Indonesian Aquaculture Journal, 15 (1), 2020, 1-6

Available online at: http://ejournal-balitbang.kkp.go.id/index.php/iaj

GROWTH PERFORMANCE OF DOMESTICATED ASIAN REDTAIL CATFISH *Hemibagrus nemurus* FINGERLINGS REARED AT DIFFERENT STOCKING DENSITIES

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(Received 26 February 2019; Final revised 24 April 2019; Accepted 24 April 2019)

ABSTRACT

Asian redtail catfish *Hemibagrus nemurus* is one of the prospective aquaculture commodities in Indonesia. However, there are still shortcomings in completing the domestication of this species. As such, this study was conducted to observe the growth of Asian redtail catfish at different stocking densities. Fish (body weight (BW) of 21.62 ± 0.57 g) were stocked in nine different floating nets (dimension: 2 m x 2 m x 1 m) inside a concrete pond (40 m x 20 m) with three stocking density treatments (10, 15, and 20 fish/m^3). Each treatment consisted of three replicates. Growth data were collected every 30 days during 120 days of rearing period which included weight gain (WG), specific growth rate in body weight (SGR_{BW}), average daily growth (ADG_{BW}), biomass gain (BG), feed conversion ratio (FCR), and survival rate (SR). Measured water quality parameters during the experiment consisted of temperature, pH, and dissolved oxygen. The results showed that the best growth performance was achieved by fish at the stocking density of 15 fish/m^3 compared to that of fish with the stocking density of 10 and 20 fish/m^3. The FCR value of fish at the stocking density of 15 fish/m^3 was also significantly better than those of 10 fish/m^3 and 20 fish/m^3 ($P<0.05$). The survival rate in each treatment was not significantly different ($P>0.05$). This study suggests that the optimal stocking density for Asian redtail catfish fingerlings is 15 fish/m^3, beyond that value, growth reduction might be expected. Further research is needed to observe its optimal stocking density in different culture systems.

KEYWORDS: **Asian redtail catfish; domestication; growth; stocking density**

INTRODUCTION

Asian redtail catfish *Hemibagrus nemurus* is one of the prospective freshwater species for aquaculture in Indonesia. This species is naturally distributed in Java, Sumatra, and Kalimantan. The species has a good economic value in the local markets, with selling price ranged between Rp50,000.00-Rp100,000.00/kg (Irwanda, 2018; Kesuma, 2018). However, the over-exploitation from capture fisheries has diminished its wild population. Several shortcomings in domestication process challenge the development on culture technology of this species, such as in broodstock management, spawning, and larval rearing. Subagja *et al.* (2015) had studied the reproductive performance of several populations of Asian redtail catfish (Cisadane, Serayu, and Cirata). They found that the Cirata population have higher productivity than the other populations. The finding has directed the use of the Cirata population as the best fish population for future domestication purposes (Subagja *et al.*, 2015).

Several studies have been carried out regarding the biological aspects (Samuel *et al.*, 1995), reproductive traits and characteristics of the first generation (Hardjamulia & Suhenda, 2000), seedling production through improvement of lipid level of broodstock feed (Suhenda *et al.*, 2009), and growth (Huwoyon *et al.*, 2011) of Asian redtail catfish. Despite the positive results from these studies, the species remains unfavored as a freshwater aquaculture species by fish farmers. Therefore, the domestication program of the species to be readily used for aquaculture as well as support its conservation are necessary. One of the most important

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parameters in successful domestication and aquaculture of Asian redtail catfish is growth performance.

Among several external factors that influence the growth in an aquaculture environment, stocking density has become a popular and widely studied external factor. Optimal stocking density could determine the optimal fish growth. Previous studies regarding the effects of stocking density on fish growth have been conducted on various fish species such as Nile tilapia *Oreochromis niloticus* (Yi *et al*., 1996; Rahman *et al*., 2016), turbot *Scophthalmus maximus* (Irwin *et al*., 1999), Amur sturgeon *Acipenser schrenckii* (Yang *et al*., 2011), rainbow trout *Oncorhynchus mykiss* (Liu *et al*., 2016), African catfish *Clarias gariepinus* (Shoko *et al*., 2016), and striped catfish *Pangasius hypophthalmus* (Islam *et al*., 2018). These previous studies showed that increasing stocking density affected negatively on growth of the species observed. Conversely, studies on Arctic charr *Salvelinus alpinus* (Jorgensen *et al*., 1993) and grouper *Epinephelus coioides* (Samad *et al*., 2014) showed positive impacts of higher stocking densities. A study on the growth performance of *H. nemurus* had also been carried out by Kristanto *et al*. (2016) who investigated the effect of incubation temperature on broodstock and shelter application on larvae to the seedling production. However, their study did not specifically deal with the impact of stocking density on fish growth. Therefore, studies on the growth performance *H. nemurus* reared at different stocking densities remain incomplete, especially related to the optimal stocking density at a certain fish size. The present study was conducted to determine the effects of different stocking densities on the growth of Asian redtail catfish fingerlings.

MATERIALS AND METHODS

The study was conducted from October 2016 to February 2017 using the pond belonged to the Institute for Conservation on Inland Open-Water Fisheries and Ornamental Fish (Balai Pelestarian Perikanan Perairan Umum dan Pengembangan Ikan Hias/BPPPUIH), Maleber, West Java, Indonesia. The fingerlings of Asian redtail catfish used in this experiment were the second generation of Asian redtail catfish produced from the institute's previous domestication process. The fingerlings (body weight (BW) of 21.62 ± 0.57 g) were stocked in nine separate nets (dimension: 2 m x 2 m x 1 m) constructed inside the pond (pond size: 40 m x 20 m).

The study used three different stocking densities (10, 15, and 20 fish/m^3) and was arranged in a completely randomized design with three replicates. The experiment was carried out for 120 days in which growth, survival, and feed conversion ratio were recorded. The fingerlings were fed with a commercial feed (30% protein) with a daily feeding rate of 3% of fish biomass twice per day. Water quality observed during the study included temperature, dissolved oxygen (measured using DO-meter, Trans Instrument HD3030), and pH (measured using a pH meter, Trans Instrument Senz pH Pro).

In each experimental treatment, 120 fingerlings (n = 30 for each treatment replicate) were sampled every 30 days starting on day-1, day-30, day-60, day-90, and day-120 during the experiment. In each sampling, fingerlings from each treatment and replication were put in the bucket and anesthetized by adding stabilizer (Ocean Free Arowana Stabilizer) in the water inside the bucket. The body weight (BW, g) was weighed using a digital scale with an accuracy of 0.1 g. After the measurement, the sampled fingerlings were returned to the corresponding nets. At day 120, all the nets were emptied, and survived fingerlings were counted to calculate the survival rates.

The effects of stocking density on growth performance were determined by calculating the following parameters for each experimental treatment. Survival rate (SR), expressed in percentage, was calculated by comparing the final number (N_t) with the initial number of fingerlings (N_o):

$$SR(\%) = \left[\left(\frac{N_t}{N_o}\right) x\, 100\right]$$

Weight gain (WG, g) was calculated using the following equation:

$$WG = \left[BW_t - BW_o\right]$$

where BW_o and BW_t are the initial average body weight (g) and the final average body, respectively.

Biomass gain (BG, g) was calculated using the following equation:

$$BG = \left[\left(N_t BW_t - N_o BW_o\right)\right]$$

where N_o and N_t are the initial number and the final number of fingerlings, respectively. BW_o and BW_t are the initial average body weight (g) and the final average body, respectively.

The specific growth rate of body weight ($SGR_{BW,}$ %/day) was calculated according to the following equation:

$$SGR_{BW} = \left[\frac{\left(\ln BW_t - \ln BW_o\right)}{t} x\, 100\right]$$

where BW_o and BW_t are the initial and final body weight of fish, respectively and t is the duration of the experiment (days).

The average daily growth of body weight (ADG_{BW}, g/day) was calculated according to the following equation:

$$ADG_{BW} = \left[\frac{(BW_t - BW_o)}{t}\right]$$

where BW_o and BW_t are the initial and final body weight of fish, respectively while t is the duration of the experiment (days).

Feed conversion ratio (FCR) was calculated using the following equation:

$$FCR = \frac{F}{(N_t\ BW_t - N_o\ BW_o)}$$

where F is the total of food intake during the whole rearing period. F was determined as the total amount of food provided.

Statistical comparisons were performed using one-way ANOVA. The level of significance for statistical analyses was always set to α = 0.05. Tukey's test was performed to compare means when a significant difference was found. All statistics were performed using PASW Statistics 18.

RESULTS AND DISCUSSION

The results of observations on the growth performance of Asian redtail catfish fingerlings reared for 120 days at different stocking densities (10, 15, and 20 fish/m^3) showed that the highest growth was achieved at the stocking density of 15 fish/m^3 (Table 1). The weight gain, biomass gain, specific growth rate in body weight, and average daily growth in body weight showed significantly different values between the 15 fish/m^3 and the other stocking densities ($P<0.05$).

This study showed that the best stocking density to culture Asian redtail catfish fingerlings is 15 fish/m^3. Increasing stocking density to 20 fish/m^3 has a negative impact on fish growth resulting in the decline of the growth rate. The growth reduction on high stocking density were also reported in other studies using different fish species, such as tilapia (Zied *et al*., 2005; Rahman *et al*., 2016), grey mullet (Zied *et al*., 2005), rainbow trout and brown trout (Sirakov & Ivancheva, 2008). Generally, the negative impacts of high stocking density on fish growth can be attributed to the food, oxygen, and shelter competition between fish, which may lead to increased fish stress (Barton & Iwama, 1991; Wedemeyer, 1997). In relation to the present study, there was a tendency of increased individual competition of Asian redtail catfish when its stocking density was increased, which affected their growth and stress response.

The results from this study also showed that space availability is a limiting factor for fish growth in relation to different stocking densities, as reported by Weatherley & Gill (1987). Higher stocking densities will increase fish stress due to the limited available culture space. In fish farming, farmers should consider avoiding stress on cultured species throughout the life cycle in order to get optimal growth. By determining their optimal stocking density, there would be a balance between optimizing economic yield per unit farm as well as reducing fish stress (Barton, 2002; Barcellos *et al*., 2004; Laiz-Carrion *et al*., 2012).

Table 2 showed that the lowest value of the feed conversion ratio was obtained by the fish at the stocking density of 15 fish/m^3 (2.37 ± 0.2). This value was significantly different from that of the stocking density of 20 fish/m^3 ($P<0.05$) but not significantly different from that of fish with the stocking density of 10 fish/m^3 ($P>0.05$). Regardless of the results of

Table 1. Growth of Asian redtail catfish fingerlings reared for 120 days at different stocking densities

Parameters	Stocking density (fish/m^3)		
	10	15	20
Initial weight (BW_0) (g)	21.90 ± 0.21^a	21.16 ± 0.96^a	21.72 ± 1.68^a
Final weight (BW_t) (g)	62.77 ± 6.23^b	70.49 ± 0.77^a	50.79 ± 4.35^c
Weight gain (WG) (g)	40.87 ± 6.03^b	49.33 ± 0.19^a	29.06 ± 2.66^c
Biomass gain (BG) (g)	1592.55 ± 236.76^b	2821.86 ± 342.10^a	1589.36 ± 550.99^b
Specific growth rate in body weight (SGR_{BW}) (%/day)	0.84 ± 0.07^b	1.00 ± 0.01^a	0.70 ± 0.06^c
Average daily growth in body weight (ADG_{BW}) (g/day)	0.34 ± 0.05^b	0.41 ± 0.01^a	0.24 ± 0.02^c

Description: Different superscript letters in the same row indicate significant differences between treatments ($P<0.05$)

Table 2. Feed conversion ratio and survival rate of Asian redtail catfish fingerlings reared for 120 days at different stocking densities

Parameters	Stocking density (fish/m^3)		
	10	15	20
Feed conversion ratio (FCR)	2.68 ± 0.2[ab]	2.37 ± 0.2[a]	3.10 ± 0.3[b]
Survival rate (SR) (%)	89.17 ± 8.32[a]	86.67 ± 1.67[a]	82.78 ± 1.92[a]

Description: Different superscript letters in the same row indicate significant differences between treatments ($P<0.05$)

the growth parameters, the fish exhibited no aggressive behavior and cannibalism throughout the experiment period. In addition, the survival rates measured at the end of the experiment were high (82.78%-89.17%) without any significant differences between the three stocking densities ($P>0.05$). These high survival rates suggest that fingerlings were reared in suitable environmental conditions.

A feed conversion ratio is an indicator to measure the effectiveness of feeding and the quality of feed (Millamena *et al*., 2002). This study found that the best FCR value was achieved by fish stocked at the medium stocking density. The FCR value achieved in this study was slightly better than that of the study by Hardjamulia & Suhenda (2000) and Muflikhah & Gafar (1992), who reported feed conversion ratios of 3.30 and 3.80 for Asian redtail catfish fingerlings, respectively. The differences of FCR value on previous studies compared to present study might be caused by the difference of reared fish size, stocking density, and rearing environment. Vijayan & Leatherland (1988) and Papoutsoglou *et al*. (2006) described that growth reduction in fish reared at higher stocking density is related to a drop in food consumption and reduced food conversion efficiency. Moreover, Zonneveld *et al*. (1991) stated that fish rearing with optimal feeding techniques would result in better feed conversion and survival of fish. In this study, insignificant differences in the survival rate among the treatments was resulted from an optimal water pond quality for Asian redtail catfish. Thus, less mortality occurred during the experiment.

The present study showed that water temperature in the pond ranged from 25.3°C to 28.2°C during the experiment. pH value and dissolved oxygen varied between 6.7-7.3 and 4.24-5.20 mg L^{-1}, respectively (Table 3). No significant differences found on water temperature, pH, and dissolved oxygen between the stocking density treatments ($P>0.05$).

Water quality is a variable that influences fish survival, reproduction, growth, management, and production. Water quality includes temperature, dissolved oxygen, pH, and other parameters (Boyd, 2000). Previous researches reported that higher stocking densities resulted in poor water quality (reduced level of oxygen, increased ammonia-nitrogen concentration, accumulation of carbon dioxide, and other organic wastes) compared to lower stocking densities. Good water quality control and optimal aeration are the best way to overcome these problems (Boyd, 2000; Samad *et al*., 2014). The negative effects of stocking density on fish growth could be related to the water quality deterioration due to higher rearing density (Kebus *et al*., 1992). In this study, the variations of water quality parameters were minimal between each stocking density treatment since the treatments were in the same pond. Hence, the effect of water quality on fish growth could be eliminated.

CONCLUSIONS

This study concludes that the highest stocking density treatment (20 fish/m^3) has negative effects on the growth of Asian redtail catfish fingerlings. The best stocking density for growth achieved by fish

Table 3. Ranges of water quality in the rearing pond of Asian redtail catfish fingerlings during the experiment

Parameters	Stocking density (fish/m^3)		
	10	15	20
Water temperature (°C)	25.4-27.6	25.8-28.2	25.3-27.9
pH	6.7-7.3	6.8-7.3	6.7-7.2
Dissolved oxygen (mg/L)	4.24-5.13	4.45-5.20	4.38-5.01

stocked at 15 fish/m^3. The FCR value stocked at 15 fish/m^3 was significantly better than those of 10 fish/m^3 and 20 fish/m^3. The research also found no significant differences in the survival rates among the treatments. This study recommends that Asian redtail catfish fingerlings should be reared using 15 fish/m^3 stocking density. Further research is needed to observe the productivity and efficiency of Asian redtail catfish with optimal stocking density in several culture systems, as well as studying their physiological responses.

ACKNOWLEDGEMENT

We would like to thank the staff of BPPPUIH, Agency for Marine and Fisheries of West Java Province, who contributed in supporting this research. The research is part of the collaboration between the Research Institute for Freshwater Aquaculture and Fisheries Extension (RIFAFE), Ministry of Marine Affairs and Fisheries and BPPPUIH funded by the BPPPUIH DPA-2016, Agency for Marine and Fisheries of West Java Province.

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