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Comparison of Hatchery Performances of Rainbow Trout (*Oncorhynchus mykiss*), Brown Trout (*Salmo trutta fario*) and Brook Trout (*Salvelinus fontinalis*) under the Same Environmental Conditions

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Abstract: In this study, eggs of rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta fario*) and brook trout (*Salvelinus fontinalis*) were incubated under the same environmental conditions. Survival to eyed stage, during eyed stage, in yolk sac stage and until first feeding were calculated. Survival to eyed stage in rainbow and brown trout were statistically different from brook trout ($p<0.01$), but all other parameters were not statistically different. It was concluded that studied all trout eggs can be hatched successfully under the same environmental conditions.

Key words: Hatchery performance, *Oncorhynchus mykiss*, *Salvelinus fontinalis*, *Salmo trutta fario*

INTRODUCTION

Trout belonging Salmonidae family form the most valuable group of fish species in the world, the low prices for salmonids for years appear to be chiefly caused by large productions in salmonid aquaculture (Rasmussen and Ostenfeld, 2000). Rainbow trout (*Oncorhynchus mykiss*) are the hardiest salmonid and can tolerate wide environmental changes. For instance, they tolerate water temperature from 0-27°C (Uysal and Alpbaz, 2002).

Brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*) are generally used in sport and recreational fisheries (Okumus *et al*., 1999). However, they could be more bred and enhanced product diversity of that kind might increase consumers interest in salmonids, if supported by sound marketing (Rasmussen and Ostenfeld, 2000).

Traits such as incubation time, life span and growth rate are probably very important in determining individual fitness (Vøllestad and Lillehammer, 2000).

The objective of this study was to compare reproductive performance of rainbow, brown and brook trout under the same environmental conditions.

MATERIALS AND METHODS

Fish and experiment design: Fish species used in this study were obtained from Research and Extension Center of the Department of Fishery Science at the Agriculture Faculty of the Atatürk University. Trout species were 4 years old and initial weights of rainbow trout, brown trout and brook trout were 3684.6±85.1, 771.32±14.58 and 1151.48±42.96 g, respectively.

Eggs from each female were fertilised with milt from 2 males. Hatching was done in three replicates with approximately 1000 eggs and eggs were hatched in the same centre. Aerated artesian water with 1 L min^{-1} inflow, 9.5°C temperature, 7-7.5 pH and 9.8 mg L^{-1} dissolved oxygen was used. All eggs in eyed stage were counted and then 500 eggs from each tray were monitored to determine hatching properties. Trays were monitored every day and dead eggs and frys were removed. Survival rates to the first feeding stage were determined by counting the fry remaining in each tray (Yanik and Aras, 1994; Yanik *et al*., 2002).

Statistical analysis: The rates of fertilization, hatching and survival to first feeding were calculated and datas were analyzed using a one-way analysis of variance (SAS Statistics Package Program, version 6.11) followed by the Duncan's multiple range test to determine significant differences among means at the $\alpha = 0.01$ level (SAS, 1996).

RESULTS AND DISCUSSION

Survival during eyed the stage, during yolk sac stage and survival to first feeding was not statistically different among species (Table 1). However, survival to the eyed

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Table 1: Comparison of survival of rainbow trout, brown trout and brook trout from fertilization to first feeding

Survival	Rainbow trout	Brown trout	Brook trout	p-value
Incubaton duration (days)	28-30	37-43	33-40	-
Survival to eyed stage (%)	99.23±0.26^{ab}	99.75±0.18^{a}	98.50±0.52^{b}	**
Survival during eyed stage (%)	98.68±0.37	99.33±0.37	99.06±0.62	ns
Yolk sac stage (days)	19-20	34-38	24-26	-
Survival in yolk sac stage (%)	97.71±1.02	98.33±0.54	98.66±0.11	ns
Survival to first feeding (%)	96.27±1.77	95.96±2.52	97.02±0.80	ns
Egg diameter (mm)	5.33±0.10^{a}	5.08±0.09^{a}	4.64±0.07^{b}	**

$^{a-b}$Means in a row with identical letters are not significantly different. Values given as mean±SD, ns = p>0.05, ** = p<0.01

stage in rainbow and brown trout statistically greater than in brook trout (p<0.01). The longest incubation duration and yolk sac stage period were seen in brown trout (37-43 and 34-38 days, respectively), rainbow trout had the shortest periods of both (28-30 and 19-20 days, respectively) (Table 1).

For the future performance of an individual, early life history is potentially of crucial importance and the effects of very early events may extend long into the later stages of life (Pakkassma and Jones, 2002). It is affected by many factors including environmental conditions, genetic factors etc. Temperature has a highly significant effect on incubation, embryo metabolism and growth (Bendiksen *et al*., 2002; Murray and Beacham, 1986; Yanik *et al*., 2002). Incubation temperature during this period is probably the main factor controlling the duration of early development stages of fish embryos and larvae (Basçinar and Okumus, 2004). In this study, especially water temperature was held stable, so incubation of eggs and hatching performance were mainly affected only by species differences.

Incubation duration and yolk sac stage of fish in this study were very different from each other (Table 1). While, rainbow trout reached the first feeding in 50 days (the longest period for this species), brook and brown trout reached first feeding in 57 and 71 days, respectively (the shortest periods for those species). The eggs of *Salvelinus fontinalis* and *Oncorhynchus mykiss* take approximately 440 and 310 day-degrees, respectively, to incubate (Basçinar and Okumus, 2004; Aras *et al*., 1996). Egg size, environmental and genetic factors have a very important role in determining hatching time. It is known that development rate is affected by maternal factors (Pakkassma and Jones, 2002). In the present study, the ages of females were similar among groups. By contrast the weights of females were different. So, differences in egg diameter were probably influenced by maternal weights.

In this study, survival rates of rainbow trout at all stages were in accordance with the research of Atilgan (2003). But the values for brook trout were dramatically higher than those reported by Basçinar and Okumus (2004). On the other hand, Aras *et al.* (2003) reported 99, 97, 98 and 95% survival rates to eyed stage, in eyed stage, in yolk sac stage and until first feeding for *Salmo trutta fario*, respectively similar to our results.

Earlier researchers suggested that rainbow trout had higher survival rates than brown and brook trout at all hatchery stages (Basçinar and Okumus, 2004; Coyle and Tidwell, 2000). By contrast, in this study, we found differences only in survival to eyed stage between rainbow and brook trout. There were no differences between rainbow and brown trout (Table 1).

In cultured salmonids, larger eggs give rise to larger fry, which can survive longer without external feeding (Atse *et al*., 2002). Ojanguren *et al*. (1996) reported that egg size affects both fecundity and offspring fitness and Bagenal (1969) suggested that larger eggs result in larger fry and this assumption was used, along with hatchery fish, to determine the extent of reproductive success of fish.

In this study, survival to the eyed stage in rainbow and brown trout were better than in brook trout. Also, egg sizes in these are greater than in *S. fontinalis*. Differences in egg size among species might have caused the difference in survival rate from fertilization to eyed stage.

CONCLUSION

We have concluded that *O. mykiss*, *S. fontinalis* and *S. trutta fario* eggs can be hatched successfully under the same environmental conditions. It is hoped that this study will help to later reproduction management studies, especially in brown and brook trout.

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