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Assessing the Growth Potential of *Clarias* sp. (Catfish) on a Hybrid Diet of Pellets and Fresh *Hermetia illucens* Maggot Inputs.

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ABSTRACT

In light of the progressive expansion of catfish aquaculture in Indonesia, there has been an observed surge in demand for high-caliber fish feed. This demand, however, is challenged by the escalated prices of commercial feeds due to the dependency on imported commodities, consequently threatening the viability of the catfish industry. This trend accentuates the critical need for innovative, indigenous, and nutrient-rich feed alternatives. The larvae of the Black Soldier Fly (BSF), endowed with their substantial protein content, stand out as a potential substitute. This study was instituted to investigate the influence of integrating varying proportions of BSF larvae with conventional pellet feed on catfish growth parameters. Conducted from May to August 2022, using a comprehensive randomized design (CRD), five distinct feed formulations were evaluated: P1 (100% pellets), P2 (75% pellets, 25% larvae), P3 (50% pellets, 50% larvae), P4 (25% pellets, 75% larvae), and P5 (100% larvae). Each treatment was replicated thrice, and tested on catfish groups maintained at a density of 15 fish per 15-liter container over 30 days. The data revealed that the 50% BSF larvae and 50% pellet mixture (P3) outperformed other treatments, registering an absolute daily growth rate of 19.67 g, relative growth of 2.25%, and a feed conversion ratio of 1.52. These empirical findings underscore the efficacy of BSF larvae as a viable feed component and highlight the strategic importance of formulating balanced feed mixtures for optimizing catfish growth.

INTRODUCTION

There is an increase in the fishing sector in Indonesia, with catfish being one of the leading fisheries. Its production has contributed 10% to the national aquaculture, with a growth rate of 17%–18% **(Suraya *et al.*, 2016)**. This upsurge in aquaculture production directly impacts the demand for catfish feed. Some of the raw materials for fish feed currently come from imported commodities. The need for animal protein in the feed is the reason for its importation by the government to date, resulting in the high price of its raw materials in the market. Therefore, the production cost is increased, which can lead to a downturn in catfish farming.

Black Soldier Fly (BSF) maggot (larvae) can be used as an alternative raw material to replace artificial feed. A fish feed should contain balanced protein, fat, carbohydrates, vitamins, and minerals. Maggot has a fairly high protein content of 41-42%, making it a very good alternative to the growth of tilapia and catfish **(Fahmi, 2015)**.

Maggot is provided as an alternative feed through its cultivation and has the additional benefit of reducing organic waste. According to data, the production of waste in Tarakan City between February to July 2021 has reached an average of 130 tons per day **(Muin, 2021)**. The composition of urban solid waste is approximately 57% of organic waste. As a result, Tarakan City generates ± 74 tons per day of organic waste, mainly from traditional markets. It can be deduced that selecting maggot as a catfish feed provides many environmental advantages. Therefore, this research examines the effectiveness of using maggot combined with commercial pellet feed in catfish cultivation. It is expected to inform fish farmers about alternative catfish seed feeds.

MATERIALS AND METHODS

2.1. Time and Place of Research

The research was conducted at the Mini Hatchery Laboratory from May to August. The water quality was measured at the Laboratory of Borneo Tarakan University.

2.2. Tools and materials

The research tools include tarpaulin pools, hoses, scales, test bottles, UV-Vis spectrophotometers, millimeter books, thermometers, pH meters, Dissolve Oxygen Meter (DO), slides, and black waring. While, the materials are catfish seeds, F999 pellet feed, organic waste, distilled water, and tissue.

2.3. Research procedure

2.3.1. Maggot Cultivation

Maggot cultivation in this study involves utilizing wild Black Soldier Fly (BSF) breeders indigenous to Tarakan City, with bran fermentation media technique employed to facilitate their breeding. The eggs yielded from this process are subsequently incubated to promote population growth. The substrate chosen for the cultivation process in this study is meticulously limited to tomato waste, a resource readily available and abundant in the Tenguyun Market, a traditional marketplace in Tarakan City. This choice is strategic, as tomato waste offers a viable and sustainable option for maggot cultivation. Additionally, to enhance the nutrient diversity of the cultivation media and optimize the growth conditions for the maggots, a combination of leftover fritters from local street food vendors is incorporated into the substrate. This integration of different organic materials is anticipated to contribute positively to the maggot cultivation process, providing a balanced and nutrient-rich environment for the larvae to thrive. To ensure the optimal progress of maggot cultivation, rigorous control measures are implemented twice daily, particularly at 09:00 a.m. and 16:00 p.m. These particular times are chosen as they coincide with the introduction of fresh cultivation media to the system, ensuring that the maggots consistently have access to fresh and nutritious substrates. This meticulous attention to the cultivation conditions underscores the commitment to achieving successful maggot cultivation while simultaneously contributing to waste reduction efforts by utilizing readily available organic waste from the local community.

2.3.2. Catfish Cultivation Research Design

The catfish sample was 7-9 cm in size, and before testing, they were acclimatized for 7 days. The method applied was a completely randomized design (CRD) with 5 treatments and 3 replications. Furthermore, the tanks were filled with 15 liters of water with a capacity of 15 individuals per test tank. Maintenance is conducted for 30 days, and the total amount of feed administered daily in the morning and evening was 4% of fish biomass for each treatment. The research was divided into 5 treatments, namely:

1. Treatment 1 (P1) contains 100% commercial feed.
2. Treatment 2 (P2) consist of 25% Maggot + 75% commercial feed.
3. Treatment 3 (P3) combines 50% Maggot + 50% commercial feed.
4. Treatment 4 (P4) comprises of 75% Maggot + 25% commercial feed.
5. Treatment 5 (P5) with 100% Maggot.

The parameters measured for water quality were temperature, pH, DO, and ammonia. The data examined include absolute growth and relative and daily growth rates. Furthermore, the Food Conversion Ratio (FCR) is also calculated.

1. The following formula is used to calculate the absolute growth (Effendi, 2009);

$$\mathbf{WG = Wt - Wo}$$

Where,
WG = Weight Gain
Wt = weight of fish at the end of the study
Wo = weight of fish at the beginning of the study

2. Daily Growth (Li ***et al.,*** 2019)

$$\mathbf{SGR = (Ln\ Wt - Ln\ Wo) / t \times 100}$$

Where
SGR = daily growth
t = time

3. Relative Growth (Peniman ***et al.,***, 1986 in Mudeng 2007);

$$\mathbf{RGR = (Wt - Wo) / Wo \times 100}$$

Where

RGR = Relative growth rate

4. Food Conversion Ratio (FCR) (Hardy, 1989):

FCR = Amount of feed given / total weight of fish

2.4.Data analysis

Growth data and feed conversion ratio of catfish were analyzed using ANOVA. When the results show a significant difference, Duncan's Further Test is performed to examine the differences in effect between treatments.

RESULTS

The absolute growth of catfish is different for each treatment. The best result was obtained in treatment 3, followed by 5, and the lowest was in 4. The following is a graph of the absolute growth of catfish.

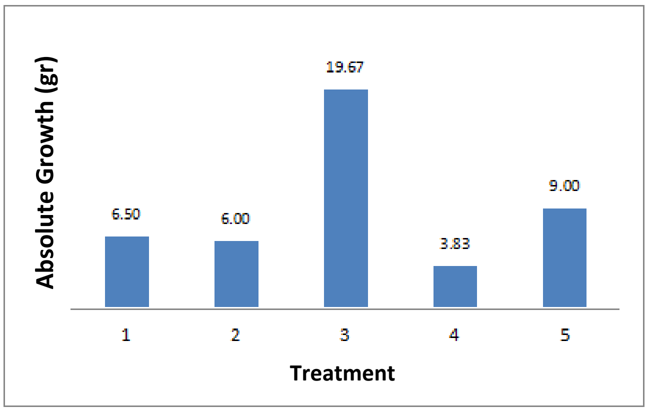

Figure 1. Absolute growth of catfish

The daily growth of catfish was different for each treatment. The best result was obtained in treatment 3, followed by 5, and the lowest was in 4. The following is a graph of the daily growth of catfish.

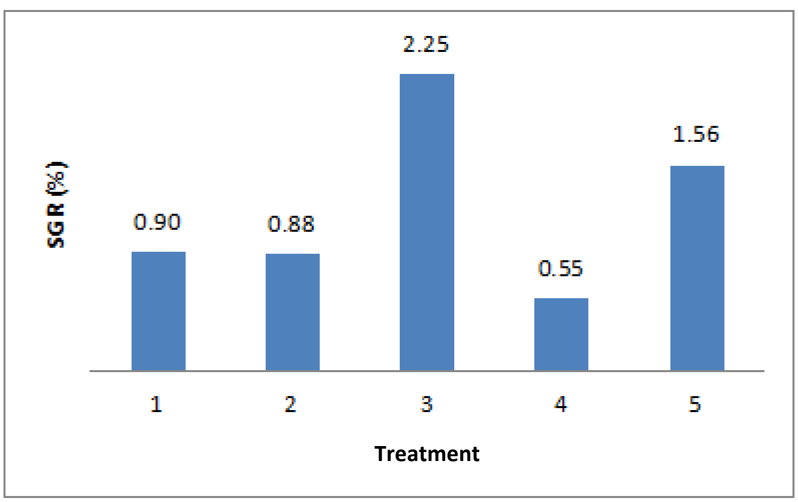

Figure 2. The daily growth rate of tilapia with different treatments

The relative growth of catfish was different for each treatment. The best result was obtained in treatment 3, followed by 5; the lowest was in 4. The following is a graph of the relative growth of catfish.

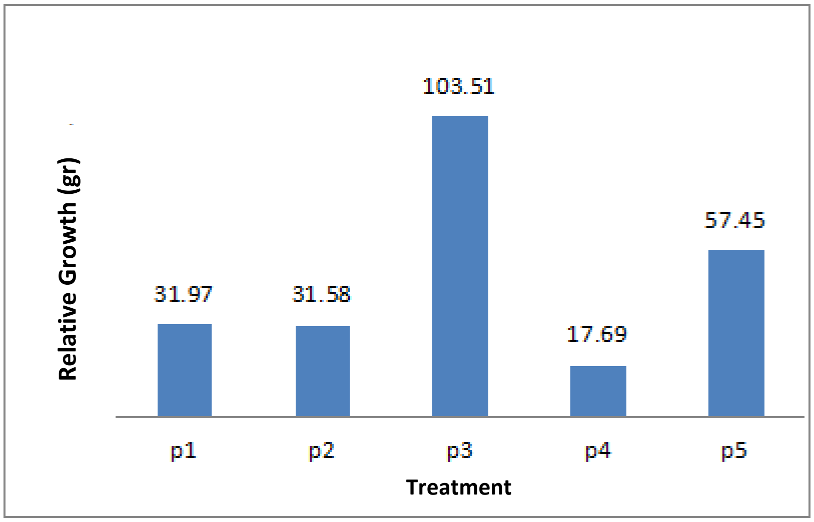

Figure 3. Relative growth of tilapia with different treatments

The results showed that the best food conversion ratio (FCR) was obtained in treatment 3, and the lowest was in 2.

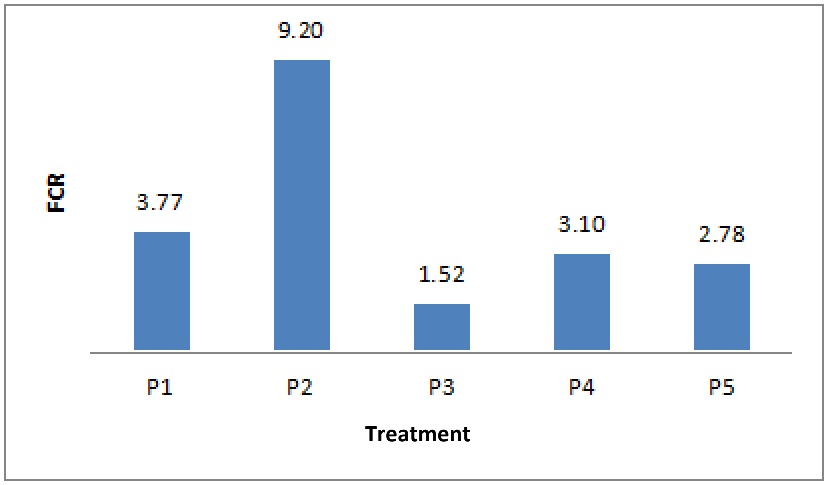

Figure 4. The feed conversion ratio for catfish with different treatments

Water quality is an important factor in aquaculture because it is one of the determinants of success. If the water quality is not suitable, fish growth will not be optimal and even cause mortality **(Effendi, 2009)**. Water quality measurements include several parameters, such as temperature, pH, and ammonia, presented in Table 1.

Table 1. Water quality measurements

treatment	Temperature(^{0}C)	pH	Ammonia (mg/L)	DO (mg/L)
P1	26-27	6,6	0.42	4,2
P2	26-27	7,4	0.12	4.0
P3	26,27	8.0	0.09	4,4
P4	26-28	7,8	0.13	4,7
P5	27-28	8.0	0.22	4,4
standard quality (Effendi, 2009)	25-32	6-8	<1	4-6

Based on the results of water quality observations on catfish temperature, pH, DO, and ammonia parameters are still within feasible limits for cultivation. Water temperature and pH will affect the growth rate, metabolic rate, fish appetite, and oxygen solubility in the water. Ammonia results from excess feed waste and metabolic secretions of fish **(Izzati 2011)**. So, the optimal water quality during maintenance is found in the P3 treatment because ammonia in this treatment is smaller due to the lack of residual feed in the maintenance media.

DISCUSSION

The growth of catfish (*Clarias* sp.) can be seen through the variables observed during the study, including absolute growth, daily growth, relative growth, and food conversion ratio. Based on the research results, substituting commercial pellets with maggot flour significantly affects ($p < 0.05$) optimal growth, daily growth, relative growth, and feed conversion ratio.

The maggot cultivation process began by summoning the parent of the black soldier fly (BSF). This is accomplished by using EM4 to attract it to the provided media for breeding. Subsequently, cultivation materials such as organic waste from the Tenguyun Market are prepared. The growing media should contain sufficient nutrients, which are one of the factors that significantly influence the biochemical composition of natural feed. They greatly affect the productivity value of the quality of the maggot produced. In this study, the nutrients provided were contained in the cultivation media, consisting of the bran and organic waste from the Tenguyun Market in the form of rotten tomatoes, cabbage, vegetables, and mixed fried foods. According to the observation of hatching maggot eggs for ± three days, the female BSF flies lay their eggs on the bran substrate. This follows Fahmi's statement **(2015)**, which stated that the eggs of black soldier fly hatch after 3–6 days. The female species, when laying, ensures that the environment is close to adequate food sources.

Additionally, according to **Fahmi *et al.*, (2009)**, maggot larvae are elliptical in shape, light yellow, and black on the head. The yellowish-white color during the larval phase lasts for approximately 12 days, after which it turns brown and darker The yellowish-white color during the larval phase lasts approximately 12 days, and then it turns brown and darker. The following is a picture of the maggot cultivation development cycle that has been performed.

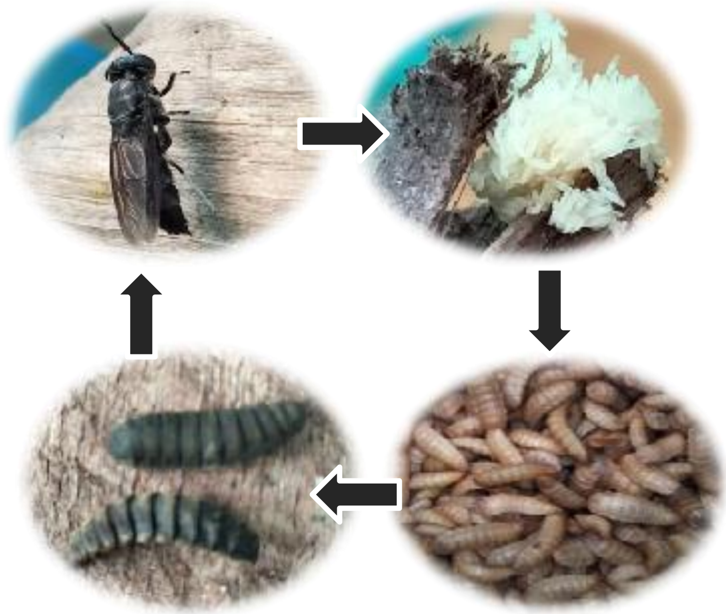

Figure 5. The life cycle of the black soldier fly (BSF)

Figure 1 shows that the absolute growth of treatment 3 with 50% pellet + 50% maggot feed was the best. The analysis of variance indicated a p-value <0.05, indicating that each treatment differed significantly. According to Duncan's advanced test (DMRT), P3 significantly differed from P1, P2, P4, and P5. This follows Murni's research (2013), which stated that using a combination of pellet and maggot feed significantly affects the growth of the test biota because of the high protein content in maggot. At P3 during the rearing period, there was no leftover feed based on observations of the amount provided; hence, the fish responded well. The treatment has a balanced dose and synergy between pellets and maggot, providing the best growth. This is different from others where there are no balanced feed doses, as fish growth requires an equilibrium intake of nutrients. Additionally, P5 does not provide maximum growth, presumably because the feed is not all eaten by the fish, giving room for leftovers in the rearing medium **(Subaima *et al.*, 2010)**.

According to Figure 2, the daily growth of P3 with 50% pellet + 50% maggot feed was the best. The analysis of variance showed a p-value <0.05, implying that each treatment was significantly different. Based on Duncan's advanced test (DMRT) results, P3 significantly differed from P1, P2, P4, and P5. A nutritional balance from the dose of P3 feed resulting from the combination of maggot, which has a higher essential amino acid content than pellet, results in better daily growth than other treatments **(Hariadi *et al.*, 2014**). According to Ediwarman (1990), feed from two or more protein sources will provide better growth because it will be rich in amino acids. Balanced and complete essential amino acids in the feed affect protein speed, resulting in an enlarged cell volume and rapid cell division, thereby increasing the growth rate **(Suhenda *et al.*, 2015)**.

At P3, the amount of a combination of pellet and maggot has a balanced dose, providing the best growth. The higher content of maggot in feed leads to non-optimal growth due to chitin content, a substance in shell skin that is difficult to digest. So, 100% of maggot in the feed could be more optimal. According to Huda **(2012)**, although maggot has high nutrition, the drawback of the utilization of maggot in feed substitution is the chitin substance, so it can only be used in limited quantities. The chitin in maggots causes more energy for digestion, so nutrients for fish growth are not optimal.

The feed conversion ratio is the amount of feed converted into 1 kg of meat **(Yulfiperius, 2011)**. The results of this study indicate that in several treatments, the fish did not utilize the feed given; hence, there was a leftover. The amount of feed given is directly proportional to the quantity fish cannot consume, causing an increase in the conversion value. Meanwhile, it affects feed conversion through increased fish weight **(Kordi & Andi, 2009)**.

In this study, the combined fish feed was a pellet ingredient combined with natural maggot feed. From an economic point of view, reducing pellets by up to 50% can increase profits because the substitute material is cheap and easy to obtain. The maggot to be used should be self-produced because it currently has a very high price value in the market. This can increase profits and become an alternative feed to reduce the use of pellets. FCR data shows that the maggot natural feed additive affects fish growth. This occurs because the protein content in each treatment at various doses differs.

The results from the observation of water quality in catfish based on the parameters of temperature, pH, DO, and ammonia are still within the feasibility limits. Water temperature and pH will affect the growth rate, metabolic rate, appetite of fish, and solubility of oxygen in the water. Ammonia comes from excess feed residue and fish metabolic secretions **(Izzati, 2011)**. Furthermore, optimal water quality during maintenance is found in P3, as ammonia at this treatment was smaller due to the minimal remaining feed on the rearing medium.

CONCLUSION

According to the study results, it can be concluded that maggot feed with a combination of pellets significantly affects the growth performance of catfish. The best treatment for growth and feeds conversion ratio is P3 with a dose of 50% maggot + 50% pellets.

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