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Application of Photoperiod Manipulation and Type of Feed on the Growth and Survival of *Clarias gariepinus* Fry

Aplikasi Manipulasi Fotoperiod dan Jenis Pakan terhadap Pertumbuhan dan Sintasan Benih Ikan Lele Dumbo (Clarias gariepinus)

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Abstract

African catfish (*Clarias gariepinus*) is a freshwater fish that has the advantages of fast growth, high economic value, adaptability to environmental changes, and easy marketing. This study aims to analyze the growth rate, survival rate, and nutritional content of African catfish after being treated with photoperiod and different types of feed. The research was conducted from September to December 2022, at the Fish Health Laboratory at the Matauli Marine and Fishery College, Central Tapanuli. The method used is an experimental method by applying a Completely Randomized Design Factorial, two factors, and three replications. The first factor is the photoperiod (B), namely natural (B1), 18 hours dark 6 hours light (B2), 24 hours dark (B3), and the second factor is the type of feed (A), commercial feed (A1) and maggot (A2). The test fish used were obtained from the Central Tapanuli Fish Cultivation Seed Center measuring 16.01±0.02 cm and weighing 30.00 ± 0.00 g for a total of 126 individuals. Fish were reared for four weeks in rearing containers with a stocking density of 1 fish/10L. Feed is given four times a day, namely at 06.00, 12.00, 18.00, and 24.00 ad satiation. The results showed that photoperiod manipulation and different types of feed affected the growth and survival of African catfish fry ($p<0.05$). The combination of photoperiod 24 hours dark and maggot feed (B3A2) gave the best results on absolute weight growth of 22.70g, absolute length of 2.56 cm, a specific growth rate of 2.01%/day, a survival rate of 100%, and nutritional content of fish meat such as protein of 18.97%, 8.68% fat, 0.73% fiber, 1.54% ash, and 80.26% water.

Keywords: Photoperiod, Black Fly Soldier, African Catfish

Abstrak

Lele dumbo (*Clarias gariepinus)* merupakan ikan air tawar yang memiliki keunggulan, seperti pertumbuhan cepat, nilai ekonomis tinggi, mudah beradaptasi terhadap perubahan lingkungan, dan pemasaran relatif mudah. Penelitian ini bertujuan untuk menganalisis laju pertumbuhan, sintasan, dan kandungan nutrisi ikan lele dumbo setelah diberi perlakuan fotoperiod dan pakan yang berbeda. Penelitian ini dilaksanakan pada September s/d Desember 2022, di Laboratorium Kesehatan Ikan Sekolah Tinggi Perikanan dan Kelautan Matauli, Tapanuli Tengah. Metode yang digunakan adalah metode eksperimen dengan menerapkan Rancangan Acak Lengkap Faktorial, dua faktor dan tiga kali ulangan. Faktor pertama adalah fotoperiod (B), yaitu natural (B1), 18 jam gelap 6 jam terang (B2), 24 jam gelap (B3), dan faktor ke dua adalah jenis pakan (A), yaitu pakan komersil (A1) dan maggot (A2). Ikan uji yang digunakan diperoleh dari Balai Benih

Budidaya Ikan Tapanuli Tengah berukuran 16,01±0,02 cm dan bobot 30,00±0,00 g sebanyak 126 ekor. Ikan dipelihara selama empat minggu pada wadah pemeliharaan dengan padat tebar 1 ekor/10L. Pakan diberikan empat kali hari, yaitu pukul 06.00, 12.00, 18.00 dan 24.00 secara *ad satiation*. Hasil penelitian menunjukkan bahwa manipulasi fotoperiod dan jenis pakan berbeda memberikan pengaruh terhadap pertumbuhan dan sintasan benih ikan lele dumbo ($p<0,05$). Kombinasi fotoperiod 24 jam gelap dan pakan maggot (B3A2) memberikan hasil terbaik terhadap pertumbuhan bobot mutlak 22,70g, panjang mutlak 2,56 cm, laju pertumbuhan spesifik 2,01 %/hari, tingkat kelulushidupan 100%, dan kandungan nutrisi daging ikan, seperti protein 18,97%, lemak 8,68%, serat 0,73%, abu 1,54%, dan air 80,26%.

Kata kunci: Fotoperiod, Black Fly Soldier, Lele Dumbo

1. Introduction

African catfish (*Clarias gariepinus*) is a fishery commodity that has advantages, such as fast growth, high economic value, adaptability to the environment (Ciptawati et al., 2021; Asriani et al., 2018), and an increasing level of market demand. This can be seen based on data from the Ministry of Marine Affairs and Fisheries, the production of African catfish increased from 981,623 tons to 1.06 million tons (KKP, 2021). The high public demand for African catfish causes the fish to be widely cultivated. Increasing the effectiveness of catfish farming production can be done by manipulating the photoperiod to influence the eating behavior of fish. According to Warseno (2018), African catfish are nocturnal, actively moving in search of food at night. The longer the dark time, the longer the fish are actively looking for food so that feed intake becomes more. Increased feed intake will trigger increased fish growth (Maishela et al., 2013).

The growth of African catfish is also influenced by the quality of feed. Feed is a source of material and energy that plays an important role in the growth and survival of fish (Mahendra et al., 2022). In aquaculture, the cost of feed is one of the obstacles that are often encountered. Feed needs to reach 80 of the total operational costs (Van Doan et al., 2021), so good feed management is needed to save feed costs. Two types of feed are commonly used in aquaculture, namely artificial feed and natural feed.

Artificial feed is generally in the form of pellets that are widely available in the market, while natural feed is feed that is available in nature. The advantages of natural feed include high nutritional content, and easy digestion (Rihi, 2019). One type of natural feed is maggot (*Hermetia illucens* L), which is the larva of BSF (Black Soldier Fly) insects that undergo metamorphosis in the second phase and turn into adult flies. BSF fly larvae have a chewy texture, high protein, and can secrete natural enzymes that help improve the digestive system of fish (Suarjuniarta et al., 2021). According to Fauzi & Sari (2018), maggot contains quite high nutrients such as crude protein 41-42%, calcium 4.8-5.1%, ash 14-15%, and phosphorus 0.6-0.63%.

The application of a combination of different photoperiods and feed has been carried out in the rearing of selais (*Ompok hypophthalmus*) by Pratiwi et al. (2020). However, information regarding the application of photoperiod and different feeds in the rearing of African catfish has not been provided. Therefore, the authors are interested in researching the "Application of photoperiod manipulation and different feeds for the growth and survival of African catfish (*Clarias gariepinus*).

The purpose of this study was to analyze the growth rate, survival rate, and nutritional content of African catfish (*Clarias gariepinus*) after being treated with different photoperiods and feeds.

2. Material and Method

2.1. Time and Place

This research was conducted in September-December 2022, at the Fish Health Laboratory of the Matauli College of Fisheries and Marine Sciences, Central Tapanuli, North Sumatra. Meanwhile, proximate analysis was carried out at the Fishery Products Chemistry Laboratory, Riau University Pekanbaru.

2.2. Methods

The method used is an experimental method by applying a Factorial Randomized Complete Design (CRD), two factors, and three replicates. The first factor is photoperiod (B) and the second factor is feed type (A). The photoperiod treatment is as follows:

1. Natural Photoperiod (B1)
2. Photoperiod 18 hours dark 6 hours light (B2)
3. 24-hour photoperiod Dark (B3)

While the types of feed given, namely
1. Commercial Feed (A1)
2. Maggot (A2).

2.3. Procedure

2.3.1. Preparation of the Research Container

The container used during the rearing of African catfish seeds is an 80 L bucket of 18 units. Before use, the container is first cleaned using detergent to avoid microorganisms. After cleaning, the container is put into a dark tent for 24-hour dark photoperiod treatment, 18-hour dark, and 6-hour light treatment, the container is put into a dark tent with two 18-watt lights. While the natural photoperiod treatment was put into a transparent tent. Each container is equipped with an aerator to increase dissolved oxygen in the water. Furthermore, each container was filled with 70 L of water and allowed to stand for 2 days.

2.3.2. Preparation of Test Feed

The test feed used was commercial feed and maggot feed. The commercial feed used was All Feed-2 brand commercial pellets. The preparation of maggot feed is done by hatching maggot eggs as much as 20 g in a 50 L black bucket and giving 10 kg of fine bran as a medium. After hatching, the maggots were reared by feeding them with fish bones and wilted vegetables. After the maggot is 14 days old, the maggot is ready to be given as fish feed (Fauzi & Sari, 2018). Before being given the test feed, a proximate analysis was carried out to determine the nutritional content of the test feed (Table 1).

Table 1. Feed proximate analysis

Nutrient content	Type of feed	
	Commercial pellets	Maggot
Protein (%)	20,33	47,68
Fat (%)	3,67	5,69
Carbohydrate (%)	2,20	2,20
Crude fiber (%)	4,95	0,67
Ash (%)	5,32	2,96
Water (%)	63,53	40,80

Source: Analysis of Fishery Products Chemistry Laboratory, Riau University (2022)

2.3.3. Preparation and Maintenance of Test Fish

The test fish used were obtained from the Central Tapanuli Fish Farming Seed Center measuring 16.01 ± 0.02 cm and weighing 30.00 ± 0.00 g as many as 126 fish. African catfish fry was adapted for one week to avoid stress by being given commercial pellet feed without photoperiod treatment. Before being put into the research container, the test fish were first measured for length, weight, and nutritional content.

The test fish were reared for four weeks, with different photoperiod manipulations, namely natural photoperiod, 18 h dark photoperiod, 6 h light, and 24 h dark photoperiod. Each container was stocked with 1 fish/10L (Yunus et al., 2014). Food was fed four times a day, at 06:00, 12:00, 18:00, and 24:00 ad satiation, with commercial feed and maggot. Every seven days, sampling measurements of fish weight and length were taken.

2.4. Observed Parameters

2.4.1. Absolute weight growth

Absolute weight growth was calculated using the formula according to Effendie (2002), namely:

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

Description:

Wm = Absolute growth (g)

Wt = Average weight of fish at the end of the study (g)

Wo = Average weight of fish at the start of the study (g)

2.4.2. Absolute Length Growth

Absolute length growth was calculated using the formula according to Effendie (2002), namely:

$$\mathbf{P = Lt - Lo}$$

Description:

P = Length Growth (cm)

Lt = Final total length of fish (cm)

Lo = Initial total length of fish (cm)

2.4.3. Specific Growth Rate

According to Zonneveld et al. (1991), the specific growth rate calculation formula is :

$$LPS = \frac{\text{Ln Wt-Ln Wo}}{T} \text{ x } 100\%$$

Description:
LPS = Specific growth rate (%/day)
W0 = Average weight of fish at the beginning of the study (g)
Wt = Average weight of fish on day t (g)
T = Length of rearing (days).

2.4.4. Survival Rate

According to Effendie (2002), the survival rate can be calculated using the following formula:

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

Description:
SR = Survival rate (%)
Nt = Number of fish at the end of the study (fish)
No = Number of fish at the beginning of the study (fish)

2.4.5. Fish Meat Nutrition

Nutritional analysis of feed and test fish was carried out by proximate analysis of nutritional levels such as protein, carbohydrates, fat, crude fiber, ash, and water.

2.5. Data Analysis

Data obtained from measurements of length growth, weight, specific growth rate, survival rate, and nutrient content of African catfish were tabulated into tables and analyzed statistically using the SPSS version 22 application. If the treatment showed significant differences (p<0.05) then Student Newman-Keuls further test was conducted to determine the differences of each treatment. While water quality data were analyzed descriptively.

3. Result and Discussion

3.1. Growth Rate of African Catfish (Clarias gariepinus)

Measurements of the starting weight of african catfish reared for 28 days ranged from 8.60-22.70 g. The absolute weight of African catfish during the study is shown in Table 2. The absolute weight growth of African catfish during the study can be seen in Table 2.

Table 2. Absolute weight growth of African catfish raised with different manipulations of photoperiod and feed

Feed Type (A)	Photoperiod (B)			Average
	Natural (B1)	18 Hours Dark (B2)	24 Hours Dark (B3)	
Commercial (A1)	$8,60 \pm 0,094^a$	$10,07 \pm 0,16^c$	$9,55 \pm 0,13^b$	$9,41 \pm 0,65^a$
Maggot (A2)	$9,58 \pm 0,06^b$	$20,95 \pm 0,03^d$	$22,70 \pm 0,16^e$	$17,74 \pm 6,17^b$
Average	$9,09 \pm 0,54^a$	$15,51 \pm 5,96^b$	$16,12 \pm 7,21^c$	

Notes: Superscript in the same column and row indicates a significant difference (p<0.05).

Table 2 shows that the treatment of photoperiod manipulation and different feeding had a significant effect (p<0.05) on the absolute weight growth of African catfish. The combination of 24 hours of dark photoperiod and maggot feeding gave the best results (B3A2), which was 22.70 g, while the lowest weight growth was in the combination of natural photoperiod and commercial feeding (B1A1) at 8.60 g. This indicates that the combination of 24-hour dark photoperiod and maggot feeding gave the best results. This shows that the combination of 24-hour dark photoperiod and natural feeding (maggot) can increase the weight growth of African catfish. Following the opinion of Pratiwi et al. (2020) the combination of 24-hour dark photoperiod and natural feed can increase the weight growth of nocturnal fish.

Fish reared in natural photoperiod (B1) had lower body weight growth, which was 9.09 g than fish reared in 18-hour photoperiod (B2) of 15.51 g, and 24 hours of darkness (B3) of 16.12 g. The results of this study are following the results of Maishela et al. (2012). The results of this study follow the results of research by Maishela et al. (2013); Lubis et al. (2018); Magwa et al. (2020); Sihombing (2021); Windarti et al. (2021) which reported that the highest weight growth occurred in fish reared in the 24-hour dark photoperiod treatment. This happens because African catfish are nocturnal fish that are more active eating in dark conditions.

Feeding maggot (A2) also increased the weight growth of African catfish by 17.74 g, higher than the feeding of commercial pellets (A1), which was 9.41 g. The weight of the fish began to look different at week two, where the fish with maggot feed had higher body weight compared to the commercial feed. The weight of the fish began to look different in the second week, where the fish with maggot feed had a higher body weight compared to the commercial feed. At the end of the study, the body weight of maggot-fed fish was significantly different from that of commercially fed fish (Figure 1).

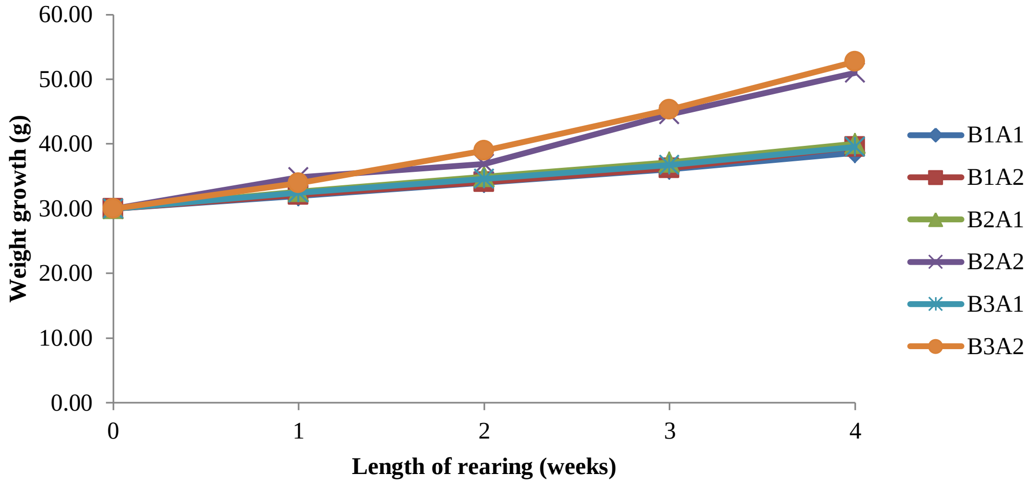

Figure 1. Weekly weight growth of African catfish reared with different photoperiod and feed manipulations.

The absolute length growth of African catfish reared with a combination of photoperiod and different feed types ranged from 1.02 to 2.56 cm. More details can be seen in Table 3.

Table 3. Absolute length growth of African catfish raised with manipulation of photoperiod and different feeds

Feed Type (A)	Photoperiod (B)			Average
	Natural (B1)	18 Hours Dark (B2)	24 Hours Dark (B3)	
Commercial (A1)	1,02±0,02[a]	1,55±0,08[c]	1,49±0,04[c]	1,36±0,26[a]
Maggot (A2)	1,39±0,07[b]	2,37±0,04[d]	2,56±0,03[e]	2,11±0,54[b]
Average	1,21±0,21[a]	1,96±0,45[b]	2,03±0,58[c]	

Notes: Superscript in the same column and row indicates a significant difference ($p<0.05$).

The data in Table 3 shows that the manipulation treatment had a significant effect ($p<0.05$) on the absolute length growth of fish. The combination of 24 hours of dark photoperiod and maggot feed (B3A2) gave the best results for the absolute length growth of African catfish, which was 2.56 cm. While the lowest in the combination of natural photoperiod and commercial feed (A1B1), which is 1.02 cm. This indicates that the combination of 24-hour dark photoperiod and natural feeding (maggot) can increase the length of growth of African catfish.

Performance length growth occurred in fish reared under 24 hours dark photoperiod conditions (B3) by 2.03 cm and 18 hours dark (B2) by 1.55 cm than fish reared under natural photoperiod conditions (B1). The results of this study are the results of research by Maishela et al. (2013); Lubis et al. (2018); Magwa et al. (2020) Sihombing et al. (2021); Windarti et al. (2021) which reported that the highest length growth occurred in fish reared in the 24-hour dark photoperiod treatment. Maggot (A2) gives the highest increase in fish length growth, which is 2.11 cm.

The high weight gain in fish fed with maggot feed occurs because maggot contains high protein. The protein content of maggot used during the study was 47.68% (Table 1). Protein is a nutrient needed to support fish growth, so by consuming protein fish get a very adequate protein intake so that fish can grow quickly. Sogbesan et al. (2017) stated that weight gain in fish is influenced by protein in the feed and fish convert it to form muscles.

According to Harlystiarini (2017), BSF larvae or maggots aged 15 days have a crude protein content of 36.6% and a low chitin content. The high chitin content in maggot skin can interfere with the digestive ability of fish. With increasing age, the chitin content in maggot skin is getting higher. Maggot is also rich in AMP *(*antimicrobial peptide*)* and has a high lauric acid content (49.18%), which can function as an antibacterial. According to Adeoye et al. (2020), BSF contains amino acids needed for fish, such as arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, tryptophan, and valine. Rohchimawati et al. (2022) stated that amino acids contained in feed protein, such as methionine, are indispensable for fish growth because they are precursors of nucleic acids, proteins, cartins, and choline. Methionine has an important role in increasing fat metabolism, so there is no accumulation of fat in the fish's body. The increase in fat metabolism is in line with the increase in amino acid metabolism which is utilized in protein synthesis, resulting in high protein stores in the fish body which are then used in increasing fish growth.

3.2. Specific Growth Rate of African Catfish

The specific growth rate of African catfish reared with a combination of photoperiod and different types of feed gives an influence ($p<0.05$) on the specific growth rate ranging from 0.90-2.01% / day. The specific weight growth rate of African catfish during the study can be seen in Table 4.

Table 4. The specific growth rate of African catfish raised with different manipulations of photoperiod and feed

Feed Type (A)	Photoperiod (B)			Average
	Natural (B1)	18 Hours Dark (B2)	24 Hours Dark (B3)	
Commercial (A1)	$0{,}90\pm0{,}01^{a}$	$1{,}03\pm0{,}02^{c}$	$0{,}98\pm0{,}01^{b}$	$0{,}97\pm0{,}06^{a}$
Maggot (A2)	$0{,}99\pm0{,}01^{b}$	$1{,}89\pm0{,}00^{d}$	$2{,}01\pm0{,}01^{e}$	$1{,}63\pm0{,}48^{b}$
Average	$0{,}95\pm0{,}05^{a}$	$1{,}46\pm0{,}47^{b}$	$1{,}49\pm0{,}56^{c}$	

Notes: Superscript in the same column and row indicates a significant difference ($p<0.05$).

Table 4 shows that the combination of 24-hour dark photoperiod manipulation and maggot feed (B3A2) produced the highest specific growth rate of 2.01%/day. The lowest was the combination of natural photoperiod and commercial feed (B1A1), which was 0.90%/day. This shows that the combination of 24-hour dark photoperiod and maggot feeding can increase the specific growth rate of African catfish.

Photoperiod manipulation gave a significant effect ($p<0.05$) on the specific growth rate of African catfish. The 24-hour dark photoperiod (B3) produced the best specific growth rate, which was 1.49%/day higher than the 18-hour photoperiod (B2) and natural (B1), which were 1.46%/day and 0.95%/day, respectively. The results of this study follow Setiawan et al. (2015) which showed the highest percentage of nocturnal fish-specific weight growth rate was seen in the photoperiod treatment (24 hours dark, 0 hours light) compared to other photoperiod treatments. This is likely because nocturnal fish are kept in dark conditions, calmer, and do not swim much to expend energy, so the nutrients absorbed by the body are more allocated to the growth of fish, this is what causes the growth of fish reared in a much faster than fish reared in no light or natural photoperiod treatment. Fujaya (2004) stated that growth can be influenced by the environment. In this study, environmental conditions were manipulated by adjusting the length of light and dark time and African catfish grew better in continuous dark conditions.

Differences in the type of feed also provide an influence between treatments ($p<0.05$) on the specific growth rate of African catfish. Giving maggot (B2) produces the highest specific growth rate, which is 1.63% / day higher when compared to dumbo catfish given commercial feed (0.97%). This occurs because the nutritional content is sufficient for the feeding needs of African catfish. According to Veldkamp & Bosch (2015), the nutrients contained in BSF meal are similar to soybean meal, especially the methionine content which is an essential amino acid for livestock and fish growth. Zannah (2019) stated that methionine is an essential amino acid that is indispensable for fish growth because it is a precursor of nucleic acids, proteins, cartins, and choline, in addition to growth methionine is also related to immune responses in several types of fish. Furthermore, maggots also can help improve the digestive system of fish. A high digestive system causes faster absorption of nutrients and faster growth. This is the opinion of Fauzi & Sari (2018) which states that maggots can secrete natural enzymes that help improve the digestive system of fish.

3.3. Survival Rate

In this study, photoperiod did not affect fish survival. Fish kept in natural photoperiod conditions, 18 hours of darkness, and 24 hours of darkness can both live well without any death, or fish survival in all treatments reaches 100%. This is following the research of Windarti et al. (2021) which shows that photoperiod manipulation does not affect the survival rate of catfish. Fish reared with natural photoperiod, 18 hours of darkness and 24 hours of darkness can live well without any dead fish. This high fish survival rate occurs because African catfish in this study are nocturnal fish and naturally live in a dark environment. According to Sihombing et al. (2021); Warseno (2018) catfish including African catfish are active in dark conditions. So dark environmental conditions for a long duration of time do not affect fish survival.

3.4. Fish Meat Nutrition

The results of the nutritional analysis of African catfish reared with the application of photoperiod and different types of feed provide an influence between treatments ($p <0.05$) on protein content. However, there was no effect ($p>0.05$) on the content of fat, fiber, ash, water, and BETN in the meat of African catfish. The highest protein content in the combination of 24-hour dark photoperiod and maggot feed type (B3A2) was 18.97%. While the lowest in the combination of natural photoperiod and commercial pellets (B1A1) at 10.41%. Nutritional analysis of African catfish meat is presented in Table 5.

Table 5 shows that there was an increase in nutrients in catfish meat compared to fish meat nutrients at the beginning of the study, such as protein, fat, carbohydrates, and ash. This is due to the influence of the feed nutrients given, both commercial pellets and maggot nutrition. According to Bimantara (2018), feed utilization can affect the growth, nutrient absorption, and proximate value of fish meat. The increase in nutrients such as protein depends on the ability of the fish to absorb and convert nutrients from the feed. Based on Table 1, the fat content of the maggot used was twice as high as that of the commercial feed. This indicates that the nutrient content of the feed can affect the fat content of the fish meat. According to Fabiola & Marta (2012), fat content in fish meat can be affected by water quality, feed type, and fish species

Table 5. Nutritional analysis of African catfish meat

Treatment	Nutrient content (%)					
	Protein	Fat	BETN	Fiber	Ash	Water
Initial	10,33	3,35	1,52	0,61	1,08	83,11
B1A1	10,41±0,49[a]	4,60±1,10	4,12±0,58[b]	1,17±0,01	1,26±0,15	80,84±0,07
B1A2	12,36±0,69[b]	4,60±2,53	1,83±1,57[b]	1,10±0,15	1,78±0,19	78,69±1,13
B2A1	12,46±0,27[b]	4,74±0,59	3,79±0,64[a]	1,02±0,02	1,67±0,04	77,54±0,39
B2A2	12,73±0,38[b]	6,31±2,53	1,07±0,36[a]	0,92±0,36	1,81±0,12	75,77±1,17
B3A1	14,14±0,18[c]	6,58±1,84	1,05±0,50[a]	0,87±0,23	2,59±1,03	71,31±0,44
B3A2	18,97±0,73[d]	8,68±4,88	0,57±0,36[a]	0,73±0,01	1,54±0,17	68,38±1,02

The protein (14.69%) and fat (6.53%) content of African catfish meat fed with maggot feed (A2) is higher than that of fish fed with commercial feed (A1), which is 12.33% protein and 5.30% fat. This is by the results of research by Xiao et al. (2018), giving BSF produces a protein in yellow catfish meat (*Pelteobagrus fulvidraco*) of 14.1% higher than fish given commercial feed, which is 13.8%. According to Poernomo et al. (2015), high meat protein content indicates the amount of protein stored in the meat is increasing and affects the texture of the resulting fish meat. Meanwhile, the carbohydrate, fiber, and ash contents of the maggot-fed diet were lower than the carbohydrate, fiber, and ash contents of the commercial diet

4. Conclusions

Based on the results showed that the manipulation of photoperiod and different types of feed influences the growth and survival of African catfish fry ($p<0.05$). The combination of 24 hours of dark photoperiod and maggot feed (B3A2) gave the best results on the growth of absolute weight 22.70g, absolute length 2.56 cm, specific growth rate 2.01%/day, 100% survival rate, and nutritional content of fish meat, such as protein 18.97%, fat 8.68%, fiber 0.73%, ash 1.54%, and water 80.26%.

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