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EFFECT OF STOCKING DENSITY ON GROWTH PERFORMANCE OF DOMESTICATED BARB (*Barbonymus balleroides*)

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ABSTRACT

Barb (*Barbonymus balleroides*) considerably has economic potential as aquaculture commodity. However, there was still lack of development on aquaculture for this species. This study was conducted to observe the effect of different stocking density on growth of barb. The fish (body weight: 14.89 ± 0.13 g) were stocked in nine floating nets (dimension: 2 m x 2 m x 1 m) inside the concrete ponds with three stocking density treatments (10, 15, and 20 fish/m^3). Each treatment consisted of three replications. Fish were fed on commercial pellet (30% of crude protein) as much as 3% of the biomass per day with twice a day of feeding frequency. Data of growth performances (body weight, specific growth rate, average daily growth, biomass, food conversion ratio, and survival rate) were collected every 30 days during 90 days of rearing period. Water quality variables (temperature, pH, and dissolved oxygen) were observed during experiment. The results showed that the optimal stocking density for the growth of barb was 10 fish/m^3. Best value of food conversion ratio was found 10 fish/m^3 compared with 15 and 20 fish/m^3 ($P<0.05$). Meanwhile, there were no significant differences on survival rate between treatments. These results also showed the potential of rearing barb on culture ponds with appropriate stocking density.

KEYWORDS: ***Barbonymus balleroides*; domestication; growth; stocking density**

INTRODUCTION

Barb (*Barbonymus balleroides*) is one of local fish species in Indonesia which potentially to become as aquaculture commodity. In Indonesia, barb is distributed in Java and Kalimantan (Kottelat *et al*., 1993). Besides its use for consumption, this species was also traded as ornamental fish. However, the availability of this species became scarce due to high exploitation on its natural habitat (Rumondang, 2013).

Recently, there was still lack of effort on culturing barb (Kusmini *et al*., 2016). Therefore, domestication efforts for the purpose of aquaculture and restocking had to be implemented. Several studies have been conducted to get the information about barb from its natural habitat (Luvi, 2000; Surawijaya, 2004; Yulfiperius, 2006; Fajarwati, 2006; Mote *et al*., 2014). However, lack of information regarded to its potential for aquaculture in order to support domestication program has made it became interesting issue to be studied. One of interesting field to be observed is on growth performance. Information on growth of domesticated barb in aquaculture environment was still not observed yet.

Stocking density is one of external factors which determine growth performance of farmed fish. Several studies on growth performance of the fish under different stocking density have been conducted in various species (Yi *et al*., 1996; Huang & Chiu, 1997; Szczepkowski *et al*., 2011; Yang *et al*., 2011; Zhu *et al*., 2011; Samad *et al*., 2014; Hernandez *et al*., 2016; Liu *et al*., 2016; Rahman *et al*., 2016). However, observation of growth performance regarding different stocking density on *Barbonymus balleroides* has not studied yet. Therefore, this study was conducted to obtain the optimal stocking density for growth performances of barb.

MATERIALS AND METHODS

The research was conducted in Maleber, Cianjur, West Java, a station of the Institute for Conservation on Inland Open-Water Fisheries and Ornamental Fish, West Java in October to December 2016. Barb

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used in the study fingerlings obtained from domestication method (body weight: 14.89 ± 0.13 g). The fish were stocked in nine floating nets (dimension: 2 m x 2 m x 1 m) inside the concrete ponds (40 m x 20 m) with three stocking density treatments (10, 15, and 20 fish/m^3) and three replications in each treatment as well. These treatments were selected to obtain higher stocking density compared with previous study which deals with post-larvae of this species (Kusmini *et al*., 2017). Fish were fed 3% of the biomass per day with twice a day of feeding frequency. Fish were fed on commercial pellet feed containing 30% crude protein.

Data of body weight was collected by random sampling from 30% of total population every 30 days during 90 days of rearing period. Meanwhile, data for specific growth rate (SGR), average daily growth (ADG), biomass gain, food conversion ratio (FCR), and survival rate (SR) were collected from total population only at the beginning and the end of rearing period. All of growth parameters were calculated using the formula according to Effendie (1979).

Water quality was observed inside the nets during experiment (morning and evening), which include water temperature, dissolved oxygen (measured by DO-meter, Trans Instrument HD3030), and pH (measured by pH-meter, Trans Instrument Senz pH Pro). Growth performance data were statistically analyzed and compared by using one-way analysis of variance (ANOVA). Differences were regarded significant when $P<0.05$.

RESULTS AND DISCUSSIONS

The result of present study showed that the best growth of barb was found at stocking density of 10 fish/m^3. The value of weight, biomass, specific growth rate, and average daily growth showed significantly different values between 10 fish/m^3 and others (15 fish/m^3 and 20 fish/m^3) ($P<0.05$). Meanwhile, survival rate was not significantly different among treatments ($P>0.05$), with the value from stocking density of 10, 15, and 20 fish/m^3 was 89.17 ± 6.29%, 93.33 ± 2.89%, and 95.00 ± 4.51%, respectively (Table 1).

Based on the best of our knowledge, no previous studies on growth performance or stocking density were found in this species at fingerling stage. However, this observation have similar pattern with growth performance of other barb species in same genus (*Barbonymus gonionotus*), of Mollah *et al*. (2011) and Faizul & Christianus (2013). They reported that the increasing of stocking density would affect negatively on fish growth, resulting in decreased growth rate. Other studies also reported on negative effect of higher stocking density (Vijayan *et al*., 1990; El-Sayed, 2002; Zied *et al*., 2005; Sirakov & Ivancheva, 2008; Rahman *et al*., 2016). On the contrary, other previous studies on other species reported that increasing the stocking density affect positively on growth (Howell, 1998; North *et al*., 2006). Therefore, studies on stocking densities should consider on species, social interaction, water quality, and environmental conditions for the efficiency of aquaculture productivity (Barcellos *et al*., 2004; Salari *et al*., 2012). Regarding to domestication level of this species, it was important to obtain the proper stocking density for barb in order to optimize their growth performance.

It has been reported that fish growth is influenced by food, space, temperature, salinity, season, and physical activity (Weatherley & Gill, 1987). From the results of this study, space became a limiting factor for optimal growth of barb as stocking density was different. Stocking density is an important factor in fish farming. The results showed that the stocking density of 10 fish/m^3 was an optimal stocking density for growth of barb. Meanwhile, higher stocking density (15 and 20 fish/m^3) caused lower growth rate. This phenomenon occurred in barb because higher stocking density had higher probability of stress which was affected by less space (Montero *et al*., 1999; Ruane *et al*., 2002; Ardiansyah & Fotedar, 2016). Thus, it will inhibit their growth. Moreover, in this study, significant differences were found in the FCR among different stocking densities, which indicates growth reduction of barb with increasing stocking density was because of feed efficiency. Barton (2002) stated that aquaculture requires optimal stocking density throughout the life cycle of species in order to avoid stress on the fish and the potential economic loss. Lower stocking densities without considering the optimization of space can lead to production costs increase and lowering profits in aquaculture activities (De las Heras *et al*., 2015). Related to this reference, different stocking density affected the estimated profit of barb farming because of its slower growth and higher feed supply. In addition, contacts between individuals, competition for food, and stress due to the higher stocking density would contribute to increase the stress response and resulted negatively on fish metabolic and growth (Barcellos *et al*., 2004; Laiz-Carrion *et al*., 2012).

During experiment, water temperature range were 27.1 ± 1.8°C, 27.0 ± 1.7°C, and 26.9 ± 1.4°C at stocking density of 10, 15, and 20 fish/m^3, respectively. Meanwhile, pH were 6.9 ± 0.4, 7.0 ± 0.3, and 7.0 ± 0.4 at stocking density of 10, 15, and 20 fish/m^3, respectively. On the other hand, dissolved oxy-

Table 1. Growth performance of barb (*Barbonymus balleroides*) reared for 90 days at different stocking density

Parameter	Stocking density (fish/m^3)		
	10	15	20
Initial weight (g)	15.02 ± 1.71^a	14.75 ± 1.08^a	14.85 ± 1.64^a
Final weight (g)	39.43 ± 8.60^a	17.94 ± 2.79^c	30.38 ± 0.89^b
Weight gain (g)	24.41 ± 6.90^a	3.18 ± 1.77^c	15.53 ± 2.06^b
Biomass gain (g)	2,392.27 ± 569,89^a	484.77 ± 219.74^c	1,119.09 ± 80.72^b
Specific growth rate (%/day)	1.06 ± 0.13^a	0.20 ± 0.15^c	0.80 ± 0.14^b
Average daily growth (g/day)	0.271 ± 0.079^a	0.035 ± 0.030^c	0.173 ± 0.023^b
Food conversion ratio	1.68 ± 0.16^a	2.24 ± 0.16^b	2.01 ± 0.14^b
Survival rate (%)	89.17 ± 6.29^a	93.33 ± 2.89^a	95.00 ± 4.51^a

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

gen content were 5.02 ± 0.30 mg/L, 5.05 ± 0.49 mg/L, and 5.08 ± 0.76 mg/L at stocking density of 10, 15, and 20 fish/m^3, respectively. Significant differences was not found among treatments at those parameters ($P>0.05$) (Table 2). Water quality is a variable that affects the survival, reproduction, growth, management, and production of fish. The water quality includes temperature, dissolved oxygen, pH, and other compounds (Boyd, 2000). Based on the results, it suggested that those parameters measured during this study remained in the tolerable range for fish (Boyd, 2000), and it will not become limiting factors for fish growth. However, higher stocking density might have relationship with dissolved oxygen content which would affect to the fish growth. The previous study reported that higher stocking density resulted in poorer water quality (such as oxygen deficiency, ammonia-nitrogen, carbon dioxide accumulation, and other organics pollution) compare with lower stocking density. A good controlling water facility including aeration is considered the best way to solve the problem (Boyd, 2000; Samad *et al*., 2014). Optimal dissolved oxygen could increase the growth and FCR of fish (Mallya, 2007), it is also related to the fact that the aerobic metabolism of the fish require dissolved oxygen (Timmons *et al*., 2002). Higher stocking density would trigger intraspecific competition which could increase fish activity and oxygen consumption. Hence, it suggested that higher stocking density would contribute to the fish metabolism (Mishrigi & Kubo, 1978; Jorgensen *et al*., 1993; Bjornsson & Olafsdottir, 2006).

According to the results from this study, higher stocking density treatment has significantly negative effect on the growth performance of barb. Further research is needed to observe productivity and efficiency of culturing barb with optimal stocking density on several culture systems, as well as obtaining their stress response by those different culture systems.

Table 2. Water quality in rearing media of barb reared for 90 days at different stocking densities

Variables	Stocking density (fish/m^3)			Optimal value (References)
	10	15	20	
Water temperature (°C)	27.1 ± 1.8^a	27.0 ± 1.7^a	26.9 ± 1.4^a	27-32 (Aisyah & Subehi, 2012)
pH	6.9 ± 0.4^a	7.0 ± 0.3^a	7.0 ± 0.4^a	6.5-9.0 (Boyd, 2000)
Dissolved oxygen (mg/L)	5.02 ± 0.30^a	5.05 ± 0.49^a	5.08 ± 0.76^a	5-9 (Alabaster & Lloyd, 1982)

Description: Different superscripts in the same row indicates significant difference among treatments ($P<0.05$)

CONCLUSION

The optimal stocking density for the growth of barb was 10 fish/m^3. The FCR value at stocking density of 10 fish/m^3 was significantly better than those of higher stocking density observed in this study. Meanwhile, survival rate at stocking density of 10 fish/m^3 was not significantly different with other higher stocking density in this study. Based on this study, it showed the potential of rearing barb in culture ponds with appropriate stocking density.

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