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The survival and growth performance of juvenile cardinal tetra (*Paracheirodon axelrodi*) with application of tropical almond (*Terminalia catappa*) leaves

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Abstract. *Nurhidayat, Wardin L, Sitorus E. 2016. The survival and growth performance of juvenile cardinal tetra (*Paracheirodon axelrodi*) with application of tropical almond (*Terminalia catappa*) leaves. Nusantara Bioscience 8: 1-4.* The proportional appearance of the length and the weight, and the color pattern are key factors of ornamental fishes. Modification of environment and application of food may be done to increase fish quality. The addition of active compound of tropical almond (*Terminalia catappa*) leaves at certain doses can be done to increase survival rate and the growth of juvenile cardinal tetra (*Paracheirodon axelrodi*). This research used completely randomized design with four treatments and four replications. Therefore, there were 16 experimental units. The treatments were four doses of almond leaves: D0 (without almond leaves), D1 (0.5 g/L), D2 (1.5 g/L) and D3 (2,5 g/L). Experimental fish used in this research was cardinal tetra. The result showed that 0.5 g/L and 1.5 g/L of almond leaves addition resulted in 100% survival rate. Those concentrations also increased the body length by 1.28 cm and increased the weight by 0.092 g. The best water parameters used during the research were: temperature of 25-29^{o}C, dissolved oxygen of 6-6.6 ppm, pH of 6-6.5, alkalinity of 22.66-33.98 ppm, water hardness of 26.17-57.00 ppm, ammonia of 0.0052-0.0104 ppm, and nitrite of 0.0029-0.0696 ppm.

Keywords: cardinal tetra, *Terminalia catappa* leaves, survival rate

INTRODUCTION

Ornamental fishes are important commodities in urban areas; however, the business of ornamental fishes is constrained by the availability of land and water. The demand for ornamental fishes is promising in both domestic and export markets. Several fishes are popular in the market such as arowana, botia, koi, discus, neon tetra, cardinal tetra, and black ghost. Cardinal tetra is an introduced species in high demand, especially for export to Asian market for aquascape. Indonesia is the fifth largest exporters of ornamental freshwater fishes with market share about 7%, following Singapore (26%), Japan (15%), Czech Republic (8%), and Thailand (8%). In 2012, the revenue from fish export was US$ 43.96 million and was expected to increase up to US$ 65 million in 2013 (DJPB-KKP 2013). The selection of freshwater ornamental fishes for cultivation depends on the demand of local market and export. Cardinal tetra (*Paracheirodon axelrodi* L.P. Schultz, 1956) is a species of fish having good prospect for cultivation (Lesmana and Dermawan 2001). However, fish cultivation has experienced low juvenile survival rate due to low water quality. Juvenile fish cultivated under low-quality water has low growth. Rearing of neon tetra in Bogor area has used tropical almond leaf extract in order to maintain water quality during rearing before the fish is sold in the market (Angraeni 2002). Tropical almond is a common tree in Indonesia, and its leaves contain active compounds which can be used to maintain water quality for optimal fish rearing. The objective of this research was to evaluate the performance of juvenile cardinal tetra cultivated in water added with different concentration of tropical almond leaf extract.

MATERIALS AND METHODS

Research site

The research was conducted in the Agency of Research and Development of Ornamental Fish Cultivation, Jalan Perikanan No. 13 Pancoran Mas, Depok, West Java, Indonesia.

Materials and equipment

Sixteen polyethylene containers were placed randomly for treatments with different doses of almond leaves. Twenty-day-old juvenile cardinal tetras obtained from fish farmer in Depok were used for this study. Each container was filled with 10 fish. During rearing, the fish were fed *ad labitum* with *Tubifex* sp.

Dried fallen almond leaves were cleansed from dirt and fungi, and then weighed and soaked in water for 1-3 days at three concentrations: 0.5 g/L, 1.5 g/L, and 2.5 g/L. Then the water was filtered and mixed with fish rearing water.

Experimental design

This research used completely randomized design due to homogeneity of samples (Steel and Torrie 1993), with four treatments and 4 replications. There were 16 containers placed in a controlled room. The notations of treatments were: DO, D1, D2, and D3 representing the doses of 0.0, 0.5g/L, 1.5g/L, and 2.5 g/L respectively.

Data analysis

The survival rate, body length, body weight, and water quality (temperature, dissolved oxygen, pH, alkalinity, water hardness, ammonia, and nitrite concentration) were recorded. The data were tabulated and analyzed statistically using ANOVA to determine whether there were differences in means of variables among treatments. If the means among treatments were significantly different, further analysis was undertaken to determine which the best treatment was.

RESULTS AND DISCUSSION

Survival rate

Survival rate is the percentage of living fish from the total number fish reared in a container (Effendie 2013). Survival of organism is affected by environmental condition. Naturally, each organism has the capability of adapting itself to external environmental changes and this is called tolerance level (Hoar 1975). According to Nikolsky (1963), the death of fish can be caused by senescence, abiotic condition, predation, parasitism, food scarcity, and fishing. In high-density habitat, there is less space for movement, high competition for food, and increased oxygen need, so little and less powerful fish cannot survive. The death of fish can be reduced by providing high-quality food, and addition of antioxidants that can reduce toxic substances. According to Chyau et al. (2002), antioxidants, such as flavonoid, glycoside, and polyphenol can prevent blood vessel constrictions. Fish exposed to toxic substances excessively can have disturbed metabolism. The extract of almond leaves used in this research contains active compounds, such as saponin, flavonoid, and tannin. The concentration of antioxidants depends on leaf color. The yellow and red leaves contain the highest antioxidants, about 6.34-10% by weight (Kuete et al. 2010). In this research, the result showed that the fallen red leaves met the standard leaves with maximal concentration of antioxidants.

The survival of fish during experiment was closely related to the dose of almond leaves given. The addition of almond extract provided positive effect on cultivated juvenile fish. The survival rate was 100% at 0.5 g/L and 1.5 g/L doses, followed by 80% at 0 g/L (the control). The lowest survival rate was 68% at 2.5 g/L dose. Almond leaf extract resulted in survival rate of 91.3% on postlarvae of *Penaeus monodon* (Ikhwanuddin et al. 2014). These results showed that almond leaf extract increased survival of juvenile fish and shrimp. *Terminalia catappa* leaf contains active compound, such as antioxidant, preventing fungus infection. *Carica papaya* leaf also has the same effect as almond leaf. These plant leaves can maintain water quality, reduce stress, and prevent the diseases from spreading (Caruso et al. 2013). The capability of *Terminalia catappa* extract in maintaining water quality, preventing fungus infection, and reducing the spread of diseases was shown by the higher survival rate of fish reared with almond leaf extract than that of the control.

Survival rate of fish is shown in Figure 1. This graph shows that the survival rate in water with the addition of leaf almond extract at 0.5 g/L was 100%. So the condition was suitable for rearing fish, and the fish could feed themselves. However, excessive addition of almond leaf extract in water causes the water to become brownish and concentrated, which can have detrimental effect to fish because the fish have difficulty to find food (Kadarini et al. 2010). Meanwhile, media without extract reduce survival rate due to lack of antibiotic. This condition causes the fish to be easily infected by fungi.

Based on analysis of variance, the addition of almond leaf had significant impact ($p<0.05$) on the survival rate during rearing. The least significance difference (LSD) test showed that the best dose for increasing survival rate was D1. This result was consistent with the result from the graph of survival rate.

The increase of body length

There was positive growth on length measurement during experiment. Growth is an increase in length and weight over time (Effendie 2013). The highest increase of body length was shown by treatment D1, which was1.28 cm, followed by the dose of 0.5 g/L with 1.12 cm increase, and by the dose of 1.5 g/L with 1.05 cm increase. The lowest growth was shown by the control with the increase of 0.74 cm. The complete results are presented in Figure 2.

Almond leaves play a role as anti-mycobacteria, anti-bacterial, and fungicide which promote survival, as Kuete et al. (2010) stated that the application of *Terminalia superba* prevented bacterial and fungal growth. Performance of almond leaf extract at 0,5g/L provided optimal condition to juvenile cardinal tetra for growth. At the end of the research, the juvenile fish were more homogenous in size than those in other treatments. The homogeneity in size for cultivated fish and high survival rate are absolute prerequisite to be fulfilled. The dose of 2.5 g/L had negative impact because this dose gave lower growth than 0.5 g/L and 1.5 g/L doses. The water added with almond leaves at 0.5 g/L and 1.5 g/L concentration was not so concentrated, and so the fish were able to adapt themselves to container condition and use the energy from food to grow. Other doses reduced the growth and in homogeneity in size because of excessive addition of almond leaves, making the water so concentrated and the fish had difficulty for feeding as stated by Kadarini et al (2010). Meanwhile, water without almond leaves (the control) had pH of 7, which lowered the growth of fishes. Walker (2004) discovered that in its natural habitat, cardinal tetra preferred water with pH between 3.35 and 5.82.

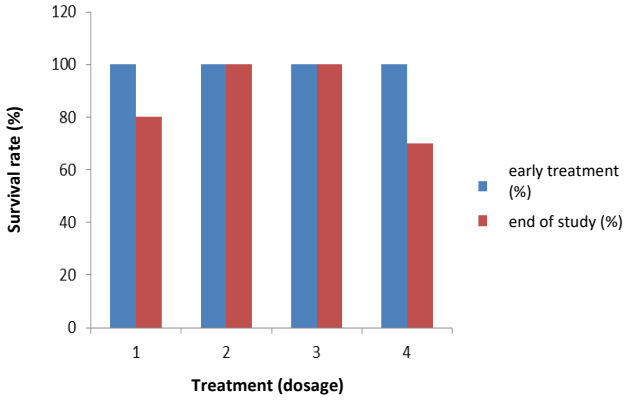

Figure 1. Survival of juvenile cardinal tetra during experiment

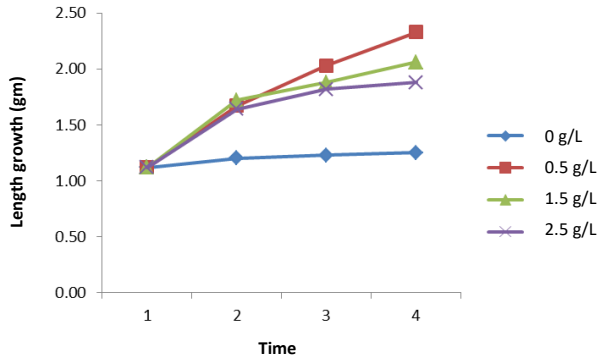

Figure 2. The length growth of juvenile cardinal tetra

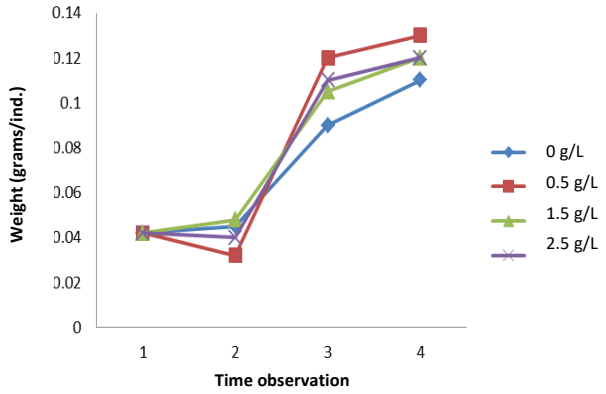

Figure 3. The body weight growth of juvenile cardinal tetra during experiment

The rate of body weight growth during experiment

Daily rate of growth of juvenile cardinal tetra was different among treatments. The highest increase of body weight was found at the dose of 0.5 g/L which was 0.0031 g/day and the weight gain of 0.092 g. Meanwhile, the control resulted in 0.080 g of weight gain, with daily growth rate about 0.0027 g/day. The lowest one was found at the dose of 2.5 g/L which increased 0.055 g body weight with daily growth rate of 0.0018 g/day. Figure 3 shows the growth rate of cardinal tetra.

The dose 0.5 g/L produced the highest growth rate. This treatment maintained water quality, therefore, the juvenile cardinal tetra grew better than in other treatments. This related to the condition of water that was not so concentrated. The excessive leaf extract on water may cause disturbance in bone development. Meanwhile, water without extract affected the growth of body weight of cardinal tetra due to lack of active compounds that maintain water quality. As stated by Walker (2004), Cardinal tetra prefers habitat with acidic condition with pH of 3.35-5.82. The treatment with dose of 2.5 g/L resulted in lower growth of body weight because the water turned brownish and the fish had difficulty in adaptation to such environment.

Water quality during experiment

Temperature is an external physical factor affecting the growth rate, because temperature affects feeding which is closely related to metabolism (NRC 1977). The temperature during experiment was relatively constant and similar among treatments, about 25-31^{o}C. This temperature range was higher than optimal temperature range, i.e., 20-26^{o}C (Walker 2004), but this could be tolerated and did not cause death. Increased temperature increases energy need, and the fish are more active for feeding (Goddard 1996).

Dissolved oxygen in water body is important factor in fish life. Oxygen is required for respiration and is a prime component in metabolism (Wardoyo 1975). The concentration of dissolved oxygen during fish rearing was about 5.2-6.7 ppm, sufficient for fish. The oxygen came from equipment used for aeration during experiment. According to Pescod (1973), 2 ppm of dissolved oxygen is enough for supporting organisms to live.

The pH during rearing in all treatments was about 5.0-6.5. This pH value was good enough for neon tetra fish which can live in pH of 3.35-5.82 (Walker 2004). Optimal condition for rearing can be maintained by using almond leaves soaked in rearing containers. Neon tetra prefers environment with low pH.

The concentration of ammonia during experiment was very low, about 0.0006-0.00252 mg/L. This was linked to condition during experiment indicating low temperature and acidic water in the environment. The condition brought about the low concentration of ammonia. Boyd (1990) states that the higher the ammonia concentration, the higher the pH of water, and vice versa. Moreover, Alabaster and Lloyd (1980) confirm similar notion that dangerous effect of ammonia is related to pH and temperature of water. The increase of ammonia and temperature of water would increase ammonia concentration.

Alkalinity during experiment was about 22.66-56.64 ppm, because the pH was stable. Alkalinity is total alkali concentration in the water (Wedenmeyer 1996). Neon tetra will grow optimally and have optimum survival rate in the water having low pH. Maintaining water quality in cardinal tetra rearing is absolutely required due to sensitivity of environmental fluctuation. Water quality affects the survival rate and the growth of juvenile cardinal tetra. Quality of water during 30-day experiment is presented in Table 1.

Table 1. The measurement of water quality during experiment

Treatments	Parameter of water quality						
	temperature (ºC)	DO (mg/L)	pH	Alkalinity (mg/L)	Water hardness (mg/L)	Ammonia (mg/L)	Nitrite (mg/L)
Dosage 0 g/L	25-31	5.2-6.6	6.5-7	22.66-33.98	29.30-43.12	0.0006-0.0051	0.0002-0.1449
Dosage 0.5 g/L	25-29	6.0-6.6	6-6.5	22.66-33.98	26.18-57.00	0.0052-0.0104	0.0029-0.0696
Dosage 1.5 g/L	25-31	5.9-6.7	6-6.5	33.98-56.64	29.26-83.20	0.0071-0.0231	0.0046-0.0664
Dosage 2.5 g/L	25-30	5.7-6.2	5-6.5	33.98-56.64	29.26-120	0.0094-0.0252	0.0083-0.0930

Note: Result of Laboratory Analysis of Water Quality-Agency of Research and Development of Ornamental Fishes

The survival rate, the growth, the number, the size, and the quality of fish are affected by media used during rearing. Based on the measurement of water quality above, there were key parameters (such pH, alkalinity, ammonia, availability of antioxidant, etc) for optimal growth of fish in order that the fish can utilize energy from the food for growth and reproduction. This research has described the quality of water as consequences of the addition of tropical almond leaves at various doses which resulted in different survival rate, and the growth rate.

The dose of 0.5 g/L almond leaves gave the highest survival rate at 100% which were supported by the highest growth rate. Aminah (2014) also reported that the use of almond leaves promoted survival rate of juvenile golden fish. The appropriate dose resulted in optimal water quality, namely the stable pH, concentration of ammonia, and temperature. The water parameters during the experiment, namely temperature of 25-29ºC, pH of 6-6.5, DO of 6-6.6 mg/L and alkalinity of 22.66-33.98 mg/L, were similar to condition of the natural habitat of cardinal tetra, in which the temperature is 21-28ºC, pH 3.35-5.82, DO >5.0 ppm and alkalinity 20-100 ppm, conductivity 8.03 µS/cm (Walker 2004). Optimal water quality promotes fish metabolism (Effendi 2000).

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