Dietary combination of maggot and commercial feed enhance the growth rate and feed conversion ratio of snakehead fish (Channa striata)

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Abstract. Snakehead fish (Channa striata) is a carnivorous freshwater fish commodity that has high economic value. However, this cultivation takes a long period due to its poor growth rate. Maggot has been proposed as a possible alternative to fish feed because it is less expensive and has nutritional value. This study aimed to determine the effect of the dietary combination of maggot and pellets on the growth rate and feed conversion ratio of snakehead fish. This study used a completely randomized design (CRD) with five treatments and four replications. The treatments were P0: 100% pellet, P1: 100% maggot, P2: 75% pellets and 25% maggot, P3: 50% pellets and 50% maggot, P4: 25% pellets and 75% maggot. The result showed a combination of pellet feed and maggot feed had a significant improvement (p<0.05) on the growth rate of snakehead fish. However, there were no significant differences in the feed conversion ratio (p>0.05). The treatment of 75% pellet feed and 25% maggot feed (P2) generated the highest growth rate of 0.154 g/day and the lowest feed conversion ratio of 3.121. It can be concluded that the combination of maggot and pellet experienced better growth performance and feed conversion ratio of snakehead fish.

1. Introduction
Snakehead fish (Channa striata) is a freshwater fish species that belongs to the Channidae family. It has high economic value due to its beneficial effect on human health. It is regarded as an aggressive predator preferring shallow, slow-moving waters with good dissolved oxygen levels and low turbidity. Snakehead fish is commonly used in medicine as a therapeutic agent to accelerate wound healing, recover from surgery, and provide energy for the sick [1]. According to Vahira et al. [2], snakehead fish has a relatively slow growth rate compared to other consumption fish such as catfish and tilapia. It requires more than 13 months to reach market size. The slow growth of this fish can be created by various factors, including inadequate protein in feed. Previous studies claimed that snakehead fish requires about 50% protein to reach the optimum growth [3,4]. Meanwhile, a formulated diet with a high protein content generally has an expensive cost that influences the increasing cost of feed. Therefore, it needs to explore the alternative raw material that can replace high protein feed at an affordable price.

Black soldier fly larvae or maggots have been documented as an alternative protein source to fish meals [5–7]. In addition, the maggot is easily obtained by bioconversion using substrates from various...
media such as chunks of poultry or livestock manure, piles of palm kernel cake waste, and other organic wastes [8]. Maggot contains high protein 40-45%, fat 30-35%, ash 11-15%, 4.8-5.1% calcium, and minerals on a dry-matter basis [9]. This content depends on the stage and quality of the substrate on which it grows [10]. Based on the nutritional value of maggot, it would be a suitable feed for increasing the growth of snakehead fish. The use of maggots as a live feed in combination with pellets is considered to become a solution to the high production cost of feed in snakehead fish cultivation. Hence, this present study purposed to determine the effect of dietary maggots and pellets on improving the growth rate and feed conversion ratio of snakehead fish.

2. Materials and methods

2.1. Time and location
This study was carried out in February-April 2021 at Laboratory of Banyuwangi Campus, Universitas Airlangga.

2.2. Materials
Snakehead fish seeds were purchased from fish farmer in Kediri, Indonesia. Black soldier fly larvae (maggot) were obtained from Banyuwangi Waste Bank (BSB) and commercial pellet with a protein content of 31-33% (Hi-Pro-Vite 781-1, CP Pertiwi, Indonesia) as a basal diet.

2.3. Fish acclimatization
About 200 of snakehead fish seeds were acclimatized in the tank for 7 days with a stocking density of 1 fish/2.8 liter. During the acclimatization period, fish were fed with a combination of pellet and maggot two times a day with ad satiation method. Prior to the feeding trial, fish were starved for 24 hours.

2.4. Experimental design
This study used a completely randomized design (CRD) with five treatments and four replications. A total of 200 fish with an average weight of 8.79 ± 0.07 g were randomly located into 20 aerated tanks in a capacity of 30 L. The treatments were P0: 100% pellet, P1: 100% maggot, P2: 75% pellets and 25% maggot, P3: 50% pellets and 50% maggot, P4: 25% pellets and 75% maggot. Feeding trial were conducted two times a day for 42 days as much as 4% of body weight. Fresh maggots were administered immediately after receiving the pellets [11]. During the experimental period, water quality parameters were monitored every day and maintained at acceptable levels: water temperature 26-32°, pH 6-8, dissolved oxygen 5-7 ppm, and ammonia-nitrogen 0.25-1.5 ppm. Siphoning was carried out once a day to control the water quality.

2.5. The growth rate and feed conversion ratio
Fish body weight was measured at intervals seven days during the experiment. Meanwhile, the quantity of feed consumed was noted daily to calculate the food conversion ratio (FCR). The number of survived fish monitored daily. The growth rate, food conversion ratio (FCR), and survival rate of fish calculated as the following formula [12]

\[
GR = \frac{W_t - W_o}{t} \tag{1}
\]

\[
FCR = \frac{\text{Feed intake}}{W_G} \tag{2}
\]

\[
SR = \frac{\text{final number of fish}}{\text{initial number of fish}} \times 100 \tag{3}
\]

Where, Wt is final weight (g), Wo is initial weight (g), t is feeding treatment period (days).
2.6. Statistical Analysis

Data of growth rate, feed conversion ratio and survival rate were statistically analyzed using a one-way ANOVA using SPSS version 13. When the differences were significant, the Duncan’s multiple range test was used to compare the mean of treatments. Significance level in all test was P<0.05.

3. Results and discussion

Dietary combination of pellet and maggot gave a significant difference (P<0.05) on the growth rate of snakehead fish. However, there was no significant different on food conversion ratio and survival rate (P>0.05). The growth rate, food conversion ratio and survival rate of snakehead fish in each treatment were displayed in table 1.

Table 1. The growth rate, food conversion ratio, and survival rate of snakehead fish with different feeding treatment for 42 days

| Treatments                     | Growth rate (g/day) ± SD | FCR ± SD       | Survival Rate (%) ± SD |
|--------------------------------|--------------------------|----------------|------------------------|
| P0 (100% pellet)               | 0.131 ± 0.003            | 3.468 ± 0.089  | 72.5 ± 12.6            |
| P1 (100% maggot)               | 0.145 ± 0.003            | 4.084 ± 1.664  | 70.0 ± 8.2             |
| P2 (75% pellet and 25% maggot) | 0.154 ± 0.004            | 3.121 ± 0.031  | 77.5 ± 5.0             |
| P3 (50% pellet and 50% maggot) | 0.138 ± 0.003            | 3.397 ± 0.048  | 72.5 ± 5.0             |
| P4 (25% pellet and 75% maggot) | 0.150 ± 0.004            | 3.184 ± 0.117  | 80.0 ± 8.2             |

Different superscript letters in the same column indicate significantly different result (P<0.05)

In this study, fish fed with pellets has the lowest growth rate compared to other treatments. During the feeding trial, the fish response on pellets and maggots as the feed was different. Fish are more aggressive when maggot as a live feed has given. This result is similar to the reported study by Roy et al. [13] that snakehead fish prefer eating live food to pellets because the movement of live feed can trigger the feeding response and satisfy the predator instinct. Consequently, a higher growth rate can be achieved by using live feed. The result showed that the administration of a dietary combination of pellet and maggot produced a higher growth rate than the group that received pellets and maggots individually. The combination of pellet and fresh maggot are considered to be a perfect combination to reach a better growth performance. This is perhaps due to the combination provided complete nutrition to support the growth of snakehead fish than a single feed [14]. Maggot has been reported as an alternative to fish feed due to its rich nutritional value. Maggot contained about 40-45% protein which provides high availability of essential amino acids that complements the nutrition of pellets. Moreover, maggot also produced hydrolytic enzymes, such as amylase, lipase, and protease, that improved nutrient digestibility [15].

The result showed the best growth rate (0.154 ± 0.004 g/day) was generated by the combination of 75% pellet feed and 25% maggot (P2). However, the increasing amount of maggot in combination feed resulted in the decreasing of fish growth rate significantly. According to Rana et al. [9], the decline of growth rate could be affected by the chitin content in maggot. Chitin is a biopolymer from the polysaccharide group that is found in crustaceans, insects, fungi, and bacteria for protecting and supporting functions [16]. Soetemans et al. [17] reported that chitin content in maggots ranged between 8-24%. The presence of chitin in feed influences nutrient digestibility and absorption because it is a non-digestible fiber that has negative impact on protein and lipid digestion.

Based on the result, there was no significant difference (P>0.05) in the food conversion ratio of snakehead fish feed. The FCR value in this study ranged from 3.12 to 4.08. The lower FCR value indicates the higher feed utilization. The best FCR obtained from P2 treatment with a value of 3.12, which means it takes 3.12 kg of feed to produce 1 kg of meat during the maintenance. Meanwhile, the
highest FCR value (4.084 ± 1.664) was obtained from fish fed with 100% maggot. The high feed conversion ratio can be caused by the feed given cannot be digested efficiently by snakehead fish. Wijayanti et al. [18] stated that a high feed conversion value indicates the food was not properly digested. This reason can be related to the chitin content in maggot that is difficult to digest while fish does not have the chitinase enzyme in their digestive system [19].

This present study proved that maggot could become a potent alternative live feed for improving snakehead fish growth due to its nutritional value, especially its protein content. Moreover, combining fresh maggot and pellet in a diet could increase the growth rate better than individual administration. However, the chitin content in maggot should become a concern in its application for fish feed because it can be an anti-nutritional factors. Hence, an appropriate feeding level should be managed in fish culture to provide maximum growth while minimizing feed loss. Further study is needed to determine the suitable application of maggot in the fish diet, considering the presence of chitin would be an anti-nutritional compound for fish.

4. Conclusion
Based on the present study, it can be concluded that the combination of maggot and pellet experienced better growth performance and feed conversion ratio of snakehead fish with the level of 75% pellet and 25% maggot.

5. Reference
[1] Shafri M A M and Manan M J A (2012) Malays. J. Nutr. 18 125–36.
[2] Vahira A D, Riadin A H, Sarida M, Utomo D S C and Setiawan W A (2020) AAACL Bioflux 13 2928–36.
[3] Mohanty S S and Samantaray K (1996) Aquac. Nutr. 2 89–94.
[4] SS M, BK K, B S, SK P, MK T and K S (2017) J. Nutr. Food Sci. 07.
[5] Belghit I, Liland N S, Gjesdal P, Biancarosa I, Menchetti E, Li Y, Waagbø R, Krogdahl Å and Lock E J (2019) Aquaculture 503 609–19.
[6] Madibana M J, Mwanza M, Lewis B R, Fouché C H, Toefy R and Mlambo V (2020) Sustain. 12 1–11.
[7] Oteri M, Di Rosa A R, Lo Presti V, Giarratana F, Toscano G and Chiofalo B (2021) Sustain. 13 1–17.
[8] Wardhana A H (2016) War. Indones. Bull. Anim. Vet. Sci. 26 069–78.
[9] Rana K M S, Salam M A, Hashem S and Islam A (2015) Int. J. Res. Fish. Aquac. 5 41–7.
[10] Bosch G, Zhang S, Oonincx D G A B and Hendriks W H (2014) J. Nutr. Sci. 3 1–4.
[11] Saleh H H E (2020) J. Zool. Res. 02 15–22.
[12] El-feky M M M, M A E, Osman A G M, S M S, A M M and A M M (2017) Int. J. Biotechnol. Bioeng. 3 171–82.
[13] Roy P, Samanta Chandan C S, Roy N C and Islam I (2020) Egypt. J. Aquat. Res. 46 377–82.
[14] Murni (2013) Octopus J. Ilmu Perikan. 2 192–8.
[15] Kim W, Bae S, Park K, Lee S, Choi Y, Han S and Koh Y (2011) J. Asia. Pac. Entomol. 14 11–4.
[16] Antonov A, Ivanov G, Pastukhova N and Bovykina G (2019) IOP Conf. Ser. Earth Environ. Sci. 315 1–7.
[17] Soetemans L, Uyttebroek M and Bastiaens L (2020) Int. J. Biol. Macromol. 165 3206–14.
[18] Wijayanti R, Muarif M and Lesmana D (2019) J. Mina Sains 5 42–9.
[19] Harefa D, Adelina and Suharman I (2018) J. Online Mhs. Fak. Perikan. dan Ilmu Kelaut. 5 1–15

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