The use of Sangkuriang catfish in this study is due to its very fast growth characterized by its greedy behavior when eating and is categorized as an omnivorous animal (Darseno, 2010).

The purpose of this study was to determine the effectiveness of using maggot flour (*Hermetia illucens* L.) to fish feed on the growth of 2 month old Sangkuriang catfish (*Clarias* sp.).

2. Methodology

This research was conducted in February - July 2019 in the greenhouse of Prof. Muhammadiyah University. Dr. Hamka. The tools used were 24 aquariums measuring 40 x 22 x 35 cm, digital scales, pellet printing machines, water quality measurement tools such as pH, TDS, and temperature thermometer. The ingredients used are 120 Sangkuriang catfish (*Clarias* sp.). The ingredients for fish feed include: corn flour, soybean flour, wheat flour, starch, fish flour, top mix, corn oil and fish oil.

The method used in this research as an experimental method. This study used a completely randomized design (CRD) consisting of 6 treatments and 4 replications according to Frederer's formula (t-1) (n-1)> 15, with t many treatments. With the number of repetitions (n) 4 replications, there were 24 experimental units. Sampling was done by purposive sampling in accordance with the criteria of the tested animals. The samples were divided into 6 groups, where each group consisted of 5 catfish. The sample distribution for each group was carried out using the completely randomized design technique (Gomez, 2015).

Research Procedures

Preparation

The aquarium used in the study was 24 units measuring 40 x 22 x 35 cm and one large drum as a reservoir. Aquarium and Drum were cleaned and washed and the drum was filled with water until it was full and allowed to stand for 7 days. The aquarium was placed on a cardboard box with its entire outside parts covered with a black trash bag. Each aquarium was filled with water as much as 8.8 liters.

Implementation

The sample used in this study was Sangkuriang catfish (*Clarias* sp.) obtained from fish farmers in Cimanggis. The initial average length was 1.25 - 1.67 cm / head and the initial average weight was 5.5 to 6.2 grams / head of 120 birds. Fish were stocked with 5 fish per pond. Once stocked, the fish were not fed for three days. After the adaptation process, the fish body was weighed in the afternoon and its length was measured using a digital scale and a ruler and water quality was measured as initial data.

Observation

During maintenance, the test feed was given in the form of artificial pellets with maggot flour as the base ingredient obtained from Biomagg maggot cultivators in Cimanggis. The size of the feed given was coarse grain according to the size of the fish's mouth. The age of catfish in this study was 2 months. The feed was given twice a day, namely morning at 09.00 WIB and evening at 17.00 WIB with a daily feed requirement dose of 5% of the weight of catfish seeds.

Before the feed was given, the feed was weighed first using a digital scale. Each aquarium was given feed, namely P0 (0% maggot), P1 (10:90), P2 (20:80), P3 (30:70), P4 (40:60), P5 (50:50). Water quality management was carried out by replacing water as much as 25% of the volume of water which is carried out every 7 days. Catfish seeds are maintained for 4 weeks or 28 days.

As supporting data, during the research water quality monitoring was carried out including pH, temperature, and TDS measurements. Water quality measurements were carried out every day so that changes in water quality can be controlled. PH measurements were made with a pH meter, temperature with a temperature thermometer, and TDS with a TDS meter. Weighing the body weight and measuring the length of the fish was done every 7 days.

Data Collection and Data Analysis

The parameters observed in this study are:

Absolute Weight

The weight gain of catfish was measured using digital scales with an accuracy of 0.01 grams and was carried out every 7 days until the end of the study. The calculation of absolute weight was done using the formula proposed by Gomez (2015), namely:

Absolute Length

= Pertumbuhan berat mutlak (cm)
= Berat rata – rata individu pada akhir penelitian (gr)
= Berat rata – rata individu pada awal penelitian (gr)

Information :

= Pertumbuhan panjang mutlak (cm)
= Panjang rata – rata individu pada akhir penelitian (gr)
= Paanjang rata – rata individu pada awal penelitian (gr)

Relative Weight

Information:

= Pertumbuhan berat relatif (%)
= Berat rata – rata individu pada akhir penelitian (gr)
= Berat rata – rata individu pada awal penelitian (gr)

=

= Pertumbuhan panjang relatif (cm)

= Panjang rata – rata individu pada akhir penelitian (cm)

= Panjang rata – rata individu pada awal penelitian (cm)

Life sustainability

Information:

SR = Kelangsungan hidup (%)
= Jumlah total ikan pada akhir pengamatan (ekor)
= Jumlah total ikan pada awal pengamatan (ekor)

Feed Efficiency Ratio

Information:

= Efisiensi pakan (%)
= Biomassa ikan uji akhir (gr)
= Biomassa ikan uji awal (gr)
= Biomassa ikan uji yang mati (gr)
F = Jumlah pakan yang diberikan selama penelitian (gr)

The data analysis began with the normality test and continued with the homogeneity test as a prerequisite for the ANAVA test. After the ANAVA test, the LSD test was carried out to see the difference in the effect between treatment pairs (Gomez, 2015).

3. Result and Discussion

The results of the research on the effect of maggot flour (Hermetia illucens L.) on the growth of Sangkuriang catfish (Clarias sp.) after 28 days of treatment showed that there were differences in treatment and water quality data. This can be seen in the following table:

Table 1. Growth Parameters of Sangkuriang Catfish (Clarias sp.)

Treatment (%)	Absolute Weight (g)	Absolute Length (cm)	Relative Weight (%)	Relative Length (%)	Sustainability (%)	Feed Efficiency (%)
P0 (100:0)	0,97	2,33^{abc}	13,99	7,35^{abc}	100	7,69
P1 (90:10)	1,28	2,58^{abc}	21,73	9,10^{abc}	100	10,56
P2 (80:20)	0,61	1,75^{ab}	8,15	5,82^{ab}	100	4,52
P3 (70:30)	1,37	3,45^{abc}	20,09	12,32^{abc}	100	10,48
P4 (60:40)	1,01	4,70^{c}	14,17	18,20^{c}	100	7,03
P5 (50:50)	1,61	1,25^{a}	26,90	5,12^{a}	100	13,28

Table 2. Value Range of Water Quality Parameters on Maintenance Media

Treatment	Water quality parameters		
	pH	Temperature (°C)	TDS (ppm)
P0	6,5 – 7,3	27-29	214 - 366
P1	6,5 – 7,3	27-29	207 - 288
P2	6,5 – 7,3	27-29	203 - 337
P3	6,5 – 7,2	27-29	227 - 295
P4	6,7 – 7,3	27-29	231 - 294
P5	6,8 – 7,4	27-29	216 - 288
Basic Standard	6,5- 8,5 (Wibowo, 2012)	25-30 (Darseno, 2010)	100-300 (moderate to slightly harsh categories) (Kuncoro, 2008)

The results of measuring the quality of pH, temperature, and TDS are in accordance with the standards of other researchers. This greatly affects the survival of Sangkuriang catfish (Clarias sp.).

The results obtained based on observations of growth parameters of Sangkuriang catfish (Clarias sp.) showcased that the P5 treatment (50% maggot and 50%) fish meal showed the highest yield on the parameters of absolute weight, relative weight, and feed efficiency ratio, while P4 treatment (40 % maggot and 60% fish meal) showed the highest yields on the absolute length and relative length parameters. The lowest results on parameters of absolute weight, relative weight, and feed efficiency ratio were in P2 treatment (20% maggot and 80% fish meal). Meanwhile, the lowest result on absolute length and relative length parameters was in P5 treatment (50% maggot and 50% fish flour).

The results of the one-factor ANOVA analysis showed that giving maggot flour to the feed had a very significant effect on the absolute length growth parameters. The real difference test (BNT) showed a significant difference in the absolute length and relative length parameters.

Table 3. Fish Feed Amino Acid Test Results

Parameters	Fish Flour	Maggot
Asam Amino Esensial **Amino acid Essential**		
Aspartic acid	1,69	1,63
Threonine	0,64	0,60
Valine	0,84	0,75
Methionine	0,22	0,18
Ileusine	0,74	0,71
Leusine	1,27	1,30
Histidine	0,46	0,49
Phenylalanine	0,78	0,80
Lysine	0,34	0,93
Arginine	0,46	0,54
Asam Amino Non Esensial **Non-Essential Amino Acids**		
Serine	0,73	0,72

Glutamate	2,59	2,73
Glisine Glycine	1,26	1.02
Alanine	0,95	0,93
Tyrosine	0,32	0,34
Total Amino acid	**13,30**	**13,67**

Source: Test Results from the Integrated Science Laboratory of the Bogor Agricultural University, 2019

The results of the analysis of the amino acid test at the Integrated Science Laboratory of the Bogor Agricultural University showed that maggot had an amino acid content of 13.67% while fish meal was 13.30%.

The average results obtained based on research and observation data, the best treatment for growth parameters absolute weight, relative weight and feed efficiency ratio was in treatment P5 with a composition of 50% maggot and 50% fish meal and in treatment P4 with a composition of 40% maggot and 40 % maggot. This was indicated by the growth average of absolute weight, relative weight, relative length, and feed efficiency ratio which was greater than the other treatments. This was presumably because in the P5 and P4 treatments the total nutritional composition of the combination of fish meal and maggot complemented each other. The protein content in feed had an effect on the height and level of fish growth. Lack of protein in feed can cause growth retardation, followed by weight loss due to the use of protein from body tissues to maintain vital functions (Mlaga et al., 2020).

The best feed treatment for growth parameters of absolute length and relative length was the P4 treatment with a composition of 40% maggot and 60% fish meal. This was indicated by the average absolute length growth and the relatively greater length growth compared to other treatments. This was probably because the P4 treatment with the composition of fish meal and maggot feed had a fairly balanced nutritional content and also the composition of feed nutrients such as protein, fat and carbohydrates as needed by fish so that fish can make optimal use of the feed given. These results are reinforced by Afrianto and Liviawati (2005) who found that fish meal generally has a balanced number and type of amino acids, so it can provide good growth in fish. The results obtained on the growth parameters of absolute length and relative length in the P4 treatment, namely the composition of 40% maggot and 60% fish meal, provide an assumption that is in line with Ediwarman's (2009) theory that a feed consisting of two or more protein sources will provide more growth better than fish given only one protein source. According to Afrianto, et al (2005), the main function of protein is for growth. However, if the fat and carbohydrate content in the feed is insufficient, the function of protein will turn into a producer of energy. The low food energy content causes most of the food protein to be used as a source of energy for metabolic needs (Kordi, 2010).

If the protein given is too much, growth will be stunted. This is reinforced by Afrianto et al. (2005) which states that if the protein content in feed is too high, only part of it would be used to make new protein, while the rest would be converted into energy. For feed with high protein levels, the composition of other feed constituents such as carbohydrates and fats become less. This can cause the proportion of non-protein at a higher protein level to allow protein catabolism to be large because catabolism requires 30% greater energy in the absorption process than carbohydrates which are only 5% (Haetami, 2012). The provision of the optimal amount of protein in the feed to get maximum fish growth results. The nutritional balance in the feed must also be taken into account to maintain the stability of fish growth. The provision of a protein source with the appropriate composition will affect the growth rate and level of feed efficiency. This is in accordance with Ediwarman, et al (2008) who found that the use of maggot to substitute trash fish which provides a specific growth rate and good feed conversion is up to 50% and will further reduce growth and feed efficiency.

In general, the lowest treatment on growth in absolute weight and relative weight was P2 treatment with a composition of 20% maggot and 80% fish meal. This may be due to inappropriate or excessive nutritional needs, making the fish unable to properly absorb them. Too high protein was given in the feed so that the feed does not run out and to avoid them inhibiting growth and polluting the quality of the water in the aquarium. The protein in the feed that is given to accelerate the growth of fish length

must be maximized. Meanwhile, to temporarily increase the body weight of the fish, the fish can consume natural foods around them such as algae and moss. However, essential protein cannot be replaced by other than protein-containing feed, where fish weight can increase temporarily but will drop dramatically if there is no energy stored in the body even though the fish consume large amounts of natural food.

According to Haetami (2012), an increase in protein content in feed results in too much work done by the body for the formation of glucose from amino acids (gluconeogenesis) through increasing the special dynamic heat effect Specific Dynamic Action (SDA). In this case, energy is wasted and not used for growth. The results of the amino acid sample test from the Integrated Science Laboratory of the Bogor Agricultural University stated that maggot had 13.67% amino acid content, while the proximate sample test results from the Indonesian Spice and Medicinal Research Institute stated that maggot had a protein content of 17.94%. The protein requirement for catfish was 17.09% (Listiarini, Asriani & Santoso, 2019). This means that maggot qualifies as a protein source.

Amino acids in maggots that are higher than fish meal include the essential amino acids Leucine, Histidine, Phenylalanine and Lysine. Meanwhile, non-essential amino acids include the amino acids Glutamate and Tyrosine. Amino acids in the BSF maggot can meet the needs of amino acids in the body of water pomfret, including tyrosine, valine, threonine, isoleucine, histidine, arginine, leucine and lysine (Lochmann, 2004). The amino acid that has a direct effect on fish growth is histidine which functions in infant brain development and growth. Non-essential amino acids Glutamate plays a role in the immune, digestive system and DNA synthesis processes. Moreover, tyrosine plays a role in reducing fat and controlling appetite.

The results of the examination of fish feed at the Laboratory of the Indonesian Spice and Medicinal Plants Research Institute (ICRI) show that the moisture content, ash content, protein content and carbohydrate contents in artificial pellets made from 100% fish meal are higher than artificial pellets made from maggot flour. However, the fat content in artificial pellets made from maggot flour was higher, namely 13.76% compared to artificial pellets made from fish meal, which is at 9.69%. This results in a complementary and balanced nutritional balance. This analysis is reinforced by Subamia, et al (2010) who discovers that the amino acid levels in maggot are slightly lower than fish meal, but the content of linoleic fatty acid (n-6) maggot flour is higher than fish meal.

The nutritional content of artificial pellets made from maggot flour is higher than the nutritional value of catfish per 500 grams. Thus, an effective feed formulation to obtain optimal catfish growth is to use a mixture of maggot flour in artificial feed.

The results of the study on the survival data of Sangkuriang catfish showed that catfish in all treatments had a high survival rate of 100%. This is because the research carried out met the water quality standards in the maintenance media. The results of temperature measurements during the study ranged from 25 ºC - 34 ºC. The pH value ranges from 6.5 - 7.2. The pH measurement results were in accordance with the Indonesian National Standard (SNI). The productive pH for Sangkuriang catfish was 221 - 337 ppm. TDS that is allowed is 500 mg / l. The results of water quality research were in line with Kordi & Tancung (2007) who said that the carrying capacity or environmental quality has a significant effect on the life of cultivated biota which is manifested in health, growth and survival.

4. Conclusion

The provision of maggot flour in fish feed tended to affect the growth of Sangkuriang catfish (Clarias sp.). The provision of maggot flour (Hermetia illucens L.) in the P5 treatment (50% maggot and 50% fish meal) gave an increase in the parameters of absolute weight, relative weight, and feed efficiency, while P4 treatment (40% maggot and 60% fish meal) gave an increase on the parameters of absolute length and relative length.

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