Evaluation on growth, survival and feed efficiency in three generations of domesticated Asian redtail catfish

*Hemibagrus nemurus* (Valenciennes, 1840)

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**Abstract.** Domestication is one of the important steps in culturing wild fish into a captive system. This study aimed to evaluate the growth, survival rate, and feed efficiency of three generations (G-1, G-2, and G-3) of domesticated Asian redtail catfish. This study was conducted in the wet laboratory of Research Institute for Freshwater Aquaculture and Fisheries Extension (RIFAFE) Bogor from October to December 2017. The Completely Randomized Experimental Design with three treatments and three replications were utilized in this study. Experimental fish were obtained from mass spawning on three generations of Asian redtail catfish Cirata population. The size of experimental fish ranged between 2-3 cm of length with average weight was 0.32 ± 0.01 g. Fish were maintained in the aquarium (dimension= 70 cm x 50 cm x 40 cm) equipped with recirculation system. The circulation system was equipped with filters (rocks and sands). Each aquarium was stocked with a density of 30 individual 100 L-1. During 40 days of rearing, fish were fed with 10% day-1 of tubifex worms from the total fish biomass. Feeding was carried out three times a day at 07.00 AM, 12.00 PM, and 17.00 PM. The result showed that Asian redtail catfish seedlings from second and third-generation (G-2 and G-3) had significantly different growth performance (P<0.05) compared to first-generation (G-1), with the length gain of 5.57 cm and 5.57 cm, weight gain of 7.98 g and 7.99 g, specific growth rate on length of 2.97 % day-1 and 3.02 % day-1, specific growth rate on weight of 8.18 % day-1 and 8.22% day-1, and survival rate of 82.11% and 84.22%. The biomass value of three generations on Asian redtail catfish did not show any significant differences (P>0.05), while the best FCR and feed efficiency value (P<0.05) were found on Asian redtail catfish from third-generation (G-3) with a value of 73.00 ± 2.24% and 1.37 ± 0.04.

**1. Introduction**

The Asian redtail catfish *Hemibagrus nemurus* is a freshwater fish commodity with high economic value and currently become one of potential commodity for business diversity of aquaculture in Indonesia. The flesh quality of this species was suitable for culinary business in several regions, such as Sumatra and Kalimantan, with promising prices ranged from IDR. 35,000-50,000/kg [1]. The commercialization and intensive culture of this species was still limited, therefore the demand of the Asian redtail catfish for consumption still depends on the wild capture. The Asian redtail catfish farming has been existed in Indonesia since the 1990’s. However, some studies reported low of
productivity, mainly on survival level. Subagja et al [2] reported that the survival rate of Asian redtail catfish only 10-30% (size of 5 cm). Meanwhile, Radona et al. [3] obtained that the survival rate of Asian redtail catfish reared in indoor (room temperature between 25-26°C) was 50%. Study on the growth performance and egg quality of *H. nemurus* have been reported by Abidin et al. [4] and Hasan et al. [5], respectively; while the breeding and sperm cryopreservation of this species have been reported by Muchlisin et al. [6, 7]. In order to improve reproductive performance, it is necessary to observe and input some technologies such as domestication programs to overcome the problems and increase productivity.

Domestication is fish adaptation process from its original environment (in situ) to an aquaculture media (ex situ) with input technology that aimed to control the rearing and reproduction. Domestication is a process of changes in living organisms involving genetic changes that occur from generation to generation for controlling the reproductive cycle, growth and survival rate [8-11]. In order to achieve the successfull of domestication programs on Asian redtail catfish, some activities have been carried out, including its performance evaluation of three generations in the nursery phase 1 [12] and evaluation of phenotypic variance [13]. Generally, Asian redtail catfish from third generation (G-3) has better performance to adapt with environmental changes.

In terms of determining more success on domestication of Asian redtail catfish, information regarding to the biological performance of each generation were necessarily needed. This study aimed to evaluate the growth, survival rate and feed efficiency on three generations (G-1, G-2 and G-3) of domesticated Asian redtail catfish. Thus, it will be useful in aquaculture activities as an effort to provide biological products from domesticated Asian redtail catfish.

2. Material and Methods

2.1 Time, site and experimental design

This study was conducted on wet laboratory of Research Institute for Freshwater Aquaculture and Fisheries Extension (RIFAFE) Bogor, from October to December 2017. The experiment was carried out using Completely Randomized Design (CRD) with three treatments and three replications. Experimental fish were obtained from mass spawning on three generations (G-1, G-2 dan G-3) of Asian redtail catfish Cirata population. G-1 was the population resulted from the spawning of the oldest broodstock, G-2 was a population resulted from spawning of the first generation broodstock and G-3 was the resulted from spawning of the second generation broodstock. Spawning process was conducted in the same time.

2.2 Experimental procedure

The size of experimental fish was 2-3 cm of length and 0.32 ± 0.01 g of weight. Fish were maintained in the aquarium (dimension= 70 cm x 50 cm x 40 cm) equipped with recirculation system. The circulation system was equipped with filters (rocks and sands). Each aquarium was stocked with density of 30 individual/100 L. The reared was carried out for 40 days based on the segmentation on the fish nursery phase two on redtail catfish (size 2-3 cm) [1]. During rearing time, fish were fed by 10% per day of tubifex worms from the total fish biomass. Feeding was carried out three times a day at 07.00 am, 12.00 pm, and 17.00 pm. Firstly, tubifex worms given to the fish was treated with tetracycline antibiotics (500 mg/100 L of water). Fish growth was observed every 10 days interval with the length and weight measurement on 30 fish per aquarium; while, the survival rate was observed by calculating based on Muchlisin et al. (14), while growth performance and feed efficiency were calculated based on [15]. Water quality in the aquarium was also observed during the study.

Temperature (°C), pH, and dissolved oxygen (mg.L⁻¹) were measured directly by using Multi Parameter Water Quality Meter EC 900 with intervals of three hours within 24 hours. TAN total ammonia nitrogen (mg.L⁻¹), nitrate (mg.L⁻¹), dan nitrite (mg.L⁻¹) was observed in laboratory tests of Research Institute for Freshwater Aquaculture and Fisheries Extension, Bogor (ISO 17025:2008; Accreditation number: LP-711 IDN) with SNI 06-989.29.2004 testing techniques for nitrite and SNI...
06-989.30.2004 for TAN. Collected data was tabulated and analyzed using analysis of variance (ANOVA) on 95% confidence level.

2.3 Data analysis
The data were subjected to one-way ANOVA and followed by the Duncan’s multiple ranges test analysis using SPSS 18. Water quality parameters were analyzed qualitatively.

3. Results and Discussions

3.1 Growth performance on three generations of Asian redtail catfish
The result of 40-day rearing showed that Asian redtail catfish from G-2 and G-3 had were not significantly different on length gain, weight gain and specific growth rate (P>0.05). However, it was significantly different (P<0.05) compared with G-1. Length gain value, weight gain and specific growth rate on three generations of Asian redtail catfish seedlings were shown in Table 1.

| Growth performance | Asian redtail catfish population |
|--------------------|---------------------------------|
|                    | G-1                | G-2                | G-3                |
| Initial length (cm) | 2.49 ± 0.04        | 2.38 ± 0.03        | 2.44 ± 0.04        |
| Initial body weight (g) | 0.33 ± 0.01 | 0.31 ± 0.02        | 0.31 ± 0.01        |
| Final length (cm)   | 7.48 ± 0.18        | 7.95 ± 0.26        | 8.00 ± 0.15        |
| Final body weight (g) | 6.65 ± 0.46 | 8.29 ± 0.77        | 8.30 ± 0.45        |
| Absolute length (cm) | 4.98 ± 0.20a  | 5.57 ± 0.29b       | 5.57 ± 0.12b       |
| Absolute weight (g) | 6.32 ± 0.45a  | 7.98 ± 0.78b       | 7.99 ± 0.45b       |
| Specific growth rate of length (% day⁻¹) | 2.75 ± 0.09a | 3.02 ± 0.11b | 2.97 ± 0.03b |
| Specific growth rate of weight (% day⁻¹) | 7.48 ± 0.16a | 8.18 ± 0.39b | 8.22 ± 0.13b |

Remarks: Numbers followed by different superscript letters in the same line indicates significant differences (P<0.05).

Growth is a genotype expression in the phenotype that is observed quantitatively and is influenced by environmental factors. On growth parameters, it showed that the performance of Asian redtail catfish (G-2 and G-3) had similar absolute length value of 5.57 cm and absolute weight of 7.98-7.99 g. Those values had 11.84% higher in length and 26% higher in weight compared with G-1. The increase of growth occurred in Asian redtail catfish G-2 and G-3 is a form improvement on a positive genetic quality in response to environmental conditions [16-18]. Furthermore, according to Millot et al. [19], domesticated fish was tended to have a high appetite level so that it can accelerate the growth process. The value of SGR on weight and length was obtained directly proportional to the value of growth in weight and length was obtained, the higher value of growth, the greater value of SGR produced.

3.2 Survival rate on three generations of Asian redtail catfish
The observation of survival on three generations of Asian redtail catfish for 40 days were shown in Figure 1. This study showed not significantly different (P>0.05) on the survival rate values of Asian redtail catfish seeds on G-2 and G-3. However, it was significantly different (P<0.05) compared with G-1.
Based on Figure 1, survival rate values obtained for the rearing of Asian redtail catfish G-1, G-2 and G-3 was 77.89%, 82.11% and 84.22%. The survival rate values obtained on Asian redtail catfish on G-2 and G-3 have increased by 5-8% compared with G-1. The higher value of survival was presumably due Asian redtail catfish (G-2 and G-3) has undergone the adaptation process in controlled environment. The results of a similar study were reported by Kusmini et al. [20], Asian redtail catfish G-3 reared on concrete ponds and floating net cages showed the highest survival value compared with G-1. The successfull of the domestication program will have an impact on increasing genetic diversity in fish. Genetic diversity is closely linked to the performance of fish such as survival and efficiency in utilizing the feed [8, 21]. Several domestication studies in fish have been reported that the domesticated population will have a more adaptive performance with the highest survival rate compared to the previous generation of fish populations, such as Barbonymus balleroides [22], Barbomyxus schwanenfeldii [23], common carp strain Rajadanu Cyprinus carpio [24], and mahseer Tor soro [25].

3.3 Biomass, FCR and feed efficiency

The observation biomass, FCR and feed efficiency on three generation of Asian redtail catfish for 40 days experiment were presented in Table 2. Biomass is strongly influenced by the value of survival rate. The results showed that the biomass on three generations of Asian redtail catfish produced not significantly different (P<0.05) ranged from 1,583 to 1,663 g. In the feed efficiency parameters and FCR, the results showed that Asian redtail G-3 has the best value by 73% and 1.37. This value is statistically have significantly different values (P<0.05) compared to Asian redtail G-1 and G-2. Feed efficiency is the proportion of added fish biomass with the amount of feed consumed by fish [26]. The FCR value indicated the utilization of feed nutrients by fish, the lower value of FCR produced shows that the more efficient use of feed. Based on the FCR value was obtained on Asian redtail G-3, it shows that fish could utilize feed efficiently.

3.4 Water quality

Measurement of water quality in the aquaria was needed to support rearing activities in Asian redtail catfish. In addition to genetic factors, the environment played an important role in the success of the process of fish adaptation and growth. Oliveira et al. [27] stated that fish growth performance is strongly influenced by the aquatic environment, such as temperature, pH, and dissolved oxygen. The observation of water quality (temperature, pH and dissolved oxygen) indicated that the value was tended to be stable. The temperature values obtained were in the range of 28.4-30.1 °C. The value of water quality was classified as optimal. According to Kusmini et al. [20], the optimal temperature value to support culture activities of Asian redtail catfish was 28-32°C. Temperature played a very
important role in the growth and survival of fish. The optimal water temperature will increase fish feeding activities so that it accelerates growth [28, 29]. Moreover, temperature could also influence the amount of oxygen dissolved in water and fish respiration [30]. The result of water quality measurement during the experiment was showed at Table 3.

### Table 2. Biomass value, FCR and feed efficiency on three generations of Asian redtail catfish.

| Parameters                  | G-1                     | G-2                     | G-3                     |
|-----------------------------|-------------------------|-------------------------|-------------------------|
| Initial biomass (g)         | 100.00 ± 3.74           | 94.00 ± 6.16            | 93.00 ± 2.45            |
| Final biomass (g)           | 1683.31 ± 25.56         | 1686.20 ± 83.12         | 1756.94 ± 56.51         |
| Absolute biomass (g)        | 1583.31 ± 24.79a        | 1592.20 ± 89.27a        | 1663.94 ± 58.94a        |
| EF                          | 63.33 ± 0.99a           | 66.87 ± 3.18a           | 73.00 ± 2.24b           |
| Feed efficiency (%)         |                         |                         |                         |
| FCR                         | 1.58 ± 0.02a            | 1.50 ± 0.07a            | 1.37 ± 0.04b            |

Remarks: Numbers followed by different superscript letters in the same line indicates significant differences (P<0.05).

### Table 3. The value of water quality in the aquarium during the experiment.

| Parameters (water quality)  | Range value            | Analysis technique |
|-----------------------------|------------------------|--------------------|
| Temperature (°C)            | 29.1 – 28.4            | -                  |
| pH                          | 6 – 7                  | -                  |
| Dissolved oxygen (mg.L⁻¹)   | 5.22 – 6.8             | SNI 06-6989.29.2004|
| Nitrate (mg.L⁻¹)            | 0.312 – 1.124          | -                  |
| Nitrite (mg.L⁻¹)            | 0.033 – 0.044          | SNI 06-6989.30.2004|
| TAN (mg.L⁻¹)                | 0.015 – 0.035          | -                  |

In pH parameter, the value was ranged 6 to 7. This value is an optimal value for aquaculture. Unstable pH values could affect the toxicity of a chemical compound in water. Increasing pH value will increase the value of ammonia [31-33]. In addition, the high value of ammonia will reduce the dissolved oxygen content in the water. Generally, the results of water quality measurements was obtained on high value and not fluctuated. It was due to the rearing media which placed on a controlled environment in a wet laboratory.

### 4. Conclusions

The domesticated Asian redtail catfish G-3 have more adaptive growth performance with the highest survival rate compared with G-1. Furthermore, Asian redtail catfish G-3 seedlings have the best feed efficiency and FCR values.

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