DEPIK
Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan
Journal homepage: www.jurnal.usk.ac.id/depik

Production performance and physiological responses of jelawat fish (*Leptobarbus hoevenii*) breeding maintained in different containers

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ARTICLE INFO

Keywords:
Aquariums
concrete tanks
floating net cages
tarpaulin ponds
jelawat fish

DOI: 10.13170/depik.13.1.35097

ABSTRACT

Jelawat fish cultivation activities are still experiencing problems with low production. In order to increase the production of jelawat fish seeds during the grow-out phase, research needs to be carried out regarding the type of containers for the cultivation. This research aims to determine the best type of container for jelawat fish (Leptobarbus hoevenii) breeding regarding production performance and physiological responses. This study used a completely randomized design with four different treatments in rearing containers and three replications including aquarium (A), fiber tanks (B), concrete tanks (C) and floating net cages (D). The fish seeds used in this study were 2.76 ± 0.15 cm long and weighed 0.17 ± 0.17 g. During breeding process, the fish were given commercial feed with a protein content of 41% and air changes were carried out at 30% of the total air volume every 2 days. The parameters observed in this research include production performance, physiological responses, and air quality. The research results showed that different types of rearing containers had a significant effect on production performance parameters, total cholesterol, and hemoglobin. Total cholesterol and hemoglobin at the start of cultivation were 191 mg/dL and 11.6 g/dL, decreasing at the end of cultivation to 120.28-141.59 mg/dL and 9.03-12.83 g/dL. Air quality was still within the appropriate range for rearing jelawat fish seeds.

Introduction

Fish farming containers are an important component in production facilities (Kumar and Karnatak, 2014; Lee *et al.* 2013). The container is directly related to the cultivation system and production capacity per unit area of production (Lee *et al.* 2013; Timmons *et al.* 1998). Using a type of container that is appropriate to the cultivation system and type of commodity can increase production capacity and streamline production costs, as well as being able to create comfort and reduce stress in cultivated fish. Jelawat fish (*Leptobarbus hoevenii*) is a cyprinid fish that can be found in several rivers and lakes in Malaysia, Cambodia, Indonesia, Laos, Thailand, and Vietnam (Vann *et al.*, 2006). In nature, jelawat fish are found along rivers and streams and feed in groups in areas with abundant food sources (Rainboth, 1996).

Jelawat fish has great potential to be developed, because several countries such as Brunei Darussalam and Malaysia import jelawat fish to meet market demands. The selling price of jelawat fish reaches Rp. 60,000.00/kg in 2018 in Kalimantan area (Selawati *et al.*, 2019). Jelawat fish have quite high production, namely 4,098 tons in 2016, 4,403 tons in 2017 and 12,203.06 tons in 2018 (KKP, 2020). In 2016 and 2017, jelawat fish production was only produced by 4 provinces, namely Jambi, West Kalimantan, Central Kalimantan, and Riau, whereas in 2019 as many as 15 provinces produced jelawat fish in quite varied quantities (KKP, 2020). Jambi Province has the potential for public waters such as rivers, lakes and swamps with an area of ± 115,000 Ha and a sustainable potential for capture fisheries of around 35,000 tons/year (DKP Jambi, 2019). The potential for developing fish farming businesses in these waters can be used for various fish species such as jelawat, catfish, belida, baung, botia, arowana and others which have high economic potential (Yuniati and Rachman 2016).

Currently, the development of jelawat fish cultivation technology is quite established. Jelawat

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p-ISSN 2089-7790; e-ISSN 2502-6194
Received 6 November 2023; Received in revised form 12 December 2023; Accepted 17 January 2024
Available online 30 April 2024
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fish hatchery in Jambi City has been carried out since 1986 using the induced spawning technique, with a limited number of seeds (Sutisna, *et al.* 2020). Jelawat fish breeding has been carried out by most communities, especially in Jambi City, using ponds and cages (Sutisna, *et al.* 2020). The jelawat fish nursery segmentation has been developed, but the production is still quite low. Nursery segmentation aims to produce fish seeds that are ready to be released or stocked in the next phase, namely rearing (Harifuzzumar, *et al.* 2018). The nursery stage is one of the important phases in fish farming. Preparing healthy and strong seeds is a challenge at this stage. There are many choices of cultivation containers that can be used to rear fish in the breeding phase, such as aquariums, tarpaulin tanks, concrete ponds, fiber pools, earthen ponds, and floating net cages. Especially for jelawat fish, several cultivation containers have been used by farmers in the breeding process. However, it is not yet known in detail which cultivation containers provide the best growth and survival performance with the lowest stress levels.

Several previous studies have shown that rearing jelawat fish in aquariums results in growth ranging from 0.95 g – 2.27 g; 81.19%-99.62% (Putri *et al.* 2021; Harianto *et al.* 2023). Rusliadi *et al.* (2015) reported that the growth and survival of jelawat fish kept in fiber pools with recirculation and aquaponic systems ranged between 1.59 – 3.03 g and 70.83% - 90%, respectively. The results of the study above are the basis for conducting development research regarding the influence of different types of containers on the growth and stress response of jelawat fish which kept in the breeding phase. This research aims to determine the best type of cultivation container for jelawat fish (*Leptobarbus hoevenii*) cultivation regarding production performance and physiological responses.

Materials and Methods

Location and time of research

This research was conducted for 2 months, 20 days in the preparation phase and 40 days in the experimental phase. This research was carried out at the Taman Angrek Ornamental Fish Installation of the Jambi Province Maritime and Fisheries Service.

Experimental design

This study used a completely randomized design with four treatments and three replications. Treatments, namely different containers for keeping jelawat fish, that are: aquarium (treatment A), fiber tanks (treatment B), concrete tanks (treatment C) and floating net cage (treatment D).

Research procedures

Preparation of research containers

The research containers in this study were the treatments that being tested in the experiment, the first container were aquariums measuring 70x40x30 cm, 3 units with a water volume of 70 L/aquarium, the second container were a 1x1x1 m concrete ponds, 3 units with a water volume of 300 L/tub, the third container were 1x1x1 m fiber pools measuring 3 units with a water volume of 300 L/tub and the fourth container were floating net cages measuring 1x1x1 m with total 3 units with a water volume of 300 L/cage. Before being used, all breeding containers were cleaned by washing with soap, rinsing with clean water and drying in the sunlight. The clean and dry containers were filled with water according to the specified volume. Each research container was equipped with an aeration unit, each container was provided with 2 aeration points as an oxygen source.

Fish preparation

The fish used in this research were jelawat seeds measuring 2.76 ± 0.15 cm long and weighing 0.17 ± 0.17 g. Jelawat fish are produced from artificial spawning by the Telanaipura Ornamental Fish Installation of the Jambi Province Maritime and Fisheries Service. The larvae of jelawat fish spawning were first kept for 20 days and then used as research fish. Test fish were stocked at a density of 1 fish/L.

Rearing fish method

Test fish were kept for 40 days. During rearing process, the fish were given commercial food in the form of pellets with a protein content of 41%. The amount of feed given adjusted to the biomass with an average of 10-7% of the biomass. Feed was given every morning, afternoon, and evening. The amount of feed was evaluated at each sampling period. During cultivation, the water changed once every 2 days, amounting to 30% of the total breeding water volume, and water quality measurements were carried out including the temperature, pH, and dissolved oxygen, measured directly every day using a digital thermometer, Hanna HI98107 pH meter and Dissolved Oxygen (DO) meter Lutron-5510. Measurements of ammonia nitrite and nitrate were carried out at the beginning and end of the study.

Data collection in this study included the data of weight, blood and water which was conducted every 8 days during maintenance. The number of samples used in this research was 30% of the total population. Weight and length samples were measured by removing the fish from the rearing container and placing them in a sampling box, then the fish were

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weighed per fish using a digital scale with an accuracy of 0.01 g, length was measured using a caliper. Blood samples were taken at the beginning and end of the study. Blood samples were captured by anesthetizing the test fish *using Ocean free special arowana stabilizer* at a dose of 1 mL/2L. Blood samples were collected at the top between the anus and the tip of the anal fin. Fish whose blood samples have been taken were revived by immersing the fish in an aerated bucket. Then the fish were returned to the rearing containers.

Parameters

The parameters observed in this research include production performance namely survival rate (SR), absolute length growth (ALG), absolute weight growth (AWG) (Goddard, 1996), specific growth rate (SGR) (Huisman, 1987), feed conversions ratio (FCR) (NRC, 2011), final weight diversity coefcient (fWDC) and final length diversity coefcient (fLDC) (Steel dan Torrie, 1981). Physiological response containing blood glucose (BG), hemoglobin (Hb) and total cholesterol (TC). The water quality parameters containing temperature, pH, dissolved oxygen (DO), nitrite and ammonia (Rusliadi *et al.*, 2015; Utami *et al.*, 2018; Putri *et al.*, 2021; PP. 22 2021; Harianto *et al.* 2023; Rusydi *et al.*, 2024).

Data analysis

The data obtained were tabulated with Microsoft Office Excel 2016 (Microsoft Corp., Washington, USA) and SPSS 22.0 (IBM Corp., New York, USA) for analysis of variance to determine the treatment effect in each parameter at 95% confidence level. Duncan's test was performed when there were significant differences among treatment groups based on the parameters obtained.

Results

Production Performance

Analysis of average weight and length progress of jelawat fish during the study showed that there was a trend of increasing weight and length, the average weight of stocked fish at the beginning of the study was 0.17 g, increasing at the end of the study ranging from 1.00 ± 0.12 - 1.60 ± 0.17 g (Figure 1). The highest average weight increase was in treatment A with a final weight of 1.60 ± 0.17 g, followed by treatments C, B and D, respectively 1.12 ± 0.05 g, 1.00 ± 0.13 g and 1.00 ± 0. 12 g. Apart from weight, the body length of jelawat fish has also increased. The average length of fish stocking at the beginning of the study was 2.76 cm, increasing at the end of the study ranging from 4.53 ± 0.19 - 5.21 ± 0.19 cm (Figure 2). The highest increase in average length was in treatment A with a final length of 5.21 ± 0.19 g, followed by treatments B, C and D, respectively 4.82 ± 0.04 g, 4.66 ± 0.12 g and 4.53 ± 0. 19 g.

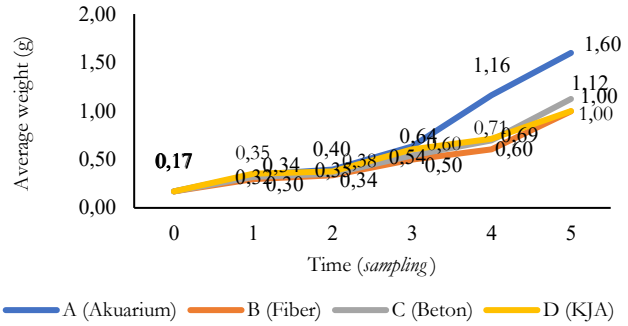

Figure 1. Average weight of jelawat fish seeds during the study

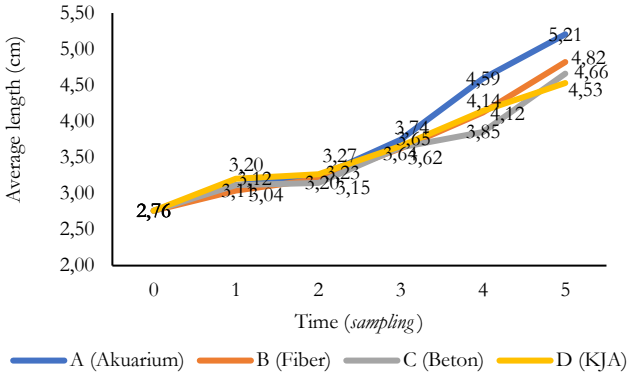

Figure 2. Average length of jelawat fish seeds during the study

In general, the production performance of jelawat fish seeds showed good results with SR values for all treatments ranging between 90.67 ± 2.40- 95.00 ± 0.87%, SGR ranging between 4.50 ± 0.35-5.75 ± 0.29 %/day, ALG ranging between 0.83±0.12 cm – 1.43±0.17 cm, AWG for all treatments ranging from 1.77±0.19–2.45±0.19 g, FCR ranging from 1.35±0.04–2.02±0.44, fWDC ranging from 17.73±2.39 % - 25.12±0.29 % and fLDC ranging from 5.87 ± 0.87- 8.69 ± 1.82 %. Data from the performance analysis of jelawat fish seed production are presented in Table 1 below.

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Table 1. Production performance of jelawat fish seeds (Leptobarbus hoevenii, Blkr) with different types of rearing containers during the 40-day rearing period

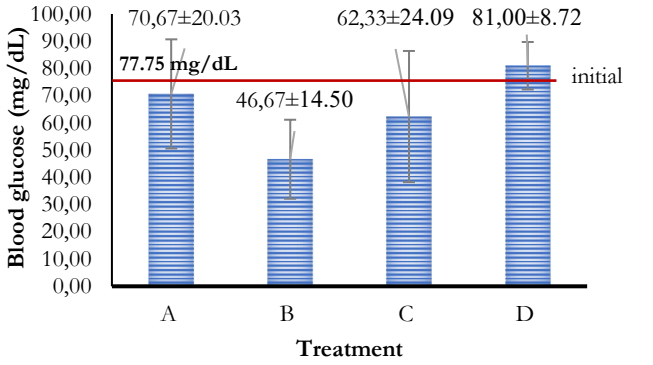
Parameter	Treatment (Type of container)			
	A	B	C	D
SR (%)	95.00±0.87[b]	89.33±1.53[a]	90.67±2.40[ab]	91.00±2.08[ab]
SGR (%/hari)	5.75±0.29[b]	4.50±0.35[a]	4.83±0.10[a]	4.51±2.91[a]
ALG (cm)	1.43±0.17[b]	0.83±0.13[a]	0.95±0.05[a]	0.83±0.12[a]
AWG (g)	2.45±0.19[b]	2.069±0.04[ab]	1.90±0.12[a]	1.77±0.19[a]
FCR	1.35±0.04[a]	1.83±0.22[ab]	1.66±0.23[ab]	2.02±0.44[b]
fWDC (%)	21.01±1.58[ab]	18.78±3.42[a]	17.73±2.39[a]	25.12±0.29[b]
fLDC (%)	7.02±0.67[ab]	5.87±0.87[a]	6.27±0.82[a]	8.69±1.82[b]

Note: Values are presented in the form of mean ± std. The same upper-case letters in the same row indicate that they are not significantly different (P>0.05; Duncan's post hoc test). A: aquarium, B: fiber tanks, C: concrete tanks and D: floating net cage. SR: survival rate, SGR: specific growth rate, ALG: absolute length growth, AWG: absolute weight growth, FCR: feed conversion ratio, fWDC: final weight diversity coefcient and fLDC: final length diversity coefcient

Based on the results of analysis of variance, it shows that the treatment of different types of rearing containers has a significant effect (P<0.05) on all production performance parameters. The highest SR value was found in treatment A at 95.00%, this value was the same as treatments C and D which were at 90.67% and 91% respectively. The highest SGR value was in treatment A at 5.75%/day, the highest ALG value was in treatment A at 1.43 cm, the highest AWG value was at treatment A at 2.45 g, this value was the same as treatment B at 2.06 g, the best FCR value was found in treatment A it was 1.35, this value was the same as treatments B and C which were 1.83 and 1.66 respectively. The best fWDC and fLDC values were found in treatments C and B at 17.73% and 5.83% respectively.

Physiological Responses

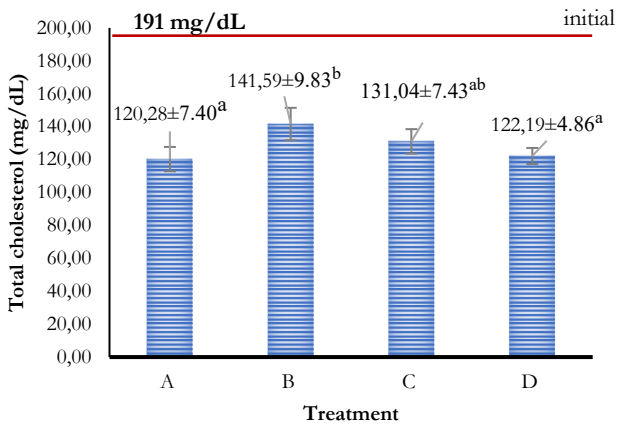
Physiological responses containing blood glucose (BG), total cholesterol (TC) and hemoglobin (Hb). Data from BG measurements are presented in the form of initial and final research data. The BG value at the end of the study showed fluctuating values for all treatments. The initial BG value was 77.75 mg/dL and at the end of the cultivation period ranged from 46.67±14.50 mg/dL – 81.00±8.72 mg/dL. Data from blood glucose analysis of jelawat fish seeds are presented in Figure 3 below.



Values are presented in the form of mean±std. The same upper case letters in the same row indicate that they are not significantly different (P>0.05; Duncan's post hoc test). A: aquarium, B: fiber tanks, C: concrete tanks and D: floating net cage

Figure 3. Blood glucose values of jelawat fish seeds (*Leptobarbus hoevenii*, Blkr) kept in different types of rearing containers during the 40 day rearing period

Treatment with different types of containers did not have a significant effect on blood glucose, the BG value at the beginning of maintenance decreased in treatments A, B and C. Meanwhile in treatment D the BG value increased. The total cholesterol (TC) value at the end of the study showed fluctuating values in all treatments. The TC value at the start of maintenance was 191 mg/dL and decreased at the end of the maintenance period ranging from 120.28±7.40 mg/dL – 141.59±9.83 mg/dL. Data from the TC analysis of jelawat fish seeds are presented in Figure 4 below.



Values are presented in the form of mean±std. The same upper-case letters in the same row indicate that they are not significantly different (P>0.05; Duncan's post hoc test). A: aquarium, B: fiber tanks, C: concrete tanks and D: floating net cage

Figure 4. Total cholesterol values of jelawat fish seeds (*Leptobarbus hoevenii*, Blkr) kept in different types of rearing containers during the 40 day rearing period

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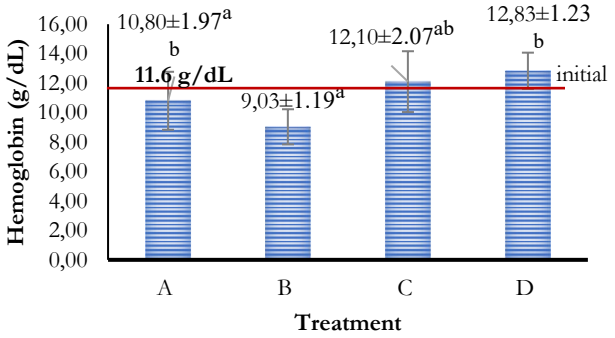
Treatment with different types of containers had a significant effect on total cholesterol at the end of rearing. The highest TC value was found in treatment B at 141.59 ± 9.83 mg/dL, this value was the same as treatment C, namely 131.04 ± 7.43 mg/dL. TC values at the start of rearing decreased in all.

Hemoglobin (Hb) values are presented in the form of average values and standard deviation. The Hb value at the end of the study showed fluctuating values in all treatments. The Hb value at the start of rearing was 11.6 g/dL and at the end of the rearing period ranged from 9.03±1.19 g/dL – 12.83±1.23 g/dL. Data from Hb analysis of jelawat fish seeds are presented in Figure 5 below.



Values are presented in the form of mean±std. The same upper case letters in the same row indicate that they are not significantly different (P>0.05; Duncan's post hoc test). A: aquarium, B: fiber tanks, C: concrete tanks and D: floating net cage

Figure 5. Hemoglobin levels of jelawat fish seeds (*Leptobarbus hoevenii*, Blkr) reared in different types of rearing containers during the 40-day rearing period

The treatment of different types of containers has a significant effect on the Hb value at the end of rearing. The highest Hb value was found in treatment D at 12.83 ± 1.23 g/dL. This value was the same as treatments A and C, which were 10.80 ± 1.97 g/dL and 12.10 ± 2.07 g/dL respectively. Meanwhile, the lowest Hb value was in treatment B at 9.03 ± 1.19 g/dL.

Water Quality Analysis

Water quality parameters containing temperature, pH, dissolved oxygen (DO), nitrite and ammonia (Table 2). The temperature value ranged between 27.8-30.1°C, the pH value ranged between 6.2-7.7, the DO value ranged between 3.7-6.8 mg/L, the nitrite value ranged between 0.0011-0.0719 mg/L and the ammonia value ranged between 0.001-0.0083 mg/L. In general, water quality was still within the appropriate range for rearing jelawat fish seeds in all treatments.

Table 2. Results of measuring the water quality of the media for rearing jelawat fish seeds (*Leptobarbus hoevenii*, Blkr) with different types of rearing containers during the 40-day rearing period

Parameter	Treatment (Type of Container)				Optimal Range (reference)
	A	B	C	D	
Temperature (°C)	27.8-28.7	28.8-29.9	27.9-29.9	28.6-30.1	25-29°C*
pH	6.5-7.7	6.4-7.5	6.2-7.4	6.5-7.5	6-8.4**
DO (mg/L)	4.0-6.8	3.7-6.5	3.8-6.3	3.9-5.8	> 3 mg/L***
Nitrite (mg/L)	0.0011-0.0469	0.0011-0.0719	0.0011-0.0214	0.0011-0.0325	0,06****
Ammonia (mg/L)	0.001-0.0045	0.001-0.0083	0.001-0.0072	0.001-0.0050	0,003-0.5*****

Note
A: aquarium, B: fiber pool, C: concrete pond dan D: floating cage
*Utami *et al.*, 2018; Putri *et al.*, 2021 : Harianto *et al.* 2023
**Putri *et al.*, 2021 : Harianto *et al.* 2023
***Rusliadi *et al.*, 2015; Putri *et al.*, 2021; Harianto *et al.* 2023
****PP. 22 2021
*****Rusliadi *et al.*, 2015; Putri *et al.*, 2021 ; PP. 22 2021 ; Harianto *et al.* 2023

Discussion

SR is the main parameter with a high SR value, so it can be said that the cultivation activities carried out have been successful. The use of different types of containers has a significant effect on the SR value. SR values for all treatments ranged from 90.67 ± 2.40% - 95.00 ± 0.87%. The highest SR value was found in treatment A at 95.00%, this value was the same as treatments C and D which were 90.67% and 91% respectively. The use of an aquarium as a nursery for jelawat fish produces the highest SR value. The high SR values in this study for all types of containers tested are supported by good water quality conditions. The water quality produced in this study is in optimal conditions for rearing jelawat fish seeds where the temperature value ranged from 27.8-30.1°C, the pH value ranged from 6.2-7.7, the DO value ranged from 3.7-6.8 mg/L, the nitrite value ranged from 0 0.0011-0.0719 mg/L and ammonia values ranged from 0.001-0.0083 mg/L. In addition, during the cultivation period, 30% of the total water volume was changed in each cultivation container. Aquaculture activities with good management and water quality will produce more and healthier fish and vice versa (Boyd and Tucker 2014; Rana and Jain, 2017; Melanie *et al.*, 2023). In addition, when compared with previous research, the SR value in this study is higher. The SR value of jelawat fish seeds reared using aquarium containers ranging from 81.19% - 84.52% (Harianto *et al.* 2023), in fiber pond

containers the SR value of jelawat fish seeds ranges from 70.83% - 90% (Rusliadi *et al.*, 2015) and in earthen pond containers with the mina rice system the resulting SR ranges from 45.24% - 89.33% (Hasan *et al.* 2014).

Another parameter analyzed in this research is growth. Growth is an important indicator in determining aquaculture productivity. Growth is usually seen from the increase in volume and length of body cells in wet weight and dry weight over a certain unit of time (Effendie, 1979). There are three main growth indicators analyzed including specific weight growth rate (SGR), absolute length growth (ALG) and absolute weight growth (AWG). The results of the study showed that different types of containers had a significant effect ($P<0.05$) on SGR, ALG and AWG. The highest SGR value was in treatment A at 5.75 ± 0.29 %/day and the lowest SGR value was in treatment B at 4.50 ± 0.35 %/day. The highest ALG value was in treatment A at 1.43 cm and the lowest was in treatments B and D at 0.83 cm. The highest AWG value was in treatment A at 2.45 g, and the lowest was in treatment D at 1.77 g. The SGR, ALG and AWG values in this study are also higher than in previous studies. Harianto *et al* (2023); Sunarno and Syamsunarno (2017) reported that jelawat fish seeds reared in aquarium containers produced SGR, ALG and AWG values ranging between 3.50%/day – 4.51%/day, 1.53 cm – 1.84 cm and 0.0438 g – 1.08 g, respectively. Apart from that, jelawat fish kept in fiber ponds produce SGR values ranging from 1.64%/day - 1.99%/day (Rusliadi *et al.*, 2015). Other research shows that jelawat fish reared with cages produce growth in weight and length of 5.67 g and 1.3 cm respectively (Kamarudin *et al.* 2013). The results of this research indicate that the use of aquarium containers (treatment A) produces the best growth values compared to other types of containers. In the breeding phase, people or farmers generally use aquariums as a cultivation container, this is because using aquariums is considered more effective and efficient, easier to control media and fish and more flexible in maintenance (Tlusty, 2002; Banhaa *et al.* 2019). On the other hand, the use of fiber pool containers, concrete ponds and floating cage provides low growth values, this is because the water quality conditions in the containers are not better than aquarium containers (Table 2), especially for DO and ammonia parameters.

Growth is always associated with the amount of feed given and the quality of the water in the cultivation container, because water temperature and oxygen levels in the water affect appetite, metabolic processes and growth (Goddard 1996). The feed given in the study was commercial feed with an average protein content of 41%. This protein level is in accordance with previous researchers' recommendations where jelawat fish seeds measuring 0.065-1.6 g should be given feed with a protein content of 36%-40% (Sunarno and Syamsunarno, 2017). High protein levels are needed by jelawat fish seeds considering that the fish are still in a high growth phase. Growing fish require feed that is rich in nutrients and energy for stable growth (Yúfera, 2011).

Feed conversion ratio (FCR) is the amount of feed given to produce 1 kg of fish body weight (NRC, 1977). Based on the results of analysis of variance, it shows that the treatment of different types of maintenance containers has a significant effect ($P<0.05$) on the FCR value. The best FCR value was found in treatment A at 1.35, this value was the same as treatments B and C which were 1.83 and 1.66 respectively. The FCR value is inversely proportional to feed efficiency. The higher FCR value, the smaller the feed efficiency. A low FCR value indicates high nutrient absorption and high feed efficiency. According to Darmayanti *et al.*, (2018) that high growth will occur if and only if the amount of feed given is as minimal as possible so that the profits obtained are as large as possible. High feed conversion indicates low feed effectiveness or less efficient use for growth NRC (1977).

In this study, the aquarium containers produced the lowest FCR value of 1.35. This shows that the aquarium containers provide a high comfort effect on the fish so that the ability to absorb food is higher for conversion into meat. The FCR value shows the utilization of feed nutrients by fish. The lower the FCR value produced indicates the more efficient use of the feed (Radona *et al.* 2017). The high FCR value in the floating cage containers (treatment D) is due to the fact that only part of the feed given is converted into meat and the other part is not eaten, fish appetite is closely related to the temperature of the rearing media, this condition is thought to be the influence of environmental variables, especially temperature which is able to control seed metabolism of jelawat fish. This is in accordance with the opinion of Saputra *et al.* (2014) that total fish feed consumption is influenced by light intensity and water temperature. High water temperature will increase fish metabolism so that fish are more aggressive towards food. Apart from that, the type of feed, protein content and level of feeding also influence the low FCR value in treatment A. In this study the feed given contained 41% protein by giving it three times a day with an ad restricted feeding

method with a giving level of 10-7 %. The feed management applied to all treatments was quite successful in producing a low FCR, namely between 1.35-2.02. The FCR results in this study were classified as more efficient than previous research, where jelawat fish seeds reared in aquariums with different feeding levels produced FCR values ranging from 1.72-3.57 (Sonavel *et al.* 2020; Harianto *et al.* 2023).

Final weight diversity coefficient (fWDC) and final length diversity coefficient (fLDC) describe the level of diversity in fish weight and length at the end of cultivation, the higher the diversity coefficient value, the smaller the level of uniformity. Based on the results of the analysis of variance, it shows that the treatment of different types of cultivation containers has a significant effect ($P<0.05$) on the fWDC and fLDC values. The fWDC values ranged between 17.73 ± 2.39% - 25.12 ± 0.29% and fLDC ranged between 5.87 ± 0.87 % - 8.69 ± 1.82 %. The best fWDC and fLDC values were found in treatments C and B at 17.73% and 5.83% respectively. The fWDC values in this study are quite good because it is still below 25%. This is in accordance with the opinion of Baras *et al.* (2011) that the fWDC value is below 25%, meaning that fish uniformity at the end of the study is high. Apart from that, the fWDC results in this study are better than previous research where the fWDC values produced ranged from 20.69% - 24.84% (Harianto *et al.* 2023).

The physiological responses analyzed in this study include: blood glucose (BG), total cholesterol (TC) and hemoglobin (Hb). Physiological responses are often associated with fish stress responses and are widely used as health indicators (Suvetha *et al.*, 2010). BG is a secondary stress response in fish, an increase in BG values is an early indicator that fish are experiencing stress. Higher blood glucose levels indicate increased levels of stress due to the treatment given. A rapid increase in blood glucose and maintaining a high level will increase energy expenditure, energy deficiency will be followed by death (Jentoft *et al.*, 2005).

The initial glucose value was 77.75 mg/dL and at the end of the cultivation period ranged from 46.67±14.50 mg/dL – 81.00±8.72 mg/dL (Figure 3). There was a decrease in the BG value in treatments A, B and C and an increase in treatment D. Based on the results of analysis of variance, it showed that the treatment of different types of rearing containers has no significant effect ($P>0.05$) on the BG value. Other research results reported that jelawat fish kept in aquarium containers showed an increase in BG values at the end of the rearing period with blood glucose values ranging from 51.17-95.67 mg/dL (Putri *et al.* 2019: Harianto *et al.* 2023). The decrease in BG at the end of rearing that occurred in treatments A, B and C indicated that there was no stress in the jelawat fish, while the increase in BG that occurred in treatment D was still within the normal range of BG levels in jelawat fish. This is in accordance with the opinion of Rizki *et al.*, (2020) that the normal blood glucose range for jelawat fish is 50.00-60.00 mg/dL. Apart from that, Patriche (2009), reported that the blood glucose content in normal fish is around 40-90 mg/dL. Rahardjo *et al.* (2011) also reported the same thing that normally freshwater fish have blood glucose levels of around 40-90 mg/dL. Meanwhile, Wedemeyer & Yasutake (1977) reported that glucose in the blood of normal fish usually does not exceed 200 mg/dL or 100 mg/dL as a short-term stress effect.

Total cholesterol (TC) is a blood biochemical parameter used to determine the health, nutritional, physiological, and reproductive status of fish (Javed and Usmani, 2015). TC is closely related to fish stress via the hypothalamic-pituitaryinterrenal axis (HPI axis) (Mormède *et al.* 2007). An increase in TC levels is an indicator that fish are experiencing stress due to total lipid being synthesized optimally to be converted into cholesterol and triglycerides so that they can be used as an energy source. Elevated TC is part of liver dysfunction and lipid metabolism disorders (Javed *et al.* 2017).

The TC value at the start of cultivation was 191 mg/dL and decreased at the end of the maintenance period ranging from 120.28±7.40 mg/dL – 141.59±9.83 mg/dL. Based on the results of analysis of variance, it shows that the treatment of different types of maintenance containers has a significant effect ($P<0.05$) on TC. The highest TC value was found in treatment B at 141.59 ± 9.83 mg/dL, this value was the same as treatment C, namely 131.04 ± 7.43 mg/dL. The decrease in TC values in this study indicates that the fish are not experiencing stress, the energy sourced from fat is not fully used by the fish as the main energy source to overcome stressful conditions. The TC values produced in this study are still within the normal range for freshwater fish in general. TC levels in the species *Labeo rohita*, *Catla catla*, *Cirrhana mrigala* and *Labeo fimbriatus* were reported to be 202.16, 272.16, 206.5 and 211.83 mg/dL (Kulkarni and Bedjargi, 2016). Additionally, Ejraei *et al.* (2015) reported that the cholesterol level of grass carp fish, *Ctenopharyngodon idella* aged 6 months was 275.7 ± 70.8 mg/dL.

Apart from GD and TC, fish stress responses can be seen from the data of blood image analysis. This

is supported by the statement of Wedemeyer and Yatsuke (1997), changes in blood picture and blood chemistry both qualitatively and quantitatively can determine the condition of the fish or its health status. According to Lagler *et al.* (1977) stated that disturbances in the body of fish were indicated by changes in the blood picture, such as hematocrit values, hemoglobin concentration, total white blood cell count and red blood cell count. Hemoglobin is a protein in erythrocytes which is composed of colorless globin protein and heme pigment produced in erythrocytes. An increase in hemoglobin levels indicates that the fish is under stress. Hb levels are related to the number of erythrocytes, so that stress conditions also affect Hb levels in the blood. The ability of blood to transport oxygen depends on Hb levels in the blood (Lagler *et al.* 1977). Wells *et al.* (2005) states that 1 g of hemoglobin can bind approximately 1.34 ml of oxygen.

The Hb value at the start of cultivation was 11.6 g/dL and at the end of the cultivation period ranged from 9.03±1.19 g/dL – 12.83±1.23 g/dL. The treatment of different types of containers has a significant effect on the Hb value at the end of cultivation. The highest Hb value was found in treatment D at 12.83 ± 1.23 g/dL. This value was the same as treatments A and C, which were 10.80 ± 1.97 g/dL and 12.10 ± 2.07 g/dL respectively. Meanwhile, the lowest Hb value was found in treatment B at 9.03 ± 1.19 g/dL. The Hb content in this study was still within the normal range for jelawat fish. This is in accordance with the statement by Bastiawan *et al.* (1995) that the Hb content in healthy fish ranges from 12-14 g/dL. The Hb value in fish is related to metabolism in the formation of energy due to oxygen being transported via Hb. Hemoglobin functions to bind oxygen which is used for the catabolism process to produce energy (Lagler *et al.* 1977). In this study, there were no significant problems with growth and FCR, all treatments showed positive growth and low FCR values. This indicates that Hb works normally in binding oxygen in the blood so that the metabolic process is not disturbed. Bastiawan *et al.* (2001) stated that low Hb levels cause the metabolic rate to decrease and the energy produced to be low. This makes the fish weak and have no appetite and appear to be sitting still at the bottom or hanging below the surface of the water. The results of other research show that Hb values in several species of freshwater fish include hemoglobin levels in semah fish of 4.72 g/dL, biawan fish of 6.12 g/dL, botia fish of 5.50 g/dL and jelawat fish of 5.40 g/dL.

Water quality is an important parameter in aquaculture. Aquaculture activities with good management and water quality will produce more and healthier fish and vice versa (Boyd and Tucker 2014; Rana and Jain 2017). The water quality of the media for rearing jelawat fish seeds which are kept in different types of containers includes temperature, pH, DO, nitrite, and ammonia. The results of the water quality analysis of the rearing media show that the water quality is still in the appropriate range for rearing jelawat fish. The temperature ranged between 27.8-30.1°C, the optimal temperature for rearing jelawat fish seeds ranges between 25-30^{0}C (Utami *et al.* 2018; Putri *et al.* 2021; Harianto *et al.* 2023). The pH value during the research ranged between 6.2-7.7, this pH value is still optimal for rearing jelawat fish seeds, namely 6-8.4 (Putri *et al.* 2021; Harianto *et al.* 2023). The DO values during the research ranged between 3.7-6.8 mg/L, the DO values in this study were still in the appropriate range for rearing jelawat fish. The optimal DO for rearing jelawat fish seeds is > 3 mg/L (Rusliadi *et al.*, 2015; Putri *et al.*, 2021; Harianto *et al.* 2023). The nitrite value ranged from 0.0011-0.0719 mg/L, the optimal nitrite value for rearing jelawat fish seeds is not to exceed 0.06 mg/L (PP. 22 2021). The ammonia values during the research ranged between 0.001-0.0083 mg/L. The optimal ammonia value for rearing jelawat fish seeds is not to exceed 0.003-0.5 mg/L (Rusliadi *et al.*, 2015; Putri *et al.*, 2021; PP. 22 2021; Harianto *et al.* 2023).

The good water quality in this research is supported by the water quality management that was implemented. During the cultivation period, the water was changed once every 2 days, amounting to 30% of the total water volume. Apart from that, each breeding containers were provided with two points of aeration to supply oxygen

Conclusion

The best type of fish cultivation container for jelawat fish (*Leptobarbus hoevenii*) cultivation is aquariums (treatment A) with the highest production performance including survival rate 95%, specific growth rate 5.75%/day, absolute length growth 1.43cm, absolute weight growth 2.45g, feed conversion ratio 1.35, final weight diversity coefficient 21.01%, final length diversity coefficient 7.02% and the best physiological responses include total cholesterol 120.28 mg/dL, hemoglobin 10.80 g/dL and water quality that is still within the normal range for rearing jelawat fish seeds.

Acknowledgments

The authors would like to thank Universitas Batanghari through the Institute for Research and

Community Service for the research grant that has been provided.

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How to cite this paper:
Harianto, E., M. Sugihartono, M. Ghofur, Safratilofa, M.Y. Arifin. 2024. Production performance and physiological responses of jelawat fish (Leptobarbus hoevenii) breeding maintained in different containers. Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan, 13(1): 173-182.