

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

Esat Mahmut Kocaman, Abdulkadir Bayir, Ahmet Necdet Sirkecioglu,

Mehtap Bayir, Telat Yanik and Harun Arslan

Department of Fishery Science, Faculty of Agriculture, Atatürk University, 25240, Erzurum, Turkey

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 Ostefeld, 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 Ostefeld, 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 fry 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 data 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

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
Incubation 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 (Başçınar 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 (Başçınar 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 Başçınar 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 (Başçınar 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.

REFERENCES

- Aras, M.S., R. Bircan, E.M. Kocaman and N.M. Aras, 1996. The Basic Principles of Culture Fisheries. Atatürk University Agriculture Faculty Offset Facilities, Erzurum, Turkey, pp: 50.
- Aras, H.S., T. Yanik and O. Hisar, 2003. Hatchery and growth performance of two trout pure breeds, *Salvelinus alpinus* and *Salmo trutta fario* and their hybrid. The Israeli J. Aquaculture-Bamidgeh, 55 (3): 154-159.

- Atilgan, E., 2003. A research on comparison of the egg and fry taken from different aged rainbow trout (*Oncorhynchus mykiss* Walbaum, 1792). Master Thesis, Atatürk University, Erzurum, Turkey.
- Atse, C.B., C. Audet and J. de la Noüe, 2002. Effects of temperature and salinity on the reproductive success of Arctic charr, *Salvelinus alpinus* (L.): Egg composition, milt characteristics and fry survival. *Aquacult. Res.*, 33: 299-309.
- Bagenal, T.B., 1969. Relationship between egg size and fry survival in brown trout (*Salmo trutta*). *J. Fish Biol.*, 1: 349-353.
- Başçınar, N. and I. Okumus, 2004. The early development of brook trout *Salvelinus fontinalis* (Mitchill): Survival and growth rates of alevins. *Turk. J. Vet. Anim. Sci.*, 28: 297-301.
- Bendiksen, E., M. Jobling, A.M. Arnesen, 2002. Feed intake of Atlantic salmon parr *Salmo salar* L. in relation to temperature and feed composition. *Aquacult. Res.*, 33: 525-532.
- Coyle, S.D. and J.H. Tidwell, 2000. Production characteristics of rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*) under seasonal pond conditions. *J. Applied Aquacult.*, 10 (1): 37-43.
- Murray, C.B. and T.D. Beacham, 1986. Effects of varying temperature regimes on the development of pink salmon (*Oncorhynchus gorbuscha*) eggs and alevins. *Can. J. Zool.*, 64: 670-676.
- Ojanguren, A.F., F.G. Reyes-Gavilán and F. Braña, 1996. Effects of egg size on offspring development and fitness in brown trout, *Salmo trutta* L. *Aquaculture*, 147: 9-20.
- Okumus, I., M.S. Çelikkale, Z. Kurtoglu and N. Başçınar, 1999. Growth performance, food intake and feed conversion ratios in rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*) reared as a single and mixed species. *Turk. J. Vet. Anim. Sci.*, 1 (23 Additional Issue): 123-130.
- Pakkassma, S. and M. Jones, 2002. Individual-level analysis of early life history traits in hatchery-reared lake trout. *J. Fish Biol.*, 60: 218-225.
- Rasmussen, R.S. and T.H. Ostefeld, 2000. Effect of growth rate on quality traits and feed utilisation of rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*). *Aquaculture*, 184: 327-337.
- SAS, 1996. System on Microsoft for Windows, Release 6.11, TS 020, SAS Institute, Inc. USA.
- Uysal, I. and A. Alpbaz, 2002. Food intake and feed conversion ratios in Abant Trout (*Salmo trutta abanticus* T., 1954) and rainbow trout (*Oncorhynchus mykiss* W., 1792) in pond culture. *Turk. J. Biol.*, 26: 83-88.
- Yanik, T. and M.S. Aras, 1994. Comparison between some traits of eggs stripped from Erzurum and Van rainbow trout (*Oncorhynchus mykiss*) broodstock strains. *J. Agric. College at Atatürk University*, 25 (4): 599-608.
- Yanik, T., H.S. Aras and C. Bölükbaşı, 2002. Early development and growth of arctic charr (*Salvelinus alpinus*) and rainbow trout (*Oncorhynchus mykiss*) at a low water temperature. *The Israeli J. Aquacult. Bamidgeh*, 54 (2): 73-78.
- Vøllestad, L.A. and T. Lillehammer, 2000. Individual variation in early life-history traits in brown trout. *Ecol. Freshwater Fish*, 9: 242-247.