Reproductive Indices of Rainbow Trout *(Oncorhynchus mykiss)* Females from a Trout Farm

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Abstract

Rainbow Trout (*Oncorhynchus mykiss*) breeding females have been studied from the standpoint of phenotypic characteristics and breeding indices for establishing future protocols of selection and improvement. The relative fecundation (RF) has been determined to a medium value of 335.88 ± 17.723 g and a variability coefficient of 52.77%. The high value of the variability coefficient is due to the fact that this is the first breeding generation of trout nursery and has not been submitted to any selection and improvement activities up to the present. From the breeding performance standpoint, the medium value of the number of eggs (TNE) obtained has been of 8127.44 ± 478.532, the medium egg weight (EW) has been of 0.06 ± 0.001g, the medium diameter of one egg (ED) = 4.16 ± 0.029 mm and the medium volume of one egg (EV) has been of 65.63 ± 1.223 mm3. The following breeding indices have also been calculated: gonadosomatic report (GR), Behning fertilizing coefficient (BFC) and the Williams absolute fecundity indices (WAFI). The outcome results have been the following: GR = 14.82 ± 0.587; BFC = 16.82 ± 0.563; WAFI = 5.77 ± 0.333. The values of the correlations point out the necessity of breeding selection work in order to improve the breeding performances.

Keywords: *Rainbow Trout, improvement, breeding selection.*

INTRODUCTION

Rainbow Trout (*Oncorhynchus mykiss*) is one of the most raised species of the Salmonidae family, due to its adaptive abilities to the intensive growing system (Bud *et al*., 2007). In Romania there are few salmonid units where rainbow trout is artificially bred, due to this fact it is necessary to streamline their technological and economic activities based on a selection-broodstock programme (Cocan *et al*., 2013).

Breeding is one of the most important aspects of the technological growing flow in a Salmonid unit, being influenced by factors such as genetics, environmental conditions, and nutrition (Kausea *et al*., 2005). Broodstock production is influenced by age, weight and conformation (Kayam, 2004). Their quality is directly reflected on offspring survival rate, growth performance and resistance to disease. Thus the breeding stock requires selection methods for a rigorous selection (Mireşan *et al*., 2013).

Selection methods for improving the breeders can use correlations between phenotypic characters and breeding indices to obtain valuable batches of breeding However correlations between breeding indices and somatic characteristics are few in scientific literature (Cocan *et al*., 2013).Therefore the aim of this study was to select the breeding females based on individual performance for obtaining batches of breeders with superior performance, above average and to correlate the reproductive indices with morpho-productive measurements for improving and selection of the future female breeding stock.

MATERIALS AND METHODS

This study was performed in February 2015, on the first breeding generation of the fishery. Reproduction performances were determined on 16 randomly selected rainbow trout (*Oncorhynchus mykiss*) female breeding stock (Ibw-initial body weight; Fbw-final body weight; RF –relative fecundity; TNE - eggs total number; Ew-eggs weight; Ed-eggs diameter; Ev-eggs volume) necessary and useful for calculating the reproduction indices: GR - gonadosomatic report, BFC - Behning fertilizing coefficient and the WAFI - Williams absolute fecundity indices (Turliu, 2008).

Reproductive indices were calculated after the following formulas:

$$\text{Gonadosomatic report} = \frac{ovary\ weight \times 100}{body\ weight}$$

$$\text{Behning fertilizing coefficient} = \frac{body\ length \times 100}{total\ number\ of\ eggs}$$

$$\text{Williams absolute fecundity indices} = \frac{gonadosomatic\ report \times body\ weight}{the\ average\ weight\ of\ an\ egg \times 100}$$

The purpose of the study was to test whether there is are any phenotypic correlations between somatic characteristics and breeding characteristics, so that in the future, selection for improved reproductive performance can be done based on one of two phenotypic correlated characteristics.

Afterwards, the existing correlations between the studied somatic characteristics: (Bw -body weight, Tl - total length, Sl - standard length, Cl - commercial length, MH - maximum height, Mh - minimum height, Bd - body depth, Hl - head length, Cpl - caudal peduncle length) and the reproduction indices previously mentioned shows close links between somatic characters and reproductive indices.

Nutrition as well is an important factor for reproductive performance, therefore the female breeding stock were fed according to the requirements (Tab. 1) starting with the first stage of growth. All data was statistically analysed with add - In Data analysis from Microsoft Excel. Correlations were performed with Pearson Correlation.

RESULTS AND DISCUSSION

The breeding rainbow trout (*Oncorhynchus mykiss*) females aged 3 years from fishery, have been studied for both production performance and reproduction indices.

Based on the samples and weighing before and after spawning, the relative fecundity (RF) has been determined to a value of 335.88 ± 17.723 g with a variability coefficient of 52.77%. The high variability coefficient is due to the fact that this was the first breeding generation in the fishery obtained from own nursery without being subjected to selection and improvement activities. (Tab. 2)

The total number of eggs (TNE) and egg diameter (Ed) are the most frequently used criteria in production, as the increase in broodstock weight directly influences the increase in the number and diameter of eggs (Bromage and Cumaranatunge, 1988).

The total number of eggs (TNE) value was 8127.44 ± 478.532, higher than that obtained by Kayam, (2004) but with greater variability coefficient, of 58.88%, therefore for the future reproduction nucleus, we will choose those

Tab. 1. Composition and nutritive value of the administered fodder

Issue	Fodder Type		
	Aqua Dynamic 2 mm	Aqua Dynamic 3 mm	Aqua Dynamic 4/6 mm
Crude protein %	43	41	40
Crude fat %	20	21	22
Cellulose %	2.0	2.2	2.2
Phosphorus %	1.20	1.30	1.35
Vitamin A (UI/kg)	10.000	10000	10000
Vitamin D3 (UI/kg)	1500	1500	1500
Vitamin E (mg/kg)	200	200	200
Convertible energy (Kcal/MJ)	20.0	19.8	20.0

individuals that produce the richest spawn. Also some of the most important factors that affect egg production at rainbow trout *(Oncorhynchus mykiss)* are consanguinity among breeding stock, age and weight, quality of feed and water quality (Billard, 1990; Bromage *et al*., 1992, Ozgur and Bayir, 2013).

In the present study, we found that the egg weight (Ew) was 0.06 ± 0.001 g, and the egg diameter (Ed) was 4.16 ± 0.029 mm, while for the egg diameter, Özgür and Bayir (2013) obtained 5.58 ± 0.18 mm at four year old female broodstocks, and for the same age, Kocaman *et al*. (2009) obtained almost the same value (5.33 ± 0.10). From this data, we can conclude that the number and diameter of eggs increase with the age of broodstocks.

The following reproduction indices: GR - gonadosomatic report, BFC - Behning fertilizing coefficient and the WAFI – Williams absolute fecundity indices have also been calculated.

The egg volume (Ev) was 65.63 ± 1.223 mm^3. Also the gonadosomatic report (GR) presented values of 14.82 ± 0.587 lower than the one obtained by Mireşan *et al*. (2013) of 15.218 ± 0.438 on 4 year-old females, and Bud *et al*., (2009) of 22.54 ± 1.13; therefore we concluded that for the future breeding stock only the females who have the greater gonadosomatic report (GR) will be selected. As other authors mentioned the breeding performance of rainbow trout and others trout females species increase with the age, reaching maximum performance at 6-8 years (Cocan *et al*., 2013; Rahbar*et al*., 2011). The batch of studied female in this paper was three years old, at the beginning of reproductive period.

Behning fertilizing coefficient (BFC) was 16.82 ± 0.563 with a variability of 33.48%; the increasing values of Behning coefficient indicate a gradual and proportional increase of total number eggs (TNE) simultaneously with age (Mireşan *et al*., 2013). Also Williams absolute fecundity (WAFI) is directly proportional with the females' age and recorded a value of 5.77 ± 0.333, higher than 4.278±0.279 found by Mireşan *et al*.(2013) at the same female age.

Gonadosomatic report (GR) presented strong and positive correlation (r = 0.621) with maximum height (MH) and initial body weight (Ibw), where the correlation value was 0.415, lower than that obtained by Cocan *et al*. (2013) at the same female age. The values of the correlation coefficients indicate that the selection can be performed for the improvement of the characteristic for which the higher correlation value was found.

Also Gonadosomatic report (GR) presented a negative correlation for total length (Tl) (r =-0.116) lower than that obtained by Cocan *et al*. (2013) (r = – 0.027), who point out that along with the increase of total length (Tl) the values of coefficients and indices of selection and breeding are decreasing.

Behning fertilizing coefficient (BFC) presented positive value for total length (Tl) (r =0.264), a value higher than that found by Cocan *et al*. (2013) (r = 0.130), and negative correlation between BFC and the initial body weight (r = -0.258).

Williams absolute fecundity index (WAFI) presented strong and positive value for maximum height (r = 0.635) and initial body weight (r = 0.562), lower than that obtained by Cocan*et al*. (2013) (0.953); The values of the correlation coefficients indicate that the selection can be performed for the improvement of the characteristic in female breeders for which the higher correlation value was found, between maximum height and initial body weight. Also negative correlations were obtained for total length (Tl) (r = -0.054), as

Tab. 2. The mean values of meristic and gravimetric measurement of rainbow trout (*Oncorhynchus mykiss*) female at age of three years.

Sp.	Ibw/g		Fbw/g		RF/g		TNE		Ew/g		Ed (mm)		Ev (mm^3)		GR		BFC		WAFI	
X±sx	2208.38±37.48		1872.5±29.556		335.88±17.723		8127.44±478.532		0.06±0.001		4.16±0.029		65.63±1.223		14.82±0.587		16.82±0.563		5.77±0.333	
V%	16.97		15.78		52.77		58.88		16.76		7.02		18.64		39.58		33.48		57.67	
S	374.795		295.562		177.233		4785.321		0.010		0.292		12.230		5.867		5.631		3.327	
Range	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
	1705	2825	1510	3475	130	900	3513	24324	0.04	0.08	3.68	4.51	40	80	7.49	31.86	6.13	27.16	2.88	17.19

(Ibw) initial body weight, (Fbw) final body weight; (RF) relative fecundity, (TNE) eggs total number, (Ew) eggs weight, (Ed) eggs diameter, (Ev) eggs volume, (GR) gonosomatic report, (BFC) Behning fertilizing coefficient (WAFI) Williams absolute fecundity indices.

Tab. 3. Phenotypic correlation coefficient values of the morphological reproductive performance at rainbow trout (*Oncorhynchus mykiss*).

Specif.	Fbw	RF	TNE	Ew	Ed	Ev	GR	BFC	WAFI
Ibw	0.887	0.636	0.593	0.288	0.230	0.092	0.415	-0.258	0.562
Tl	0.350	0.018	-0.012	0.194	0.141	-0.136	-0.116	0.264	-0.054
Sl	0.379	0.101	0.060	0.318	0.252	-0.020	-0.027	0.165	-0.002
Cl	0.454	0.070	0.030	0.334	0.242	0.045	-0.061	0.148	-0.312
MH	0.585	0.752	0.696	0.450	0.294	0.275	0.621	-0.510	0.635
Mh	0.578	0.104	0.070	0.282	0.362	-0.087	-0.048	0.094	0.033
Bd	0.520	0.579	0.583	0.152	-0.0002	0.247	0.432	-0.331	0.559
HL	0.416	0.067	0.015	0.430	0.412	0.336	-0.020	0.080	-0.045
CpL	-0.095	0.162	0.152	-0.085	-0.060	0.021	0.137	0.001	0.158

(Ibw) initial body weight, (Fbw) final body weight; (RF) relative fecundity, (TNE) eggs total number, (Ew) eggs weight, (Ed) eggs diameter, (Ev) eggs volume, (GR) gonosomatic report, (BFC) Behning fertilizing coefficient (WAFI) Williams absolute fecundity indices, (Tl) total length, (Sl) standard length, (Cl) commercial length, (MH) maximum height, (Mh) minimum height, (Bd) body depth, (HL) head length, (CpL) caudal peduncle length.

opposed to the positive correlation obtained by Cocan *et al*. (2013) (r = 0.162), showing again the necessity of further analysis to obtain accurate results.

Strong and positive correlations were obtained for the following characteristics: between final body weight (Fbw) and initial body weight (Ibw) (r = 0.887); as expected, relative fecundity (RF) and maximum height (MH) (r = 0.752); as well as between total number eggs (TNE) and maximum height (MH) (r = 0.696).

In conclusion, the present correlations are useful for selection of the future female breeders starting with the first year of reproduction for obtaining of the quantitatively and qualitatively best egg production, for the entire optimal reproduction age range.

CONCLUSION

The resulting values of the correlations show strong interdependencies between morpho-productive measurements and reproduction indices of fertility; therefore in the breeding stock we must take into account to select the females who show the greatest value for initial body weight to increase the total number eggs (TNE), eggs weight (Ew) and reproduction indice performances. This study can contribute to increasing fish production and reproduction performance in Romanian rainbow trout fisheries.

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REFERENCES:

1. Billard R, (1990). Culture of salmonids in fresh water. In: G. Barnabé Ed. Aquaculture. vol. 2, Ellis Harwood Limited, London, 549592.
2. Bromage N, Cumaranatunge PRC, (1988). Egg Production in the Rainbow Trout. In RJ, Roberts JF, Muir Eds. Recent Advances in Aquaculture. Vol. 3, Croom Helm, London, 65-137.
3. Bromage N, Jones J, Randall C, Thrush M, Davies B, Springate J, Duston J, Barker G, (1992). Broodstock Management, Fecundity, Egg Quality and Timing of Egg Production in the Rainbow Trout (Oncorhynchus mykiss), Aquaculture, 100: 141-166.
4. Bud I, Boaru A, Petrescu-Mag V (2009). Influence of food and age on breeding and reproductive performances in a rainbow trout population. AACL Bioflux 2(2):239-247.
5. Bud I, Ionescu O, Vlădău V, Pop S (2007). Peştii din apelereci. Păstrăvii. Ed. Risoprint Cluj-Napoca.
6. Cocan D, Mireşan V, Constantinescu R, Răducu C, Ihuţ A, (2013). Correlation between Age and Fertility Indices of Rainbow Trout *(Oncorhynchus mykiss)* Females. Bulletin UASVM Animal Science and Biotechnologies 70 (1): 199-200.
7. Kausea A, Ritolab O, PaananenbT,Wahlroosa H, Mäntysaaria EA, (2005). Genetic trends in growth, sexual maturity and skeletal deformations, and rate of inbreeding in a breeding program for rainbow trout (*Oncorhynchus mykiss*). Aquaculture,247: 177–187.
8. Kayam S,(2004) The Effect of Mating Different Age Groups of Broodstocks on the Reproductive performance, Sex Ratio, Growth, and Survival bate of Rainbow Trout (Oncorhynchus mykiss), Journal of Freshwater Ecology, 19 (4): 695-699.

9. Kocaman EM, Bayir A, Sirkecioglu AH, Bayir M, Yanik T, Arslan H, (2009). Comparison of Hatchery Performances of Rainbow Trout (*Oncorhynchus mykiss*) Brown Trout (Salmo truttafario) and Brook Trout (Salvelinusfontinalis) under the Same Enviromental Conditions. Journal of Animal and Veterinary Advances 8 (7) : 1429_1431.
10. Mireşan V, Cocan D, Răducu C, Constantinescu R, Ihuţ A, (2013). Female Fertility Curve of Rainbow Trout (*Oncorhynchus mykiss*) by Different Ages. Bulletin UASVM Animal Science and Biotechnologies 70 (1), 15-18
11. Özgür ME, Bayir İ., (2013). A Research on Reproduction Performance for Broodstocks of Rainbow Trout in A Fish Farm. BiyolojiBilimleriAraştırmaDergisi 6 (2): 01-07.
12. Rahbar M, Nezami Sh, Khara H, Rezvani M, Khodadoust A, Movahed R, Eslami S, (2011). Effect of age on reproductive performance in female Caspian brown trout (Salmo trutta caspious, Kessler 1877) Caspian Caspian Journal of Environmental Sciences 9 (1):97-103.
13. Turliu, GN. (2008). Piscicultura practică. Ed. Ceres, Bucuresti, 248-252.