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The Influence of Photoperiod Regimes on Growth Performance and Survival Rate of Rainbow Trout (*Oncorhynchus mykiss*) Larvae

[1]Moein Faramarzi, [2]Saeed Kiaalvandi and [3]Farnaz Iranshahi

[1]Department of Fishery, Gonbad University,
Faculty of Agricultural Sciences and Natural Resources, Gonbad, Iran
[2]Department of Fishery, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran
[3]Department of Fishery, Shahid Bahonar University, Kerman, Iran

Abstract: The effects of 4 different scotophase, the dark phase of photoperiods, LD 8:16 (8 h light: 16 h dark), LD 12:12 (12 h light:12 h dark), LD 16:8 (16 h light:8 h dark) and LD 24:0 (24 h light:0 h dark) on growth, feed conversion and survival rate of rainbow trout, *Oncorhynchus mykiss* fry with 2 g initial weight were investigated. The fry exhibited better growth and feed utilization in longer light periods but differences appeared only after 60 days of exposure time. The highest growth rate and lowest feed conversion ratio were recorded in LD 16:8 groups. In addition, growth and feed conversion ratio in the fry exposed to LD 12:12, LD16:8 and LD 24:0 photoperiods were statistically better than that of LD 8:16 photoperiod ($p<0.05$). There was no significant photoperiod effects on the survival rate ($p>0.05$). Consequently, it can be supposed that growth and feed utilization of rainbow trout fry were improved when cultured in longer light periods.

Key words: Rainbow trout · *Oncorhynchus mykiss* · Scotophase · Photoperiod

INTRODUCTION

Freshwater fish culture began in the late 1960's with the importation of trout eggs (*Oncorhyncus mykiss*) from Europe in Iran. Since then, the number of fish farms increased considerably. Today, rainbow trout is the most commonly cultured freshwater fish in Iran due to their high consumer acceptability and tasty flesh [1].

Developmental and maturational events in animal are influenced by genetic, environmental and nutritional factors. Environmental factors are particularly important in the growth of ectothermic vertebrates such as teleost fish, which rely on temperature and photoperiod [2, 3]. Therefore, it is supposed that correct application of photoperiod may improve performance, profitability and sustainability of aquacultural practices.

Photoperiod, classified as a directive factor, controls growth as a zeitgeber through its influence on endogenous rhythms and circulating levels of growth hormones [4]. Many fish species react to photoperiod treatments. Expose to extended and constant light photoperiod regimes has been shown to lead to increased growth rates in largemouth bass, *Micropterus salmoides* [5], Japanese medaka, *Oryzias latipes* [6], halibut, *Hippoglossus hippoglossus* [7,8], turbot, *Scophthalmus maximus*, [3,9], haddock, *Melanogrammus aeglefinus* [10], European sea bass, *Dicentrarchus labrax*, [11] and gilthead sea bream, *Sparus aurata*, [12], Atlantic cod, *Gadus morhua* [13] and salmonids, *Salmo salar* [14-16]. However, in many studies on juvenile salmonids there is the inherent problem of dissociating photoperiod induced growth from smoltification [17-19], since growth and size will determine whether a fish is of sufficient size to under go the transformation [20].

While, the effect of photoperiod on growth and survival of rainbow trout (*Oncorhynchus mykiss*) has been demonstrated, there are inconclusive and contradictory results on the effect of photoperiod at the juvenile stage of rainbow trout, does not undergo parr-smolt transformation during its normal life history [21, 22]. Therefore, the present study aimed to evaluate the effect of different photoperiods on the growth, feed utilization and survival of rainbow trout, *Oncorhynchus mykiss* fry.

Corresponding Author: M. Faramarzi, Department of Fishery, Faculty of Agricultural Sciences and Natural Resources, Gonbad University, Gonbad, Iran. E-mail: faramarzimoein@gmail.com.

MATERIALS AND METHODS

Rainbow trout fry with 1.91±0.03 g (Mean ± SD) initial weight were obtained from the personal hatchery. A total of 216 fry was randomly scattered to 70 L of 12 fiberglass tanks (4 groups with 3 replicates) and acclimatized for 2 weeks prior to the start of the experiment.

Four scotophase (long scotophase, 8 h light: 16 h dark, lights on at 09:00; medium scotophase 12 h light: 12 h dark, lights on at 06:00; short scotophase, 16 h light: 8 h dark, lights on at 04:00 and no scotophase, 24 h light: 0 h dark, lights on all time) were used to test the effect of photoperiod on growth, feed efficiency and survival at a constant water temperature of 9±1°C. Light was provided by one 26 W fluorescent daylight tube installed in the tank cover. Each tank was completely isolated by using a box made from black plastic sheeting to prevent the escape of light to the surrounding tanks and to enable isolation from natural light.

Aerated and dechlorinated fresh water with flow rate of 1.5 L min^{-1}, 9 ppm dissolved oxygen, 7.8 pH and 102 mg as $CaCO_3$ total water hardness was used. Experiment was extended for 8 weeks.

The fry were fed a commercial fishmeal-based extruded rainbow trout diet (diameter 1 mm; 55% crude protein; 14% crude lipid; 4296 cal g^{-1} diet gross energy) at 3.5% body weight twice daily at 10.00 am and 14.00 pm. About 30 min after feeding, uneaten feed were removed by the standpipe at the bottom of the tank.

Individually weighing of fry in each tank during the photophase was done twice a month and quantity of feed was adjusted weekly. Mortality was recorded daily during the experiment. Weight gain, relative growth rate (%), Specific Growth Rate (SGR (%) day^{-1}), Feed Conversion Ratio (FCR) and percentage survival (%) were calculated using standard formulae outlined by Yanik and Aras [23].

All data were subjected to a one-way analysis of variance followed by Duncan's multiple-range test to determine significant differences among the means at the 0.05 level. Results are presented as means ± SD.

RESULTS AND DISCUSSION

The growth, feed conversion rate and survival rate of fry were presented in table 1. Although, the differences between groups were not significant at initial, the final weights, specific growth rates and feed conversion rates of fish from LD 16:8 groups were significantly ($p<0.05$) better than those of the rest. No significant changes were observed between the groups LD 12:12 and LD 24:0 with respect to tested properties ($p>0.05$). Average final weight of individuals was significantly lower at a rate of 6-17% in the long scotophase, LD 8:16 photoperiod than those in the LD 12:12, LD 16:8 and LD24:0 photoperiod groups. There was no significant differences were observed between groups with respect to survival of fry ($p>0.05$).

One of the most important factors influencing fish growth is the water temperature [24]. Data of the optimum temperature ranges are available for many fish species. Optimal temperature ranges for growth were previously reported between 10 and 13°C for fry of salmonids [25]. Although, a temperature of 9°C has been considered suboptimal for growth of rainbow trout, growth rates were low in the present study compared to the findings of Taylor *et al.* [26], this was probably due to the low constant water temperature during the course of this experiment conducted in spring.

Photoperiod requirement is extremely variable and related to environmental adaptation, species and age specific [27-29].

Table1: Mean ± standard deviation for weight, specific growth rate, feed conversion ratio, survival and percent weight gain of rainbow trout, kept at different scotophases of photoperiod at 9°C water temperature during 60 days. Significance of results was compared only within the same line

	Scotophases			
Parameters	Long (LD8:16)	Medium(LD12:12)	Short (LD16:8)	Zero (LD24:0)
Initial weight(g)	1.92±0.02^a	1.91±0.03^a	1.92±0.04^a	1.90±0.02^a
Final weight(g)	8.53±0.22^a	9.08±0.31^b	10.24±0.03^c	9.22±0.02^b
Weight gain(%)	344.59±8.60^a	375.68±9.38^b	438.55±10.14^c	387.52±0.05^b
Specific growth rate (%day^{-1})	2.49±0.03^a	2.56±0.03^b	2.81±0.03^c	2.64±0.00^b
Feed conversion ratio	1.16±0.05^a	1.08±0.02^b	0.93±0.02^c	1.30±0.00^b
Survival	100	100	100	100

Mean with the different superscripts in horizontal row are significantly different ($p<0.05$)

The results of the present study showed that the changes in the length of scotophase affected the growth and feed efficiency of fry over the 60 days of the experiment. The highest weight gain of fish was observed in LD 16:8 photoperiod than those in LD8:16, LD 12:12 and LD 24:0. This result confirms earlier studies that rainbow trout are photophilic and that long term extended photoperiod has a growth promoting effect on rainbow trout [14, 30]. Similarly, Taylor *et al.* [26] observed exposure to long or continuous light photoperiods can improve growth rate in juvenile rainbow trout in covered freshwater tanks. Mason *et al.* [22] related this observation to increased food intake during the extended photophase.

It was also demonstrated that under natural photoperiod cycles a reduction in the rate of decreasing day length improves growth and feed conversion efficiency in freshwater reared rainbow trout [21]. On the other hand, Solbakken *et al.* [3] reported that, there was no effect of constant light application on winter growth rate of seawater cage reared rainbow trout.

Most of the fundamental rhythms in nature (diurnal or seasonal) are related to the periodicity of light. Fish exhibit a 24 h cycle in their activities and they are either more active in light, less active in darkness, or vice versa. The lower weight gain observed with the fry cultured in 8 h of light might be due to diminishing release of several hormones, somatotropin and thyroid hormones from the fish in the long scotophase [29]. In addition, with regards to photoperiodic effect on final wet gain of the fish, it was observed that disturbances in growth of the fry were lower in short and no scotophase groups (LD18:6 and LD24:0) than medium and long scotophases (LD12:12and LD8:16).

CONCLUSION

The results of this study showed that the feed utilization, growth and survival of rainbow trout fry were influenced by different scotophases. The results also suggested that LD16:8 was adequate for a good growth of trout fry, as the fish growth in this group was better than that of the other groups. Consequently, LD16:8 photoperiod regime could be recommended as a technique for intensification of rainbow trout production.

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