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Survival and growth of *Pangasianodon hypophthalmus* cultured under controlled photoperiod

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ABSTRACT

Changes in the photoperiod duration affect the physiology of nocturnal fish such as *Pangasianodon hypophthalmus*. Therefore this study aims to evaluate the effects of controlled photoperiod on survival and growth of *P. hypophthalmus*. This study was conducted from June to August 2020, and Three treatments were applied, namely natural photoperiod, as well as 18 and 24 hours dark (18D and 24D) with three replications in each treatment. Meanwhile, the rearing tanks used were 100L circular plastic tanks. Furthermore, in the 24D treatment, the tanks were placed under a dark-colored tarp tent continuously. Meanwhile, in the 18D, the tanks were also placed under a dark tarp tent, but the tent was opened for 6 hours/day (the tanks were in dark condition for 18 hours/day). The control tanks were placed under natural photoperiod. *P. hypophthalmus* fingerlings, 6-8 cm TL and 4-5g BW were used in this study. Thirty fishes were reared in each rearing tank and fed with commercial pellets, two times/day, ad libitum. Fish survival was monitored every day, while samplings for growth were conducted weekly for eight weeks. The results showed that fish survival was 100% in each treatment, but growth indicated differences. The growth of fish reared in the 24D and 18D was better than the control. At the 9th week, the fish in 24D was about 70.71g BW with 19.27 cm TL (daily growth rate 9.35%), while others in the 18D were 69.41 g BW, 18.77 cm TL, and 9.29% daily growth rate. The fish reared under natural photoperiod was about 61.95 g BW with 18.19 cm TL and 7.33% of daily growth rate. Furthermore, based on the results, the application of more prolonged dark conditions positively improves *P. hypophthalmus*.

Introduction

Pangasianodon hypophthalmus is one of the most favored fish in Riau and has been commonly cultured (Rumimpunu, 2017). There is an upward trend in production with 373,245 tons in 2018 which increased to 476.208 in 2019. Also, the national production seems to be increasing and might reach 1.200.000 tons in 2020 (KKP, 2020).

In Riau markets, *P. hypophthalmus* has a relatively high economic value, around Rp 30.000/Kg approximately $ 2 USD). Meanwhile, to fulfill the needs of the fish, intensive aquaculture efforts have been conducted (Makmur, 2003). In the Kampung Patin, Kampar, several people culture this fish in earthen or concrete ponds.

In fish culture, especially for *P. hypophthalmus*, the operational cost mostly spent is for providing feed during the culture. To reduce this cost, the effectiveness of the culture method has to be improved. Magwa (2020) stated that manipulated photoperiod is applicable to increase the effectiveness of the culture. By applying short photoperiod 24 and 18 hours dark, the fish showed positive response to feed provided (Magwa, 2020) and relatively less active in swimming (Windarti *et al*., 2019). Similar results were also obtained in other nocturnal fishes such as *Clarias batracus* (Lubis, 2018) and *Ompok hypophthalmus*

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(Sari, 2017).

Given that *P. hypophthalmus* is a nocturnal fish that actively search for food in the night (Kordi, 2005), applying short photoperiod might be effective to boost the growth of the cultured fish.

Materials and Methods

Location and time of research

This study was conducted from May to July 2020 at the Aquatic Biology Laboratory of the Fisheries and Marine Science Faculty, Riau University. The Completely Randomized Design (CRD) method was applied with 3 treatments, namely 24 and 18 hours dark (24 and 18D), as well as natural photoperiod as control (Nat) with 3 replications/ treatment. Furthermore, the fish was reared in 120 L circular plastic tanks (filled with 100 L water and completed with aerator and recirculation pumps). The density was 30 fishes/ tanks (6-8 cm TL and 4-5 g BW), meanwhile, prior to the treatment, the fish were acclimated for 7 days. Afterwards, the fish were cultured for 56 days and were feed 2 times/day, in the morning and evening, ad libitum. The feed provided, F999 contain 38-42% protein and 4-6% fat (in the 1st-4th week). As the fish grew, the feed was replaced with F781-1 (5th to 6th week) and F781-2 (7th to 9th week) which contain 18% protein.

Absolute growth of weight

Samplings for growth in weight and total length were conducted once/week. In each sampling, 3 fishes from each tank were measured and returned to the tank after measurements, meanwhile, growth was calculated using this formula according to Effendi (2002):

$$Wm = Wt - Wo$$

Explanation: Wm = Absolute Growth of Weight (Total growth) (g); Wt = The average of fish weight by the end of the study or in the 56th day (g); Wo = The average of fish weight before the treatment/baseline (g).

Relative growth of fish length (total length)

The length increment of the fish during the study was calculated based on Effendi (2002):

$$PP = (Lt - Lo) / Lo$$

Explanation: PP = Length increment (cm); Lt = Total length by the end of the study (cm); Lo = Initial (baseline) of total length (cm).

Condition factor

Samplings for condition factors were conducted prior and post treatment (56th day). The condition factor was calculated based on Effendi (2002):

$$K = \frac{W}{SL^3} x\ 10^5$$

Explanation: K= Condition factor; W =The average of body weight by the end of experiment (g); SL^3= The average of total length by the end of experiment (cm); 10^5 = Constant value.

Data analysis

The data obtained were analyzed using *Analysis of variance* (ANOVA). When there is a significant difference, the *Duncan* test was applied using SPSS version 23.

Results

Growth

The data on growth of *P. hypophthalmus* reared under controlled photoperiod showed that the body weight and total length under 18D and 24D were significantly higher than the Natural, while the condition factor of the 18D fish was higher compared to 24D and natural (Table 1 and Figure 1).

The ANOVA test showed that there was a significant difference in growth total length, weight, and condition factor of fish reared under different photoperiod (Figure 1).

Total length

The total length increased significantly during the 8 weeks study (Figure 2).

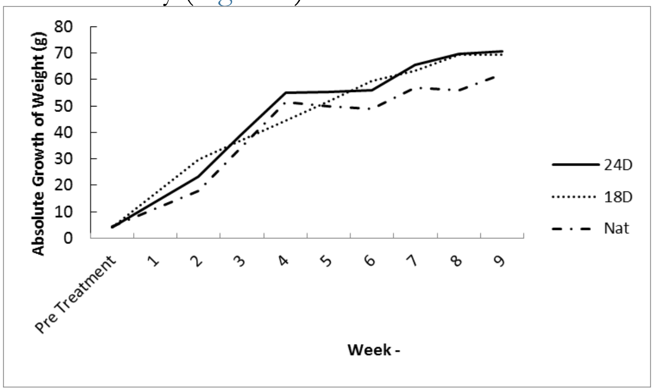

Figure 1. Absolute growth of weight of *P. hypophthalmus* cultured under different photoperiod.

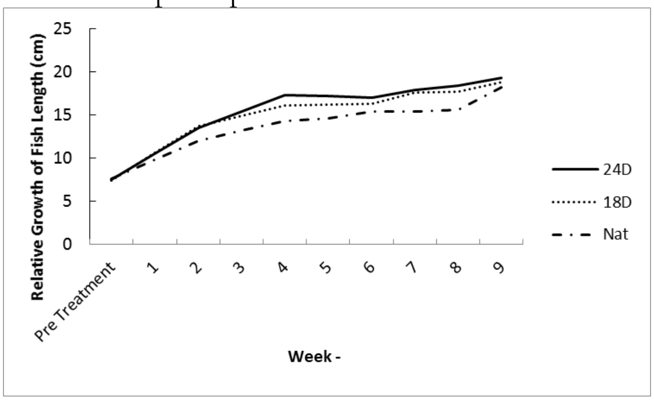

Figure 2. Relative growth of *P. hypophthalmus* length during the study.

Table 1. Absolute growth of weight, relative growth of fish length and condition factors of *P. hypophthalmus* cultured under controlled photoperiod.

No	Parameters	Photoperiod		
		24D	18D	Natural
1	Absolute growth of Weight (g)	74.06 ± 12.29[b]	72.75 ± 5.36[b]	58.61 ± 11.66[a]
2	Relative Growth of Fish Length (cm)	19.28 ± 1.16[b]	18.77 ± 0.81[b]	17.73 ± 0.72[a]
3	Condition factor	1.03 ± 0.01	1.06 ± 0.02	1.01 ± 0.01

Mean with standard error followed by different letters are significantly different (P<0.05).

Table 2. Water quality parameters of rearing tanks of (*P. hypophthalmus*) reared under controlled photoperiod.

No	Parameters	Unit	Controlled photoperiod		
			24D	18D	Nat
1	Nitrate	mg/L	4.54 ± 0.86	3.89 ± 1.03	2.73 ± 1.33
2	Phosphate	mg/L	64.89 ± 9.00	59.72 ± 0.34	59.00 ± 23.50
3	Ammonia	mg/L	6.05 ± 1.46[b]	5.34± 0.61[b]	2.60 ± 1.62[a]
4	BOD5	mg/L	35.22 ± 16.93	44.17 ± 6.21	47.54 ± 19.59
5	Temperature	^{O}C	29.67 ± 0.58	29.00± 1.00	28.67 ± 0.58
6	DO	mg/L	4.50 ± 1.60	5.73± 2.55	5.99 ± 2.15
7	pH	-	5	5	5

Mean with standard error followed by different letters are significantly different (P<0.05).

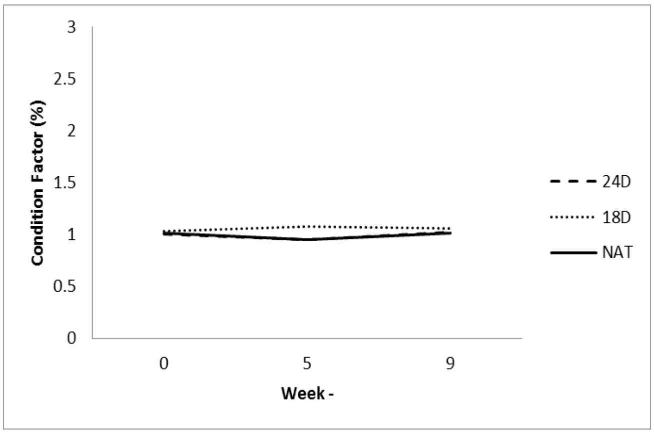

Figure 3. Condition factor of *P. hypophthalmus* reared under controlled photoperiod.

Condition factor

Condition factor of *P. hypophthalmus* reared under controlled photoperiod is presented in Figure 3.

Water quality

Data on water quality such as Nitrate, Phosphate, Ammonia, BOD5, Temperature, DO and pH are shown in Table 2.

Discussion

Absolute growth of weight

The graph in Figure 1 shows that there is an upward trend of growth. Meanwhile, the average baseline of body weight was 4.29 g, and increased to 67.35g by the end of experiment.

The lowest growth was in fish treated with natural photoperiod, amounting to 58.61 gr /fish, while the highest was found in continuous dark (24D) amounting to 74.06 g/fish. Besides, the fish reared under Natural had longer photoperiod compared to other treatments. Given that the presence of light triggers active swimming (Syafri, 2016; Windarti *et al.*, 2019), the fish tends to spend more energy for swimming thereby, allocating less energy for growth, therefore, growth was lower compared to fish reared in 18D and 24D treatments.

The highest growth was found in the continuous dark (24D), but it was not significantly different from the 18 hours dark treatment.

The ANOVA test showed that the controlled photoperiod positively affect the growth of P. hypophthalmus. Furthermore, given that it is a nocturnal fish, rearing under continuos dark might be more effective in feeding the pellets provided and tends to allocate more energy for growth, hence, it grow better (Magwa, 2020).

Maishela *et al.* (2013) stated that during the dark, nocturnal fish are more active in feeding and movement. The longer the dark duration, the longer the fish feeding activity, higher food intake and faster growth.

Relative Growth of Fish Length

Figure 2 shows that the length increased significantly in all treatments during the study. The fish reared under 24 and 18 hours dark as well as natural photoperiod increased to 19.28 cm; 18.77 cm and 17.73 (19.27 cm; 18.77 cm and 18.19 cm) respectively.

However, the ANOVA test (P<0,05) showed that the 24 hours dark treatment had the best performance while the Duncan test indicated significant difference for 18 hours dark and natural.

The total length was affected by the amount and quality of food intake as well as the energy spent for various activities such as movement. Hermawan *et al.* (2015) stated that provision of sufficient feed increase fish growth. Furthermore, given that *P. hypophthalmus* reared under dark condition consume more feed (Magwa, 2020; Lubis, 2019), and relax more (Syafri, 2016; Windarti *et al.*, 2019), it grew better compared to others reared under natural photoperiod. *P. hypophthalmus* reared under dark condition and fed with turmeric enriched pellets also grew better compared to natural condition (Magwa, 2020).

The total length and growth pattern of fish in all treatments showed similar patterns. From the 1st to 4th weeks, there was rapid growth which then decreased starting from the 5th week. This growth patterns was probably due to the changing of feed provided. During the 4 weeks of experiments, the fish were fed with F999 pellets which contain about 38-42% protein and 4-6% fat. Meanwhile, during the following weeks, the feed was changed to F781-1 and F781-2 which contain less protein (18 % protein) (31-33% protein and 4-6 fat). The decrease in the growth rate observed probably relate to protein consumption. Cahyadi (2019) stated that decreased protein intake reduced the growth, especially in carnivorous fish such as *P. hypophthalmus*. Moreover, there was no difference in the growth pattern in all treatments, indicating that the growth rate is not due to the photoperiod treatments applied.

Condition factor

Figure 3 shows that condition factor in all treatment showed no differences. The condition factor was almost steady from the 1st to the 9th week of experiment in all treatments. Furthermore, the condition factors the 24D, 18D and Natural conditions were 1.03±0.01, 1.06±0.02, and 1.01±0.01, respectively. These data indicate that the fish in all treatments have similar growth pattern and body shape.

Effendi (1997) stated that the condition factor indicates the body shape of the fish, while Rahardjo (2007) stated that the condition factor index do not indicate the physiological condition, but it shows the body shape in general. Condition factor less than 2 indicates that the fish is not fatty, but rather elongated. Alterations in the condition factor affected the intrinsic (gonad development and fat accumulation) as well as extrinsic factors such as feed and environmental condition (temperature and photoperiod). The fish were about 3 months old, before sampling and might probably be yet to reach maturity thereby leading to undeveloped gonad. Sah *et al.* (2018) and Mian *et al.* (2019) stated that the age of maturity for *P. hypophthalmus* is around 2.5 to 3 years. Given that there was no difference in the condition factor for all treatments, it was concluded that controlled photoperiod do not affect the condition factor.

Junaidi *et al. in* Sogbesan *et al.* (2017) stated that the condition factor might be used to understand the health status of fish. High condition factor indicates that the fish is well fed and the environmental condition is suitable for life. Meanwhile, low condition factor indicate distress due to feeding or environmental factors.

The condition factors in all treatments were relatively the same and ranged from 1.01 to 1.06. This indicates that the photoperiod treatments applied did not affect the condition factor.

Water quality

Rearing fish in enclosed tanks results in the presence of organic materials which originate from metabolic waste and feed remains, this greatly affects the water quality. The accumulation of these organic materials tends to reduce water quality and affects the fish life in general. Besides, the ANOVA test (Table 2) shows that the water quality of the rearing tanks treated with controlled photoperiod were relatively good. There were no differences in the Nitrate and Phosphate content, as well as BOD5, DO, pH and temperature.

The only difference was found in the ammonia content, which was higher in the 24D and 18D treatments (5.34-6.05 mg/L). This was categorized as normal but was higher compared to natural photoperiod treatment. Meanwhile, the difference in the ammonia content is probably due to the presence of phytoplankton that uses organic matters for growth. In tanks placed under natural photoperiod, phytoplankton tends to thrive using organic matters for supporting live, thereby reducing the organic matter as well as the ammonia content in the water. In contrast, there was almost no phytoplankton growth under dark condition, hence, there were no organisms using the organic matters, therefore it might accumulate in rearing tanks.

The water temperature ranged from 28-29°C, and it supports the fish life. Subagja (2009) stated that the suitable water temperature for *P. hypophthalmus* ranges from 25 to 33 °C. Other parameters such as pH (5) and DO (4-6 ppm) were also normal. Adriyanto *et al.* (2012) and Khairuman and Sudenda (2002) stated that the optimum pH for *P. hypophthalmus* was 6.5-9.0 while the DO was 5 mg/L. These data indicate that the rearing media for *P. hypophthalmus* in all treatments are suitable to support the fish life.

Conclusion

Based on the results, controlled photoperiod affects the growth of *P. hypophthalmus* in general. The fish reared under long dark condition (18 and 24 hours dark) had better growth compared to natural photoperiod. Moreover, water quality parameters such as temperature, pH, DO and BOD5 were not affected by the treatment, but the ammonia content in 18- and 24-hours dark condition were relatively higher compared to the natural.

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