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Survival and Growth of *Pangasianodon hypophthalmus* Fed with *Moringa oleifera* Enriched Pellets and Reared in Tank with Aquaponic System and Dark Condition

Kelulushidupan dan Pertumbuhan *Pangasianodon hypophthalmus* yang Diberi Pakan Pelet Diperkaya *Moringa oleifera* dan Dipelihara pada Bak dengan Sistem Akuaponik dan Kondisi Gelap

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ABSTRACT

Pangasianodon hypophthalmus grows well in a dark tank completed with an aquaponic system. To improve the growth, a feed supplement made from *Moringa oleifera* might be used as it is rich in protein, vitamins A, B, C, and minerals. To understand the effect of *M.oleifera* addition in the feed of fish, research has been conducted in June-July 2022. *M. oleifera* leaves were dried and powdered and then mixed with commercial fish feed pellets. There were 4 treatments of *M. oleifera* dosages, namely T0 (no *M. oleifera*), T1 (10 g/kg), T2 (15 g/kg), and T3 (20 g/kg). The fish was reared in a 100L container (30 fishes/tank, around 4 g BW and 8 cm TL), covered with a dark-colored tarp, and completed with the aquaponic system using *Ipomoea aquatica*. The feed was given 2 times/day, *ad libitum*. Samplings were conducted once/10 days, for 40 days. Results showed that the survival of fish in all treatments was 93.3 – 98.89%. The growth of fish, however, was different. There was no difference in fish body weight (BW), total length (TL), and specific growth rate (SGR) of fish fed with Moringa, they were around 23.5 g BW, 5.8 cm TL, and 4.3 cm SGR respectively. While those of the control fish were 13.0 g BW, 4.23 cm TL, and 2.89% per day SGR respectively. The fish that was fed with Moringa-enriched pellets showed the highest Feed Efficiency (90.42-97.46%) and the lowest FCR (1.03 – 1.11). While in the fish that was not fed with Moringa showed the lowest FE (75.48%) and the highest FCR (1.33%). Data obtained indicate that *Moringa* positively improves the growth of fish as well as improving feed efficiency.

Keywords: Moringa Powder, Supplement, FCR, Specific Growth Rate

ABSTRAK

Ikan patin tumbuh dengan baik di bak gelap yang dilengkapi dengan sistem akuaponik. Untuk meningkatkan pertumbuhan dapat digunakan suplemen pakan berbahan dasar kelor (*Moringa oleifera*) karena kaya akan protein, vitamin A,B,C dan mineral. Untuk mengetahui pengaruh penambahan kelor pada pakan ikan telah dilakukan penelitian pada bulan Juni-Juli 2022. Daun kelor dikeringkan dan dijadikan bubuk, kemudian dicampur dengan pelet pakan ikan komersial. Pemberian dosis daun kelor ada 4 perlakuan, yaitu T0 (tanpa daun kelor), T1 (10 g/kg), T2 (15 g/kg), dan T3 (20 g/kg). Ikan dipelihara dalam wadah berukuran 100L (30 ekor/wadah, berat sekitar 4 g BB, dan TL 8 cm), kemudian ditutup dengan terpal berwarna gelap dan dilengkapi dengan sistem akuaponik menggunakan *Ipomoea aquatica*. Pakan diberikan sebanyak 2 kali/hari, secara ad libitum. Pengambilan sampel dilakukan sekali/10 hari, dengan lama pemeliharaan 40 hari. Hasil penelitian menunjukkan bahwa kelulushidupan ikan pada semua perlakuan adalah 93,3 – 98,89%. Namun, pertumbuhan ikan berbeda. Tidak ada perbedaan berat badan ikan (BB), panjang total (TL), dan laju pertumbuhan spesifik (SGR) ikan yang diberi kelor, masing-masing sekitar 23,5 g BB, 5,8 cm TL dan 4,3 cm SGR. Sedangkan ikan kontrol masing-masing 13,0 g BB, 4,23 cm TL, dan 2,89% SGR per hari. Ikan yang diberi pakan pelet diperkaya daun kelor menunjukkan efisiensi pakan tertinggi (90,42-97,46%) dan FCR terendah (1,03 – 1,11). Sedangkan pada ikan yang tidak diberi kelor menunjukkan efisiensi pakan terendah (75,48%) dan FCR tertinggi (1,33%). Data yang diperoleh menunjukkan bahwa kelor secara positif meningkatkan pertumbuhan ikan serta meningkatkan efisiensi pakan.

Kata Kunci : Tepung Kelor, Suplemen, FCR, Laju Pertumbuhan Spesifik

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INTRODUCTION

Pangasianodon hypophthalmus is a type of freshwater fish that is very common in Riau. This fish used to be sold fresh or smoked and dried. Many of Riau's traditional cuisines use this fish as the main ingredient. As the demand for fish is relatively high, this type of fish is commonly cultured using floating net cages in the dam as well as in the river and also being cultured in ponds.

To improve fish production, the most common effort conducted by the fish farmers is providing a lot amount of feed or feeding the fish at satiation. Application of this method in fish culture may boost fish growth, but there are several negative impacts occur. As a high amount of fish feed pellets is provided to the fish, the fish feed cost became high and it increases the operational cost as well as the Food Conversion Rate of the culture that means reduces the benefits of the culture. Another negative impact of the *ad libitum* fish feeding method is the presence of a high amount of uneaten feed that pollute the water. In household-scaled fish rearing, the presence of uneaten feed also worsens the water and thus it needs to be replaced frequently.

A cheap and environmental save effort that has been applied to improve the growth of *P. hypophthalmus* is by rearing the fish using a manipulation photoperiod or rearing the fish in short photoperiod or dark conditions. Syafri *et al.* (2016); Magwa *et al.* (2020); Windarti *et al.* (2021) that rearing nocturnal fishes such as *Ompok hypopthal*mus and *P. hypopthalmus* in short photoperiod stated that those fishes grew better than those of the fish reared in the long or natural photoperiod. This method is very easy and cheap to be applied; the rearing tanks may be placed under a dark tarp tent (Windarti *et al.*, 2016) or covered by a dark-colored tarp (Magwa *et al*., 2020 ;Windarti *et al*., 2021) to create the dark condition.

Even though the nocturnal fish can grow well in dark conditions, the water quality of the media tends to be worsened. As phytoplankton do not grow in dark conditions, the organic materials present are not been absorb and they may be accumulated in the water and thus reduce their quality. Windarti *et al.* (2021) solved the problem by setting up an aquaponics system in the tank that was used to rear the fish in dark conditions. The water was flown to the aquaponics system using a circulation pump. By using this method, the water quality was maintained as the organic materials in the water were absorbed by plants used in the aquaponic system, and the cleaned water was returned to the rearing tank.

Another problem in rearing fish in the dark condition is the lack of sunlight that is needed to destroy germs and microorganisms. As the photoperiod treatments do not affect the immunity nor the hematology of fish (Windarti *et al.*, 2021), the fish reared in the dark may face the danger of microorganism attack. Windarti *et al.* (2021) find out that *P.hypophthalmus* reared in the dark condition is vulnerable to the attack of pathogen microorganisms such as *Aeromonas hydrophila*. The microorganism's attack may be fatal when the fish has a low immunity system and do not able to combat the pathogen. In contrast, a pathogen attack may not fatal when the fish have a good immunity system and can defend themselves against pathogen attack. Therefore, rearing fish in dark conditions may be more effective if the fish's health and immunity are also boosted.

One of the natural sources that have been used to improve the health of fish is *Moringa oleifera* leaves. Fish that was fed with *M. oleifera* enriched pellet performed better immunity (Azhar *et al*., 2021; Bbole *et al*., 2016; Helmiati *et al*., 2011) as well as better growth (Helmiati *et al*., 2011). Moringa leaves is a nutritious food resource, they contain protein, vitamin A, B, C, and minerals. Helmiati *et al*. (2011) stated that Moringa leaves also contain beta-carotene, flavonoid, saponin, and alkaloid that can boost the immune activities of the fish. The addition of 20% fermented Moringa leaves in fish feed pellets increases the hematocrit and leukocyte levels increase the phagocytosis activities, diminish the monocyte, and improves the lymphocytes and plasma's protein. The moringa leaves can be cooked as a vegetable and can be used as food for rabbits, poultry, ruminants, and pigs (Heuze *et al*., 2016). In fish culture, the addition of 7% moringa leaves in fish feed pellets increases 0.12% of the specific growth rate of *Oreochromis niloticus* (Astiyani *et al*., 2020).

As the fish that are reared in the dark condition is more vulnerable to pathogen attack, the immunity of the fish should be improved and Moringa leaves enriched pellets might be used to feed the fish. By combining the photoperiod manipulation, applying the aquaponic system, and feeding the fish using the Moringa enriched pellets, the fish culture may become more effective. By consuming those pellets, the fish's growth, health, and survival will be improved. However, there is no information on the effectiveness of the Moringa-enriched pellets in improving the growth and survival of *P. hypophthalmus* and thus a study titled "Survival and growth of *Pangasianodon hypophthalmus* fed with *Moringa oleifera* enriched pellets and reared in the tank with aquaponic system and dark condition" is needed to be conducted.

MATERIALS AND METHOD

This study was conducted for around 2 months period, from June to July 2022, in the Aquatic Biology laboratory, Fisheries and Marine Science Faculty, Riau University Pekanbaru. As the results from the research before showed that *P. hypopthalmus* grew better in the tank with the dark condition and *I. aquatica* aquaponic system, in this research all of the rearing tanks were set for dark treatment with the aquaponic system. The treatment applied was the Moringa dosages. There was a CRD design with four treatments, namely:

Control (C): commercial pellets with no Moringa addition
T1: 10 grams of dried Moringa powder in 1 kg fish feed pellets
T2: 15 grams of dried Moringa powder in 1 kg fish feed pellets
T3: 20 grams of dried Moringa powder in 1 kg fish feed pellets

There were 3 replications for each treatment, and in total there were 12 fish-rearing tanks. The design of the fish-rearing tank is as follows (Figure 1):

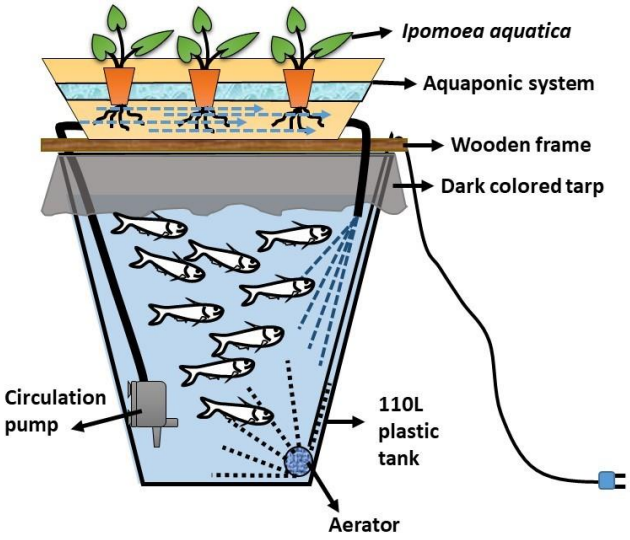

Figure 1. The design of the fish-rearing tank

The fish used in this study was fingerling of *P.hypophthalmus* (around 4 g BW and 6 - 8 cm TL). The fish reared in the tank, 30 fishes/ tank and were fed with commercial pellets produced by PT Central Proteina Prima, type F999 (1^{st} – 3^{rd} week) and F 781-1 (after 3^{rd} week), 2 times/ day (in the morning and evening), *at satiation*. Each rearing tank was completed with a circulatory pump and an aquaponic system using the *I. aquatica* plant.

The tank used in this study was a circular plastic tank, 110 L volume, aerator pump, and aquaponic unit (18L circular plastic bowls, styrofoam, net pot, and *I. aquatica* seed). The bowl and styrofoam were modified to place the net pot. A piece of rock wool was placed in each net pot for Ipomoea media. The aquaponics system used in this study was a DFT (*Deep Fall Technique*). The water from the tank was pumped to the aquaponic unit using a circulatory pump. The water was flown through the aquaponic media and the organic matter may be absorbed by the plant. The water was then flown back to the tank.

The Moringa leaves used in this study were obtained from the *M. oleifera* tree that grows naturally in the backyard of the author's house and it has never been fertilized nor sprayed with pesticides. The leaves were taken, dried and blended in a blender, and then sieved. The Moringa powder was then coated into the pellets using the following method:

a. 20 grams of tapioca powder was mixed with around 50 ml of water
b. The mixture of tapioca and water was then added with around 100 ml of very hot boiling water and was mixed well to form a thick-sticky mixture of Moringa and tapioca powder
c. The mixture was then mixed well with 1 kilogram of fish feed pellets
d. The moringa-enriched pellets were sun-dried and then kept in containers and ready for feeding the fish.

In this study, the parameters measured were as follows: survival rate, growth rate, and FCR. The fish was reared for 40 days and samplings for fish growth were conducted once/ 10 days. The survival of the fish was monitored 2 times per day. During the feeding time in the morning and in the evening, the presence of dead fish

was monitored. To monitor the growth of the fish, once/in 10 days, three fish from each tank were taken randomly. Their total length was then measured using a ruler and they were weighed using a digital scale. The length and weight of the fish were noted.

The FCR of the fish in this study was calculated by the end of the research, on the 40th day. The fish was fed *at satiation*, but the amount of feed given to the fish was monitored. A bottle filled with a certain amount of feed pellets was provided for each tank. The amount of addition of feed pellets in the bottle was noted. By the end of the experiment, the fish feed pellets that remained in the bottle were weighed and the total amount of feed consumed by the fish during the experiment can be calculated. This amount of feed was used as a basis for calculating the FCR of fish in each treatment.

The absolute growth of the fish was calculated using the following formula:

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

Explanation:
Wm = Absolute Growth (g)
Wt = The average fish weight by the end of the research (g)
Wo = The average fish weight on the initial day of the research (g)

The Specific growth rate was calculated using the following formula:

$$\mathbf{SGR} = \frac{Ln\,Wt - LnWo}{t}\ x\ \mathbf{100\%}$$

SGR = Specific Growth Rate (%/day),
Wt = the final body weight (g),
Wo = the initial body weight (g),
t = the duration of the experimental period (days).

The Food Efficiency was calculated using the following formula:

$$\mathbf{FE} = \frac{(Wt+d) - Wo}{F}\ x\ \mathbf{100\%}$$

Explanation:
FE = Food Efficiency
F = The weight of food consumed during the fish-rearing period
D = The weight of dead fish during the rearing period
Wt = Total weight of fish by the end of the rearing period
Wo = Total weight of fish on the initial day of the rearing period

The food Conversion Rate was calculated using the following formula

$$\mathbf{FCR} = \frac{F}{(Wt+D) - Wo}$$

Explanation:
FCR = Food Conversion Rate
F = the total weight of food consumed during the fish-rearing period
D = the weight of dead fish during the rearing period
Wt = Total weight of fish by the end of the rearing period
Wo = Total weight of fish on the initial day of the rearing period

RESULT AND DISCUSSION

During the research, the survival rate of fish in all treatments was high, from 93.33 – 98.89%. Fish in all treatments were actively swimming and do not show any sickness clinical signs or abnormality. This fact indicates that the rearing system applied in this research is good; the facilities used in the rearing system and the food provided were suitable to support the fish life. The fishes adapt well to dark condition as in nature the fish is active at night. According to Magwa *et al.* (2020); Pratiwi *et al.* (2020); Sihombing *et al.* (2021); Windarti *et al.* (2021), *P.hypophthalmus* survives and grows well in dark conditions. The presence of an aquaponic system may manage the water quality as the root of the plant absorbed organic material present in the water and it keeps

the water quality in good condition and supports the life of the fish. Dauhan *et al*. (2014) stated that by applying the aquaponic system. The ammonia as well as organic matter originated from fish metabolic waste and food remains were absorbed by the root of the plant. In this research, there was no difference between the survival rate of commercial pellet-fed fish and the moringa-enriched pellet-fed fish. This fact indicates that the addition of Moringa leaf in fish feed does not negatively affect the fish in general and it may not change the taste as well as the diameter of the pellets as the tapioca starch-moringa powder coating layer is thin. It means that the taste of Moringa does not disturb the appetite of the fish. Table 1 shows the survival rate of the fish during the research.

Table 1. The survival rate of *Pangasianodon hypopthalmus* fed with *Moringa oleifera* enriched pellets and reared in the tank with an aquaponic system and dark condition

Treatments	The number of fish that survive (day)							Survival Rate (%)
	0	10	20	30	40	50	60	
C	30.00	30.00	30.00	29.67	29.67	29.67	29.67	93.33±8.82
T1	30.00	30.00	30.00	29.67	29.67	29.67	29.67	98.89±1.92
T2	30.00	30.00	30.00	29.67	29.67	29.67	29.67	98.89±1.92
T3	30.00	30.00	30.00	29.67	29.67	29.33	29.33	97.78±1.92

Note: In each treatment, there are 3 rearing tanks and the initial fish density was 30 fishes/ tank. The number of fish that survive is obtained by calculating the average of fish survive in each rearing tank; Treatments: Control: no Moringa addition in fish feed pellets, T1: addition of 10 grams Moringa powder in 1 kg pellets, T2: addition of 15 grams Moringa powder in 1 kg pellets, T3: addition of 20 grams Moringa powder in 1 kg pellets

Unlike the survival rate, the growth of the fish in each treatment is different. The body length and body weight of fish that was not fed with Moringa enriched pellets is lower than that of the fish fed with Moringa enriched pellet. Results of the ANOVA test showed that the length increment, as well as body weight increment of fish with no Moringa diet, is significantly lower than those of the fish fed with Moringa-enriched pellets. The best growth of the fish was obtained in T1, namely the fish that was fed with Moringa-enriched pellets (10 grams/ kg pellet). Similar results were obtained by Astiyani *et al*. (2020); Helmiati *et al.* (2021) who find out that the use of *Moringa oleifera* as a food supplement significantly increases the growth of fish. The nutrient content in the Moringa leaf such as Ca, Fe, protein, vitamins A, B, C, and minerals may improve fish growth.

The specific growth rate and the biomass of the fish in this research do not show any differences. Even though the Moringa-fed fish show a slightly higher specific growth rate and biomass than that of the fish with no Moringa, the result of the ANOVA test on both parameters shows that there is no significant difference. A similar result was obtained by Bbole *et al*. (2016) who stated that in *Oreochromis niloticus*, the use of Moringa as a protein source addition does not increase the growth of the fish, but improves the immunity of the fish as there is an increase in white blood cells. Table 2 shows the growth parameters of fish by the end of the experiment.

Table 2. Total length, body weight, specific growth rate, and biomass of *Pangasianodon hypopthalmus* fed with *Moringa oleifera* enriched pellets and reared in the tank with an aquaponic system and dark condition

Treatments	Body Length (cm)		Body Weight (gram)		Specific growth rate (% per day)	Biomass (g)
	TL on the 60th day	Length increment	BW on the 60th day	Weight increment		
C	14.32	5.69±0.10a	28.53	23.48±1.34a	2.89±0.20	800.53
T1	16.36	7.62±0.21c	37.10	31.94±0.56c	3.29±0.16	1100.53
T2	15.76	6.96±0.19b	35.50	30.05±0.74b	3.12±0.03	1053.27
T3	15.72	6.95±0.39b	34.55	29.34±0.12b	3.16±0.13	1013.48

Note: Mean with standard error followed by different letters are significantly different (P0.05)

Table 3. Food Efficiency and Food Conversion rate of *Pangasianodon hypopthalmus* fed with *Moringa oleifera* enriched pellets and reared in the tank with an aquaponic system and dark condition

Treatments	Food Efficiency (%)	Food Conversion rate
C	75.48 ± 3.57^{a}	1.33 ± 0.06^{b}
T1	97.66 ± 1.46^{c}	1.03 ± 0.02^{a}
T2	94.75 ± 1.41^{bc}	1.05 ± 0.02^{a}
T3	90.42 ± 2.25^{b}	1.11 ± 0.03^{a}

Note: Mean with standard error followed by different letters are significantly different (P0.05)

The Food Efficiency (FE) and Food Conversion Rate (FCR) of the fish during the research are various. In a container with 30 fish, the food consumed for 60 days of the research ranged from 905 to 974 grams. The fish that was fed with Moringa enriched pellets showed the highest efficiency (FE 90.42-97.46%) and the best/

lowest FCR (1.03 – 1.11), while in the fish that was not fed with Moringa, the FE was low (75.48%) and the FCR was relatively high (1.33%) respectively (Table 3). These data indicate that the Moringa-fed fish grow better and spent less feed to grow compared to the fish that was not fed with Moringa-enriched pellets. The addition of Moringa powder may improve the digestion process and the fish may able to use the energy intact effectively to support their growth. Astiyani *et al*. (2020) stated that *M. oleifera* leaf is rich in protein as well as the amino acid that play important role in supporting the growth of fish. Data obtained in this research indicate that the addition of Moringa leaves powder in the fish feed pellets may improve the growth of the fish as well as improve the Food Efficiency and the food conversion rate and the use of Moringa leaves as a fish feed supplement is recommended.

CONCLUSION

Based on data obtained in this research, it can be concluded that the addition of Moringa to the fish diet could be beneficial as it improves the growth as well as the food efficiency and the food conversion rate in *Pangasianodon hypophthalmus* culture.

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