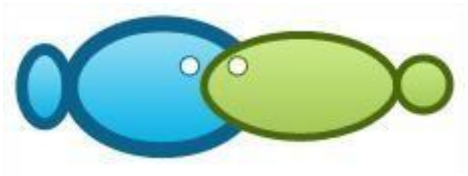

Effect of different container colors on the growth and survival rate of guppies (*Poecilia reticulata*) in the juvenile phase

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Abstract. The purpose of this study was to determine the effect of different container colors on the growth and survival rate of guppy fish (*Poecilia reticulata*) in the juvenile phase. This research was conducted at the SUPM Kupang Hatchery Teaching Factory Facility which is located in the government area of West Kupang District. This research design uses a completely randomized design (CRD) where there are 4 treatments with each treatment having 3 replicates. The variables observed during this study were weight growth and survival rate of fish. Observations of weight growth and survival rate of fish were carried out in an interval of 10 days. Body weight gain (BWG), body weight increase (BWI) and specific growth rate (SGR) for each treatment during 40 days of maintenance showed results that were not significantly different ($p>0.05$). The first highest weight growth results were obtained in the clear colored container treatment with values of 0.008±0.006 g BWG, 0.31±0.26 g BWI and 0.77±0.006% SGR, respectively. The second highest growth was obtained in the red container treatment with a value of 0.006±0.03 g BWG, 0.25±0.13 BWI and 0.62±0.003% SGR. This was followed by the yellow colored container treatment with values of 0.005±0.001 g BWG, 0.20±0.05 g BWI and 0.50±0.001 % SGR. The lowest weight growth value was obtained in the black colored aquarium treatment with values of 0.004±0.001 g BWG, 0.15±0.04 g BWI and 0.36±0.001 % SGR. The highest result for the survival rate was obtained in the black colored container treatment with a value of 89%. While the lowest value was obtained in the clear colored container treatment which was 50%. The second and third highest survival rates were obtained in the yellow and red colored container treatments with values of 72% and 67%.
Key Words: aquarium, guppy fish, ornamental fish.

Introduction. The growth and survival rate of fish larvae is highly dependent on the successful management of the rearing environment. In addition to water and feed quality, the color of the rearing environment or aquarium color is also a key factor in successful rearing. According to Hunter (1981), Blaxter (1986) in Mulantika et al (2020), this is because most fish larvae rely on vision to detect their prey (feed). The vision of fish larvae depends on the light that enters the rearing aquarium or the accuracy of the color selection of the rearing aquarium. Montajami et al (2012), Duk-Young and Hyo-Chan (2013) in Rahmawati and Kadarini (2018) state that different colors of rearing tanks will affect feed response and growth. Research on the effect of different aquarium colors on the growth and survival rate of fish larvae has been conducted. In addition to consumed fish larvae, the same research has also been conducted for ornamental fish larvae.

The effects of using different aquarium colors on the growth and survival rate of larvae or juveniles of consumer fish and ornamental fish that have been studied previously include *Lates calcarifer* (Wirasakti et al 2021), *Oreochromis niloticus* larvae (Labaika et al 2022), *Portunus pelagicus* (Muthmainnah et al 2020), *Cyprinus carpio* larvae (Mulantika et al 2020), *Melanotaenia parva* larvae (Rahmawati & Kadarini 2018), *Chaetodon lunulatus* larvae (Abidin et al 2022) and *Amphiprion ocellaris* larvae (Zulfikar et al 2018).

Guppy fish (*Poecilia reticulata*) is a freshwater ornamental fish that has a high selling value in Indonesia. The popularity of guppy fish is not only among ornamental fish lovers in Indonesia, but this fish is one of the ornamental fish that is in great demand by ornamental fish hobbyists outside Indonesia. The high demand for this fish is one of the important reasons to develop production both in terms of quality and quantity. Some of the maintenance techniques carried out through research for this fish include the use of different feeds for the mother on the number of larvae produced (To'bungan 2019). Masculinization through the use of ingredients such as coconut water conducted by Dwinanti et al (2018) and Malik et al (2019) and the use of honey by Nurlina and Zulfikar (2016) and Habibi (2022). The effect of the addition of ketapang leaves on color quality, behavioral response and blood glucose levels of fish was researched by Haq et al 2022. In addition, the use of aquarium colors to improve color quality has been carried out by Pratama et al (2018).

From some of the studies described, no one has looked at the effects of using different container colors on the growth and survival rate of guppy larvae or juveniles. This is considered important, considering that the maintenance of the initial phase in the fish production stage is something that needs to be seen as one of the supports for the quality and quantity of production. Based on this, it is necessary to conduct research on environmental engineering by using different container colors for the maintenance of juvenile phase guppies.

The purpose of this study was to determine the effect of different container colors on the growth and survival rate of guppy fish (*Poecilia reticulata*) juvenile phase. The results of this study are expected to be the latest information for the use of the right aquarium color in the rearing of juvenile guppy fish.

Material and Method

Research design. This study lasted for 40 days from November to December 2022. This research was conducted at the SUPM Kupang Hatchery Teaching Factory Facility which is located in the government area of West Kupang District, East Nusa Tenggara, Indonesia. This research design uses a completely randomized design (CRD) where there are 4 treatments with each treatment having 3 replicates. The treatments used include:

Treatment 1: Clear colored aquarium (control).
Treatment 2: Red colored aquarium.
Treatment 3: Yellow colored aquarium.
Treatment 4: Black colored aquarium.

Based on this design, 72 guppies (*Poecilia reticulata*) were used in this study. The guppies used were obtained from a guppy farm that sold them online. The fish were purchased with at 40 days old (juvenile phase) with an initial weight ranging from 0.05-0.20 g. Before the experiment, fish were acclimatized and weighed to determine the average weight of fish in each aquarium. After weighing, the fish were then stocked at a density of 6 fish/aquarium. The aquariums used were 12 pieces with a volume of 3000 ml or 3 litres. The number of aquariums used was adjusted to the number of aquarium color treatments used. Before use, the aquarium was cleaned, dried, and then coated with colored paper according to the aquarium color treatment chosen. The clear aquarium was used as the control treatment, so the clear aquarium was not coated with color paper. After completing the color paper application, the aquarium was then placed in accordance with the provisions of the type of experimental design used, namely completely randomized design (Figure 1). Aquariums have been placed according to the plan, then given aeration as a supply of oxygen for fish during the maintenance process. Weight data, aquarium code and description can be seen in Table 1.

Table 1

Initial weight data of guppies (*Poecilia reticulata*) and their codes

Initial average weight (g)	*Aquarium code*	*Description*
0.09	BN 1	
0.10	BN 2	BN = clear
0.16	BN 3	
0.12	MR 1	
0.11	MR 2	MR = red
0.08	MR 3	
0.08	KN 1	
0.10	KN 2	KN = yellow
0.05	KN 3	
0.10	HT 1	
0.08	HT 2	HT = black
0.10	HT 3	

Figure 1. Aquarium color design and aquarium placement plan.

Growth and survival rate observations. The variables observed during this study were body weight growth and survival rate of fish. Observations were carried out at intervals of 10 days. Measurement of fish weight growth was carried out by weighing all fish from each experimental aquarium. Weighing fish for weight growth data needs was carried out using digital scales. Fish survival rate was calculated at the end of rearing period, and fish that died during the rearing process were removed from the rearing aquarium and discarded.

Data on weight growth and survival rate were processed using the following formulas. Body weight increase (BWI) was calculated using the formula of Tacon (1990):

$$\mathrm{BWI} = W_t - W_0$$

Where:

BWI = body weight increase (g)
W_t = total weight of fish at the end of rearing (g)
W_0 = total weight of fish at the beginning of rearing (g)

Body weight gain (BWG) was calculated using the formula of De Silva and Anderson (1995):

$$\mathrm{BWG} = \frac{W_t - W_0}{N_t}$$

Where:

BWG = body weight gain (g)
W_t = average weight at day t (g)
W_0 = average weight at stocking (g)
N_t = length of rearing (days)

Specific growth rate (SGR) was calculated using the formula of Hevrøy et al (2005):

$$\mathrm{SGR} = \frac{\mathrm{Ln}\, W_t - \mathrm{Ln}\, W_0}{t} x100\%$$

Where:

SGR = specific growth rate (%)
W_t = average weight of fish at the end of rearing (g)
W_0 = average weight of fish at the beginning of rearing (g)
t = length of rearing time (days)

Survival rate (SR) was calculated using the formula of Goddard (1996):

$$\mathrm{SR} = \frac{N_t}{N_0}\, x\, 100$$

Where:

SR = survival rate (%)
N_t = total number of fish alive at the end of rearing (g)
N_0 = total number of fish alive at the beginning of rearing (g)

Water quality. During the rearing process, water quality parameters were also observed. The observed water quality parameters were temperature, pH, and dissolved oxygen, which were measured every day during rearing. Parameters, tools, and measurement type can be seen in Table 2.

Table 2

Parameter, tools, and measurement type

No.	*Parameters*	*Tools*	*Measurement type*
1	Thermometer	mercury thermometer	In situ
2	pH	pH meter (Hanna HI-98128)	In situ
3	Dissolved Oxygen	Lutron DO-5510	In situ

Statistical analysis. *The* results of observations of differences in the color of the rearing aquarium on the growth and survival rate of juvenile phase guppies were tabulated using Microsoft Office Excel (version 2016). Furthermore, the data were tested using ANOVA. If there is a significant difference ($p<0.05$), we continued with the analysis of the smallest real difference (BNT). If the results found no significant difference ($p>0.05$), we then analyzed the data descriptively. ANOVA test was conducted using IBM SPSS Statistics version 25.

Results

Water quality. Water quality during rearing showed optimum values for temperature, pH, and dissolved oxygen. Temperature during maintenance was in the range of 28-31°C, as well as for pH and dissolved oxygen values which were respectively in the range of 7-8.3 and 5.7-8.4 mg/L (Table 3).

Table 3

Water quality parameters

Parameters	*Unit*	*Range value*	*Optimum value*
Temperature	°C	28-31	26-30[a]
pH		7-8.3	6-8[b]
DO	mg/L	5.7-8.4	>3[c]

Sources: a) Panjaitan et al 2016; b) Kordi & Tancung 2007; c) Zonneveld et al 1991.

Fish growth. Based on the statistical analysis conducted, the measurement of weight growth in terms of absolute growth and daily growth rate is presented in Table 4. From Table 4, it can be seen that body weight gain, body weight increase and specific growth rate for each treatment during 40 days of maintenance showed results that were not significantly different ($p>0.05$).

Body weight gain showed the highest average value for the clear colored container treatment and the lowest value was in the black colored container treatment. The same thing was also found in the observation of body weight increase and specific growth rate where the highest weight growth value was in the clear colored container treatment and the lowest value was in the black colored container treatment. The results of statistical analysis for weight growth observations (body weight gain, body weight increase and specific body weight) are presented in Table 4.

Table 4

Growth performance of the juvenile guppy in 40 days of experiment

Treatment	*Initial weight (g)*	*Final weight (g)*	*BWG (g)*	*BWI (g)*	*SGR (%)*
Clear	0.12±0.04	0.21±0.29	0.008±0.006	0.31±0.26	0.77±0.006
Yellow	0.07±0.04	0.22±0.17	0.005±0.001	0.20±0.05	0.50±0.001
Red	0.10±0.04	0.22±0.27	0.006±0.003	0.25±0.13	0.62±0.003
Black	0.09±0.04	0.21±0.13	0.004±0.001	0.15±0.04	0.36±0.001

Note: Values are means±SD of different treatments (n=12). All data are not significantly different ($p>0.05$).

Survival rate. Survival rate of guppy (*Poecilia reticulata*) juvenile phase can be seen in Figure 2. The highest survival rate value was obtained in the black aquarium and the lowest value in the clear container. Survival rate was determined at the end of observation by comparing the number of fish stocked at the beginning of rearing with the number of fish at the end of rearing.

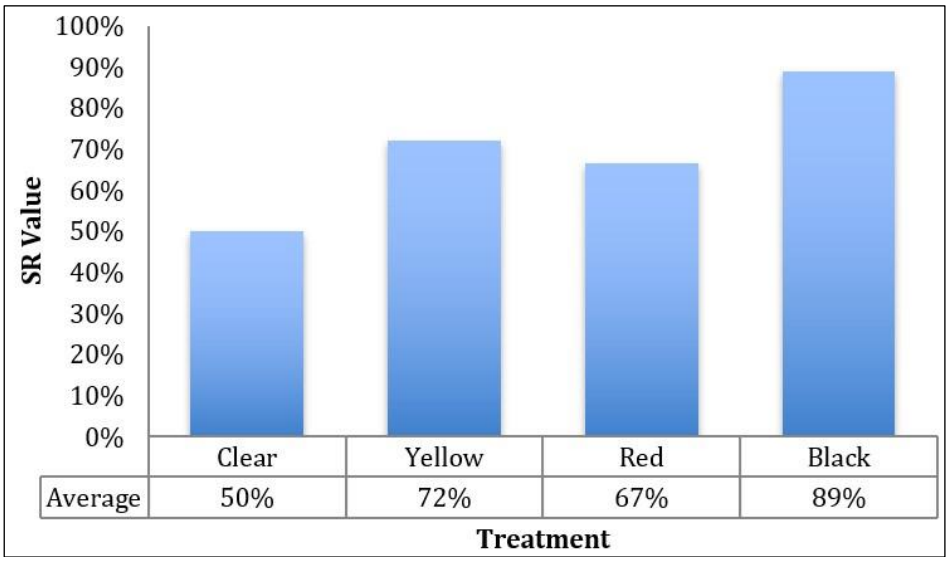

Figure 2. Survival rate of guppy (*Poecilia reticulata*) in each treatment.

Discussion. Fish growth is the increase in length and weight of fish that can be seen from changes in length and weight in units of time (Christin et al 2021). The survival rate is the percentage of the number of live fish at a certain time compared to the number of fish at the beginning of the period. Based on the data of research conducted for 40 days on guppy (*Poecilia reticulata*) in the juvenile phase and the results of the ANOVA test for body weight gain (BWG), body weight increase (BWI) and specific growth rate (SGR), results were not significantly different ($p>0.05$) in each treatment. This indicates that the weight growth of juvenile guppy fish from each treatment is not significantly different.

Descriptively, it can be seen that the highest weight growth results were obtained in the clear colored container treatment with values of 0.008±0.006 g (BWG), 0.31±0.26 g (BWI) and 0.77±0.006% (SGR), respectively. The second highest growth was obtained in the red container treatment with a value of 0.006 ± 0.03 g (BWG), 0.25 ± 0.13 g (BWI) and 0.62 ± 0.003% (SGR). This was followed by the yellow colored container treatment with values of 0.005±0.001 g (BWG), 0.20±0.05 g (BWI) and 0.50±0.001% (SGR). The lowest weight growth value was obtained in the black colored aquarium treatment with values of 0.004±0.001 g (BWG), 0.15±0.04 g (BWI) and 0.36±0.001% (SGR). Furthermore, it can be seen that the highest result for the survival rate was obtained in the black colored container treatment with a value of 89%. While the lowest value was obtained in the clear colored container treatment which was 50%. The second and third highest survival rates were obtained in the yellow and red colored container treatments with values of 72% and 67%.

From the results obtained, it can be seen that both parameters show a contradiction, where in the growth parameter, the clear colored container is the treatment with the highest value but in the survival rate parameter, the clear colored container is actually the treatment with the lowest value. The same thing was also obtained for the black colored container treatment, where in the growth parameter, the black colored container obtained the lowest value, while in the survival rate parameter, the black colored container actually became the treatment with the highest value. This is thought to occur because in clear container conditions, the light that enters the rearing container greatly helps the vision process of guppies so that they can respond well to the feed given so that fish growth becomes optimal. Conversely, in the condition of the dark container (black), it is suspected that the incoming light cannot help the vision processso that the feed given is not eaten by the guppies, and the growth of guppies is not optimal.

Previous research also showed that, in semi darkness conditions and bright conditions, guppy can see the target (feed) but in dark conditions they did not react, because the visual receptors did not perceive enough light (Rajaei et al 2012). The same results were obtained in the experiment of raising white snapper (*Lates calcarifer*) seeds, where the low growth value was thought to be due to the influence of the light intensity that was passed on to the maintenance medium on the black colored container so that the fish tended to be passive in moving and consuming food (Wirasakti et al 2021). In a passive state, fish swimming activity is diminished. This swimming activity is intended to find food. This is the basis for the assumption that the highest survival rate obtained in the black container color treatment is because in dark conditions, fish swimming activity is low, so the less food is obtained, the nutrients are limited, and the fish use the nutrients allegedly mostly for survival rather than for growth.

Although clear containers are good for growth, they also increase the stress response of the fish. The brighter the light, the more aggressive the fish will be (Santos et al 2019). The response to stressors that can be seen directly is the behavioral response. Guppies that can maintain their physiological response to stress will remain alive. Fish that cannot maintain their physiological response will reduce the percentage of fish behaviors (Aras et al 2015). In addition to light as an external factor, it is suspected that internal factors also play a role in the low survival rate obtained in the clear container. The internal factor in question is heredity. In this study, information on the offspring of the test fish was not determined, so this is thought to be a contributing factor to the

differences in growth for each experimental container. During the study, the internal factors considered were the age and weight of the test fish. The consideration of using the age and weight of the fish was adjusted to the juvenile phase of the guppies. From this consideration, it can be seen that during the study, all aspects regarding internal factors have not been fulfilled so that this is also thought to be an influence on growth and survival rates in each treatment container.

For the red and yellow colored container treatments, the second and third highest weight growth results were obtained. As for the survival rate, the yellow container is the second highest treatment followed by the red container treatment. The results obtained from these two containers are thought to be influenced by the same factors like in the clear and black containers. The factor in question is the intensity of light entering the rearing container. In addition to this, according to Zulfikar et al (2018), the wavelength of light also has an influence, where the greater the wavelength, the smaller the penetrating power into the water. The results of several studies have shown that not all types of light can be captured by fish eyes, only light that has a wavelength in the interval of 400 to 750 nanometers can be captured by fish eyes (Wiyono 2010). From these results it can be said that all container colors affect the growth and survival rate of guppies in the juvenile phase. The best growth is obtained in bright and slightly dark containers while the best survival rate is obtained in dark containers.

Conclusions. The response of each fish is different to the color of the container used. The use of clear containers can increase the growth rate but has an impact on the survival rate of guppies. The brighter the rearing container will have an impact on the feed response and aggressiveness of the guppies.

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Conflict of interest. The authors declare that there is no conflict of interest.

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