Periodic starvation provokes the growth performance and feed efficiency of jelawat fish (*Leptobarbus hoevenii*)

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Abstract. This study aims to determine the effect of periodic starvation on feed efficiency and growth rate of Jelawat fish (*Leptobarbus hoevenii*) fingerlings. A completely randomized design (CRD) was used with four treatments and five replications, namely treatment A (control), treatment B (1 day of fasting and 1 day of feeding), treatment C (1 day of fasting and 2 days of feeding), treatment D (1 day fasting 3 days feeding). The results showed that periodic starvation had a significant effect ($P<0.05$) on absolute weight growth, specific growth rate (SGR), feed conversion ratio (FCR), feed efficiency (EP) and Survival Rate (SR) but had no significant effect ($P>0.05$) on the absolute length growth of Jelawat fish. This study showed that the optimum absolute growth values in length, absolute weight, specific growth rate, feed efficiency, and feed conversion ratio were in treatment D with absolute length growth values of 2.40 ± 0.07 cm, growth absolute weight 2.82 ± 0.13gram, specific growth rate 1.14 ± 0.04%/day, feed efficiency 99.03 ± 1.08% and feed conversion ratio 1.01 ± 0.01 respectively. Thus the starvation has a significant result in saving the feeding cost effectively.

1 Introduction

Jelawat fish (*Leptobarbus hoevenii*) is a fish native to Indonesia and spreaded in many rivers on the islands of Kalimantan and Sumatra, Indonesia [1]. Several regions that have developed *Leptobarbus hoevenii* cultivation include the provinces of Jambi, Riau, West Kalimantan, Central Kalimantan and East Kalimantan [2]. *Leptobarbus hoevenii* fish is an export commodity and has potential prospects for development and cultivation by having its economic value and potential to be cultivated in ponds and cages [3]. The problem faced in cultivating *Leptobarbus hoevenii* fish is due to their slow growth. Slow growth is affected by inefficient fish feeding which is currently still not optimal, therefore the feed consumed by fish is not used effectively and efficiently for their growth. One of the important nutrients needed by fish is protein [4, 5]. This is because protein is a feed substance that is very necessary for growth [6]. The use of various kinds of appetite enhancing or growth promoting

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ingredients will incur separate costs. One of the innovations in cultivation technology that can be done is to periodically fast the cultivated fish [7]. Starvation is one strategy to overcome the problem by providing minimal feed but not hampering fish growth [8]. According to [7], cultivating fish with starving treatment which is maintained for a sufficient period or satiation level will stimulate the rapid growth after the starving period. An increase in feed consumption after fish is starved is followed by an increase in absolute growth rate, so that feed consumption becomes more efficient [9], [10].

Several studies on the starvation in freshwater fish has been widely reported. Research by [11] reported the periodically fasted of freshwater pomfret (*Colossoma macropomum*) expressed the better growth compared to feeding fish (control). [8] claimed that the gouramy (*Osphronemus gouramy*) which was fasted periodically obtained the best growth instead of no starvation fish. Research by [12] which was carried out on milkfish (*Chanos chanos*) which were fasted periodically, showed that the best growth values in length, specific growth rate, feed efficiency, and feed conversion ratio. Another study conducted by [13] about periodic-fasted in catfish (*Hemibagrus nemurus*) showed significant weight gain and the highest daily growth rate.

Moreover [14] reported that periodic fasting of stripped catfish (*Pangasius* sp.) showed that the better growth values for absolute weight, absolute length and feed conversion ratio (FCR) compared to non-fasting. In another study [15] reported that fasting had a significant effect ($P<0.05$) on the feed conversion ratio (FCR) of tilapia (O. *niloticus*) seeds. Then [16] also explained the periodic-fasted of star pomfret (*Thachinotus blochii*) obtained the best growth parameter results and feed efficiency in the treatment of feeding without fasting. This is in line with the effect of the fasting period on carp (*Cyprinus carpio*) which was carried out by [17] which showed the best results in the feed consumption value, the relative weight growth value, and the absolute length growth value in the treatment without fasting.

However, there is no current information regarding the effect of periodically fasted on the feed efficiency and growth performance of jelawat fish (*Leptobarbus hoevenii*). Therefore, the current study is necessary to support more information of the effect of starvation in freshwater fish culture.

2. Materials and methods

2.1 experimental design

The test fish used in this study were the fingerlings of the jelawat fish (*Leptobarbus hoevenii*) with a length of 3-5 cm. a four hundreds Jelawat fish (*Leptobarbus hoevenii*) fish were used and obtained from the Freshwater Aquaculture Fishery Center (BPBAT) Sungai Gelam, Jambi. This study used an experimental method which was carried out in a completely randomized design (CRD) with 4 treatment levels and 5 repetitions. This treatment was based on the results of previous preliminary tests, namely a one-day fasting period (Cahyanti *et al*., 2015). The treatments in this study were, A (feeding every day), B (1 day being fed 1 day fasting), C (2 days being fed 1 day fasting), D (3 days being fed 1 day fasting).

The container used in this study used a aquarium with the size of the aquarium: 50 cm long, 40 cm wide, 40 cm high with a total of twenty units. In each aquarium, twenty Jelawat fish were included with a stocking density of 1 fish/2 liters. Acclimatized first for a week until the fish really adapt to the new environment. After the fish have adapted to the fish, they are fasted for 24 hours, then the length is measured and the weight is measured as data on the length and initial body weight of the fish [18]. The culture of the tested fish was carried out for 50 days and during the culture the fish were fed commercial feed with a protein content of 39-41%. According to [19], 38% protein is optimum feed for the growth of Jelawat fish fry. Three times feeding a day, namely in the morning, afternoon and evening ad libitum by giving 5% of the biomass of jelawat fish (*Leptobarbus hoevenii*) seeds. Jelawat fish were reared based on the guidelines of Research Ethics Guideline of Universitas Syiah Kuala No. 958/2015.

3 research parameters

3.1 Absolute length gain

The formula used to calculate growth in length according to [20] is:

$$L = Lt - LO \qquad (1)$$

Description:

L = Growth in length (cm)
Lt = Final fish length (cm)
Lo = Initial fish length (cm)

3.2 Absolute weight gain

The formula used to calculate weight growth according to [20] is:

$$W = Wt - Wo \qquad (1)$$

Description:
W = Absolute weight growth (g)
Wt = Final fish weight (g)
Wo = Initial fish weight (g)

3.3 Specific growth rate

Specific growth rate (SGR) was calculated using the formula from [42] [21]:

$$SGR = \frac{In\, Wt - In\, Wo}{t} x100\ \% \qquad (1)$$

Description :
SGR = Specific daily growth rate (%/day)
Wt = Average weight of fish at the end of the study (g/head)
Wo = Average weight of fish at the start of the study (g/head)
Q = Length of treatment (days)

3.4 feed conversion rasio

Feed Conversion Ratio (FCR) is the ratio between the amount of feed given and the fish produced. According to [22], FCR can be calculated based on the following formula:

$$FCR = \frac{F}{Wg} x100 \qquad (1)$$

Description :

FCR = Feed conversion rate
F = Amount of feed consumed during the study (g)
Wg = Weight gain during the study (g)

3.5 Feed Efficiency

The efficiency of using feed shows the level of efficiency of feed digested by fish. The formula used to calculate feed efficiency according to [20] is:

$$EP = \frac{1}{FCR} x100\% \quad (1)$$

Description :

EP = Feed efficiency (%)

FCR = Feed conversion rate

3.6 Survival rate

Fish survival is calculated according to [20] as follows:

$$SR = \frac{Nt}{No} x100\% \quad (1)$$

Description :

SR = Survival rate (%)

Nt = Number of fish at the end of rearing

N0 = Number of fish at the start of rearing

3.7 Data analysis

Data processing including absolute weight growth, absolute length, survival, specific growth rate, feed ratio conversion and feed efficiency values were analyzed using analysis of variance (ANOVA) with a 95% confidence interval. If the data shows a significant effect, then a follow-up test is carried out in the form of the Duncan test to compare these treatments. Water quality data were analyzed descriptively.

4 Results and discussion

The periodic fasting had a significant effect (P<0.05) on absolute weight grogainwth, specific growth rate (SGR), feed conversion ratio (FCR), feed efficiency (EP) and Survival Rate (SR) but had no effect significant (P>0.05) on the absolute length gain. Result showed that there were significant differences between treatments for absolute weight gain, absolute length gain, specific growth rate, FCR, feed efficiency and survival of barnacle (*Leptobarbus hoevenii*) fingerlings (Table 1).

Table 1. Absolute weight growth, absolute length growth, specific growth rate (LPS), feed conversion rate (FCR) and survival (SR) of jelawat fish (*Leptobarbus hoevenii*) seeds.

Treatment	Research Parameter					
	Absolute Length gain (cm)	Absolute Weight gain (g)	SGR (%/day)	FCR	EP (%)	SR (%)
A	2.26 ± 0.28^{ab}	2.45 ± 0.54^{bc}	1.00±0.19bc	1.25 ± 0.04^{b}	79.88 ± 2.73^{a}	84.0 ± 6.52^{b}
B	2.08 ± 0.21^{a}	1.89 ± 0.24^{a}	0.78 ± 0.11^{a}	1.10 ± 0.12^{a}	91.85 ± 8.98^{b}	73.0 ± 2.74^{a}
C	2.32 ± 0.20^{ab}	2.31 ± 0.26^{ab}	0.96 ± 0.10^{b}	1.05 ± 0.12^{a}	96.32 ± 11.34^{b}	84.0 ± 4.18^{b}
D	2.40 ± 0.07^{b}	2.82 ± 0.13^{c}	1.14 ± 0.04^{c}	1.01 ± 0.01^{a}	99.03 ± 1.08^{b}	87.0 ± 2.74^{b}

Note: Different superscript letters indicate that there is a significantly different effect between the treatments and the ± sign indicates the standard deviation number.

The mean value in the same column as the effect of fasting on feed efficiency and growth rate of periodically fasted jelawat fish (Leptobarbus hoevenii) fingerlings was significantly different (P<0.05). A = daily feeding; B = 1 day of being fed 1 day of fasting; C = 2 days of being fed 1 day of fasting; D = 3 days of being fed 1 day of fasting. Water is an important medium to support fish life. The results of water quality measurements during the study are presented in (Table 2).

Table 2. Water Quality Parameters.

Parameter	Treatment				Reference
	A	B	C	D	
DO (mg/l)	5.69-6.08	5.92-6.43	5.62-6.48	5.69-6.36	3.59-9.65 [23]
Temperature(°C)	27.3-28.5	27.3-28.5	27,3-28,3	27.3-28.5	18-28 [24]
pH	7,1-7,5	7,1-7,4	7,1-7,5	7,1-7,5	6.5-7.5 [24]

Based on the research conducted for 50 days of rearing, the absolute length gain (Figure 1) in the fingerlings of jelawat fish (*Leptobarbus hoevenii*) during the study obtained the highest results in treatment D (3 days fed 1 fasting day) of 2.40 ± 0.07 cm and the lowest yield was in treatment B (1 day fed 1 fasting day) of 2.08 ± 0.21 cm. parameters in this research have been well organized and optimal.

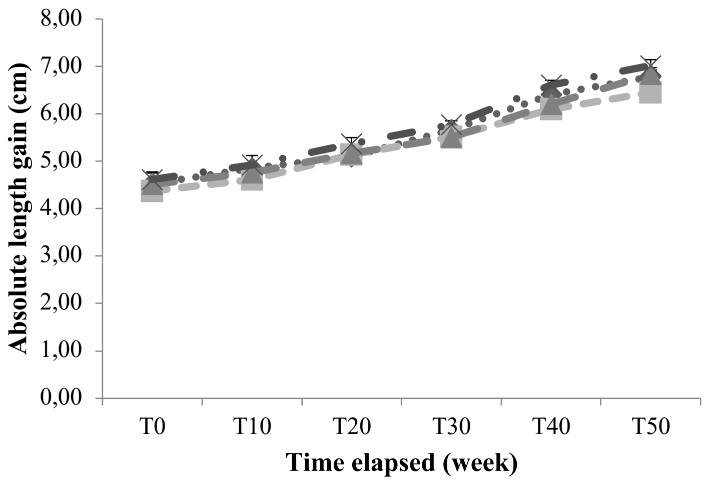

Fig. 1. Graph of absolute length gain (cm) of Jelawat for 50 days of rearing.

The higher absolute length gain in treatment D (3 days fed 1 day fasting) compared to treatment B (1 day fed 1 day fasted) was due to the test fish in treatment D (3 days fed 1 day fasting) consumed more feed, where feed is a source of nutrition for growth. This shows that fish are able to utilize the feed provided for the growth and maintenance of their bodies [6]. Treatment B (1 day of being fed and 1 day of fasting) experienced a decrease in growth because it experienced the most fasting. This is in line with the research of [16], the slowest growth occurred in the treatment which was treated with 1 day of fasting and 1 day of feeding during rearing. Fish that are fasted have the ability to use feed better caused by the intensification of energy utilization by fish and more energy is allocated to somatic growth than the substrate for movement [25].

Periodic fasting has a significant effect on the absolute weight gain (Fig. 2) on the jelawat fish fry. The highest absolute weight growth was shown by treatment D (3 days fed 1 fasting day) of 2.82 ± 0.13 grams while the lowest was in treatment B (1 day fed 1 fasting day) of 1.89 ± 0.24 grams.

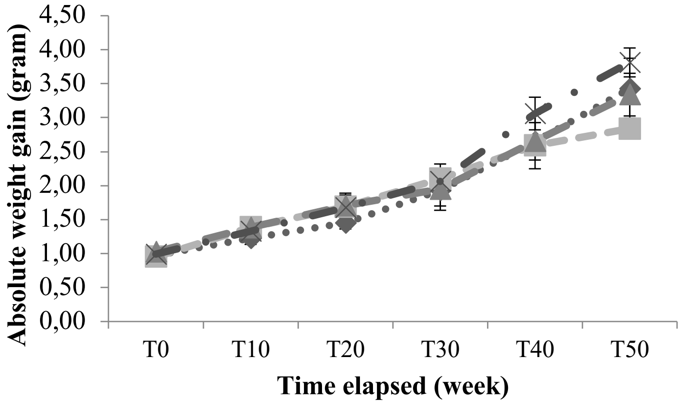

Fig. 2. Graph of weight growth (g) of fingerlings for 50 days of rearing.

Treatment B (1 day of being fed and 1 day of fasting) experienced a decrease in growth because it experienced the most fasting. This matter showed that, fish that were fed one day and one day without feed experienced a more significant decrease in growth. Basically, fish that are fasted can better reformulate the intake of feed received, such as catfish which are fasted periodically, are able to adapt to conditions of hunger or lack of energy by reducing movement so that metabolism is reduced [26]. Even though fish are fasted, these fish are able to experience *catch-up growth* so that fish that experience fasting can reach the same body weight or even higher when compared to fish that are not fasted [14]. The higher absolute weight growth in treatment D is thought to have increased appetite after the fish were fasted. An increase in feed consumption after the fish has been fasted causes the fish to experience *hyperphagia*, which is a condition where the fish has an increased appetite for some time 2-3 days after the fish has been fasted for a certain period and this appetite will return to normal appetite [11]. This increase in feed consumption can lead to compensatory growth [27]. This is in line with preliminary research [28], keeping BEST tilapia in aquariums can experience compensatory growth, namely very fast growth after the fish are satisfied and then fed again normally.

Specific growth rate (Table 1) is the daily growth percentage calculated based on the weight of the test fish for 50 days of study. The results showed that the highest was in treatment D (3 days fed 1 fasting day) of 1.14 ± 0.04%/day while the lowest was in treatment B (1 day fed 1 fasting day) of 0.78 ± 0. 11%/day). This is different from the research by [29], reported that tilapia fed one day of feed and one day of fasting resulted in the best daily growth rate. Overall, the more often the fish received starvation treatment during rearing, the lower the specific growth of fish. This shows that the growth of the barnacle fish is getting better with more routine feeding. Relatively the same growth between fish that are fasted and those that are not fasted and there is a feed savings of 15-40% for fish that are fasted [8].

According to [28], that fasting in fish will affect its metabolic rate, this increase in metabolic rate is related to an increase in the hormone thyroxine. This was reinforced by [30] that the hormone thyroxine in the body plays an important role in the process of metabolism, development, and tissue growth. The metabolic function of the hormone thyroxine is to increase oxygen consumption and stimulate an increase in the rate of oxidation of cells to food ingredients followed by an increase in fish metabolism, and to increase the absorption of amino acids by the intestine [7]. This increase in activity is related to the increased efforts of fish to maximize the use of nutrients so that they are able to meet nutritional needs after the fish are fasted.

The lowest feed conversion value during rearing was found in treatment D (3 days fed 1 fasting day) of 1.01 ± 0.01 then followed in treatment C (2 days fed 1 fasting day) of 1.05 ± 0.12, treatment B (1 day fed 1 fasting day) of 1.10 ± 0.12, and treatment A (daily feeding) of 1.25 ± 0.04. This is in line with the research by [15] that periodic fasting of tilapia produces the best FCR value, namely in the one-day treatment without feed. This is thought to occur because fish that receive feed every day will experience a decrease in appetite compared to fish that are fasted. A high FCR value was obtained in treatment A, followed by treatment B and treatment C. This was due to the fact that the feed eaten was not completely absorbed and wasted through the feces, meaning that the feed given was given a redundant impression. It can be seen that growth in treatments A, B, C was relatively slow compared treatment D. In accordance with the opinion of [31], that a high feed conversion ratio is due to the fact that the feed given is underutilized by fish so that the nutrients in the feed are not maximally absorbed by the body and are only wasted through feces so that the growth rate obtained is relatively low.

The highest feed utilization results were in treatment D (3 days fed 1 fasting day) of 99.03 ± 1.08%, followed by treatment C (2 days fed 1 fasting day) of 96.32 ± 11.34%, treatment B (1 day of feeding and 1 day of fasting) of 91.85 ± 8.98%, and the lowest treatment A (feeding every day) of 79.88 ± 2.73%. This is in line with the research of [17] that the lowest feed utilization efficiency (EPP) value was the non-starching treatment with a value of 65.40 ± 1.64%. Periodically fasted goldfish had a higher feed efficiency value. compared to non-starved carp. This means that treatment B (fish fasted for 1 day followed by feeding for 1 day) often experiences a fasting period, so the total value of feed consumption produced is the lowest. This is in line with research [32], which shows that the feed efficiency of tilapia is fasted one day and one day is fed with the highest amount of feed saved. This is confirmed by [33] the efficiency of good feed utilization is more than 50% or even close to 100%.

According to [34] reported that a good feed efficiency value indicates that the feed consumed is of good quality, so it can be easily digested and efficiently utilized by fish. However, feed efficiency decreases if fish are fasted for more than three days [9]. The efficiency of feed utilization is closely related to the digestibility of fish for the feed given. Digestibility of fish on a feed is influenced by several factors, namely the chemical properties of water, water temperature, type of feed, size and age of fish, nutritional content of feed, frequency of feeding as well as the amount and type of digestive enzymes contained in the digestive tract of feed [35]. The increase in enzyme activity is thought to be related to increasing fish efforts to digest nutrient content, especially protein in order to maximize the use of feed protein for growth [36].

Periodic fasting resulted in the highest percentage of survival (Table 1) in treatment D (3 days fed 1 fasting day) of 87.0 ± 2.74%, treatment C (2 days fed 1 fasting day) of 84.0 ± 4.18%, treatment A (feeding every day) of 84.0 ± 6.52%, and the lowest in treatment B (1 day of being fed and 1 day of fasting) of 73.0 ± 2.74%. Survival is the ability of fish to survive a certain period. Fish death occurs early in rearing fish. This is assumed to be an adaptation response to the environment and fasting treatment.

Temperature parameter measurements were obtained, namely results ranging from 27.3 – 28.5°C. Measurement of the parameters of the DO meter, the DO values obtained were 5.62 – 6.48 mg/l. Measurement of pH parameters, pH values during the study ranged from

7.1 to 7.5. Poor water quality can cause aquaculture failure because fish experience stress, slow growth, increase in disease and death [37, 38]. Good water quality will increase the growth rate of fish from various diseases.

Conclusion

We concluded that periodic fasting had a significant effect ($P<0.05$) on absolute weight gain, specific growth rate (LPS), feed conversion ratio (FCR), feed efficiency (EP) and survival rate (SR) but had no effect significant ($P>0.05$) on the absolute length gain. Therefore, the periodic fasting pattern (1 day of fasting and 3 days of feeding) for Jelawat culture is potential to gain compensatory growth and feed efficiency.

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