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Comparisons of the Effects of Aquaria Made of Glass or Fiberglass on Growth and Pigmentation of Goldfish, *Carassius auratus* and Electric Yellow Cichlid, *Labidochromis caeruleus*

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Abstract: This study was conducted to compare effects of aquria made of glass or fiberglass on growth and pigmentation in goldfish, *Carassius auratus* (initial weight of 8.1 g) and electric yellow cichlid, *Labidochromis caeruleus* (initial weight of 0.47 g) for a rearing period of 80 days. Skin colour assessment was performed by reflectance spectroscopy with transformation into colour parameters based on tristimulus values, L (lightness), a (redness) and b (yellowness). A lower L and a higher a, b was obtained on skin of goldfish reared in fiberglass aquarium compared to those in glass one ($p<0.05$) while no differences were observed among L, a and b of electric yellow cichlid reared in glass or fiberglass aquarium ($p>0.05$). Growth performance, feed conversion ratio and survival ratio in both species were not affected by the aquarium types ($p>0.05$). Aquarium made of fiberglass should be preferred for goldfish rearing as skin colour is significantly improved in this media.

Key words: Glass aquarium, fiberglass tank, pigmentation, growth, *Carassius auratus*, *Labidochromis caeruleus*

INTRODUCTION

The growing interest in ornamental fish has resulted in a steady increase in ornamental fish trade globally. Today with a turnover of US$ 9 billion a year and an annual growth of 8%, production of ornamental fish is an important business activity as well as one of the most popular hobbies in the world. It is thought that this sector can contribute to the economic development in underdeveloped countries, especially in the tropics.

Aquaria made of glass or fibreglass are usually used in ornamental fish rearing or experimental studies in indoor systems. Each of these aquarium types has certain advantages and disadvantages compared with each other. Glass aquarium is more luminous and costs less than fiberglass one while the latter has a certain background colour, lighter, stronger and better insulators than the glass one. Although, there are some documents dealing with the influences of light and background colour, some of which are related to transparent or opaque features of glass or fiberglass aquarium, nothing is known about the effects of these aquarium types on growth and pigmentation of fish.

Electric yellow cichlid and especially goldfish are among the most popular fish and have a high market value in the ornamental fish trade (Lee and Newman, 1997). It is well known that in addition to body shape, fin shape and size, skin pigmentation is one of the most important quality criteria setting the market value of such ornamental fishes (Paripatananont *et al*., 1999; Lovell, 2000; Gouveia *et al*., 2003). Besides dietary carotenoid pigments, environmental stimuli such as light intensity and background colour tone can influence fish pigmentation. Long-term adaptation of fish to a certain background results in generally morphological colour changes (Matsumoto *et al*., 1984; Sugimoto, 2002). Such fish are dark on a black background or pale on a white background. Relationship between light intensity and pigmentation degree in fish has also been reported (Booth *et al*., 2004; Rotllant *et al*., 2003; Han *et al*., 2005). On the other hand the results of effects of light or background colours on growth performance of fish have been controversial. Fish larvae seem to prefer white or lightly coloured tanks (Duray *et al*., 1996; Downing and Litvak, 1999; Tamazouzt *et al*., 2000; Papoutsoglou *et al*., 2005).

There is no clear available information on what type of materials should be preferred in building aquarium for the culture of ornamental fish as well as for the experimental studies in indoor systems. Therefore, the present study was designed to compare the effects of aquaria made of glass or fiberglass on growth performance, survival, feed utilization and pigmentation in goldfish and electric yellow cichlid.

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MATERIALS AND METHODS

This study was carried out in an indoor system at the Freshwater Fish Experimental Station of the Faculty of Fisheries of Cukurova University, Adana, Turkey. As experimental fish, red goldfish, *Carassius auratus* and electric yellow cichlid, *Labidochromis caeruleus* reared in this station were used. Goldfish at an average initial weight of 8.1 g, standard length of 4.6 cm and 5 month of age and electric yellow cichlid at a mean weight of 0.47 g, a total length of 3 cm and 3 month of age were selected from the general population and then acclimatized to the experimental conditions for 3 weeks before the experiment. About 60 goldfish or 100 electric yellow cichlid were separately stocked in three replicates per glass or fiberglass aquarium painted in dark blue, each of which had a volume of 310 L. Thus, the effects of these two aquarium types on growth and pigmentation was separately tested for each of the two ornamental fish species. The fish were fed by hand three times a day at a rate of 3% of body weight during the experimental period of 80 days. Body weight, length and skin colour of fish were measured every 20 days.

All the fish were measured for growth parameters but 16 individuals from each replicate for goldfish were used for colorimetric values of skin colour and thirty two individuals for electric yellow cichlid. During the measurements, the fish were anaesthetized using 2-phenoxyethanol at a concentration of 0.25 mL L^{-1}. All indices were calculated as follow: Specific growth rate:

$$(SGR) = 100\times(\ln Wt - \ln Wo)/t$$

Where:

W_t = The final body weight (g)
Wo = The initial body weight (g)
t = The days of rearing)

Food Conversion Ratio (FCR) is Food consumed/Weight gain. Commercial diets were separately used for each of the fish species. The diet used for goldfish contained 40% crude protein, 10% crude fat, 4% fibre, 12% ash, 12% moisture, a commercial vitamin mixture (2.880 ME kg cal^{-1} energy) while the diet for electric yellow cichlid had 45% protein, 12% crude fat, 3% fibre, 13% ash, 12% moisture, a commercial vitamin mixture (3.230 ME kg cal^{-1} energy).

Dechlorinated tap water was used in the experiment after it had been exposed to the air for 24 h. Compressed air with air stone was used for maintaining soluble oxygen throughout the experiment. The water in each aquarium was changed at a rate of 70% volume per day. Uneaten feed and faces were siphoned out andaquaria were checked daily and mortalities (if present) were recorded. Everyday temperature, pH and dissolved oxygen level in the water of aquaria were measured while ammonia and nitrite were analysed every week. Throughout the experimental period, the water temperature was maintained between 25 and 26°C, dissolved oxygen level was kept above 6.4 mg L^{-1}, pH was around 7.8, ammonia (as NH_4) and nitrite were less than 0.10 and 0.05 mg L^{-1}, respectively. All aquaria were maintained under a constant photoperiod (12 h light and 12 h dark, 250 lux at the water surface of the aquaria) created by fluorescent lamps. Skin colour assessment was performed by reflectance spectroscopy with transformation into colour parameters based on tristimulus values, L*, a* and b*, lightness, redness and yellowness, respectively using a manual version 2.3 of Hunter Lab. The colorimetric values of skin colour were performed on both sides of each fish body. All data are expressed as mean±standard error. The statistical significance of any inter-group differences was assessed independently for each sampling period using by Student's t test wherever appropriate and $p<0.05$ was considered statistically significant. All statistical procedures were performed by using the SPSS 12.0 software for Windows. Experiments were conducted according to the European Council Directive 86/609/EEC regarding the protection of animals used for experimental and other scientific purposes.

RESULTS AND DISCUSSION

Rearing parameters: Both fish species exhibited a normal growth. Body weight of goldfish and electric yellow cichlid increased about 2.5 and 3 fold, respectively at the end of the rearing period of 80 days. No mortality or specific signs of disease in fishes were observed throughout the experimental period. Survival rate of both fish species was over 95%. Rearing parameters for both fish species are shown in Table 1. The final weight between goldfish reared in glass and fiberglass aquaria varied from 20.31-21.08 g, standard length from 6.19-6.34 cm, Specific Growth Ratio (SGR) from 1.14-1.18 and Feed Conversion Ratio (FCR) from 1.95-1.88, respectively. No significant differences were found between two treatments in terms of these rearing parameters ($p>0.05$). Similar results were also observed in electric yellow cichlid. The final weight among electric yellow cichlid cultured in glass and fibreglass aquarium ranged from 1.39-1.31 g, total length from 4.94-4.79 cm, SGR from 1.36-1.28 and FCR from 1.85-1.77, respectively.

Pigmentation: Colorimetric values on the skin of goldfish are shown in Table 2. After 20 days of treatment, a and b

Table 1: Rearing parameters of goldfish and electric yellow cichlid cultured glass and fibreglass aquaria at a rearing period of 80 days

	Experimental groups			
	Goldfish		Electric yellow cichlid	
Rearing parameters	Glass aquarium	Fibreglass tank	Glass aquarium	Fibreglass tank
Initial weight (g)	8.13±0.09	8.19±0.09	0.47±0.01	0.47±0.01
Final weight (g)	20.31±0.34	21.08±0.35	1.39±0.03	1.31±0.03
Initial length (cm)	4.64±0.03	4.66±0.03	3.06±0.02	3.03±0.02
Final length (cm)	6.19±0.05	6.34±0.05	4.94±0.04	4.79±0.04
Specific growth rate	1.14±0.02	1.18±0.02	1.36±0.03	1.28±0.05
Feed conversion ratio	1.95±0.02	1.88±0.02	1.85±0.08	1.77±0.06
Survival rate (%)	97.5±1.440	99.17±0.83	96.33±1.45	95.00±1.15

Table 2: Lab values of goldfish reared glass and fiberglass aquaria at a rearing period of 80 days

	Experimental groups					
	Glass aquarium			Fiberglass tank		
Rearing periods	L	a	b	L	a	b
Day 0	58.33±0.50	30.74±0.59	57.21±0.70	60.72±0.66	29.43±0.65	56.69±0.82
Day 20	59.35±0.56	24.51±0.65	53.27±1.05	57.64±0.67	30.69±0.69*	58.70±0.82*
Day 40	62.56±0.75*	20.31±0.60	50.48±0.95	57.23±0.78	31.43±0.62*	57.98±0.74*
Day 60	67.36±0.68*	15.81±0.63	45.09±1.07	58.96±0.69	28.76±0.66*	54.59±0.79*
Day 80	70.78±0.71*	10.22±0.85	43.36±1.12	60.81±0.93	26.61±1.02*	51.58±1.11*

Each value is a mean±S.E. (n = 3 replicates) and each replicate consist of measurements from 16 gold fish. Comparison were made between columns separately for each tristimulus values of different groups and means marked with* represents difference at 0.05 probability level

Table 3: Lab values of electric yellow cichlid reared glass and fiberglass aquaria at a rearing period of 80 days

	Experimental groups					
	Glass aquarium			Fibreglass tank		
Rearing periods	L	a	b	L	a	b
Day 0	39.49±0.37	1.83±0.11	21.10±0.43	39.82±0.24	1.80±0.22	21.77±0.38
Day 20	39.58±0.29	1.69±0.12	20.63±0.34	39.99±0.26	1.59±0.11	21.21±0.43
Day 40	39.85±0.26	1.65±0.12	20.44±0.38	39.96±0.22	1.59±0.08	20.58±0.44
Day 60	39.52±0.30	1.51±0.11	20.97±0.38	39.92±0.24	1.42±0.09	20.49±0.39
Day 80	39.50±0.27	1.43±0.11	20.79±0.37	40.45±0.24	1.29±0.09	20.91±0.35

Each value is a mean±S.E. (n=3 replicates) and each replicate consist of measurements from 32 electric yellow cichlid

values between the fish from glass and fiberglass aquaria started to differ. The final a (26.61) and b (51.58) on the skin of the fish reared in fiberglass aquarium were considerably higher than those (a: 10.22, b: 43.36) in glass aquarium ($p<0.05$). However, on the contrary, L value (70.78) in the fish reared in glass aquarium was >60.81 in fiberglass tank. The L, a and b values on the skin of electric yellow cichlid; however were similar ($p>0.05$) in both aquarium types (Table 3).

The results of the present study showed that the aquarium types had no significant effect on growth performance, feed conversion ratio and survival ratio in both fish species. Although, there are some publications dealing with the light intensity and background colour which are basically related to transparent or opaque features of glass or fibreglass aquarium, no study has yet been reported about the effects of materials used in aquarium building on fish growth. Effects of light or background colour intensity on fish growth vary according to fish species. Grouper, *Epinephelus suillus* (Duray *et al*., 1996); haddock, *Melanogrammus aeglefinus* (Downing and Litvak, 1999); Eurasian perch, *Perca fluviatilis* (Tamazouzt *et al*., 2000); Senegal sole *Solea senegalensis* (Dinis *et al*., 2001) and rainbow trout *Oncorhynchus mykiss* (Papoutsoglou *et al*., 2005); seem to prefer white or illumined tanks. In contrast, black or dark tanks led to a higher growth and survival in turbot *Scophthalmus maximus* (Howell, 1979) stone flounder *Kareius bicolouratus* (Matsuda *et al*., 1987) and striped bass *Morone saxatilis* (Martin-Robichaud and Peterson, 1998). The positive effects of dark tanks on growth is associated with fish neural and hormonal processes, behaviour, feed acceptance or their combined effects (Fanta, 1995; Papoutsoglou, 1998; Bradner and McRobert, 2001; Hoglund *et al*., 2002). Differing from the mentioned studies above, the growth of both fish species in the study are not affected by transparent/illumined or opaque/dark media from glass or fibreglass. A similar phenomenon was also observed in Atlantic salmon *Salmo salar* (Stefansson and Hansen, 1989), grouper

Epinephelus polyphekadion (James *et al*., 1997), African catfish *Clarias gariepinus* (Bardocz *et al*., 1999) and Atlantic cod *Gadus morhua* (Bransden *et al*., 2005). As for colour assessment, the results indicated that a higher red and yellow colouration and a lower lightness were obtained on the skin of goldfish reared in fiberglass aquarium compared to those in glass one while no differences were observed among all colour assessment of electric yellow cichlid reared in the two media. Although, many studies report the effects of culture conditions on the skin colour (Fujimoto *et al*., 1991; Fernandez and Bagnara, 1991; Rotllant *et al*., 2003), there is no direct information about the effects of materials used in aquarium building on fish pigmentation.

It has been generally accepted that light and background colour have a significant effect on pigmentation of fish (Booth *et al*., 2004; Han *et al*., 2005) for example dark background increased significantly the degree of pigmentation in juvenile Atlantic cod compared to pale background (Bransden *et al*., 2005).

Similarly in the study, red or yellow colour of goldfish reared in fibreglass aquarium is significantly enhanced than the glass tank. However, the skin colour of electric yellow cichlid is not affected by the aquarium types. The reason for the colour changes in goldfish might be caused by an increase in number of pigments and/or morphologic changes in chromatophores as also suggested by Matsumoto *et al*. (1984) and Sugimoto (2002).

CONCLUSION

Fiberglass aquarium led to a higher pigmentation in gold fish compared to glass one while neither of the aquarium types affected growth performance, survival ratio and feed utilisation in both goldfish and electric yellow cichlid.

Since the market value of ornamental fish increases with increasing degree of colouration in their skin, fibreglass tanks should be preferred for the culture of goldfish. On the other hand, both aquarium types can be used in the culture of electric yellow cichlid or in any experimental studies as their effects on fish growth are similar. However, this subject should be further tested with many more fish species.

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