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Effects of Different Photoperiod Regimes on Growth and Feed Conversion Rate of Young Iranian and French Rainbow Trout (*Oncorhynchus mykiss*)

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Abstract: To determine whether the French and Iranian rainbow trout (*Oncorhynchus mykiss*) will show different responses to the different photoperiod regimes or not, fish were kept under four photoperiod (light:dark, L:D) cycles (24L:0D, 16L:8D, 12L:12D, 16D:8L), for 60 days. The results of this study showed that in French rainbow trout with 45.14±0.72 g initial weight, weight gain was higher in the (24L:0D) photoperiod, but did not significantly differ from the (16L:8D) photoperiod ($p>0.05$). Specific growth rate (SGR), was significantly higher in the (24L:0D) photoperiod, than other treatments. Condition factor (CF) in (24L:0D) photoperiod, was higher than other treatments but did not significantly differ from the (16L:8D) and (12L:12D) photoperiods. The feed conversion rate in the (24L:0D) photoperiod, was significantly lower than other treatments. In the Iranian rainbow trout with 46.02±0.6 g initial weight, weight gain in the long photoperiod (16L:8D), was significantly higher than other treatments. Specific growth rate and condition factor were higher in the long photoperiod (16L:8D), than other treatments but did not significantly differ from the other treatments ($p>0.05$). Feed conversion rate in the long photoperiod (16L:8D), was significantly lower than other treatments. Survival in both experiments was not affected by photoperiod manipulation. For higher growth and lower feed conversion rate, the continuous (24L:0D) and the long photoperiod (16L:8D) are recommended respectively for young French and Iranian rainbow trout.

Key words: Photoperiod · Rainbow trout · Weight gain · Feed conversion rate · Specific growth rate · Condition factor

INTRODUCTION

Rainbow trout (*Oncorhynchus mykiss*) has been cultured from 1959 in Iran and since then, the number of rainbow trout farms increased as a result of consumer acceptability [1]. From 15 years ago Iran has imported rainbow trout's eyed eggs from other countries like France, Norway, Denmark, Scotland and Italy [2]. French rainbow trout have special qualities, such as same weight in most of the fish, higher growth rate and better resistant against diseases. So, it seems there are some cultivated differences between Iranian and French rainbow trout.

The benefits of photoperiod manipulation to improve growth rate have been well documented [3]. Photoperiod, classified as a directive factor, control growth as a zeitgeber through its influence on endocrine system and circulating levels of growth hormones [4]. Photoperiod manipulation has been used successfully to improve the growth of young, juvenile and larval stages of a number of fish species. Continuous and long photoperiods can increase growth rate and decrease feed conversion rate in different species that reported by some authors such as Ergun *et al* : 2003: Sonmez *et al* : 2009: El-Sayed and Kavanna : 2004: Biswas *et al* : 2005: Danisman and Yigit : 2009: Arvedlund *et al* : 2000: Hart *et al* : 1999: and Turker *et al* : 2005. Continuous light can enhance the juvenile growth of Atlantic salmon *(Salmo salar*) [5]. Recently, Biswas and Takeuchi (2003) found that a 12-h cycle (6L:6D) photoperiod can increase the growth rate of tilapia (*Oreochromis niloticus*). In contrast, Adewolu *et al* (2008) showed that 24h darkness had more effect on increasing growth rate and survival and decreasing feed conversion rate in *Clarias gariepinus*.

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The aim of this study was to evaluate the effect of different photoperiods on the growth rate, feed conversion rate and survival of young French and Iranian rainbow trout.

MATERIALS AND METHODS

Experimental Design: A total of 120 young Iranian rainbow trout, weight (46.02±0.6 g) (mean±SD), were randomly distributed among twelve tanks with 8L volume and acclimated for two weeks to the new rearing environment. The similar number of young French rainbow trout, weight (45.14±0.72 g) (mean±SD), also divided randomly into three groups for each treatment. Fish stocked in the same tanks and exposed to the culture condition, light intensity and photoperiod cycles used for Iranian rainbow trout. The culture unites consist of concrete tanks in a recirculating indoor system. The rearing tanks aerated to maintain the oxygen level 6.5±0.4 mg/l and pH was 7.4±0.2. The water flow was 3 l/s and the temperature was maintained at 12±1°C throughout the study. The fish were exposed to four photoperiod (light : dark) cycles (24L:0D, 16L:8D, 12L:12D, 8L:16D). Light was provided by one 26 W fluorescent daylight tube installed in the each tank cover. Each tank was completely isolated by using a black plastic sheeting to prevent the escape of light and to enable isolation from natural light. Fish were fed with a commercial extruded rainbow trout diet (protein 40%, lipid 10%, moisture 10% and fiber 10%), three times a day for 60 days. All the fish in each tank were weighted at 15-day interval, their average weights recorded and the daily ration measured. At the end of experiment, all fish in each tank netted, weighted and the average final weight and length recorded.

Parameters measured: The data obtained were evaluated according to Olivera *et al* (1990) as follows :

- Weight gain (g) = final body weight – initial body weight
- Total increase length (cm) = final total length – initial total length
- Specific growth rate (SGR) = 100 × (In wf -In wi) / t
- CF = 100 × [wet body weight (g) / (body length (cm))^3].
- FCR = Feed [dry weight of feed eaten (g) / fish weight gain (g)]
- Survival percentage (SR) = [(final number of fish ×100)/Initial number of fish]

Where
wi = Initial weight,
wf = Final average weight,
t = Number of days.

Statistical Analysis: Data obtained were subjected to analysis of variance (ANOVA), using the computer program SPSS. Significant differences in means at $P< 0.05$ were evaluated using Duncan's Multiple Range Test [6].

RESULTS

Growth Parameters: Weight gain in Iranian rainbow trout was significantly higher in the long photoperiod (16L:8D), than other treatments ($p<0.05$) (Table 1). Increase in total length was higher in (16L:8D) photoperiod, but did not significantly differ from (24L:0D) and (12L:12D) photoperiods ($p>0.05$) (Table 1). Also, specific growth rate and condition factor were higher in

Table 1: Effect of photoperiod on growth rate and feed conversion rate of Iranian rainbow trout

	Photoperiods			
Parameters	24L:0D	16L:8D	12L:12D	8L:16D
Weight gain (g)[1]	47.59 ± 0.42^c	51.46 ± 0.41^a	48.49 ± 0.39^b	46.63 ± 0.35^d
Total increase length (cm)[2]	1.69 ± 0.05^a	1.74 ± 0.33^a	1.67 ± 0.09^a	1.21 ± 0.19^b
SGR (%)[3]	1.19 ± 0.29^a	1.20 ± 0.02^a	1.16 ± 0.01^a	1.09 ± 0.01^a
CF[4]	1.58 ± 0.05^a	1.61 ± 0.06^a	1.57 ± 0.03^a	1.56 ± 0.04^a
FCR[5]	1.28 ± 0.01^b	1.26 ± 0.01^a	1.33 ± 0.01^c	1.39 ± 0.01^d

Values are mean± SD (n=3). Mean values within rows not sharing the same superscript are significantly ($p<0.05$)

L = Light hours, D = Dark hours

[1] Weight gain (g) = final body weight – initial body weight

[2] Total increase length (cm) = final total length – initial total length

[3] Specific growth rate = 100 × (ln FW – ln IW) / time (days).

[4] CF = 100 × [wet body weight (g) / (body length (cm))^3].

[5] FCR = Feed [dry weight of feed eaten (g) / fish weight gain (g)]

Table 2: Effect of photoperiod on growth rate and feed conversion rate of French rainbow trout

	Photoperiods			
Parameters	24L:0D	16L:8D	12L:12D	8L:16D
Weight gain (g)[1]	54.00 ± 0.80[a]	53.85 ± 0.07[a]	51.58 ± 0.08[b]	43.72 ± 0.27[c]
Total increase length (cm)[2]	1.92 ± 0.34[a]	1.73 ± 0.20[ab]	1.51 ± 0.17[ab]	1.45 ± 0.15[b]
SGR (%)[3]	1.32 ± 0.03[a]	1.31 ± 0.01[ab]	1.28 ± 0.00[b]	1.11 ± 0.01[c]
CF[4]	1.64 ± 0.06[a]	1.63 ± 0.07[a]	1.60 ± 0.02[a]	1.47 ± 0.06[b]
FCR[5]	1.14 ± 0.01[a]	1.16 ± 0.01[b]	1.21 ± 0.00[c]	1.37 ± 0.01[d]

Values are mean± SD (n=3). Mean values within rows not sharing the same superscript are significantly ($p<0.05$)

L = Light hours, D = Dark hours

[1]Weight gain (g) = final body weight – initial body weight

[2]Total increase length (cm) = final total length – initial total length

[3]Specific growth rate = 100 × (ln FW – ln IW)/time (days).

[4]CF = 100 × [wet body weight (g) / (body length (cm))^3].

[5]FCR = Feed [dry weight of feed eaten (g) / fish weight gain (g)].

the long photoperiod (16L:8D), but did not significantly differ from the other treatments (Table 1). Weight gain in French rainbow trout was higher in the (24L:0D) photoperiod, but did not significantly differ from the (16L:8D) photoperiod. Weight gain in these two treatments were significantly higher than other treatments ($p<0.05$) (Table 2). Also Increase in total length was significantly higher in (24L:0D) photoperiod than other treatments. Specific growth rate (SGR), was significantly higher in the (24L:0D) photoperiod (Table 2). Condition factor (CF) in (24L:0D) photoperiod, was higher than other treatments but did not significantly differ from the (16L:8D) and (12L:12D) photoperiods ($p>0.05$) (Table 2). Condition factor in (16D:8L) photoperiod was significantly lower than other three treatments (Table 2).

Feed Conversion Rate: Feed conversion rate in Iranian rainbow trout was significantly lower in the long (16L:8D) photoperiod than other treatments ($p<0.05$) (Table 1). The feed conversion rate in French rainbow trout was significantly lower in the (24L:0D) photoperiod, than other treatments ($p<0.05$) (Table 2).

Survival: Survival did not affected by photoperiod manipulation in both Iranian and French young rainbow trout.

DISCUSSION

A full understanding and application of photoperiod restriction may go a long way in improving productivity and sustainability of aquaculture. Photoperiod requirement is extremely variable, can be with or without effect and is related to environmental adaptation, species and age specific [7]. It has been suggested that fresh water fish are more sensitive to photoperiod than marine and diadromous species [8]. However, the response of marine species to photoperiod has been well investigated, while less information is available on freshwater species [9].

The results of the present study indicated that the responses of young Iranian and French rainbow trout to photoperiod cycles depend on fish group. The young French rainbow trout that subjected to long light periods (24 and 16 h) had significantly higher weight gain than other treatments and in Iranian rainbow trout highest weight gain observed in 16L:8D photoperiod that was significantly differ than other treatments. Similar results in *Oncorhynchus mykiss* [10, 11], *Oreochromis niloticus* [9], *Pagrus major* [12], *Cyprinus carpio* [13], *Amphiprion melanopus* [14], *Rhombosolea tapirina* [15], *Psetta maeotica* [16] and *Scophthalmus maximus* [8] were reported. The higher growth rate in continuous (24L:0D) and long (16L:8D) photoperiod may due to diurnal fishes are more active under continuous and long photoperiods and having a greater foraging activity when food is delivered or be related to hormonal stimulation of appetite under a long and continuous photoperiod. For example growth hormone, known to has a positive effect on appetite, increased with increasing day length in salmon [12].

Specific growth rate (SGR), in French rainbow trout was higher in the (24L:0D) photoperiod and in Iranian rainbow trout was higher in 16L:8D but there was no differ from other treatments. Sayer (1998) has noted that a continuous photoperiod has been associated with improved growth rates for some species at the length of feeding time available to fish is increased. Tripple and Neil (2003) found an increase in the weight of juvenile haddock (*Melanogrammus aeglefinus*) reared under continuous

light for 24 weeks compared to fish reared under natural photoperiod. In contrast, Ballagh *et al* (2008) noticed under a 24L;0D photoperiod, significantly poorer growth(weight, length and FCR) of mulloway (*Argyrosomus japonicus*) was obtained compared with that of fish under 12L:12D and 18L:6D photoperiods. Biswas and Takeuchi (2003) found that a 24L:0D photoperiod is less effective in obtain high growth rates (in terms of specific growth rate- SGR) for Nile tilapia (*Oreochromis niloticus*) when compared to 3L:3D, 6L:6D and 12L:12D photoperiods.

Condition factor (CF) in French rainbow trout was higher in (24, 16 and 12 h) of light and in Iranian rainbow trout was higher in 16L:8D but there was no differ from other treatments. In general, the CF positively correlates with the body weight of fish. Similar result was demonstrated in *Oncorhynchus mykiss* [10].

Feed conversion rate (FCR), in French rainbow trout was lower in the (24L:0D) photoperiod and in Iranian rainbow trout was lower in 16L:8D. These mean FCR in rainbow trout decrease with day light. These suggest that young rainbow trout are better at converting energy into somatic growth during longer photoperiods. Similar result reported by Rad *et al*. (2006), they found that continuous light improved the FCR of *Oreochromis niloticus*, also indicating that growth performance under long photoperiods is species specific. In contrast, Adewolu *et al* (2008), resulted that 24h darkness significantly increased growth rates and decreased feed conversion rate of *Clarias gariepinus*.

As the results of photoperiod trails on fish growth have been inconsistent between species, it is apparent that photoperiod requirements are species and growth rates may partly depend on the species ability to reduce energy expenditure in long light phases [3].

Survival did not affected by photoperiod manipulation in both Iranian and French young rainbow trout. Similar results were reported by some authors in rainbow trout [10, 11], but in contrast of these findings Adewolu *et al*; (2008), found higher survival in the fingerlings of *Clarias gariepinus* cultured under 24 h darkness. They found when this fish cultured in darkness, ate comfortably, spent more time resting, which have been implicated in the high feed intake, low wastage and better growth. These may have reduced stress culminating in high survival.

In conclusion, these results revealed that the growth rates of young Iranian and French rainbow trout (*Oncorhynchus mykiss*) respectively can be enhanced significantly by using long (16L:8D) and continuous (24L:0D) photoperiods. Different results in these two groups may be caused by selection or genetic modification in French rainbow trout which needs to investigate.

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