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EFFECTS OF DIFFERENT pH SETTINGS ON GROWTH AND SURVIVAL OF COMMON CARP RAJADANU STRAIN

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ABSTRACT

pH is one of the important water quality parameters in aquaculture. This study aimed to observe the growth performance and survival rate of common carp (*Cyprinus carpio*) Rajadanu strain reared in culture media with different pH levels. Fish (length: 3.60 ± 0.18 cm; weight: 1.68 ± 0.18 g) were stocked in nine aquariums (40 cm x 40 cm x 30 cm) for 10 days with a stocking density of 25 fish per aquarium. The treatments used were (A) pH 4-5, (B) pH 5-6, and (C) pH 6-7, with three replications. A commercial feed containing 28% protein was given daily and as much as 3% of the total biomass. The observed data were analyzed using variance analysis (ANOVA), followed by Duncan test. The results showed that the pH treatments did not affect the growth (length and weight) and survival rate of common carp Rajadanu strain ($P > 0.05$). The best growth was achieved by the fish group reared in water with a pH range of 6-7 (length = 0.38 cm; weight = 0.17 g). The highest survival was attained by the fish group reared in water with a pH range of 5-6 (90.66%).

KEYWORDS: growth; survival; Rajadanu; *Cyprinus carpio*; pH

INTRODUCTION

Fluctuations in water quality condition will have a significant impact on aquatic living organisms reared in an aquaculture system. Water quality is very important parameters for the growth of aquatic organisms (Boyd, 1990; Bhatnagar & Devi, 2013). One of the unpredictable water quality parameters in aquaculture is pH. The value of pH in water always fluctuates over time due to the unbalanced natural conditions (Arafad, 2000; Kwong *et al*., 2014). Hence, the selection of pH-adapted fish species is required to overcome the water quality problems as well as improving aquaculture productivity.

Rajadanu strain of common carp (*Cyprinus carpio*) is a good candidate for the purpose above due to its wide range adaptability to water quality changes, especially pH. Rajadanu strain was obtained from the selection of 21 strains of common carp in Indonesia. Rajadanu strain is already distributed in most of local fish-farmers' hatcheries in Indonesia and considered a profitable culture species. This strain has a faster growth rate, higher diseases resistance, greater percentage of eggs hatching rate, and longer life (Nugroho & Wahyudi, 1991). However, there is still no information regarding the growth performance of this strain if subjected to pH changes. Previously, the observations on the growth parameters of fish reared at different pH levels had been conducted, such as in tilapia (El-Sherif & El-Feky, 2009; Reboucas *et al*., 2015), common carp (Korwin-Kossakowski, 1988; Heydarnejad, 2012), yellowtail kingfish (Abbink *et al*., 2012), silver catfish (Copatti *et al*., 2011), channel catfish (Murad & Boyd, 1991), African catfish (Uzoka *et al*., 2012; Ndubuisi *et al*., 2015), brook trout (Wesner *et al*., 2011), and other several freshwater teleosts (Baldisserotto, 2011). This study was carried to fill the gap of knowledge regarding the growth performance of Rajadanu strain subjected to different pH levels. The results of this study were expected to be applied in improving the production and productivity of Rajadanu strain, especially in the areas with high fluctuations of water pH.

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MATERIALS AND METHODS

The study was conducted in a hatchery facility owned by the Germplasm Research Station, Research Institute for Freshwater Aquaculture and Fisheries Extension (BRPBATPP), located in Cijeruk, Bogor, West Java.

Seedlings of Rajadanu carp were obtained from the artificial spawning of the hatchery's broodstock collection. A total of 1,000 individuals obtained from the artificial spawning were acclimatized in two rearing tanks (Volume: 1,000 L) and fed with a commercial feed on ad-libitum for two weeks. The fish average size ranged from 3.60 ± 0.18 cm in length or 1.68 ± 0.18 g in weight.

The experiment was arranged in a completely randomized design with three replications for each treatment. The treatments were different levels of water pH (4-5, 5-6, and 6-7). The water pH was changed to a desirable level through the addition of a 98% acetic acid solution to decrease water pH level and NaOH solution to increase water pH level. The values of pH during the experiment were measured using a pH meter (Hanna Instruments).

Nine aquariums (40 cm x 30 cm x 30 cm) were used in this experiment. The tested fish were stocked and acclimatized with a stocking density of 25 individuals in each aquarium. The fish were fed with a commercial feed containing 28% protein by 3% of the total body weight per day. Fish mortality was observed daily. The individual body length and weight of the fish were measured at the end of the experiment. The length gain (ΔL), weight gain (ΔW), specific growth rate (SGR), and survival rate (SR) were calculated using the equations suggested by Effendie (2002):

$$\Delta L = L_t - L_o$$

$$\Delta W = Wt - Wo$$

$$SGR = \left\{ \frac{(\ln W_t - \ln W_o)}{t} \right\} x\,100$$

$$SR = \frac{N_t}{N_o} x\,100$$

where: L_t represents the final length, L_o is the initial length, W_t is the final weight, W_o is the initial weight, t is the duration of the study, N_t is the final number of fish, and N_o is the initial number of fish

The effects of the treatments on the measured parameters were analyzed using variance analysis (ANOVA) at 95% confidence level. If there was a significant difference, a further test was performed using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

The survival rate of seedling of Rajadanu strain during the experiment were shown in Figure 1. No significant differences in the survival rates were found within the treatments ($P > 0.05$). The percentages of the survival rates ranged from 77.73% to 90.66%.

The change of pH value could affect the toxicity of chemical compounds in water. When pH increases, the ammonia value in the water will also increase (Machditiara, 2003; Boyd & Tucker, 2012; Alabaster & Lloyd, 2013). The high value of ammonia would reduce the dissolved oxygen content in the water. Kelabora (2010) argued that temperature and oxygen levels beyond optimal range could affect energy utilization, mostly for the environmental adaptation. It could disturb the metabolic system of fish. The variations of water temperature during the experiment ranged from 23°C-24°C, which indicated a normal temperature range for the fish. This temperature range was similar to the findings of Emaliana *et al*. (2016) regarding the optimum temperature for goldfish koi's growth that varied from 26°C-31°C with oxygen levels above 4 mg/L.

The length gain, weight gain, and specific growth rate of the seedlings of common carp Rajadanu strain subjected to different pH levels were presented in Table 1, 2, and 3. The statistical analysis indicated that no significant effect of the pH treatments on the growth of Rajadanu strain seedlings ($P > 0.05$).

The highest length gain was found at pH range of 6-7 (0.38 ± 0.07 cm). This value was considered normal for an experiment in laboratory scale. Furthermore, at pH 6-7, the average weight gain of Rajadanu seedlings was 0.17 ± 0.14 g with the specific growth rate of 0.93 ± 0.78%. The length and weight gains obtained at pH ranges of 4-5 and 5-6 were 0.20 ± 0.18 cm; 0.14 ± 0.10 g, and 0.20 ± 0.02 cm; 0.15 ± 0.02 g, respectively. These findings suggested that the pH ranges were within the tolerance limit of Rajadanu strain seedlings. According to Boyd & Zimmerman (2001), the effect of pH variation on fish was depending on its species and size. For this particular common carp strain, the pH range was from 4 to 7. Nevertheless, the results of this study indicate that a lower pH exposure had a tendency to lower the growth and survival rate of the seedlings. Similar

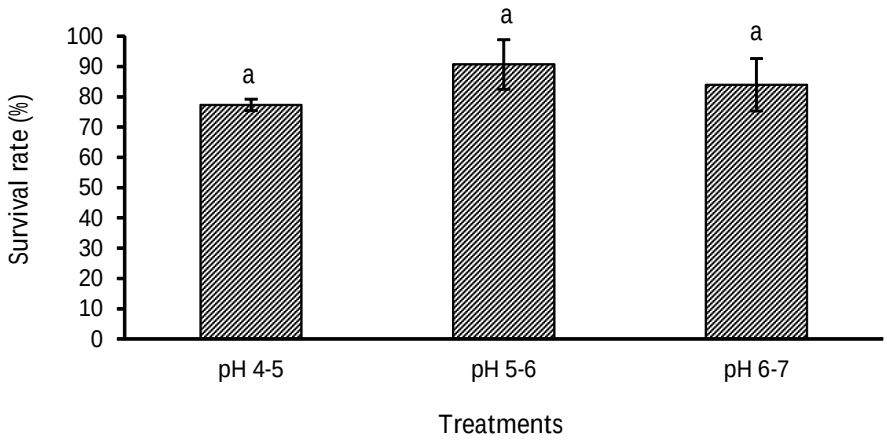

Figure 1. The survival rate of seedlings common carp (*Cyprinus carpio*) Rajadanu strain subjected to various pH levels.

Table 1. Length gain of common carp (*Cyprinus carpio*) Rajadanu strain seedlings subjected to various pH levels

pH	Length (cm)		
	Initial	Final	Gain
4-5	3.60 ± 0.18	3.80 ± 0.18[a]	0.20 ± 0.18[b]
5-6	3.60 ± 0.18	3.79 ± 0.02[a]	0.20 ± 0.02[b]
6-7	3.60 ± 0.18	3.98 ± 0.07[a]	0.38 ± 0.07[b]

Description: Numbers followed by the same letter in the same column indicated not significantly different (P > 0.05)

Table 2. Weight gain of common carp (*Cyprinus carpio*) Rajadanu strain seedlings subjected to various pH levels

pH	Weight (g)		
	Initial	Final	Gain
4-5	1.68 ± 0.18	1.82 ± 0.10[a]	0.14 ± 0.10[b]
5-6	1.68 ± 0.18	1.83 ± 0.02[a]	0.15 ± 0.02[b]
6-7	1.68 ± 0.18	1.84 ± 0.14[a]	0.17 ± 0.14[b]

Description: Numbers followed by the same letter in the same column indicated not significantly different (P > 0.05)

Table 3. The specific growth rate (SGR) of common carp (*Cyprinus carpio*) Rajadanu strain seedlings subjected to various pH levels

pH	Specific growth rate (%)	
	Length	Weight
4-5	0.54 ± 0.49[a]	0.79 ± 0.60[b]
5-6	0.53 ± 0.06[a]	0.87 ± 0.15[b]
6-7	1.00 ± 0.17[a]	0.93 ± 0.78[b]

Description: Numbers followed by the same letter in the same column indicated not significantly different (P > 0.05)

results were also found in other species with a similar treatment of pH, such as in brown trout (Sadler & Lynam, 1987), African catfish (Uzoka *et al*., 2012), yellowtail kingfish (Abbink *et al*., 2012), common carp (Heydarnejad, 2012), and striped snakehead (Purnamawati *et al*., 2017).

According to Boyd (1990), the optimal pH range is from 6.5 to 9.5 to support an optimum fish growth. The suitable range of pH for Cyprinidae is ranged from 6 to 9 (Zonneveld *et al*., 1991). When the pH level is below 6.5 and above 9.0, slower growth is expected. In an extreme situation, water pH below 4 and above 11 can lead to fish mortality (Wardoyo, 1975).

CONCLUSION

The survival, length gain, weight gain, and specific growth rate of the seedlings of common carp Rajadanu strain were not significantly influenced by the pH variations within the range of 4 to 7. The pH treatments in this study are still within the range of pH tolerance levels of seedlings of common carp Rajadanu strain.

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