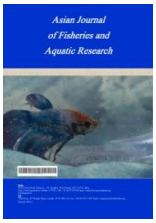

Asian Journal of Fisheries and Aquatic Research

11(4): 32-42, 2021; Article no.AJFAR.65803
ISSN: 2582-3760

The Effect of Difference Culture Media Maggot Black Soldier Fly *Hermetia illucens* (Linnaeus, 1758) (Diptera: Stratiomyidae) on the Growth of Striped Catfish Seeds *Pangasianodon hypophthalmus* (Sauvage, 1878) (Pangasiidae)

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Authors' contributions

This work was carried out in collaboration among all authors. Author KH designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors BSZ and YD managed the analyses of the study. Author IBBS managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2021/v11i430211
Editor(s):
(1) Dr. Rakpong Petkam, Khon Kaen University, Thailand.
Reviewers:
(1) Felipe Varussa De Oliveira Lima, Universidade Federal da Grande Dourados, Brazil.
(2) Katia Alcione Kopp, Federal University of Goiás, Brazil.
Complete Peer review History: http://www.sdiarticle4.com/review-history/65803

Original Research Article

Received 15 December 2020
Accepted 20 February 2021
Published 10 March 2021

ABSTRACT

The purpose of this study was to determine the type of maggot media that can produce the highest survival, growth, feed efficiency and lowest feed conversion ratio (FCR) to Striped catfish fingerling. This research was conducted during July 2020 – January 2021 at the Laboratory of Building 4, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran. The research method was carried out experimentally using the Completely Randomized Design (CRD) method and four treatments. The treatment given is a combination of commercial feed and maggot with different media consisting of A (50% commercial feed + maggot with 50% mixed media), B (50% commercial feed + maggot with 50% fruit media), C (50% commercial feed + maggot with 50% layer media) and D (50% commercial feed + maggot with 50% bran media). The parameters

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observed were survival, daily weight growth rate, length, feed efficiency, food conversion ratio and water quality. . Giving a combination of 50% commercial feed and cultured maggot with mixed media of 50% gave the best daily growth rate, length growth and feed efficiency results, namely 1.23%, 0.99% and 62.79% and the lowest feed conversion ratio value. that is 1.67.

Keywords: Black soldier fly maggot; growth; Pangasius hypophthalmus; striped catfish.

1. INTRODUCTION

Striped catfish farming in Indonesia is growing very rapidly. This is directly proportional to the increasing demand every year. To optimize production results, there are several factors that must be considered. Quality feed is a factor that greatly affects success in cultivation [1]. Striped catfish (*Pangasius hypophthalmus*) is one of the economically valuable freshwater consumption fish commodities. Striped catfish have fast growth, are easy to cultivate and can be maintained with low oxygen content [2].

Cultivators generally use factory-made feed to raise Striped catfish. Factory-made feed has calculated nutrients so that fish can grow quickly but the price is very expensive. Feed in cultivation activities, which is 80% of the total production costs [3]. Apart from factory-made feed, it is advisable to give natural feed on Striped catfish seeds. Natural feed is used to reduce production costs. The natural feed used must be easy to find and easy to cultivate. One of the natural food example that can be cultured is from the type of insect larvae, in the form of maggots [4-7]. The combination of commercial feed and maggot can accelerate the growth of fish both in length and weight [8-11].

Maggot larvae that come from flies that are included in the insect order Diptera. One of the maggots that has high nutrition is the black soldier fly (BSF) maggot. The protein content of BSF maggot ranges from 40-50% and fat content ranges from 29-32% [12]. M*aggot* It also has other advantages such as reducing organic waste, not carrying disease genes and a long life as a larva (± 4 weeks) [13].

Different maggot culture media affect the nutritional content of maggot. The difference in maggot media is expected to accelerate the growth of Striped catfish [14,15]. This is based on the nature of Striped catfish that like food in the form of meat or commonly called carnivores. Therefore, it is necessary to do research on the differences in maggot media to get the fastest growing Striped catfish seeds.

The protein content of black soldier fly (BSF) maggot protein size 10-15 mm is higher than the BSF maggot size 20-25 mm [16]. Adult BSF does not require food, but utilizes energy reserves from fat stored during the larval phase. Adult flies play a role only for the reproductive process. This makes BSF flies not classified as vectors of disease. Therefore, it is better if BSF maggots are harvested before they become adult flies so that the fat content is not reduced [17,18].

Research by Azir et al. [19] stated that differences in maggot black soldier fly (BSF) culture media affect the mass on maggot growth. Media fish waste, coconut dregs, bran, fruit and layer or chicken feed is the best medium for maggot growth compared to other media such as chicken manure, cow dung, coconut meal, vegetables and tofu dregs [20-23].

Different maggot culture media play a role in accumulating nutrient content in the maggot phase. The nutritional needs of Striped catfish for feed are also influenced by the phase of the fish. At the seed stage, the need for Striped catfish protein is 32-40% [24]. The protein energy ratio (DE / P) of feed for Striped catfish ranges from 7.4–12 kcal / g [25]. The fat content needed by Striped catfish seeds is 6% [26,27]. According to Sanjayasari et al. [28], the occurrence of protein sparing effect by carbohydrates and fats can balance the use of most metabolic activities and body maintenance does not only rely on protein, so that the protein contained in the feed can be used for growth Preliminary test results show that fruit, bran, and layer waste media are the best media for maggot growth compared to vegetables and tofu pulp. The results of the proximate BSF maggot test on different media showed the proportion of the nutritional content in the BSF maggot (Table 1).

Table 1. Percentage of BSF maggot nutritional content in different media

No	Sample name	Water %	Ash %	Protein %	Fiber %	Fat %	Energy kcal/kg	DE/P kcal/g
1	Maggot 10 Days Mixed Media	70,57	7,74	40,43	2,06	19,88	3916	7,1
2	Maggot 10 Days Fruit Media	78,13	9,27	37,95	2,27	18,29	3762	6,7
3	Maggot 10 Days Layer Media	71,43	11,95	38,09	1,07	18,04	3747	6,6
4	Maggot 10 Days Bran Media	66,67	9,07	39,01	1,42	18,92	3817	6,9

Source : *results of laboratory analysis of animal nutrition and food chemistry livestock, faculty of animal husbandry, universitas padjadjaran* (*2019*)

To meet the nutritional needs of the Striped catfish growth in the seed phase, a qualified feeding management is needed. The combination of artificial feed and maggot with a ratio of 50%: 50% in catfish gives the highest daily growth rate, length growth and feed efficiency results [29].

2. RESEARCH AND METHODS

2.1 Time and Place Research

This research was conducted from June 2020 to January 2021 at the laboratory of building 4, faculty of fisheries and marine sciences, Padjadjaran University, Indonesia.

2.2 Materials and Method

Research activities include preparation of tools and materials, maintenance and analysis of research results. The research was conducted at the Aquaculture Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

The research method was carried out experimentally by using an experimental design, namely a completely randomized design (CRD) consisting of four treatments and four replications for each treatment, which became the treatment in this study can be seen in Table 2.

2.3 Research Procedure

2.3.1 Maggot culture

The maggot culture activity begins with incubating the BSF prepupa obtained from the BSF Bandung community at a price of Rp. 80,000, **-** / kg. The prepupa is hatched in the cage, while the maggot and the media are spread into the fiber and maintained until it becomes a prepupa. The prepupa will hatch after 7-14 days and become adult flies. The survival of adult flies is very fast, namely 7-10 days and the entire life of adult flies is carried out only once to reproduce. Adult flies tend to lay eggs in a place close to food, so that the larvae that hatch will get food. Therefore, the BSF cage must be engineered by adding an attractant in the form of organic waste which has a strong odor and added a wood substrate on top so that later BSF will lay eggs on the wood.

The wood that has BSF eggs is transferred to a new maintenance container in the form of a box basin that has been added with soft organic waste. This is done to make it easier for the newly hatched BSF larvae to eat. The eggs will hatch after three days. The warmer the temperature, the eggs will hatch faster. Maggot larvae in the basin container are maintained for five days.

After five days the maggot larvae are moved into a larger container made of fiber. Maggot maintenance is carried out by adding different media every day according to treatment. Within five days maggot can be given to Striped catfish seeds. *Maggot* only 70**%** of the total available maggot is given for fish feed, the remaining 30**%** is maintained until it becomes a parent to get eggs again.

Apart from being obtained from cultivation, eggs can also be obtained from nature. Biopond is a place for BSF growth. The biopond used isin the form of plastic to facilitate the cleaning process. BSF brooders also exist in nature, therefore in the biopond, wood is placed as the BSF parent substrate for laying eggs because the media in the biopond functions as an attractant for BSF parents to lay eggs. The maggot culture process is carried out every three days so that maggot is always available for Striped catfish seeds.

Table 2. Treatment of the research

Treatment
A: 50% commercial feed + maggot with 50% mixed media
B: 50% commercial feed + maggot with 50% fruit media
C: 50% commercial feed + maggot with 50% layer media
D: 50% commercial feed + maggot with 50% bran media

Source: *primary data* (*2020*)

2.3.2 Container preparation stage

The preparatory stage begins with cleaning the aquarium as many as 16 aquariums and all the equipment to be used using clean water then the aquarium is sterilized using chlorine and given aeration. The aquarium used is 60 x 30 x 30 cm3 filled with a volume of 40 liters. There are 16 aquariums used. To maintain the temperature during the study, the fish rearing containers were given a heater and to maintain the dissolved oxygen content, the rearing containers were aerated. Aquarium that is used enough to accommodate 15 fish.*Preparation Stage of Striped Catfish Seeds.*

The seeds to be tested are 5-7 cm in size obtained from Subang Striped catfish cultivators. The sizes of Striped catfish fry were sampled using a sorting basin of 500 heads, 240 fish as test fish and 260 heads as stock. Before the Striped catfish seeds are stocked, acclimatization is carried out for three days first. The stocking density of Striped catfish for each aquarium is 1/2 liters.

2.3.3 Maintance stage

Striped catfish seeds will be maintained for 30 days and sampling will be carried out every ten days to measure the weight gain, length and determination of the amount of feed. Striped catfish seeds are given daily feed according to treatment, namely the difference in maggot. Feed is given as much as 3% of the biomass of Striped catfish seeds. For maggot, it is given 3 times more than commercial feed. The commercial feed given is commercial feed with 30% protein content and the maggots given are live maggots aged 5-10 days.

2.4 Observation Parameters

2.4.1 Life sustainability

The formula used to determine the survival percentage of tested fish according to Effendie (1997):

$$SR = \text{-} \times 100\%$$

Information:

SR: Survival Rate *(%)*
Nt: Number of fish seeds at the end of maintenance
No: The number of fish seeds early in the maintenance.

2.4.2 Growth

2.4.2.1 Weight growth

The formula used in calculating the Daily Growth Rate (DGR) using the Effendie formula (1997) is:

$$DGR = \frac{}{} \times 100\%$$

Information:

DGR : Daily Growth Rate (%)
LnWt : Average fish weight at the end of treatment (day t)
LnWo: Average fish weight at the start of treatment (day 0)
t : Length of study (days)

2.4.2.2 Length growth

The formula used in calculating length growth using the Effendie formula (1997) is:

$$\text{Length Growth} = \frac{}{} \times 100\%$$

Information:

Lt : Average length of fish at the end of treatment (cm)
Lo : Average length of fish at the start of treatment (cm)
t : Time of study (30 days)

2.4.3 Water quality

The water quality parameters observed were temperature, pH, DO, and ammonia. This water quality measurement is carried out in the

morning. Observations were made four times, namely on the first, tenth, twentieth and thirtieth day.

2.5 Data Analysis

Data processing of survival rate, weight growth and length growth was carried out by statistical calculations using the ANOVA **(**Analysis of Variance**)** method to determine differences in the treatment given**.** If the results of Fcount> Ftable, then proceed with Duncan's multiple distance analysis with a 95**%** confidence level**.** Meanwhile, water quality data were analyzed descriptively**.**

3. RESULTS AND DISCUSSION

3.1 Life Sustainability

The results of the variance test with a 95% confidence level, giving a combination of commercial feed and different media on maggot did not significantly affect the survival of Striped catfish seeds. The high survival value in this study was caused by the quality of water during the maintenance process which was controlled under optimum conditions for the survival of Striped catfish seeds. According to SNI (2014) the optimal conditions of water for Striped catfish seed rearing have a 25-30 of temperature, 6,5-8 of pH, > 3 mg/L of DO, and < 0,1 mg/L of ammonia. Data on the survival of Striped catfish seeds given a combination of commercil feed and different media in maggot.

Kusdiarti et al. [27] stated that the stocking density of above 20 fish / L-1 can interfere with the physiological processes and behavior of fish in the space for movement which in turn can reduce the health and physiological conditions of the fish. However, no fish carcasses were found in the rearing containers. This is thought to be due to Striped catfish which have cannibal characteristics and eat Striped catfish carcasses in the rearing container. Cannibalism is thought to occur at night when Striped catfish are actively moving and there is no food available in the rearing containers according to the statement of Fessehaye et al. [30] cannibalism is strongly influenced by fish stock density, fish age and weight ratio of individual predators. Cannibalism will be reduced if there are other foods as alternatives. Based on research conducted by Melard et al. [31] showed that cannibalism decreased at lower fish stock densities. The results of this study showed that the combination of commercil feed and different media in maggot did not affect the survival of Striped catfish seeds. This is because the provision of maggot as feed does not affect the quality of water in the maintenance container [29].

The results of the variance test, giving a combination of commercial feed and different media on maggot did not significantly affect the survival of catfish seeds. The high survival value in this study was caused by the quality of the water during the maintenance process which was controlled under optimum conditions for the survival of Striped catfish seed. The data on the survival of catfish seeds given a combination of commercil feed and different media in maggot can be seen in Table 3.

3.2 Growth

3.2.1 Daily weight growth rate

Growth is a change in shape due to additional length, weight and volume over a certain period [32]. Based on the results of observations of Striped catfish seeds given feed in the form of a combination of commercial feed and different media in maggot with a maintenance time of 30 days resulting in a different growth average weight.

The growth of the average weight of Striped catfish seeds always increases every day. This is because the feed given, which is a combination of commercial feed and different media in maggot, is well responded to by Striped catfish seeds. The nutritional content of the feed affects the growth of fish quickly or slowly.

The growth rate value of Striped catfish seeds maintained for 30 days with treatment A resulted in the highest daily growth rate of 1.23%. According to Amri and Khairuman [33]. In choosing good fish feed there are several aspects that must be considered, namely availability must always be available, easy to find or find, cheap price, does not compete with human food ingredients, high nutritional quality, according to the diameter of the fish's mouth opening, easy to digest and has a taste aroma favored by fish.

Based on the results of observations of catfish seeds given feed in the form of a combination of commercial feed and different media in maggot with a maintenance time of 30 days resulting in a different growth average weight. Graph of the

average weight of catfish seeds can be seen in Fig. 1.

The highest average weight growth for 30 days of maintenance was 5.62 grams obtained from catfish seeds given treatment A, while the lowest average weight growth of 4.95 grams was obtained from catfish seeds given treatment C. The four treatments showed that the feed given was able to be digested by the Striped catfish.

The results of the average weight of catfish seeds were then followed by the calculation of the daily growth rate. Based on the analysis of variance, the daily growth rate given the combination treatment of commercial feed and different media on maggot gave a significantly different effect. Based on Duncan's multiple range test, treatment A produced the highest growth rate can be seen in Table 4.

Maggot is a natural food that can be directly feed to fish. The size of the maggot larvae aged 5-10 days can be eaten by Striped catfish seeds 5-7 cm in size because they match the mouth openings of the Striped catfish seeds. Striped catfish are omnivorous and tend to be carnivores. The characteristic of carnivorous fish is that they like to hunt moving prey, so the provision of maggot will increase the response of Striped catfish to eating because the maggot is actively moving in the water. This is also in accordance with the food habits of Striped catfish that like live food. According to Kunto [34]. In general, Striped catfish favorite food depends on environmental conditions and the availability of food in nature. Another advantage that the maggot has which is immediately given is that the maggot protein content is not damaged because it does not undergo a heating or shining process so that its nutritional quality can be maintained.

Table 3. Striped catfish seed survival

Treatment	Life sustainability (%)
A: 50% commercial feed + maggot with 50% mixed media	83.33 ± 3,849a
B: 50% commercial feed + maggot with 50% fruit media	86.66 ± 5,443a
C: 50% commercial feed + maggot with 50% layer media	83.33 ± 8,607a
D: 50% commercial feed + maggot with 50% bran media	81.66 ± 11.386a

Source: *primary data* (*2020*)

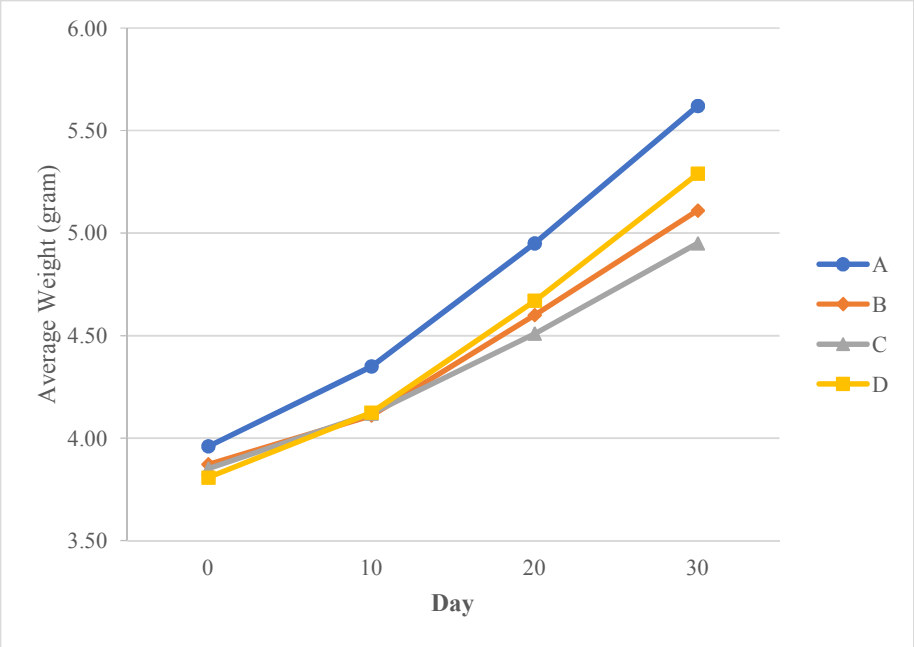

Fig. 1. Graph of average weight of striped catfish
Source: *primary data* (*2020*)

The fat content of 10 days old maggot is in accordance with the nutritional needs of Striped catfish seeds because the fat content of maggot will increase with age. Maggots that are 10 days old have a fat content ranging from 18% -19%. One of the fish feed that can meet the needs of fish is 4-18% fat. The need for fish fat is to meet its energy needs and essential fatty acids. If the fat content in the feed is less than the needs of the fish, some of the energy from the protein source will be used for fish activity and will inhibit growth. According to Fahmi [16], the suitability of the need for fat content in fish has an impact on the high energy in fish feed so that fish can utilize energy from fat for their activities and maximize the function of protein for growth (energy sparing effect).

Maggot is a natural food containing probiotic microbes and natural enzymes contained in its digestion so as to facilitate the metabolic process of Striped catfish seeds. According to Awoniyi et al. [35] found the bacteria *Bacillus sp*. in the maggot digestive tract. *Bacillus sp*. Is a probiotic bacteria that helps increase growth and maintain fish health. *Bacillus sp*. in the intestine produces antibiotics to fight pathogenic microbes. *Bacillus sp*. able to secrete enzymes that can simplify complex molecules into simple molecules so that the intestines more easily absorb the nutrients in the feed given.

The lowest daily growth rate was found in treatment C, namely with layer media, namely 0.88%. This is because the nutritional content of the layer has the lowest protein energy ratio value compared to other media. Arief et al. [36] stated that lack of energy can inhibit the development of the maggot body. Murni et al. (2008) said that the protein in the layer is a non-nitrogen protein compound, thus the quality is lower than the crude protein found in other media and this affects the supply of nutrients for maggots development.

3.2.2 Daily length growt rate

Based on observations of the average length of fish that are given a combination of commercial feed and different media in maggot with a maintenance time of 30 days, the average length of fish is different and has increased every day. Graph of the average length of catfish fry can be seen in Fig. 2.

Observations of the increase in the average length of fish seeds were carried out every 10 days. The data obtained showed that the fish seeds from each treatment had different average length growth. This is because the nutritional components in the feed for each treatment are different. Data on the length increase of catfish seeds can be seen in Table 5.

Growth is a very important factor for the success of cultivation. Growth can be defined as the increase in length or weight over time. The food consumed by catfish will be used by the body for metabolism, movement, production of sexual organs, and to replace cells that are no longer used. The increase in cells in the tissue is responsible for the mass increase in fish [32].

Table 4. Daily weight growth rate of striped catfish seeds

Treatment	Average DWG (%)
A: 50% commercial feed + maggot with 50% mixed media	1.23 ± 0.089b
B: 50% commercial feed + maggot with 50% fruit media	0.93 ± 0.281a
C: 50% commercial feed + maggot with 50% layer media	0.88 ± 0.168a
D: 50% commercial feed + maggot with 50% bran media	1.22 ± 0.054b

Source: *primary data* (*2020*)

Table 5. Daily length growth rate of siamiese catfish seeds

Treatment	Increase in Length (%)
A: 50% commercial feed + maggot with 50% mixed media	0.99 ± 0.048c
B: 50% commercial feed + maggot with 50% fruit media	0.79 ± 0.102a
C: 50% commercial feed + maggot with 50% layer media	0.73 ± 0.028a
D: 50% commercial feed + maggot with 50% bran media	0.87 ± 0.060b

Source: *primary data* (*2020*)

One of the most important aspects of assessing feed quality is the energy ratio of feed protein. Determination of the optimum feed protein and energy ratio is required to obtain maximum fish growth [37]. This is because growth can only occur if the energy requirements for the maintenance of life processes and other functions are met [38].

Treatments C and B had the lowest length growth. This is presumably because the content in the layer and bran has a low protein energy ratio.

3.3 Water Quality

Water quality shows a value in accordance with SNI (2014). Data of water quality of catfish seeds can be seen in Table 6.

Water quality is maintained within the normal range so that fish do not die due to unfavorable environmental conditions. The temperature of each treatment shows almost the same range, namely 27-30℃. The temperature value in the rearing container is in the optimal range for live Striped catfish seeds, according to the statement of Arifin and Asyari (1992) in Nurhamidah [39] Striped catfish that are kept in ponds can grow well in a temperature range of 26.5-28.

The degree of acidity (pH) of each treatment shows a range of 7.1-8.4 In accordance with the statement of Arifin and Tupang (1983) in Nurhamidah ,[39] the pH suitable for the life of Striped catfish ranges from 6.5-8.0. The growth and survival of Striped catfish is influenced by the pH value if the pH value of Striped catfish is too low and too high it will cause slow growth of Striped catfish or can cause death [40].

Ammonia is one of the factors that cause fish mortality. Ammonia values in each treatment range from 0.003-0.05 mg / l. This value is still in the optimal range for live Striped catfish. Giving food in the form of a combination of commercial feed and different media in maggot does not affect water quality in maintaining Striped catfish seeds. This is indicated by the values of temperature, pH, DO and ammonia in accordance with SNI so that fish can maintain their survival and growth can take place optimally.

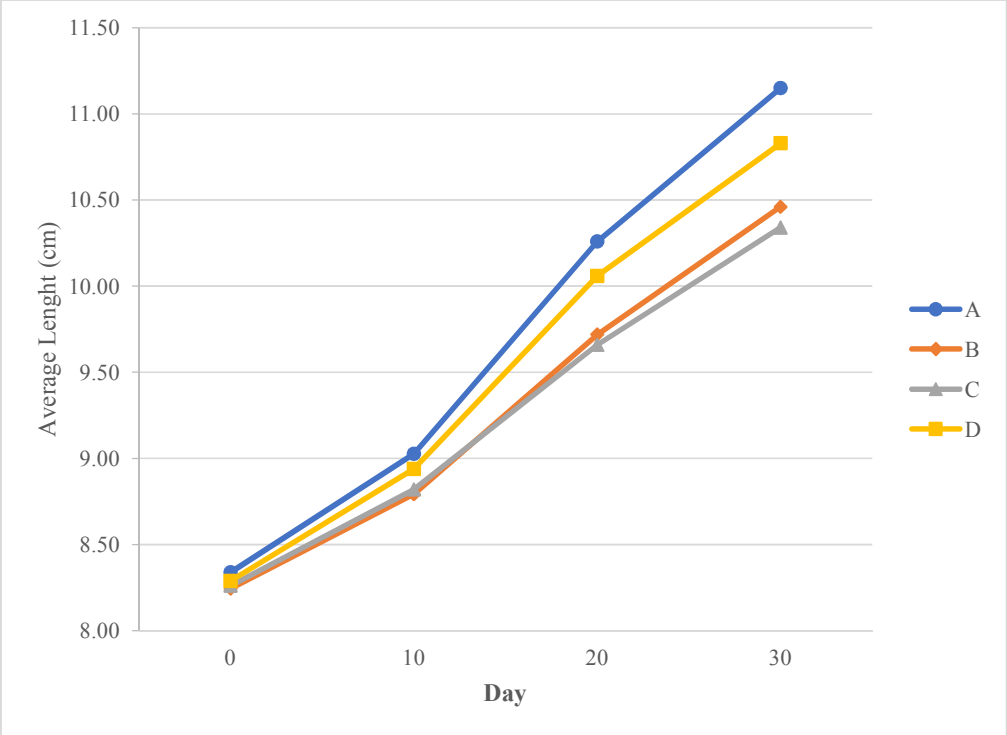

Fig. 2. Graph of average length of striped catfish
Source: primary data (2020)

Table 6. Water quality during striped catfish seed maintenance

Treatment	Observable observations			
	Temperature	pH	DO	Ammonia
A: 50% commercil feed + maggot with 50% mixed media	27-30	7.18-8.15	6,3-6,8	0.003-0.03
B: 50% commercil feed + maggot with 50% fruit media	27-29	7.31-8.3	6.4-6.9	0.003-0.03
C: 50% commercil feed + maggot with 50% layer media	27-29	7.17-8.34	6,2-6,9	0.003-0.03
D: 50% commercil feed + maggot with 50% bran media	27-29	7.19-8.43	6,4-6,8	0.003-0.05
Quality Standards (SNI 2014)	25-30oC	6.5-8	> 3mg / L	<0.1 mg / L

4. CONCLUSION

Based on this study, giving a combination of 50% commercial feed and cultured maggot with mixed media of 50% gave the best daily growth rate, length growth and feed efficiency results, namely 1.23%, 0.99% and 62.79% and the lowest feed conversion ratio value. that is 1.67.

ACKNOWLEDGEMENTS

We would like to thank Faculty of Marine Science, Universitas Padjadjaran, Indonesia for making this research possible.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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