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The Effect of Maggot Flour Substitution in Artificial Feed Formulations on the Growth and Survival of Snakehead *(Channa striata)*

Pengaruh Substitusi Tepung Maggot dalam Formulasi Pakan Buatan terhadap Pertumbuhan dan Kelulushidupan Ikan Gabus (Channa striata)

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Abstract

The high price of fish meal is also a reason for alternatives and better protein sources. This research aims to substitute fish meal with maggot meal in feed for snakehead fish's growth rate and survival. The method used in this research is the experimental method of Completely Randomized Design (CRD), which consists of five treatments and three replications. The treatments used were (A) without the use of maggot flour (control), (B) 15% maggot flour substitution, (C) 30% maggot flour substitution, (D) 45% maggot flour substitution, (E) 60% maggot flour substitution, which was maintained for 50 days. The test fish used were snakehead fish with a 9-10 cm length and weighing 7-9 g. The container used is an aquarium with dimensions of 40x26x28 cm^3 or a water volume of 15 L, in which five snakehead fish are placed in each aquarium. The amount of feed given is 5% of the fish biomass. The results obtained during the research showed that treatment E with the substitution of fishmeal for maggot meal at 60% of the feed resulted in the highest absolute length growth of 4.0 cm, the highest specific growth rate of 2.54%, and survival of 87%.

Keywords: Snakehead Fish, Specific Growth Rate, Maggot Flour

Abstrak

Permasalahan yang ada pada budidaya ikan terutama ikan gabus adalah lamanya pertumbuhan ikan gabus dan penggunaan pelet komersil yang banyak. Perbandingan antara harga tepung ikan yang tinggi juga menjadi alasan perlunya mencari alternatif lain sebagai sumber protein baru yang lebih murah dan lebih baik. Penelitian ini bertujuan untuk mensubstitusikan tepung ikan dengan tepung maggot dalam pakan terhadap laju pertumbuhan dan kelangsungan hidup ikan gabus. Metode yang digunakan dalam riset ini adalah metode eksperimental Rancangan Acak Lengkap langkap (RAL), yang terdiri dari lima perlakuan dan tiga ulangan. Perlakuan yang digunakan adalah (A) tanpa penggunaan tepung maggot (kontrol), (B) substitusi tepung magot 15%, (C) substitusi tepung maggot 30%, (D) substitusi tepung magot 45%, (E) substitusi tepung maggot 60%, yang dipelihara selama 50 hari. Ikan uji yang digunakan merupakan ikan gabus dengan ukuran panjang 9-10 cm dan bobot 7-9 g. Wadah yang digunakan merupakan akuarium dengan ukuran 40x26x28 cm3 atau volume air sebesar 15 liter yang dimana ikan gabus ditempatkan sebanyak 5 buah setiap akuarium. Jumah pakan yang diberikan sebanyak 5% dari biomassa ikan. Hasil yang didapatkan selama penelitian menunjukan bahwa perlakuan E dengan substitusi tepung ikan oleh tepung maggot sebesar 60% pakan menghasilkan pertumbuhan panjang mutlak tertinggi sebesar 4,0 cm, laju pertumbuhan spesifik tertinggi sebesar 2,54%, dan kelangsungan hidup sebesar 87%.

Kata kunci: Ikan Gabus, Laju Pertumbuhan Spesifik, Maggot

1. Introduction

An important component in fish farming is feed. The growth and survival of fish are determined by the feed provided. On the other hand, feed is also the most significant component (60-70%) of aquaculture production costs (Santoso & Agusmansyah, 2011). The BPS (2010) data shows Indonesia imported 65,601 tons of fishmeal in 2009. The high amount of imported fishmeal, which causes the price of the flour to become increasingly expensive, creates an obstacle to the development of fisheries businesses. Snakehead fish or *Channa striata* (striped snakehead, chevron snakehead) is a source of protein and has high economic value in several countries, especially in Southeast Asia. Snakehead fish has functional biomedical benefits, such as anti-inflammatory, antimicrobial, anti-pain nociception, and anticancer properties (Hue et al., 2017).

Maggot (*Hermetia illucens*) cannot be utilized optimally as a fish feed ingredient due to the anti-nutrient chitin on the outside of its body (Marganov, 2003). Chitin is the most abundant natural polymer in the world after cellulose, found in exoskeletons (outer frames) in crustacean animals, insects, fungi, and molluscs (Kusumaningsih et al., 2004). The presence of chitin in nature is generally bound to proteins, minerals, and various pigments (Hirano, 1986). This situation makes chitin difficult for fish to digest because fish do not have chitinase, an enzyme that can digest chitin. According to Knorr (1984), maggots have a chitin content of 33.7%. An important component in fish farming is feed. The growth and survival of fish are determined by the feed provided. On the other hand, feed is also the most significant component (60-70%) of the production costs of fish farming (Santoso & Agusmansyah, 2011).

Utilizing new protein sources to substitute fish meals can be a solution to overcome the high cost of fish meals and the slow growth of snakehead fish themselves. Maggots or larvae of the black soldier fly (*H. illicens*) are an alternative food source that meets the requirements as a protein source. Feed sources that contain more than 19% crude protein are classified as protein-source feed ingredients (Nangoy et al., 2017). Maggot contains 41-42% crude protein, 14-15% ash, 4.8-5.1% calcium, and 0.6-0.63% phosphorus in dry form (Fauzi & Sari, 2018). Also, magot contains amino acids and minerals, such as glycine and lysine in maggot, which are around 3.80% and 10.65%, respectively (Newton et al., 2005).

Substituting fish meals with maggot meals to snakehead fish up to 20% of the feed produces the highest survival, growth rate, SGR, and FCR compared to fish meal substitution (Wahono, 2016). Solving the problem in feed can be done by substituting high levels of magot flour while accelerating the growth of snakehead fish.

2. Material and Method

2.1. Time and Place

This research was conducted in Building IV FPIK UNPAD Education Laboratory, Jatinangor, Sumedang Regency. This research will be carried out in October - December 2023, with a total fish acclimatization time of 10 days and fish rearing for 50 days.

2.2. Methods

This research method uses a completely randomized design (CRD), the simplest experimental design type. CRD is usually used for experiments with a uniform or homogeneous experimental medium or environment (Mattjik & Sumertajaya, 2000). The treatments used in this research were as follows:

Treatment A: 0% maggot flour substitution (Control)
Treatment B: 15% maggot flour substitution
Treatment C: 30% maggot flour substitution
Treatment D: 45% Maggot flour substitution
Treatment E: 60% maggot flour substitution

2.3. Materials and Tools

The tools used in this research include 1) Tray or container for mixing feed ingredients, 2) Pelleting tool to mould feed ingredients into pellets, 3) Oven to dry the moulded pellets, 4) A baking sheet for the base during the drying process under the sun, 5) Jar for storing dry pellets, 6) Aquarium for keeping snakehead fish, 7) Cover the aquarium to keep the fish from leaving the aquarium, 8) Hose for the cleaning process during the maintenance process, 9) Net to pick up and move fish during the rearing process, 10) Plastic clip for pellet storage, and 11) Silica gel to keep the pellets moist in the jar.

The materials used in this research include 1) Snakehead fish (*C.striata*) measuring 9-10 cm, weighing 7-9 g per fish, with a density of 5 fish per aquarium, 2) maggot flour, 3) fish flour, 4) tapioca flour, 5) corn flour, 6) soy flour, 7) bran, 8) premix, and 9) water.

2.4. Procedures

2.4.1. Preparation of Maintenance Containers

The container used when keeping snakehead fish is an aquarium with a volume of 15 L, consisting of 15 pieces. Before use, the container is cleaned using unides aqua (Chloramin-T) to avoid microorganisms. After cleaning, the aquarium is covered with plastic to reduce stress levels and light entering the aquarium.

2.4.2. Preparation for Making Test Feed

The test feed was made with the main ingredients of fish and maggot meals. According to the formulation made using a person square, the fish and maggot meal selection was based on a protein content of 40%. Next, feed preparation is carried out: Pellets made from ingredients such as maggot flour, fish meal, corn flour, soy flour, bran, progol, premix, and water. 2) Prepare pellets from ingredients such as magot flour, fish meal, corn flour, soy flour, bran, progol, premix, and water. 3) Add all the ingredients in the form of flour and stir until homogeneous. 4) When all the ingredients are evenly mixed, add water until the dough becomes smooth. 5) Insert the feed mixture into the pelleting machine and place the printed mixture on a baking sheet. 6) Dry the feed using an oven at 80° for two days. 7) Reduce the pellet size by breaking it until it reaches the size of the snakehead fish's mouth opening, and 8) Store in a jar and add silica gel to maintain humidity.

2.4.3. Fish Maintenance and Sampling

Samples such as length growth, weight growth, and water quality are taken every ten days to determine the amount of feed given. Feeding was carried out twice a day from 08.00 to 16.00 with a feed rate of 5% adjusted to the biomass weight of the research fish for each treatment.

2.5. Parameters Measured

2.5.1. Absolute Length Growth

Absolute length growth can be calculated using the formula according to Hidayat & Sasanti (2013):

$$\Delta L = Lt - L0$$

Information:

ΔL = Absolute length growth (cm)
Lt = length of fish at the end of rearing (cm)
L0 = Initial length of fish rearing (cm)

2.5.2. Specific Growth Rate (SGR)

Specific growth rate can be calculated using the formula according to Mulqan et al. (2017):

$$SGR = \frac{\mathrm{Ln(Wt)} - \mathrm{Ln(W0)}}{t} \ x \ 100\%$$

Information:

SGR = Daily growth rate (%)
Wt = Average weight of fish at the end of rearing (fish)
W0 = Average weight of fish at the start of rearing (fish)
t = length of maintenance time (days)

2.5.3. Survival Rate (SR)

Survival can be calculated using the formula according to Effendie (1997):

$$SR = \frac{Nt}{No} \ x \ 100\%$$

Information :

SR = Survival rate (%)
Nt = Number of fish alive at the end of rearing
N*o* = Number of fish at the start of rearing

2.6. Data Analysis

Data from length, weight, specific growth rate, FCR, and survival calculations were analyzed using Analysis of Variance (ANOVA) with a confidence level of 95%. Duncan's multiple range test was carried out to determine if there were significant differences. Air quality data on temperature, pH, and DO were analyzed descriptively.

3. Result and Discussion

3.1 Absolute Length Growth

At the end of the study, the absolute length of snakehead fish-fed maggot and those fed fishmeal that were reared for 50 days resulted in a growth of 2.73-4 cm, as shown in Figure 1.

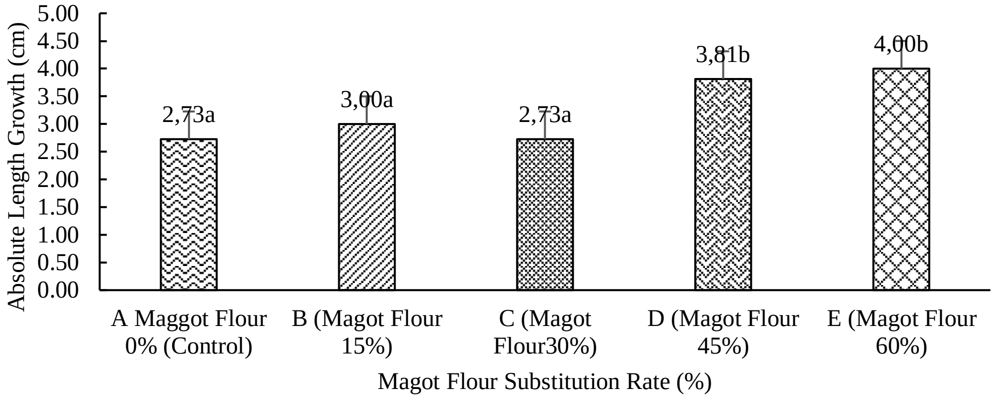

Figure 1. Absolute length growth

Based on Figure 1, observations show that the magot flour substitution treatment can potentially increase the absolute growth of snakehead fish. The highest absolute length growth ($p<0.05$) was obtained in treatment E with 60% maggot flour substituted in the feed, which resulted in a length growth of 4 cm. Meanwhile, treatment D was the most effective treatment because it did not show a significant difference ($p>0.05$) with treatment E, which means that by substituting 45% of maggot flour, the feed was able to produce absolute length growth (3.81 cm) which results were the same as treatment E.

Substitution of magot flour in treatments D (45%) and E (60%) as feed for snakehead fish that are reared has a good effect on the absolute growth rate of the fish. The results of research using the substitution of maggot flour produced absolute length growth of 2.73-4 cm, which gave higher results than those carried out by Fitriani et al. (2023), which produced absolute length growth of snakehead fish of 1.97 - 3.06 cm, which were kept for 60 days, with a combination of 25% pellet feed and 75% maggot of 3.06 cm.

Based on absolute length growth calculations, it is known that treatment E with 60% maggot flour substitution of feed is the highest result. Maggot flour has complete nutritional content with adequate protein and mineral content as a quality protein source. This follows the statement by Hartami et al. (2015) that maggot (*H.illucens*) has relatively high protein, namely 42.1%. This is in line with the statement by Hardianti & Widodo (2016) that snakehead fish are carnivorous fish, which require higher protein than herbivorous fish. Maggots contain complete protein, such as amino acids and minerals, especially maggot larvae. Maggot larvae are an ideal raw material that can be used as feed. At the larval to fry stage, snakehead fish require 43% higher protein than 30-day-old snakehead fish, requiring 36% protein in feed (Webster & Lim, 2002). Apart from that, the aquatic environment also dramatically influences the protein needed by fish. This maggot's essential amino acid content is complete; it has ten essential amino acids.

3.2. Specific Growth Rates

At the end of the study, the specific growth rate of snakehead fish-fed maggots and fish meals kept for 50 days resulted in growth between 2.49-2.64%, as shown in the graph in Figure 2.

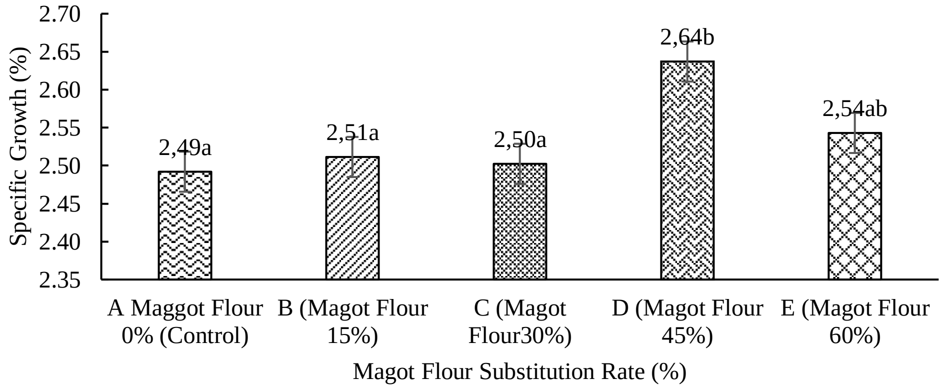

Figure 2. Specific growth rate

Based on Figure 2, observations show that the magot meal substitution treatment can potentially increase the specific growth rate of snakehead fish. The highest specific growth rate ($p<0.05$) was obtained in treatment D with 45% maggot meal substitution, which resulted in a specific growth of 2.64%. Meanwhile, treatment E did not show a significant difference ($p> 0.05$) from treatment D, which means that by substituting 45% of maggot flour, the feed was able to produce a specific growth rate (2.64%), whose results were the same as treatment E.

Substitution of maggot flour in treatments D (45%) and E (60%) as feed for maintained snakehead fish has a good effect on the specific growth rate of the fish. The results of this research were higher than those conducted by Wahono (2016), with the highest specific growth rate when substituting a fish meal with maggot flour at 20% and the highest yield of 1.67%.

Based on specific growth rate calculations, it is known that treatment D with 45% maggot flour substitution of feed has the highest results. Maggot flour has a high protein content and adequate amino acids and minerals, such as glycine and lysine. Glycine and lysine in magot are around 3.80% and 10.65% respectively (Newton et al., 2005). Lysine plays a role in forming carnitine, which functions as a growth promoter, protects against ammonia toxicity, and increases the body's defence against extreme temperature changes (Harpaz, 2005). The lysine content in feed can increase protein synthesis in the fish's body so that the protein content in fish meat will increase and influence the growth and survival processes of fish (Amin et al., 2017). Lysine also functions as a primary ingredient for blood antibodies, strengthens the circulatory system, and maintains average cell growth.

3.3. Survival Rate

At the end of the study, the survival of snakehead fish fed magot and those fed fishmeal that were reared for 50 days produced results that were not significantly different between treatments, as shown in Figure 3

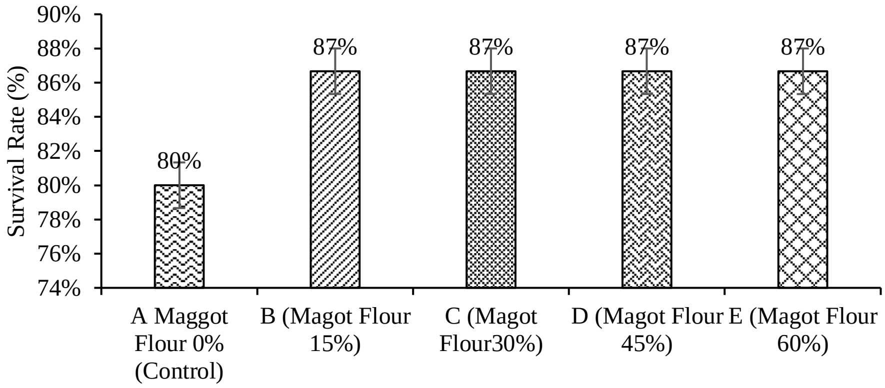

Figure 3. Survival rate

The survival rate of snakehead fish fed fish meal and maggot meal was not significantly different ($p>0.05$), with a survival rate of between 80–87%. Based on the statement by Andriyan et al. (2018), the value of a reasonable survival rate ranges from 73.5-86.0%, and the optimum survival rate for research snakehead fish is above 80%.

Fish survival is influenced by two influencing factors: internal and external. Internal factors originate from individual fish, while external factors are influenced from outside, such as feed quality, water quality, and the environment (Rozi et al., 2019). Apart from these factors, snakehead fish are a group of fish with a breathing organ, a labyrinth, located at the top of the gills, which breathe air from the atmosphere (Muslim & Syaifudin, 2012). Snakehead fish can also breathe directly from the air and have a high survival rate, which is a commercial advantage in transporting snakehead fish alive (Listyanto & Adriyanto, 2009).

The role of amino acids such as lysine also influences the survival of snakehead fish. According to Sundari et al. (2013), lysine is an amino acid beneficial for the body because it is essential for blood antibodies, can strengthen the blood circulation system, and maintains normal cell growth. Proline and vitamin C will form collagen tissue and can reduce excessive blood triglyceride levels. Lysine is an essential amino acid for growth and tissue repair in fish (Nur, 2011).

4. Conclusions

Based on the research results, substituting fish meal with maggot meal increased snakehead fish's absolute length growth and specific growth rate. Substitution by magot flour up to 60% resulted in absolute length growth and the highest specific growth rate, namely 4 cm and 2.54%, respectively, followed by 45% substitution, resulting in length growth of 3.81 cm and a specific growth rate of 2.64%. Fishmeal substitution of 0-60% results in survival rates ranging from 80-87%. Substituting fish meal with maggot meal at 45-60% is an adequate substitute for fish meal in snakehead fish feed formulations.

5. Suggestion

This research suggests that further research is needed to see the optimum limit for using magot flour, which can produce maximum growth, with other test parameters to see its helpful value in health.

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