Bangladesh J. Fish. (2021) **33**(1) : 13-20

Effect of background color on the growth pattern and coloration of guppy (*Poecilia reticulata*)

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Abstract. A study was carried out to investigate the effects of background color on the growth, skin pigmentation and breeding performances of guppy, *Poecilia reticulata*. Guppy fish was reared in tanks with four different colors as treatments such as T_0 (transparent), T_1 (red), T_3 (blue) and T_4 (green) for 5 months. There were significant differences in growth and coloration among the treatments. The growth performance was found significantly higher in transparent background compared to the other treatments. The results showed that the highest mean weight (0.259 $\pm$0.018 g), mean length (3.067$\pm$0.208 cm) and SGR (0.165$\pm$0.012) of the fish were significantly higher in T_0. Least mean weight (0.167$\pm$ 0.025 g), mean length (2.53$\pm$.0.058 cm) and SGR (0.104$\pm$0.017) were observed in T_1 indicating association of red color with slower growth performance of guppy, compared to other treatments. Study showed significant influence of background color in skin pigmentation. Fishes reared in transparent tanks showed the highest value of carotenoid (0.00175$\pm$0.00004mg/g) and fishes reared in the red tank showed the lowest value of carotenoid (0.00092$\pm$0.000035 mg/g). Green background enhanced red orange color on fish skin and provided high amount of carotenoid value (0.00143$\pm$0.000046 mg/g) than that with blue (0.00095$\pm$0.000025 mg/g). These results suggest significant influence of background color on growth and skin pigmentation patterns of *Guppy*.
Keywords: *Poecilia reticulata,* Growth performance, Carotenoid

Introduction

Fish kept in artificial environment may impact its physiology and behavior. Fish have chromatic vision and their ability to acknowledge feed and consequently their food intake, growth and survival rate might be influenced by background color (Papoutsoglou *et al.* 2005, Strand *et al.* 2007). Moreover, different background colors could cause differences in physiological state, skin pigmentation (Van der Salm *et al.* 2004, Doolan *et al.* 2008). Thus, the fish reactions to various background colors differ considerably counting on fish species and life stage (Papoutsoglou *et al.* 2005). Fish color can be altered by environmental factors through the rearrangement of chromatophore in the skin (Bagnara and Hadley 1973, Sugimoto 1993). Changes in color and pattern are considered as a result of physiological adaptation through chromatophore reallocation or an after effect of morphological variation by varying the amount of pigmentary materials under skin. Cryptic coloration enables animals to conceal in which they change their color property and patterns to blend into the background (Moyle and Cech 2004). Most color changes in fish result from the migration of melanophores, dark brown pigment cells, xanthophores, and iridophores (Oshima *et al.* 1989). A clear difference in body color was marked for *Oreochromis niloticus* kept in dark and clear aquaria, almost dark shaded fish coming from the black aquaria and very pale fish coming from the clear aquaria (Opiyo *et al.* 2014). The change in the color of the fish could be as result to Melanin Concentrating Hormone (MCH). Comparable perceptions were recorded for rainbow trout (*Oncorhynchus mykiss*) and Arctic charr (*Salvelinus alpinus*) raised on high contrast backgrounds where it was seen that

https://doi.org/10.52168/bjf.2021.33.02

MCH levels were extraordinarily expanded in the pituitary organ of the fish raised in white backgrounds (Green *et al.* 1991). Different species showed different results for same background color. However there are debates about the impacts of background color on fish pigmentation. Moreover, in ornamental fish sector several fish species like gold fish have been studied to show the effects of background color (Eslamloo *et al.* 2013). But there is no information available on their effects of background color on the growth performance and coloration of the Guppy fish. Study was conducted to investigate the influence of different background colors on growth performance and coloration of guppy fish.

Materials and Methods

Fish rearing and experimental design: About eighty guppy fry were kept for three days in several rectangular aquaria without any background color (transparent glass) to acclimatize to the treatment conditions. Twelve (12) glass aquaria (9.3inch × 7inch × 11inch) with 8L of water holding capacity were taken. Among the 12 tanks, three different colors (red, blue and green) were used in triplicate and three rectangular glass aquaria were kept transparent to provide no background color. Seventy two fry had been distributed into the tanks (six fish per aquarium). The fish in each treatment were fed two times daily at ration size of approximately 5% body weight. Water in each tank was changed at a rate of 30% volume per day by treated tap water. The water quality parameters including temperature, dissolved oxygen and pH were kept in suitable range for the experimental fish during the experiment.

Sampling and determination of growth performance:: Sampling of the experimental fish was done in regular interval of two weeks. Weight of fish was taken by using a digital weight machine and length of fish was taken by using measuring scales. Data was collected and recorded for determination different of the parameters of growth performance. Mean weight and length were calculated and recorded for the determination of the growth performance. Moreover, SGR and survival rate were also measured to analyze the overall effects of background color on growth.

***Determination total carotenoid*:** Total carotenoid content of fish body was estimated by using method of Torrissen and Naevdal (1984). The total carotenoid was estimated and expressed as mg/g carotenoid using the following equation:

- Carotenoid value $= \frac{Abs \times 10000 \times V}{1900 \times W}$

Where, V is total volume of the extract, W is the weight of the sample and Abs is the absorbance rate measured by spectrophotometer.

Statistical analysis: Statistical analyses were performed by using Microsoft Office Excel (Version-2016) and IBM SPSS (Version-25). Values were expressed as means standard deviation (SD). Data were analyzed by one-way analysis of variance (ANOVA) and statistical significance was set at $p < 0.05$.

Results

Growth Performance: Initial mean body weight and mean length of guppy fish were about 0.0112 g and 1 cm. Mean weights of the fish in T_0, T_1, T_2 and T_3 were 0.259 ± 0.018^a, 0.167 ± 0.025^b, 0.192 ± 0.009^b, and 0.188 ± 0.011^b (g), respectively (Fig. 1) and the mean lengths were 3.067 ± 0.208^a, $2.53 \pm .0.058^b$, 2.67 ± 0.035^b, 2.64 ± 0.051^b (cm), respectively (Fig. 2). Mean SGR for T_0, T_1, T_2 and T_3 fish were recorded 0.165 ± 0.012^a, 0.104 ± 0.017^b, 0.12 ± 0.006^b and 0.118 ± 0.007^b, respectively (Fig. 3). According to the values, it was cleared that colored tanks didn't provide good performance in the growth but growth parameters were found significantly higher ($p < 0.05$) in T_0 (Table I).

Table I. Growth performance of guppy, reared in the different background colors for five months

Treatment	Weight (g)	Length(cm)	SGR (Specific Growth Rate)
T_0	0.259 ± 0.018^a	3.067 ± 0.208^a	0.165 ± 0.012^a
(Transparent Background)	(0.214 -0.303)	(2.55-3.58)	(0.136-0.194)
T_1	0.167 ± 0.025^b	$2.53 \pm .0.058^b$	0.104 ± 0.017^b
(Red Background)	(0.104-0.229)	(2.39-2.68)	(0.062-0.146)
T_2	0.192 ± 0.009^b	2.67 ± 0.035^b	0.12 ± 0.006^b
(Blue Background)	(0.169-0.214)	(2.58-2.75)	(0.105-0.135)
T_3	0.188 ± 0.011^b	2.64 ± 0.051^b	0.118 ± 0.007^b
(Green Background)	(0.161-0.149)	(2.52-2.77)	(0.099-0.137)
Level of Significance	0.001	0.002	0.001

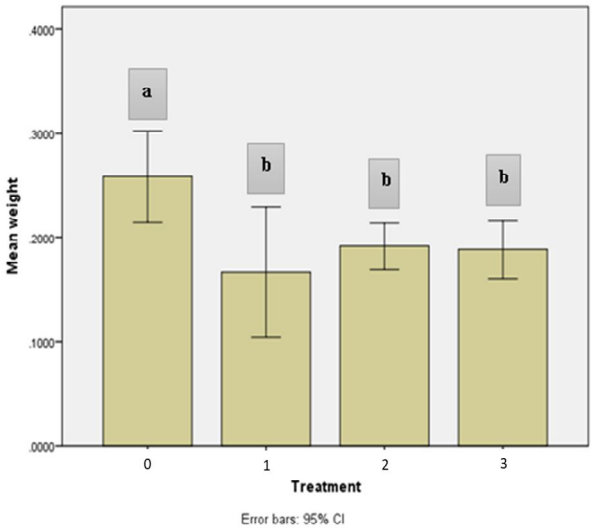

Fig. 1. Effects of background color on weight of fish body (Mean ± SD) after five months.

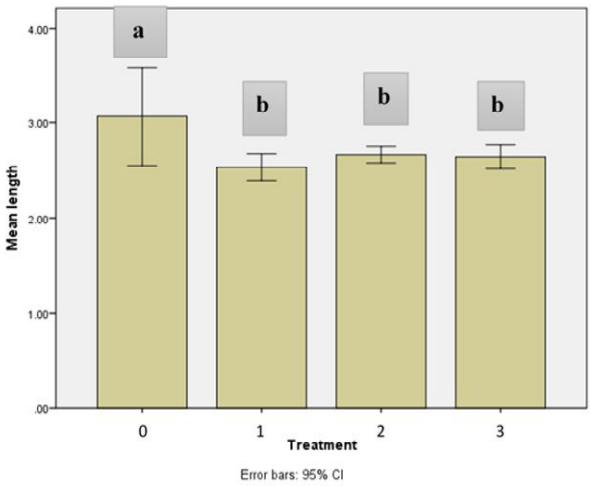

Fig. 2. Effects of background color on length of fish body (Mean ± SD) after five months.

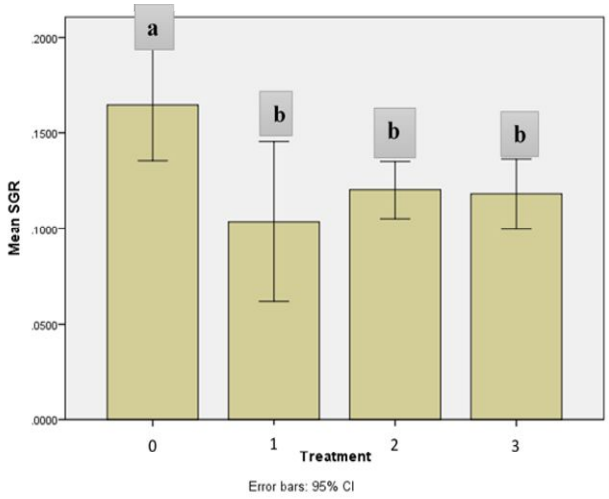

Fig. 3. Effects of background color on specific growth rate (Mean ± SD) after five months.

Total carotenoid content: Highest value of total carotenoid content was observed in T_0 (0.00175 ± 0.00004) compared to those in the others treatments (Table II and Fig. 2). The concentration of total carotenoid of the fish body reared in transparent background was significantly higher than the other treatments ($p < 0.05$, Fig. 4 and Table II).

Table II. Coloration of guppy, reared in the different background colors for five months

Treatment	Carotenoid Content (mg/g)	Color formation of fish
T_0 (Transparent Background)	0.00175 ± 0.00004^a (0.00165-0.00185)	Vibrant color (Orange, red, blue)
T_1 (Red Background)	0.00092 ± 0.000035^c (0.00084-0.00101)	Blackish but orange fin found in several fishes
T_2 (Blue Background)	0.00095 ± 0.000025^c (0.00089-0.00102)	Bluish-gray color and blue fin
T_3 (Green Background)	0.00143 ± 0.000046^b (0.00132-0.00154)	Mostly orange in color
Level of Significance	0.00	–

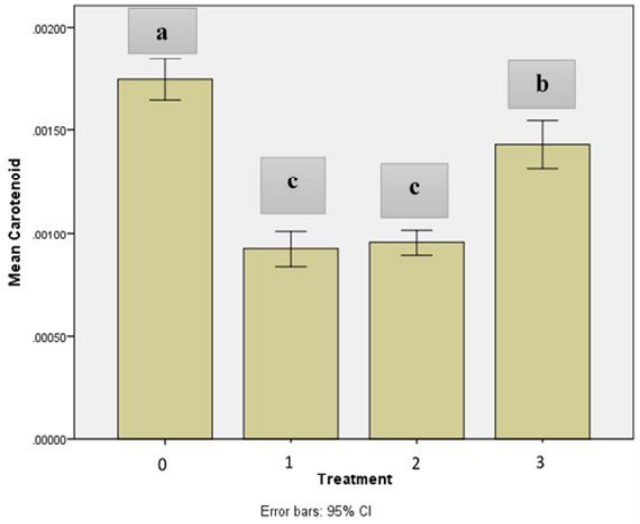

Fig. 4. Effects of background color on carotenoid content (Mean ± SD) after five months.

Discussion

Effects of background color on the growth performance of guppy: In the present study, all growth parameters were considerably improved in guppy reared on a transparent background (T_0) in comparison with the others (Table I). The growth performance of barfin flounder (*Verasper moseri*), eurasian perch (*Perca fluviatilis*) and white sea bream (*Diplodus sargus*) rose by rearing in transparent tanks (Amiya *et al.* 2005, Karakatsouli *et al.* 2007, Strand *et al.* 2007) which agreed with the present study. Jentoft et al. (2006) reported the significant increase in the growth performance of fish raised in transparent background could be due in part to the high contrast between feed and background color and consequently improving the visibility of feed in light tanks. In the present study, fish reared in red tank (T_1 tank) showed lowest growth rate among the colored background. There were no significant differences among the T_1, T_2, and T_3 in terms of growth performance of the guppy but green and blue showed higher values of growth parameters than the red (Table I). Ruchin (2004) revealed that red light reduced the growth of juvenile goldfish. Volpato *et al.* (2013) conducted an experiment on red light effects

on Nile Tilapia (*Oreochromis niloticus*). These findings indicate that red background is stressful for fish growth. Blue is usually water like color which is associated with openness, peace and tranquility. On the other hand, green color is environmental related which reduces the level of stress hormone of fish. Fanta (1995) studied the effects of environmental colors on some behaviors of the Nile tilapia. Fanta visually analyzed some parameters, including male nest construction, and suggested that blue color improves male nest investment, but she did not investigate spawning.

Effects of background color on fish coloration: Highest amount of carotenoid content was found in fish of transparent tank (0.00175 ± 0.00004 mg/g) (Table II). The reason behind that could be the proper light penetration in the tank which might help in developing vibrant colors on fish skin. Amiya *et al.* (2008) found that proper light penetration in the white tank raised Melanine Contrating hormone (MCH) levels in the brain and pituitary which helped developing color in the fish skin (Amiya *et al.* 2008). This MCH is a neuropeptide that was originally isolated from pituitary where it causes pigment aggregation. Similar observations were recorded for rainbow trout (*Oncorhynchus mykiss)* and arctic charr (*Salvelinus alpinus*) reared on black and white backgrounds where it was observed that MCH levels were incredibly expanded in the pituitary gland of the fish raised in white backgrounds (Green *et al.* 1991). There was no significant differences observed among the T_1, T_2, and T_3 in terms of coloration of Guppy (Table II) but carotenoid content was higher in green tank (0.00143 ± 0.000046 mg/g) than the red and blue color tanks. If only aesthetic purpose is concern, green background could be a suitable choice.

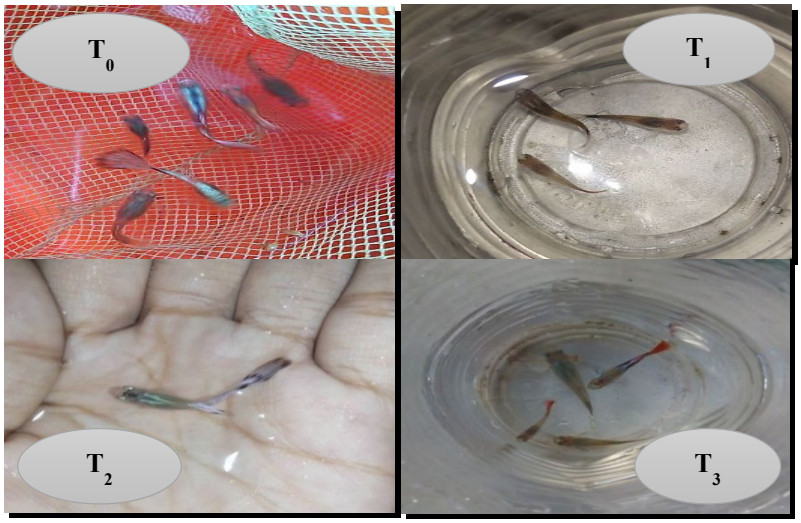

Fig. 5. Color enhancement of Guppy fish due to use of different background color (T_0 = Transparent, T_1 = Red, T_2 = Blue, T_3 = Green).

The color of the tanks affects growth performance and skin pigmentation of fish hence it is advisable to consider the tank colors when setting-up an aquaculture facility. In addition,

coloration is the most considerable factor to count in ornamental fish culture. Particularly, this study revealed that the growth performance and coloration of guppy fish was significantly improved by rearing the fish in a transparent background.

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(Manuscript received: 13 June 2021)