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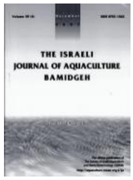

Effect of Low Salinity on Yolk Sac Absorption and Alevin Wet Weight of Rainbow Trout Larvae (*Oncorhynchus mykiss*)

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Key words: rainbow trout, yolk sac absorption, maximum alevin wet weight, growth, salinity

Abstract

Growth, yolk sac absorption, and maximum wet weight of alevin rainbow trout (*Oncorhynchus mykiss*) stocked in fresh water (0 salinity), water with 4‰ salinity, or water with 8‰ salinity were determined. Larvae were sampled on the 329th degree-day when 50% of the eggs hatched, and on degree-days 361, 396, 432, 467, 496, 528, 557, and 584. Sampled larvae were anesthetized in benzocaine solution (20 mg/l) and preserved in 10% formaldehyde. At hatching, mean length was 14.25±0.63 mm and total wet weight was 58.16±9.98 mg. Larvae reached the swim-up stage at 96.94±8.71 mg on the 28th day in fresh water, at 120.29±9.26 mg on 19th day in 4‰ salinity, and at 102.80±5.88 mg on 22nd day in 8‰ salinity. The total length and dry weight of the larvae at the swim-up stage differed significantly among treatments ($p<0.001$). There was a significant relationship between larvae dry weight and degree-day. The best growth, yolk sac consumption, and alevin wet weight were obtained in 4‰ salinity.

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Introduction

The first external feeding activity of fish larvae starts when larvae swim up in the incubator. In trout hatcheries, the first external feeding starts when over 30% percent of the larvae start to swim up. As in other finfish species, this development and transition stage is critical in rainbow trout larvae due to susceptibility to disease and pathogens, environmental fluctuations, and starvation. With appropriate hatchery management, survival and growth rates can be increased and larvae and fry can be produced during seasons when they are not typically available. To develop appropriate hatchery procedures, qualitative and quantitative data on early development including hatching and larvae stages in different salinities is needed.

Yolk sac absorption and maximum alevin wet weight were evaluated in fresh water in Atlantic salmon (Hansen and Møller, 1985; Petersen and Martin-Robichaud, 1995), rainbow trout (Hodson and Blunt, 1986), sea trout (Hansen, 1985; Ojanguren and Braña, 2003), brook trout (Başçınar et al., 2003), and brook trout and Arctic charr and their hybrids (Dumas et al., 1995). The aim of the present study was to investigate larvae growth during yolk absorption, yolk conversion efficiency, and maximum alevin wet weight of rainbow trout larvae in fresh water and two low salinities.

Materials and Methods

Eggs from four females were collected and fertilized with milt from two males at the trout hatchery in the Faculty of Marine Sciences, Karadeniz Technical University, Trabzon. The eggs were hatched in a vertical incubator. After hatching, about 3000 larvae were randomly divided into triplicate batches for each treatment: fresh water (control), 4‰ salinity, and 8‰ salinity. Aerated water in the batches was recirculated and 20% was replaced daily. Temperature was measured with a mercury thermometer three times a day (8:30, 12:30, 16:00) and ranged 6.5-13.0°C (mean 9.87±1.30°C). Dead larvae were removed twice a week.

Ten larvae were randomly sampled at 3 or 4 day intervals from the 329th degree-day (ΣT: sum of daily mean temperatures) when 50% of the larvae had hatched. Thus, larvae were sampled at the 361, 396, 432, 467, 496, 528, 557, and 584 degree-days. Sampled larvae were anesthetized in a benzocaine solution (20 mg/l) and preserved in 10% formaldehyde. After a minimum interval of three weeks, fixed larvae were dissected to separate the yolk sac from the body. Body and yolk were dried separately at 60°C for 48 h and weighed individually after 48 h (Hansen, 1985).

Yolk sac efficiency was calculated as $YCE = (L_t - L_0)/(Y_0 - Y_t)$ as per Hodson and Blunt (1986), where L is dry larvae weight, Y is yolk sac dry weight, and t is day. The dry yolk sac consumption rate (mg/day) was calculated as $YCR = (Y_0 - Y_t)/t$, daily length growth rate (mm/day) as $LGR = (length_t - length_0)/t$, daily weight growth rate (mg/day) as $WGR = (wt_t - wt_0)/t$; and development index as $KD = 10(\text{wet wt}^{1/3})/\text{length}$ (Peterson and Martin-Robichaud, 1995).

Data were analyzed with analysis of variance (ANOVA), Tukey test, and regression analysis using MINITAB® and MS EXCEL® software. The significance of all slopes (Ho: b = 0) and regressions were tested at the 0.05 probability level (Hodson and Blunt, 1986). Statistical significance of differences among regression evaluations and slopes values were determined with analysis of covariance (Zar, 1999).

Results

Hatching started at 311.5 degree-days and ended at 346.5 degree-days. The mean length and maximum wet weight at hatching were 14.25±0.63 mm and 58.16±9.98 mg. Lengths and weights throughout the experiment significantly differed (Fig. 1). Growth was fastest in 4‰ salinity where larvae reached the swim-up stage at 22.35±0.82 mm and 120.29±9.26 mg on the 19th day. Larvae in 8‰ salinity reached the swim-up stage at 21.80±1.27 mm and 102.80±5.88 mg on the 22nd day and larvae grown in fresh water required 28 days to reach swim-up at 21.30±0.67 mm and 96.94±8.71 mg. Mortality was less than 5% in all groups. The best performance was observed in 4‰ salinity (Table 1). Larvae weight was positively related and dry yolk weight negatively related to degree-day (Fig. 2).

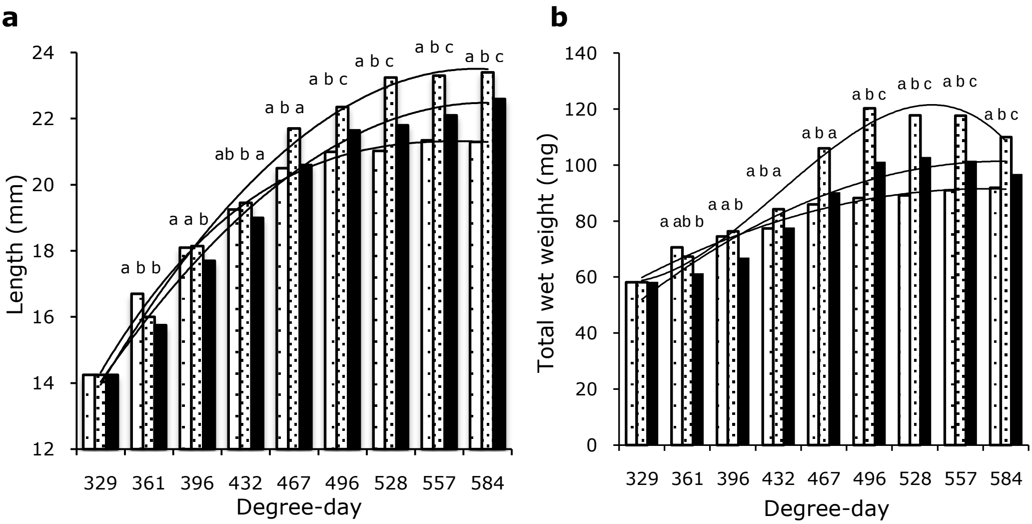

Fig. 1. Gains in (a) length and (b) wet weight of rainbow trout larvae raised in freshwater (░), water with 4‰ salinity (▒), or water with 8‰ (█) salinity. Letters above bars indicate significant (p<0.001) differences between treatments.

Table 1. The effect of salinity on rainbow trout larvae at the swim-up stage.

	Salinity (days to swim-up stage)				
	Freshwater (day 28)	*4‰ (day 19)*	*8‰ (day 22)*	*F*	*p*
Yolk conversion efficiency	0.60±0.04 [b]	0.86±0.08 [a]	0.67±0.13 [b]	20.64	<0.001
Yolk consumption rate (mg/day)	0.55±0.07 [b]	0.81±0.13 [a]	0.80±0.11 [a]	22.12	<0.001
Length growth rate (mm/day)	0.25±0.03 [c]	0.42±0.05 [a]	0.34±0.07 [b]	25.91	<0.001
Weight growth rate (mg/day)	1.39±0.36 [c]	3.27±0.68 [a]	2.03±0.58 [b]	29.77	<0.001
Development index	2.15±0.05	2.13±0.06	2.15±0.11	0.12	>0.05
Water content (%)*	83.10±1.49	83.33±0.77	83.54±1.60	0.15	>0.05

* water content was 59.28% at hatch

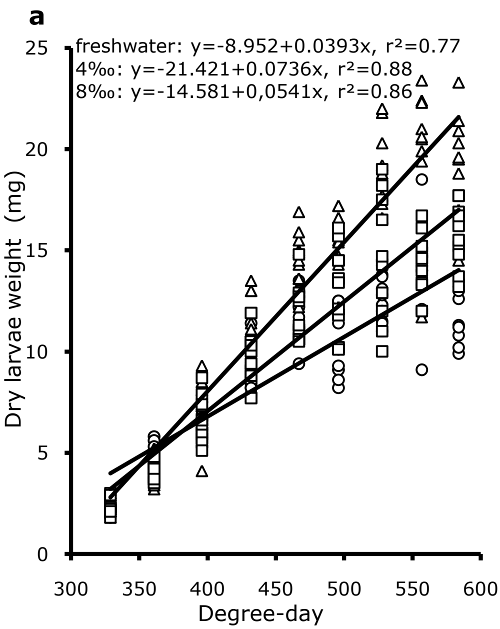

Fig. 2. Relationship between degree-day and (a) dry larvae weight and (b) yolk-sac weight in rainbow trout alevins grown in fresh water (○), water containing 4‰ salinity (∆), or water containing 8‰ salinity (□).

Discussion

While water temperature is known to be one of the most important abiotic factors affecting the development of salmonid larvae, the effects of water salinity are less well known. Growth of *Oncorhynchus mykiss* embryos in brackish water (salinity 6‰) is slightly depressed but, between hatching and onset of external feeding, growth of larvae is normal (Kamler, 2008). In our study, after the end of the depressed embryo growth, larvae grew faster at the lower salinity (4‰) than at the higher (8‰) salinity.

In this study the highest YCE was 0.86 at 4‰ salinity. YCE was 0.4-0.8 for several species (Blaxter, 1969, cited in Hodson and Blunt, 1986). Since larvae absorb their yolk sac and synthesize water in tissue, many researchers prefer using dry weight instead of total wet weight (Hansen, 1985; Hansen and Møller, 1985; Dumas et al., 1995). The YCE in our study was 0.82 on a dry weight basis.

The appropriate time for first feeding of alevins is when they reach their maximum wet weight (Rombough, 1985). The development index and water content for first feeding of Atlantic salmon alevin are 1.98 and 82-82.5% (Peterson and Martin-Robichaud, 1995). Alevins stocked in 4‰ saline water had less time to consume the yolk sac, higher water content, and higher KD values than Atlantic salmon, which can be explained by species differences (Kamler, 2008).

The best growth performance of larvae after adaptation was observed in 4‰ salinity in contrast to other studies where growth was slow in the first period after adaptation (Spannhof and Pavlov, 1984, cited in Kamler, 2008). This may be due to energy recruitment for activities such as water regulation and ion transfer.

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