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Survival and Development After Incubating and Hatching of Rainbow Trout (*Oncorhynchus mykiss*) Larvae in Two Different Farming Systems

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Abstract. Given that the market demand for food is growing, aspect correlated with climatic changes more pronounced in the last decade, the growth technologies in fish farms it adapt, trying as much as possible to exclude environmental factors from the production equation. This is possible by maintaining constant physicochemical characteristics of water, artificially, using recirculating systems. Because some of the most important stages of the technological growth of trout are incubation, hatching and post-embryonic development, in this study we want to evaluate the obtained performance in two different growth systems: a classical system for incubation and post-embryonic development, respectively a recirculating system. Taken in the study two groups of 10.000 trout eggs each, with common origins, were studied and monitored: physico-chemical characteristics of the water in the two systems, losses during incubation, hatching rate, survival rate, duration of incubation and growth dynamics during post-embryonic stage. The results showed favorable and approximately constant values of the physico-chemical parameters in recirculating water system, while in the classical system were major variations. Also, the results for the other proposed objectives were favorable for the exploited group in recirculating system. This reflects the importance of recirculating systems using, at least in the early stages of the technological process.

Keywords: rainbow trout, eggs, larvae, incubation, pre-development

INTRODUCTION

Final production and economic efficiency of trout farms depend largely on the obtained performances during incubation and post-embryonic development (Karabulut *et al.*, 2010) of the biological material. There are a number of factors that can influence the performance, as well: genetic heritage of species, environmental conditions, diet (Kenari and Mirzakhani, 2005), stress and disease management (Mohapatra *et al.*, 2013) etc. From the perspective of climate change that occurred lately (Roque d'Orbcastel *et al.*, 2009), appears an increasingly and acute need for artificiality of the environment, as is case for incubators in the recirculating system (Krejszeff *et al.*, 2010). In this way can be avoided the permanent fluctuations of main environmental factors that influence processes of fertilization, embryonic and post-embyonic development: temperature, dissolved oxygen, pH of the water, nitrite, nitrate, ammonia, hydrogen sulfide, light intensity and other ones (Ciuhandu *et al.*, 2007; Gräns, 2012; Razeaei and Nateghi, 2013; Sternecker *et al.*, 2012). Keeping these parameters within the limits of biological comfort of fish, it can be obtain higher production performance, with evident economic benefits. Even if the recirculating systems have disadvantage of consuming much energy on the entire production cycle, their advantage is derived from shortening the time to obtain the final production (Martins *et al.*, 2010). It is even possible to

obtain two stages of the production in the same period of time, in which, in a classical system can be obtained one single cycle. Also in recirculating systems used in aquaculture, is declining much feed intake, by obtaining a favorable conversion (Mahmoodzadeh *et al*., 2013; Bailey and Alanärä, 2006).

MATERIALS AND METHODS

The biological material has been originating from Fiad-Telcișor Salmonid Nursery Complex, Bistrița-Năsăud County, having common origins. The two groups were made up of 10.000 of embryonated rainbow trout eggs each (maximum capacity of a incubator). First group (control group-M) was incubated in Telcișor station (a classical system), and the second group (experimental group-E), was incubated in a recirculating system arranged in Cluj-Napoca City, using drilling groundwater. Were evaluated and monitored: physico-chemical characteristics of water, incubation period, survival rate, growth performance and feed consumption. The duration of the study was 80 days after artificial fertilization. The administered feed was Aller Futura EX MP type, with the following specifications (*Tab. 1*).

Tab. 1

The chemical composition of the administered feed after hatching of rainbow trout larvae – Aller Futura EX MP

Specification	0.2 mm	0.4 mm	0.7 mm	1 mm
Crude protein %	60	60	60	60
Crude fat %	17	17	17	17
NFE %	5.3	5.3	5.3	5.3
Ash %	10.5	10.5	10.5	10.5
Fiber %	0.5	0.5	0.5	0.5
Gross energy Kcal/MJ	5234/21.9	5234/21.9	5234/21.9	5234/21.9
Convertible energy Kcal/MJ	4179/17.5	4179/17.5	4179/17.5	4179/17.5

Feeding was done manually, following the manufacturer's instructions, as shown in the following table (*Tab. 2*)

Tab. 2

Feeding table of Aller Futura EX MP

Length (cm)	Weight (g)	Granulation (mm)	Temperature ^{o}C								
			2	4	6	8	10	12	14	16	18
2–3	0.1–0.3	0.4	1.4-1.0	2.5-1.9	3.4-3.0	4.0-3.7	4.3-4.2	4.5-4.4	4.6-4.5	4.6-4.6	4.5-4.4
2.8–4.5	0.2–0.5	0.7	1.0-0.7	1.8-1.2	2.2-1.9	2.6-2.4	2.9-2.8	3.0-2.9	3.1-3.0	3.1-3.1	3.0-2.9
4-7	0.4–3.0	1.0	0.7-0.5	1.2-0.9	1.7-1.5	2.0-1.9	2.2-2.1	2.3-2.2	2.4-2.3	2.4-2.4	2.3-2.2

Note: kg feed/100 kg fish/day

RESULTS AND DISCUSSIONS

The physico-chemical characteristics of water in the two systems, showed wide variations in temperature at the Telcișor Salmonid Nursery Complex (3.5–8.0^{o}C), while in the recirculating system from Cluj-Napoca, these values have been relatively constant (8.8-10.6^{o}C) (*Fig. 1*). That fact influenced the incubation period –42 day for group M, respectively 29 day for group E, and survival and hatching rate at the end: 78%-group M, 93%-group E. The wide variation in temperature also influenced differently post-embryonic development of rainbow trout larvae, giving them at 10 days after hatching a body weight of 0.08±0.001 g (M group) vs. 0.10±0.001 g (E group), respectively a total length of 16.77±0.182 mm (M group) vs. 18.21±0.093 mm (E group). The same situation was reported at 20 days after hatching, the

larvae presenting a body weight of 0.11±0.001 g (M group) vs. 0.14±0.002 g (E group), and a total length of 20.93±0.096 mm (M group) vs. 25.11±0.085 mm (group E).

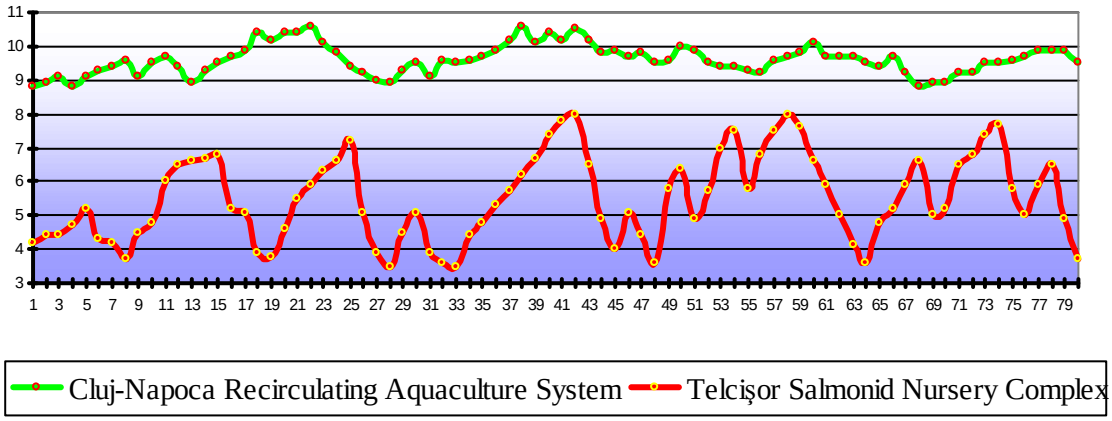

Fig. 1. Variation of the temperature in both experimental location

Because it is in inverse relationship with temperature, dissolved oxygen also showed variations in both stations, but its values were in accordance with the biological requirements of larvae (*Fig. 2*).

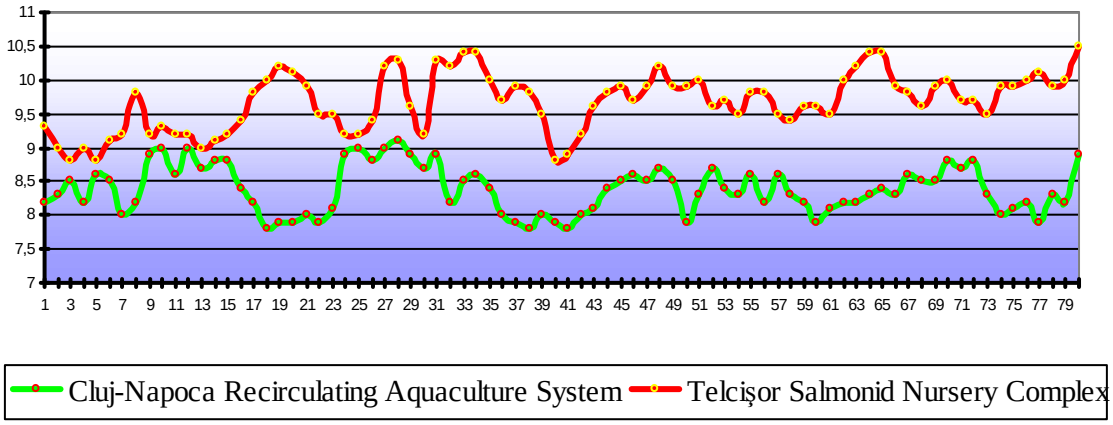

Fig. 2. Daily values of dissolved oxygen in the two hatcheries

As can be seen in *Figure 2*, in the recirculating system from Cluj-Napoca, the values of dissolved oxygen were lower, compared with Telcişor hatchery station, but even in these conditions the embryonated eggs of rainbow trout have appropriately evolved. Differences between the two groups, resulting in the duration of incubation (42 day–M group, vs. 29 day–E group), being necessary the accumulation of degree days, specific for this species (285–350 degree days) (Jokumsen and Svendsen, 2010), respectively in survival rate after incubation (78%-M group, vs. 93%-E group). The losses during the incubation period are presented in *Table 3*, for both systems. As can be seen, in the first week, the losses of the M group have been by 286 eggs, representing 2.86% from the initial number of eggs. In the same week, the losses of the E group was 113 eggs, representing 1.13% from the initial number of eggs. In the second week of incubation, the losses were 796 eggs in the M group, representing 7.96% from the initial number of eggs, vs. 382 eggs in E group (3.82% from the initial number of eggs). During the third week, the losses in M group have been by 583 eggs (5.83% from

initial number of eggs), respectively 164 eggs in E group (1.64% from initial number of eggs). In the fourth week, the losses were 442 eggs in M group (4.42% from the initial number of eggs), respectively 33 eggs in E group (0.33% from the initial number of eggs). In the fifth week, the losses were 76 eggs in the M group (0.76% from initial number of eggs), respectively 8 eggs in E group (0.08% from the initial number of eggs). Should be noted that in this week, have hatched the larvae in group E, while the group M the incubation was extended by 13 days. Losses for the M group in the last period of incubation were by 17 eggs (0.17% from initial number of eggs).

Tab. 3

The losses during incubation in both systems

Group	ine	The weekly losses during incubation (numarically)						fne
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	
M	10.000	286	796	583	442	76	17	2200
E	10.000	113	382	164	33	8	-	700
Group	ine	The weekly losses during incubation (%)						fne
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	
M	10.000	2.86	7.96	5.83	4.42	0.76	0.17	22.00
E	10.000	1.13	3.82	1.64	0.33	0.08	-	7.00

Note: ine-initial number of rainbow trout eggs (before incubation);
fne-final number of rainbow trout eggs (after incubation).

In the following photo collage are presenting some aspects during the fertilization and incubation of rainbow trout eggs, in both systems (*Fig. 3*).

Fig. 3. Some aspects during the incubation of rainbow trout eggs: a–eggs fertilization;
b-placing eggs in incubators; c–dead eggs elimination; d–rainbow trout larvae

As can be seen in *Tables 4* and *5* wide variations of environmental parameters of the classical system, have led to obtaining lower performance of production compared with the recirculating system. An important role in this situation was the low temperature that affected

negative the embryonal and post-embryonic metabolism, respectively, growth dynamics. Statistically, differences between phenotypic characters analyzed were very significant and in favor of E group, excepting Hl (head length) of larvae at 10 days of age.

Tab. 4

Differences and their statistical significance between average values of the main phenotypic characters of 10 days larvae, from both system

Specification	Group	n	Variables			
			X ± sx	V%	Semnif.	Difference
Bw (gr)	M	20	0.08 ± 0.001	10.48	p<0.001	0.020 ooo
	E		0.10 ± 0.001	9.45		
Tl (mm)	M	20	16.77 ± 0.182	10.87	p<0.001	2.050 ooo
	E		18.82 ± 0.166	6.72		
H (mm)	M	20	4.52 ± 0.057	12.52	p<0.001	1.920 ooo
	E		6.44 ± 0.062	9.62		
Bd (mm)	M	20	1.63 ± 0.020	12.26	p<0.001	0.220 ooo
	E		1.85 ± 0.192	11.32		
P (mm)	M	20	10.22 ± 0.128	12.53	p<0.001	1.800 ooo
	E		12.02 ± 0.121	10.51		
Hl (mm)	M	20	3.81 ± 0.031	8.21	p<0.001	0.050 ***
	E		3.76 ± 0.029	9.32		

Note: Bw-body weight; Tl-total length; H-Maximum height; Bd-body depth; P-great perimeter; Hl-head length.

Tab. 5

Differences and their statistical significance between average values of the main phenotypic characters of 20 days larvae, from both system

Specification	Group	n	Variables			
			X ± sx	V%	Significance	Difference
Bw (gr)	M	20	0.11 ± 0.001	9.49	p<0.001	0.030 ooo
	E		0.14 ± 0.001	9.32		
Tl (mm)	M	20	20.93 ± 0.096	4.59	p<0.001	2.920 ooo
	E		23.85 ± 0.121	5.44		
H (mm)	M	20	4.11 ± 0.031	7.51	p<0.001	0.670 ooo
	E		4.78 ± 0.044	6.98		
Bd (mm)	M	20	2.49 ± 0.014	5.74	p<0.001	0.270 ooo
	E		2.76 ± 0.016	6.32		
P (mm)	M	20	9.28 ± 0.070	7.52	p<0.001	0.740 ooo
	E		10.02 ± 0.122	9.63		
Hl (mm)	M	20	5.17 ± 0.032	6.17	p<0.001	0.110 ooo
	E		5.28 ± 0.091	8.36		

Note: Bw-body weight; Tl-total length; H-Maximum height; Bd-body depth; P-great perimeter; Hl-head length

CONCLUSION

The high variation of physical-chemical parameters of water negatively influences incubation duration and the post embryonic stage, also leading to a low rate of survival. To obtain higher performance, we recommend the use of groundwater and the recirculating technologies. In this way (using groundwater and recirculating technologies) can be maintained the optimum values of environmental factors and the physico-chemical characteristics of water in accordance with the biological requirements of fish.

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