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Effects of different artificial light colors on the growth of juveniles common carp (*Cyprinus carpio*)

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Abstract

The experiment was carried out to investigate the effects of light colors on growth and survival of juvenile common carp *Cyprinus carpio*. Five different light colors were tested in triplicates. Juveniles fish were fed to satiation twice a day for 60 days. The fish was significantly affected by light intensity. The survival percentage rate of the fish was also assessed and varied from 40% to 90% at different treatments. The results also showed that growth performance was significantly affected by the light colors. The effect of red light was better than other colors lights , where the red light gave the best fish percentage weight gain (WG = 88.5 %), specific growth rate (SGR = 2.90 %) and daily growth rate (DGR = 12.81 %) . The lowest mean values of feed conversation ratio (FCR = 0.564) was showed in red light while The highest mean values of feed conversation ratio (FCR = 0.603) was found in dark condition. These details can be applied to start steady mass-scale and sustainable farming technology for common carp and will improve the culturing effectiveness of the fish juveniles.

Keywords

Growth performance, Juvenile common carp, Dietary, light colors

Introduction

Most fishes are visual feeders and require a minimal brink light intensity to develop and grow [1-3]. However, Light intensity was also found to have an effect on swimming activity and feeding [4], skin color [5], physiological hormones [3], metabolism [6,7].

Photoperiod affects growth, locomotors activity, metabolic rates, body pigmentation, sexual maturation and reproduction [8; 9 and 10]. On the other hand, the growth and metabolic rates of several other species were not significantly affected by photoperiods [11; 12]. In the meantime, photoperiod might affect larval stages, but not juvenile stages [13]. However, adaptations of fish to their natural environment may also influence their response to the farming environment. As in nature, light and background color can affect feed detection and feeding success of cultured fish, thus influencing fish growth and mortality. [14]; [15] and [16] found that the highest growth rates of fish larvae are attained when light conditions and background color optimize the contrast between the feed and the background . [17] reported that the light intensity may also affect the size of prey preferred by juvenile fish. [18] stated that the colour has been shown to influence the success of larval swim bladder inflation. The majority of fish species are very sensitive to colored light because they have well-developed color vision. [19] reported the survival rate of haddock larvae *(Mellanogrammus aeglefinus L.)* increases with blue and green light. The effects of environmental color on fish have been increasingly investigated during this century, particularly after the first publication of endocrine modulation by light color [20]. Other investigations such as effects of light color on fish mostly involve production variables, such as growth [10], feeding [21], reproduction [22], stress , [23], and survival [24]. Investigations on effect of light color on growth performance and other physiological aspects of fish species and particularly juvenile of common carp under culture conditions are little. The most important objective of the current investigation was to assess light color effects on juvenile common carp (*Cyprinus carpio*) growth performance and survival rate. The growth represents a balance between energy gained and energy demand, this study hypothesized that color might influence these two processes. Previously, light colors have been found to create different effects on fish in a species-specific manner [22]. Therefore, the present study measured the common carp, *C. carpio* growth under dark, white, blue, yellow, red or green light condition .

Material and Methods

180 common carp juveniles (your sample not fingerlings ?? because its size just 3.2 cm) (*1.6* ± 1.098 cm; *0.816* ± 0.032 mg) were collected from Marine science center fish farm and acclimated for15 days before the start of the experiment , then maintained for 60 days in closed system under one of five light color conditions (maximum wavelength absorbance): Dark, white (full spectrum), blue (~452 nm), green (~516 nm), yellow (~520 nm) or red (~628 nm), under similar light levels. During both the acclimation and experimental period fish were fed by hand twice a day with a formulated diet for 60 days (Table 1).

Table 1. The composition of fish's food ingredients (for 100g feed) and chemical analysis of the experimental diets.

Ingredients	gm	(%)
Fish meal	30	30
Soybean meal	25	25
Corn	15	15
Wheat bran	15	15
Barley	10	10
Sun flower oil	3	3
Vitamins	2	2
Total	100	100

The fish were weighed using an electronic balance before feeding on the first day of the experiment (initial) and on the last day of the experiment (final). Differences between mean initial weights of fish in four experimental groups were thus statistically insignificant (P>0.05).

The survival rate of the fish was calculated as:

Survival rate = (Final fish number-Initial fish number)*100 / Initial fish number

Growth and feed parameters were also determined following [25] as:

Mean weight gain (MWG) = Mean final weight - Mean initial weight

Specific growth rate in wet weight (SGR) = 100 (ln W2- ln W1) /T

Where

W1: average initial body weights

W2: average final body weights,

T: time (days)

Feed conversion ratio (FCR) = Feed intake / Weight gain

FCE: feed conversion efficiency in wet weight (%) =100*wet weight gain / total feed intake.

Statistical analysis

The effect of light color on the growth rates and feed utilization were analyzed among groups using one-way analysis of variance (ANOVA) and Duncan test . independent t-test used to analyzed the significant differences between groups by using SPSS program version 17 [26]. Significance was tested at 0.05 level.

Results

Survival

The survival rate of common carp juveniles exposed to five kinds of light colors and Dark condition are shown in Figure 1. The common carp juvenile was clearly affected by light color. The final survival rate of the fish juveniles ranged from 40 % to 90% (Figure 1) at different treatments. There was no significant difference between experimental groups while the final survival tended to be higher at red light color.

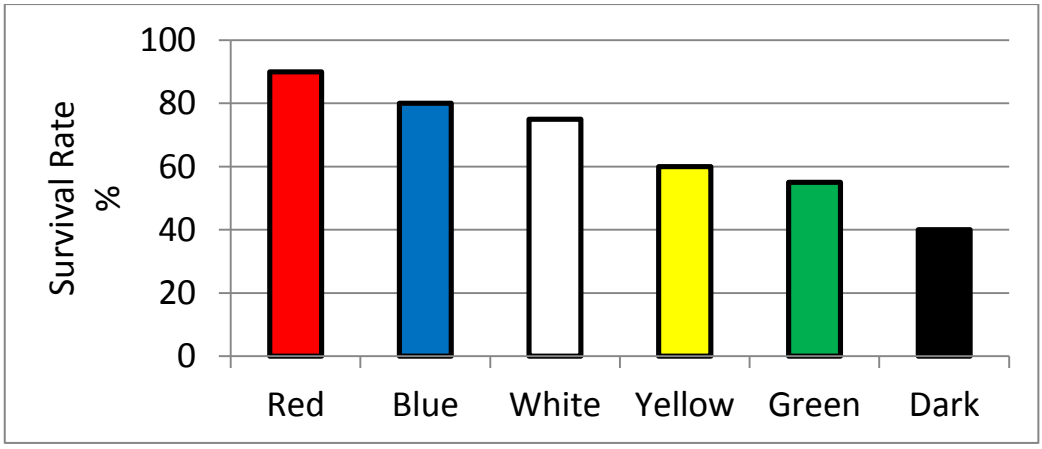

Figure1. Survival rate of the fish juveniles at different types of light colors and Dark condition

Growth performance

There were no significant differences (P>0.05) in initial mean length and weights among treatments in this study (Table 2). The final body length and weight was significantly higher for the fish kept at Red light and lower at dark condition (Table 2).

Table (2). Effects of Different Light Colors on juvenile carp length (cm) and weight increments (gm) .

- Value of one column with similar letters are non-significant at p>0.05.

Aquariums	Total length at beginning of Experiment	Total length at the end of Experiment	Total weight at beginning of the Experiment	Total weight at the end of Experiment
Red(B)	1.5±1.197	a**3.8±1.388	**0.807**±0.055	a**7.038±1.097
Blue(A)	1.6±1.188	a **3.1**±1.301	**0.798**±0.031	a**6.836**±1.052
White(E)	1.5±1.143	b **2.4**±1.223	**0.795**±0.030	b**6.059**± 1.004
Yellow(D)	1.6±1.117	c **2.2**±1.219	**0.863**±0.046	c**5.867**±0.996
Green(C)	1.7±1.105	c**2.1**±1.217	**0.823**±0.037	c**5.823**±0.829
Dark(F)	1.7±1.097	d***2.0**±1.205	**0.810**±0.029	d***4.739**±0.801

- (*) a symbol means that the values in the same column with different superscripts are significantly different from each other at p>0.05.

Data and illustrations on growth patterns of common carp juveniles exposed to five kinds of light colors and dark condition are given in Table 3. There are significant differences in the fish growth patterns between light colors ($p<0.05$). The fish reared in tanks under red light demonstrated higher weight gains (0.108 ± 0.081) than fish in other groups during the experiment. Fish under red light ended up with a mean final body weight of 7.038 ± 1.097 which was significantly higher than those kept under blue, white, yellow, green light and dark ($P<0.05$) (Table 3) . The lowest mean final body weight (4.739 ± 0.801 g) was observed in fish kept in tank under dark condition (Table 3). Therefore, the results of study suggested that light colors (red, blue, white, yellow and green) significantly ($P<0.05$) affected fish growth performance (Table 3). However, the red light gave the best fish weight gain (WG =0.108), specific growth rate (SGR = 2.90 %) and daily growth rate (DGR = 12.86%). The lowest mean values of feed conversation ratio (FCR = 0.564) was noticed in red light condition. The highest mean values of feed conversation ratio (FCR = 0.603) was found in dark condition. while there was no significant difference in other groups (Table 3). ((Significant treatment effects and the interactions are shown as letters; means with the same letters are not significantly different ($P>0.05$, two-way ANOVA); *: $P<0.05$))

Table (3). Effects of Different Light Colors on juvenile carp growth parameters

Perimeter	Light condition					
	Red	Blue	White	Yellow	Green	Dark
Initial weight (g)	0.807 ± 0.055a	0.798± 0.031b	0.795± 0.030b	0.863 ± 0.046a	0.823± 0.037a	0.810 ± 0.029a
Final weight (g)	7.038 ±1.097a	6.836 ±1.052a	6.059 ± 1.004b	5.867 ± 0.996c	5.823 ± 0.829c	4.739 ± 0.801d
Weight gain	0.108 ± 1.028a	0.098 ± 1.025b	0.087 ± 1.014c	0.080 ± 1.015c	0.069 ± 1.012d	0.065 ± 1.009d
Specific growth rate (SGR)	2.897 ± 0.089a	2.830 ± 0.099a	2.622 ± 0.107c	2.704 ± 0.086b	2.614 ± 0.088c	2.250 ± 0.197d
Daily growth rate (DGR)	0.1286 ± 0.009a	0.121 ± 0.013a	0.1104 ± 0.011b	0.0965 ± 0.036d	0.1033 ± 0.019c	0.0809 ± 0.028e
Feed conversion ratio (FCR)	0.564 ±1.009c	0.566 ±1.028c	0.575 ±1.099d	0.586 ±1.102b	0.582 ±1.104b	0.603 ±1.108a

*Values in the same row with different superscripts are significantly different from each other between the rows

Discussion

The current study showed that the growth and feed efficiency of juvenile carp were significantly affected by light colors. Mean final weights and growth performance (SGR, WG, DGR and GE) of fish kept under different light colors in this study (Tables 3) indicated that growth of juveniles common carp is improved under red light when compared to blue, white , yellow and green lights. The effect and interaction of light color could be a clarification for comparatively better growth performance of juvenile common carp kept at the tank with a red color in this study. In fact, light colors have been previously stated to stimulate growth in a number of fish species [27]; [28]; [16] and [29]. Moreover, the majority of fish species have well-developed color sight, and are consequently very sensitive to colored light. [19] reported that the survival rate of haddock larvae *(Mellanogrammus aeglefinus L.)* is higher with blue and green light. [30] and [27] stated the growth rate of silver carp larvae (*Hypophthalmichthys molitrix Val.*) and young carp (*C. carpio L.*) increased with green light.

[31] found that the growth and feed efficiency of Nile tilapia were significantly affected by light colors. The growth in Nile Tilapia is enhanced under blue light when compared to white and red lights. Light colors have been reported to stimulate growth in some of fish species [27]; [28]; [16] and [29]. This enhanced detection of feed in turn increases feeding success giving higher somatic growth in fish [16; 32; 33]. However, higher feed intake in fish might also be related with several neuro-hormonal mechanism [34; 35].

However, spectral composition is a main characteristic of light. In water light rays of different wavelength pass to different depths depending on light absorption and diffusion as well as on availability of admixtures and small organisms in a water body. Some studies show that light spectrum affects farmed fish growth performance [36; 37]. Light intensity may be a limiting factor in aquaculture depending on turbidity, depth, and different species [3]. Most of the fish require a minimal threshold light intensity to be able to develop and grow normally. [39] stated that the combined effect and interaction of tank color and light intensity might be an explanation for comparatively better growth performance of rainbow trout juveniles kept in beige colored tanks.

Conclusions

The red light color may be more suitable for on-growing of common carp juveniles than blue, white , yellow, green light color and dark condition. However; this affirmation cannot be generalized as different culture conditions may produce different growth patterns. Therefore, additional studies using similar colors and different light intensities are required. More investigations on effect of tank color on stress physiology of common carp juveniles using biological indicators of stress such as plasma cortisol are also necessary for generalization of results as such indicators were not studied in the current work

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