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EFFECT OF FEEDING TIME OF BSF (*Hermatia illucens*) LARVAE AS SUPPLEMENTARY FEED ON GROWTH AND SURVIVAL CATFISH FRY (*Clarias sp*)

PENGARUH WAKTU PEMBERIAN LARVA BSF (*Hermatia illucens)* SEBAGAI PAKAN TAMBAHAN TERHADAP PERTUMBUHAN DAN KELANGSUNGAN HIDUP BENIH IKAN LELE (*Clarias sp)*

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Abstract

This research aims to determine the effect of the timing of feeding BSF larvae (*Hermatia illucens*) as additional feed on the survival and growth of catfish fry (*Clarias sp*). This research was conducted for 30 days in May - June 2019 at the Laboratory of the Fish Seed and Feed Production Technology Department, Politeknik Indonesia. The research method used in this study is an experimental method using a completely randomized design (CRD) consisting of four treatments and four replicates resulting in 16 experimental units with treatment A (Control) Adlibitum, B (BSF larvae in the morning) Adlibitum, C (BSF larvae in the afternoon) Adlibitum, and D (BSF larvae in the afternoon) Adlibitum. The provision of BSF larvae (*Hermatia illucens*) as additional food has a significant effect on survival, specific growth, relative growth, absolute length growth of catfish seeds (*Clarias sp*). The best treatment is found in treatment B, namely the provision of BSF larvae in the morning as additional feed with a specific growth rate of 0.05 grams/day, absolute length growth of 6.29 cm, relative growth value of 9.64%/day and feed conversion ratio of 0.63.

Keywords **:** *Adlibitum, Catfish, BSF larvae, Feed*

Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh waktu pemberian larva BSF (*Hermatia illucens)* sebagai pakan tambahan terhadap sintasan dan pertumbuhan benih ikan lele (*Clarias sp*). Penelitian ini dilaksanakan selama 30 hari pada bulan Mei – Juni 2019 di Laboratorium Program Studi Teknologi Produksi Benih dan Pakan Ikan Politeknik Indonesia – Venezuela. Metode penelitian yang digunakan dalam penelitian ini adalah metode eksperimental dengan menggunakan Rancangan Acak Lengkap (RAL) terdiri atas empat perlakuan dan empat kali ulangan sehingga mengahasilkan 16 satuan percobaan dengan perlakuan A (Kontrol) *Adlibitum*, B(Larva BSF pagi) *Adlibitum*, C (Larva BSF siang) *Adlibitum*, dan D (Larva BSF sore) *Adlibitum.* Pemberian larva BSF (*Hermatia illucens)* sebagai pakan tambahan berpengaruh nyata terhadap sintasan, pertumbuhan spesifik, pertumbuhan relatif, pertumbuhan panjang

mutlak benih ikan lele (*Clarias sp*). Perlakuan terbaik terdapat pada perlakuan B yaitu pemberian larva BSF di pagi hari sebagai pakan tambahan dengan nilai laju pertumbuhan spesifik 0,05 gram/hari, pertumbuhan panjang mutlak sebesar 6,29 cm, nilai pertumbuhan relatif 9,64%/hari dan rasio konversi pakan sebesar 0,63.

Kata Kunci : *Adlibitum, Ikan Lele, Larva BSF, Pakan*

INTRODUCTION

Catfish (*Clarias sp*.) is a fish that lives in freshwater, with a current that is not swift or calm waters. Catfish is one of the leading freshwater commodities to be cultivated, because the nutrition of catfish contains high protein and good bone strengthening substances (calcium). (Mullah *et al*., 2019). Nurhayati *et al*., (2014) stated that the high demand for catfish so that many catfish farmers do artificial hatcheries so that catfish seeds are always available when needed for the cultivation process and also to improve the quality of seeds. catfish larvae have a digestive system that is still simple and undifferentiated both morphologically and physiologically, so feeding is needed.

Feed is one of the important elements in the development of aquaculture activities that support the growth and survival of fish. Feed in aquaculture activities generally uses commercial feed which consumes around 60-70% of the total production costs incurred (Arief *et al*., 2014). The high price of commercial feed causes the profit of fish production obtained by farmers to not be maximized and even experience losses. Feed also greatly affects the growth and survival of fish. Proper feeding must pay attention to quality and quantity so that it suits the needs of the fish to be cultivated. Feed that contains high protein nutritional value can encourage faster fish growth

The price of commercial feed is currently very expensive so that the costs incurred for feed in the process of consuming fish have been greatly felt by fish farmers, because the price of fish feed continues to increase. To reduce the price of feed, it is necessary to find alternatives to animal protein sources that are cheaper and easier to obtain. The increasing price of protein sources and the threat of animal feed security, environmental pressure, increasing human population and increasing demand for protein in the market have caused the price of animal-based protein to become more expensive (Siagian *et al*., 2021).

One of the alternative feed ingredients as a source of animal protein is easy to breed maggot. Maggot has the potential as a high protein source feed of 44.26%. The protein content of maggot is higher than the content of commercial feed ranging from 20 - 25% (Berampu *et al*., 2021). Maggot also has a function as an alternative feed for fish that can be given in fresh form. The use of maggot can be applied with commercial feed so that production costs can automatically be reduced without reducing fish growth (Putri *et al*., 2019).

The cultivation of the black soldier fly (*Hermetia illucens*) is an effort to overcome the problem of organic waste in the form of food waste, vegetables and fruits and leaves. The use of maggot or BSF larvae is an innovative strategy to overcome the problem of organic waste so that it can help reduce the accumulation of waste in landfills (Budiharjo *et al*., 2022).

Tippayadara *et al.*, (2021) explained that BSF larval meal can replace fishmeal protein in feed formulations up to 100% without causing negative effects on growth performance, feed utilisation and survival of tilapia. Fresh maggot has the potential to replace the utilisation of commercial feed as an alternative feed for tilapia where the growth between maggot feed treatment and commercial feed provides the same good yield and meat quality. Fresh maggot can replace the use of commercial feed as an alternative feed for freshwater ornamental fish where the growth between maggot feed treatment and commercial feed provides the same good results.

Hanief *et al.*, (2014) explained that one of the efforts made to support the success of aquaculture is feeding management which is expected so that the feed given can be utilised by fish effectively and efficiently so as to produce optimal fish growth. One application of feeding management is setting the frequency of feeding, namely the number of times the feed is given in one day. Feeding management requires that the feed given to fish must be right in quality, quantity and on time for the success of the aquaculture business. Feeding at different times will affect fish growth.

One application of feeding management is Feeding Time, which is the number of times feed is given in one day. Feeding time is related to the frequency of fish hunger. The interval of feeding time is deliberately set to spur fish growth. Feeding with a more frequent time will make the fish not get full quickly and the fish's appetite is maintained. (Sianturi *et al.*, 2018). The purpose of this study was to determine the effect of feeding time of BSF larvae (*Hermatia illucens*) as an additional feed on the growth and survival of catfish fry (*Clarias sp*).

RESEARCH METHODS

This research was conducted in May - June 2019 at the Laboratory of the Fish Seed and Feed Production Technology Study Programme, Politeknik Indonesia Venezuela, Aceh Besar, Aceh. The tools used in this study were aquarium, camera, aerator, ruler, digital scales, while the materials used in this study were 240 catfish seeds, water, commercial feed, BSF larvae.

This study used a completely randomised design (CRD) with four treatments and four replications, resulting in 16 experimental units. The treatment in this study is the time of giving BSF larvae as additional feed consisting of:

A = Commercial Feed (Control) Ad libitum
B = BSF larvae morning ad libitum
C = BSF larvae afternoon ad libitum
D = BSF larvae evening ad libitum

Research Procedures

Preparation of Research Containers

Preparation begins with cleaning the container in the form of a jar with a capacity of 25 litres then dried and affixed a code or treatment label to each container. After that, it is filled with 15 litres of water, then aeration is installed in the container, then catfish seeds are put into the

container that has been filled with water. The water requirement for 1 catfish seed is 1 litre, so 15 catfish seeds are put in the container.

Preparation of Test Organisms

The test organisms used were 240 catfish fry of size 2 - 4 cm. Catfish fry were obtained from Cot Nambak Village, Blang Bintang District, Aceh Besar Regency. Catfish fry were acclimatised to freshwater for 2 days, only healthy catfish fry were used for the next treatment.

Maintenance of Test Organisms

Catfish fry were stocked and maintained for 1 month in the containers used during the study. During rearing, catfish fry were fed commercial feed with 40% protein content and BSF larvae. The frequency of commercial feed (control) was 3 times a day adlibintum and BSF larvae feed once a day for each treatment. Treatment B was only fed BSF larvae once in the morning adlibitum, treatment C was only fed BSF larvae once in the afternoon adlibitum, and treatment D was only fed BSF larvae once in the afternoon adlibitum, while treatment A (Control) only used commercial feed. Feeding was done at 08.00 am (morning), 13.00 pm (afternoon), and 18.00 pm (evening).

Preparation of Test Feed

The feed given to catfish seeds is Black Soldier Fly (BSF) larvae. In this study, BSF larvae used for catfish seeds were harvested aged 3 - 10 days, this aims to adjust to the mouth opening of catfish seeds. Before the BSF larvae are given to catfish seeds, the BSF larvae are washed first using water so that the substrate is not carried away before being given to catfish seeds, after which the BSF larvae are weighed using digital scales before being given to catfish seeds.

Test Parameters

The test parameters in this study are survival rate (SR), specific growth rate (SGR), absolute length growth, relative growth rate (RGR) and feed conversion ratio (CTR). These parameters were calculated with the following formulations:

1. Survival Rate (SR)

Survival rate (SR) is the percentage of live fish at the end of rearing compared to the number of fish at the beginning of stocking. Observation of survival rate is done every day by recording the number of dead fish. The survival rate can be expressed by the following formula (Effendie, 1979):

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

Description:

SR : Trajectory (%)
Nt : Number of fish at the end of rearing (fish)

No : Number of fish at the beginning of rearing (fish) Number of fish at the beginning of rearing (fish).

2. Specific Growth Rate

Specific growth rate (SGR) is done by weighing seed samples to determine the growth of fish seed weight against the feed given. Samples were measured using digital scales. Effendie, (1979) states that SGR is calculated by the following formula:

$$LPS = \frac{LnWt - LnWo}{T}$$

Description:

LPS :Specific growth rate (gram/day)
Wo :Fish biomass weight at the beginning of the study (gram)
Wt : Fish biomass weight at the end of the study (gram)
T : Duration of study (days)

3. Absolute Length Growth

Absolute length growth is calculating the development of fish length every day during the study, this is very important to know to determine the level of fish growth rate during cultivation. Length measurement is done by placing the seed under the ruler on the top of its back and then calculating the length of the fish. Forumulation to determine the length of fish is (Effendie, 1979):

$$L = LT - Lo$$

Description:

L : Absolute length growth (cm)
Lt: Final length of maintenance (cm)
Lo: Initial length of rearing (cm)

4. Relative Growth Rate (RGR)

Relative growth rate (RGR) can be calculated with the following formula:

$$RGR = \frac{Wt - Wo}{Wo} x100\%$$

Description:

RGR: Relative Growth Rate (%/day)
Wt: Weight of test fish at the end of the study (gram)
Wo: Weight of test fish at the beginning of the study (gram)
T : Duration of the study (days)

5. Feed Conversion Ratio

Feed Conversion Ratio (FCR) is the ratio of the amount of feed consumed to the increase in body weight. According to Effendie, (1979) feed conversion can be calculated using the following formula:

$$RKP = \frac{F}{Bt - Bo}$$

Description:

RKP: Feed Conversion Ratio
F : The amount of fish feed given during the study (grams)
Bt: Biomass of fish fry at the end of the study (grams)
Bt : Biomass of fish seed at the beginning of the study (gram)

RESULTS AND DISCUSSION

Survival Rate

The results showed that the best survival results were obtained in treatment B with an average value of 98%, in treatment C the survival value obtained was 97%, and for treatment D was 95%, the lowest survival value was in treatment A which was 93% which can be seen in Fig. 1 below. 1 below. The results of analysis of variance (ANOVA) showed that the provision of BSF larvae as additional feed did not significantly affect the survival rate of catfish fry at the 0.05 confidence level (p>0.05). The results showed that the best survival in treatment B reached 98% due to good water quality and low ammonia levels. The highest mortality of 7% in treatment A occurred in the last seven days of the study period, this was caused by declining water quality and high levels of ammonia in the water.

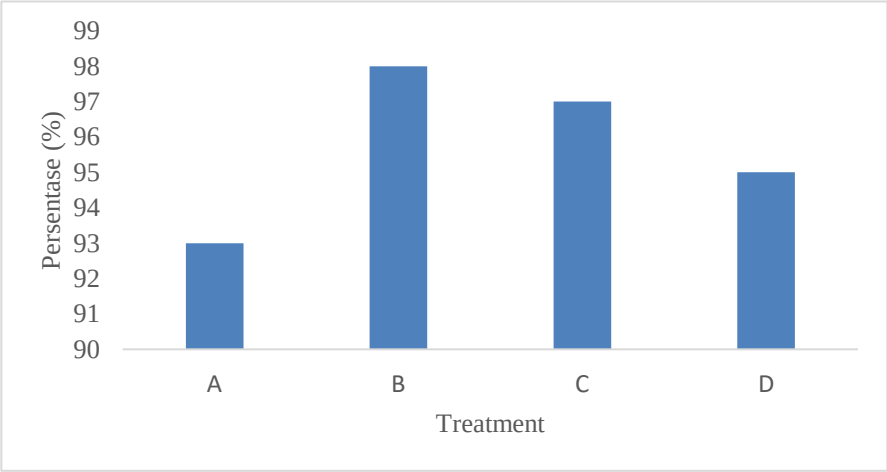

Figure. 1 Survival rate of catfish fry

During maintenance there were several fish deaths in the control, this occurred more at the end of maintenance. Presumably because it is caused by the size and age of fish that are still vulnerable to survive well, the influence of external responses, for example when handling when weighing on analysis. (Rihi, 2019). The high value of survival in the results of the study indicates that catfish seeds have been able to utilise the feed provided by the BSF larvae supplement, so that energy needs for activity, growth and survival can be used optimally (Nazlia *et al*., 2023). According to (Mulyadi *et al*., 2014) survival can be influenced by biotic and abiotic factors. Biotic factors consist of age and the ability of fish to adapt to the environment. Abiotic factors include food availability and quality of living media.

Specific Growth Rate (SGR)

The specific growth rate results in Figure 2 below explain that the highest specific growth rate was obtained in treatment B with a value of 0.05 grams/day. Treatment C and Treatment D had the same specific growth rate value of 0.04 grams/day, while the lowest specific growth rate value was obtained in treatment A (Control) with a value of 0.03 grams/day. Based on the results of the analysis of variance, it shows that the provision of BSF larvae as additional feed has a real effect on the specific growth rate of catfish fry growth.

The best specific growth rate of catfish seeds was obtained by treatment B, namely the provision of BSF larvae as additional feed with the time of administration in the morning, this is due to the long time interval between the provision of BSF larvae in the afternoon with Ad Libitum in the morning, when compared to other additional feeding time intervals that cause the fish stomach to be empty so that it eats more voraciously than treatments C and D. Increased growth of catfish seeds is able to increase weight every day, this is due to feed that is maximally utilised in the metabolic process and growth of fish body weight. The lowest value of specific growth rate in treatment A (control) is due to the protein in the feed consumed cannot be digested properly, but is excreted back by the fish through faeces. Melanie *et al*., (2024) explained that the specific growth rate (SGR) of a fish describes its growth rate over time. This refers to the fish's ability to convert feed nutrients into energy. Specific growth rate (SGR) shows different results depending on the treatment.

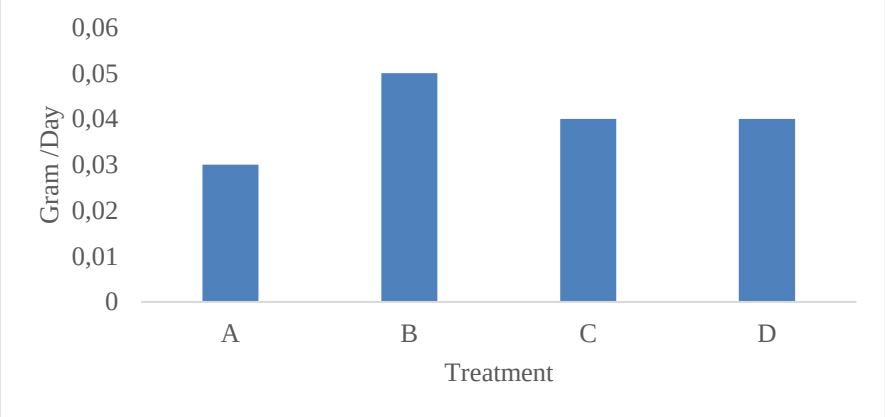

Figure 2. Specific Growth Rate

Prihadi, (2007) explains that feeding fish in the morning and pellets in the afternoon tends to produce high absolute growth. This is because feeding fish in the morning provides sufficient nutrients for metabolism because fish protein can be digested immediately, and giving pellets in the afternoon gives fish the opportunity to digest at night with a relatively longer time, so that the nutrients needed by fish are always available until the next feeding because pellets have a concentration of food substances in dry matter more or dense. Fish energy sources are obtained from protein and omega 3 fatty acids in fresh fish, while pellet energy is obtained from processed high protein and fat producers. states that the interval of feeding should be adjusted to the length of time from eating to excretion (faeces).

Absolute Length Growth

Figure 3. explains that the highest absolute length growth was obtained in the treatment with an average value of 6.29 cm. In treatments C and D, the absolute length growth value was obtained with an average value of 5.17 cm and 5.74 cm, while the absolute length growth was obtained in treatment A (control) with an average value of 4.77 cm.

This is due to the provision of maggot which has high nutrition in accordance with the mouth size of catfish seeds. Feeding that is favoured by Sangkuriang catfish fry can trigger fish growth. According to Prasetiyo *et al*., (2020), length growth is different from weight growth, length growth is positive growth, meaning that the length of a living thing will not decrease with the age of living things, while weight growth can be positive and negative. Giving maggot as additional feed provides stimulation for fish to eat, maggot has a high protein content. Maggot does not have a skeleton skeleton so it is easily and quickly digested in the fish intestine**.**

Rihi, 2019 explains that this protein is able to make dumbo catfish grow quickly, besides that fish need high protein for growth and through high protein fish can quickly grow and develop. The increase in length and weight of dumbo catfish is caused by a sufficient amount of feed nutrients. In treatment B the amount of nutrients, both protein fat and carbohydrates, there is a balance of nutrients needed for the growth of dumbo catfish seeds, this is because carbohydrates and fats can meet the body's calorie needs, so protein is only slightly oxidised to increase calories but is used for building blocks of fish seed growth.

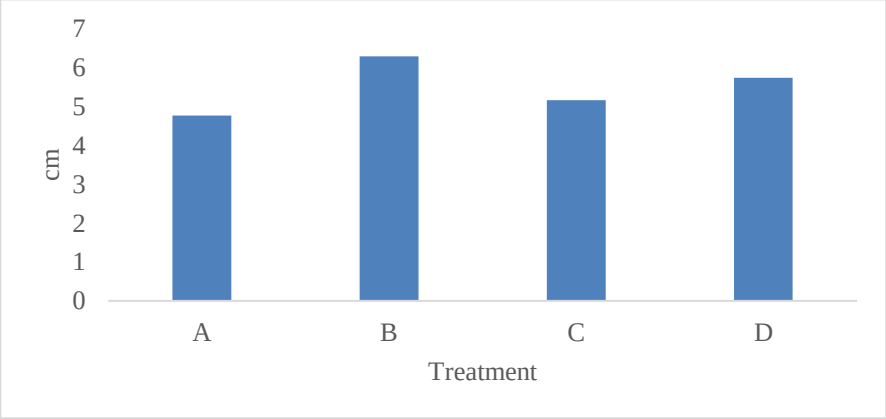

Figure 3. Absolute Length Growth

According to Mullah *et al.*, (2019) states that growth is the addition of length or weight of fish in a certain period of time which is influenced by feed, age and fish size. The length growth of sangkuriang catfish is influenced by two factors, namely internal and external. Internal factors are factors related to fish such as age and genetic traits of fish (heredity, ability to utilise food and resistance to disease). External factors are factors related to the environment in which fish live, including the physical and chemical properties of water, space for movement and the availability of food in terms of quality and quantity.

Relative Growth Rate (RGR)

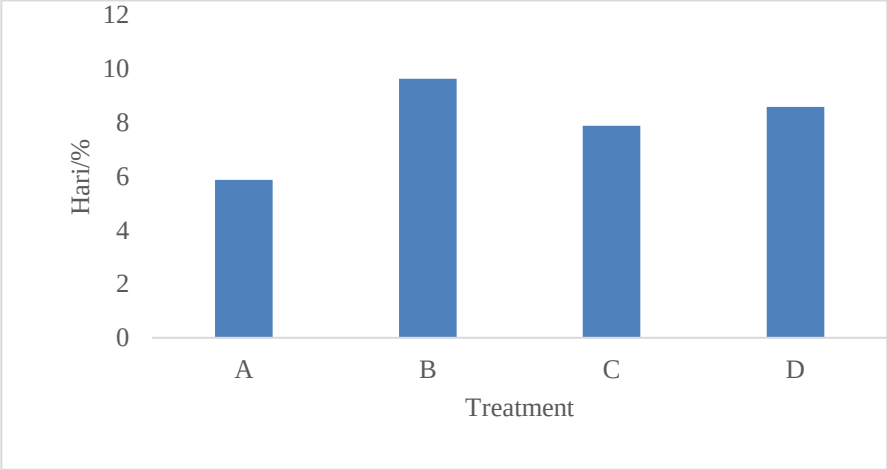

Figure 4. Relative growth rate

Figure 4. above shows the results of the lowest relative growth rate found in treatment A (control) with an average value of 5.87%/day, the relative growth rate in treatments C and D had an average value of 7.89%/day and 8.59%/day, while the highest relative growth rate was obtained in treatment B with an average value of 9.64%/day. The low value of the relative growth rate in treatment A (control) compared to the other treatments is thought to be due to a decrease in water quality. This is in accordance with the statement of Primashita *et al*., (2017) explaining that high levels of ammonia can affect fish growth, cause fish stress, decreased appetite, the onset of disease and cause death. In addition, the control treatment did not add probiotics to the maintenance media so that the population of bacteria that can oxidise organic matter. The most important component of feed nutrition required by fish is protein, which is an indispensable feed substance for growth. Protein in feed is needed as a source of essential amino acids for fish. Given that essential amino acids cannot be produced by the body, it is very important to find these amino acids (Berampu *et al*., 2021).

The essential amino acid needs of catfish feed can be fulfilled from maggot animals as a source of protein nutrition provided. According to Makhrojan *et al*., (2019) maggot is a source of protein which is an alternative feed for fish. The protein content of maggot is quite high around 41-42%. The protein in the maggot body contains essential amino acids consisting of methionine

(0.38), lysine (2.21), leucine (2.61), isoleucine (1.51), histidine (0.96), phenylalanine (1.49), valine (2.23), arginine (1.77), threonine (1.41), tryptopan (0.59).

Feed Conversion Ratio

Figure 5 below shows that the highest feed conversion ratio value was obtained in treatment A (control) with an average value of 1.31%/day, while the lowest feed conversion ratio value was found in treatment B, which is the treatment with the provision of BSF larvae ad libitum in the morning as additional feed with an average value of 0.63%/day. Treatments C and D, where BSF larvae were fed ad libitum in the afternoon and evening, had an average feed conversion ratio of 1.13%/day and 0.92%/day, respectively.

Siagian *et.al*., (2021) explained that the size of the feed efficiency value is not only determined by the amount of feed given, but also influenced by several factors such as density, weight of each individual, age of fish, water temperature and feeding method (quality, placement and frequency of feeding). According to (Mufidah K, Samidjan I, 2017), the more effective and efficient the feed utilisation, the lower the feed conversion value because the feed has good quality and quantity. According to Farooq Aga *et al*., (2017), states that giving the right frequency will have a positive effect on growth (weight growth, specific growth rate, feed conversion, and survival rate).

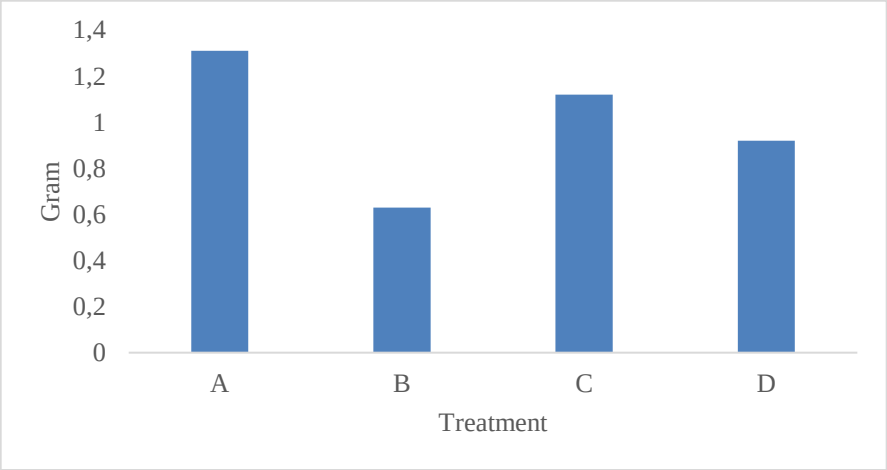

Figure 5. Feed Conversion Ratio

One of the factors that influences the level of feed efficiency is the type of nutrient source and the amount of each component of the nutrient source in the feed. The amount and quality of feed given to fish affects fish growth (Arief *et al*., 2014). The low feed conversion value in treatment B is caused by the large amount of feed consumed by the fish which is then converted into biomass, so it can be concluded that feeding with different protein levels must still be supported by other compositions of feed needed by the fish for growth, such as fat, vitamins, fiber and others. Febri *et al*., (2022) stated that in order to maintain optimal feed efficiency for

growth. Sihombing *et al.*, (2023) stated that the higher the FCR, it means that more feed is not converted into biomass.

The efficiency of feed utilization can also be influenced by the rate of gastric emptying, the faster the fish's stomach digests the feed given, the higher the feed utilization efficiency value. According to Mullah *et al*., 2019, feed consumption is directly related to the available stomach capacity, so it is directly related to digestibility and the rate of gastric emptying. The higher the ability to digest nutrients, the faster the rate of gastric emptying, so that the amount of feed consumed increases. Decreased digestibility causes the amount of feed that is digested to be less. This is thought to slow down the rate of gastric emptying, thereby reducing the amount of feed consumed.

Water Quality

The water temperature during the study ranged between 27ºC – 29ºC, with dissolved oxygen (DO) levels of 8 mg/L. The degree of acidity (pH) ranges from 6.5 – 8.5 with ammonia levels of less than 0.002 ppm with nitrite of 0.005 mg/l. The water quality conditions in the study where BSF larvae were given as additional feed ad libitum were still in normal and safe conditions. This is in accordance with Siagian *et al*., (2021), who explained that the water quality during the research was still within a suitable range for the growth and survival of African catfish (*Clarias gariepinus*) fry at a temperature range of 27.33–27.44^{0}C. The optimal temperature for fish life is between 25-32^{0}C.

CONCLUSION

Providing BSF larvae as additional feed to catfish fry (*Clarias sp*) has a significant effect on specific growth, relative growth, absolute length and feed conversion ratio. The best treatment was obtained in Treatment B (Ad libitum), namely giving BSF larvae in the morning with a specific growth rate value of 0.05 grams/day, absolute length growth of 6.29 cm, relative growth of 9.64%/day with a feed conversion ratio of 0 .63 gram.

REFERENCES

Arief, M., Nur, F., dan Sri, S. 2014. Pengaruh Pemberian Probiotik Berbeda pada Pakan Komersial terhadap Pertumbuhan dan Efisiensi Pakan Ikan Lele Sangkuriang (*Clarias sp.*). Jurnal Ilmiah Perikanan dan Kelautan. 6(1): 49-54.

Berampu, L. E., Patriono, E., & Amalia, R. (2021). Pemberian kombinasi maggot dan pakan komersial untuk efektifias pemberian pakan tambahan benih ikan Lele Sangkuriang (*Clarias gariepinus*) oleh kelompok pembudidaya ikan Lele. *Sriwijaya Bioscientia*, *2*(2), 35-44.

Budiharjo, A., Nuhriawangsa, A. M. P., Kartikasari, L. R., & Hertanto, B. S. (2022). Aplikasi teknologi floating catfish pellet sebagai solusi pemanfaatan larva black soldier fly di mitra usaha mazgot bsf boyolali. *PRIMA: Journal of Community Empowering and Services*, *6*(1), 14-24.

Effendie. 1979. Metode Biologi Perikanan. Yayasan Dewi Sri Bogor.

Farooq Aga, A., Dhawan, A., Ansal, M. D., & Ashfauq Farooq Aga, C. (2017). Efficacy of feeding frequency, feeding rates and formulated diets on growth and survival of rohu Labeo rohita brood stock under intensive rearing. International Journal of Fisheries and Aquatic Studies, 5(1), 85–89.

Febri, S.P., Purba, F.A., Hanisah., and Gigentika, S. 2022. Development strategy of tiger shrimp (Penaeus monodon) cultivation in traditional ponds in East Aceh District, Aceh Province, Indonesia. Bioflux - Aquaculture, Aquarium, Conservation & Legislation. 15(4): 2142-2151.

Firdus, F., Samadi, S., Muhammadar, A. A., Sarong, M. A., Muchlisin, Z. A., Sari, W., Batubara, A. S. 2022. Supplementation of rice husk activated charcoal in feed and its effects on growth and histology of the stomach and intestines from giant trevally, Caranx ignobilis [version 2 ; peer review : 2 approved , 1 approved with reservations]. 1–16.

Hanief, M. A. R. (2014). Pengaruh frekuensi pemberian pakan terhadap pertumbuhan dan kelulushidupan benih tawes (*Puntius javanicus*). *Journal of Aquaculture Management and Technology*, *3*(4), 67-74.

Makhrojan, M. 2019. Analisis Usaha Budidaya Ikan Lele dengan Pakan AlternatifMaggot. Jurnal Ekonomi. 9(2): 142-149.

Melanie, K., Nazlia, S., Saputra, J., Febri, S. P., & Aprita, I. R. (2024). The effect of banana peel flour (*Musa paradisiaca*) as additional feed raw materials for common carp (*Cyprinus carpio*). In *BIO Web of Conferences* (Vol. 87, p. 03024). EDP Sciences.

Mufidah K, Samidjan I, P. (2017). Pengaruh perbedaan frekuensi pakan komersil menggunakan sistem resirkulasi dengan filter arang aktif terhadap pertumbuhan dan kelulushidupan ikan patin (*Pangasius hypopthalmus*). Journal of Aquaculture Management and Technology, 6, 133–140.

Mulyadi, Tang, U., & Sri Yani, E. 2014. Sistem Resirkulasi dengan Menggunakan Filter yang Berbeda terhadap Pertumbuhan Benih Ikan Nila (*Oreochromis niloticus*). Jurnal Akuakultur Rawa Indonesia, 2(2), 117–124.

Mullah, A., Diniarti, N., & Astriana, B. H. (2019). Pengaruh penambahan cacing sutra (Tubifex) sebagai kombinasi pakan buatan terhadap efisiensi pemanfaatan pakan dan pertumbuhan larva ikan lele sangkuriang (*Clarias gariepinus*). *Jurnal Perikanan Unram*, *9*(2), 160-171.

Nazlia, S., Nurhayati, N., Riski, A. M., Aprita, I. R., Sabri, M., Afriana, S., & Febri, S. P. (2023). Growth performance of gouramy (*Osphronemus gouramy*) with the addition of activated charcoal from tuna (*Thunnus sp*) bone waste in feed. *Acta Aquatica: Aquatic Sciences Journal*, *10*(1), 62-66.

Nurhayati, Nur, B.P.U., Mia, S. 2014. Perkembangan Enzim Pencernaan dan Pertumbuhan Larva Ikan Lele Dumbo, Clarias gariepinus Burchell 1822, Yang Diberi Kombinasi Cacing Sutra dan Pakan Buatan. Jurnal Ikhtiologi Indonesia.14(3) : 167-178

Prasetiyo, H., Sri, M., dan Purnama, S. 2020. Mikroenkapsulasi Ekstrak Kasar Maggot se-bagai Pakan Substitusi pada Penyapihan Pakan Larva Ikan Nila (*Oreochromis niloticus*). Jurnal Kemaritiman: Indonesian Journal of Maritime. 1(2):68-79

Prihadi, D. J. (2007). Pengaruh jenis dan waktu pemberian pakan terhadap tingkat kelangsungan hidup dan pertumbuhan kerapu macan (Epinephelus fuscoguttatus) dalam keramba jarring apung di Balai Budidaya Laut Lampung. Fakultas Perikanan dan Ilmu Kelautan Universitas Padjadjaran. Bandung. *Jurnal Akuakultur Indonesia*, *1*, 493-953.

Primashita, A. H., Rahardja, B. S., & Prayogo, P. (2017). Pengaruh Pemberian Probiotik Berbeda dalam Sistem Akuaponik terhadap Laju Pertumbuhan dan Survival Rate Ikan Lele (*Clarias sp*.). *Journal of Aquaculture Science*, *1*(1), 276586.

Putri, W. R., Helmi, H., Kusuma, H., dan Rangga, B. 2019. Kombinasi Maggot pada Pakan Komersial terhadap Pertumbuhan, Kelangsungan Hidup, FCR dan Biaya Pakan Ikan Patin Siam (*Pangasius hypophthalmus*). Jurnal Ilmu-ilmu Perikanan dan Budidaya Perairan. 14(1): 7-16

Rihi, A. P. (2019). Pengaruh pemberian pakan alami dan buatan terhadap pertumbuhan dan kelangsungan hidup benih ikan lele dumbo (Clarias gariepinus burchell.) di Balai Benih Sentral Noekele Kabupaten Kupang. *Bio-Edu: Jurnal Pendidikan Biologi*, *4*(2), 59-68.

Siagian, G. Situmorang V.M. 2021 Pengaruh Pemberian Pakan Azolla Mikrophylla Terhadap Pertumbuhan Ikan Lele Dumbo (*Clarias Gariepinus*). urnal Sains dan Teknologi . Vol.10 No 2 hal : 308-315

Sianturi, A., & Usman, S. (2018). Pengaruh Waktu Pemberian Pakan Buatan Terhadap Pertumbuhan dan Kelangsungan Hidup Ikan Lele (*Clarias sp*.). *Skripsi Program Studi Manajemen Sumberdaya Perairan, Fakultas Pertanian Universitas Sumatera Utara. Universitas Sumatera Utara, Medan*.

Sihombing, A., Febri, S. P., Isma, M. F., Haser, T. F., Nazlia, S., Aprita, I. R., ... & Nurdin, M. S. (2023). The effect of commercial feeds with different protein content on the growth and survival of tiger shrimp fry (*Penaeus monodon*). *Acta Aquatica: Aquatic Sciences Journal*, *10*(3), 216-220.

Tippayadara, N., Dawood, M. A., Krutmuang, P., Hoseinifar, S. H., Doan, H. V., & Paolucci, M. (2021). Replacement of fish meal by black soldier fly (*Hermetia illucens*) larvae meal: effects on growth, haematology, and skin mucus immunity of *Nile tilapia, Oreochromis niloticus*. *Animals*, *11*(1), 193.