RESULTS ON THE PATTERNS OF GROWTH AND MORPHO-PRODUCTIVE INDICES OF RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) REARED IN TWO DIFFERENT SYSTEMS

D. Cocan, Vioara Mireşan, Camelia Răducu

University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca,
Faculty of Animal Science and Biotechnology, Romania
e-mail:cocandaniel@yahoo.com; vmiresan@yahoo.com

Abstract

The purpose of this study was highlighting reared systems on growth rhythm and morpho-productive indices in rainbow trout (Oncorhynchus mykiss). The biological material was represented by a rainbow trout population, divided into two groups of 400 individuals per groups. The first group was exploited in a classic growth system (Fiad trout farm, Bistrița-Năsăud county), and the second group was exploited in a recirculating system. Initial average weight was 22.69±0.65 g for group exploited in recirculating system, and 22.71±0.25 g for the group exploited in the classical system. At the end of the study, average weight of trout exploited from the recirculating system was 317.78±9.39 g, respectively 102.28±2.56 g for trout of classical system. Feed used during the study was the same for both groups. It was found that the recirculating system is advantageous in terms of growth rhythm and morpho-productive indices, because at the end of the study, trouts have reached the market weight required. The morpho-productive indices studied were: slaughter yield, the share of the body components, the carcass meat yield and the percentage distribution of meat, depending on the considered anatomically segment.

Key words: rainbow trout, farming systems, growth dynamics, bioproduct indices

INTRODUCTION

Among the animal products, the meat is a great food resource, to which the consumer preference and tastes were and still growing. Due to the high biological value of proteins, lipids and minerals, attributes that can be added the special dietary and suitability for a wide variety of dishes, fish meat are much appreciated. To obtain the fish meat at effective economic and technical parameters, is necessary a technique for accurate assessment of meat and a knowledge of biochemical processes that characterizes. Fish meat production capacity depends on the species considered its own, by the quantity and quality of feed given, by the environmental conditions and the rearing technology. The productive capacity and the economic efficiency, also depend on the anatomical and morphological characteristics of the species and some physiological features and microstructure.

Rainbow trout (*Oncorhynchus mykiss*) is found in the most trout farms from Romania, due to the adaptability at intensive farming conditions. Rainbow trout is a much more resistant species than other salmonid species, in terms of medial parameters. It is a less demanding species at the level of dissolved oxygen in the water [14] and supports well the temperature variations [6]. Also, stand well in waters with a high suspension levels, but not for long periods and only if they are assured a high water flow [9]. On the strength of these qualities, but also thanks to the particular organoleptic characteristics of meat, the rainbow trout is much appreciated by consumers. The literature deals extensively aspects about meat quality of rainbow trout and the slaughter yields, depending on several factors such as feeding structure [7], season, body size [4], or fish age [3]. Has not yet been studied the recirculating systems influence on bioproduct indices, because that technology of trout rearing, is a relatively recent.

In this study, we aimed to determine the growth and development dynamics of rainbow trout (*Oncorhynchus mykiss*), rearing in two different farming systems. We also studied the morpho-productive indices of the two lots of trout: slaughter yield, the share of the body components, the carcass meat yield and the percentage distribution of meat, depending on the considered anatomically segment.

MATERIAL AND METHOD

Two groups were constituted of 400 samples of rainbow trout (*Oncorhynchus mykiss*). First lot has been rearing in the Fiad-Telcişor salmonid complex, Bistriţa-Năsăud county, and the second lot has been rearing in a recirculating system. The Fiad-Telcişor salmonids complex was established in two phases. Fiad trout farm was established in 1983, and in 1993 was inaugurated the breeding and hatching station from Telcişor. Today, the Fiad-Telcişor salmonids complex are subordinated to the National Forest Company, and belongs to Wine Waley Forestry, Bistriţa-Năsăud county.

Recirculating experimental system was developed in a hall covered with double reflective foil. Hall walls were insulated with polystyrene and reinforcement mesh, and externally was applied an hydrophobic material. Tank culture was made of reinforced concrete and painted with special rubber paint for swimming pools, in a light blue color. Basin shape was oval (lenght 2.5 m, width 2.2 m), with a depth of 1.1 m, net volume of water being $4m^3$. Centrally located drain trap diameter was 110 mm. Recirculation pumps and water supply were as BGP Budget 2800 (water flow 1.8 m^3/h) and GJ 750 (water flow 2.8 m^3/h). Source of water used was groundwater. To ensure the necessary dissolved oxygen, we used two air pumps, type Resun ACO 003 (65 l/min), respectively Boyu ACQ 001 (35 l/min). Water filter used had a useful volume of 180 liters, filter provided with three compartments and semicircular sponge filter with a thickness of 12 cm. Water filtration has been gravitationally, to minimize as much is possible the energy consumption, because in a recirculating system the energy cost is very important [5]. Feeds used according to the age of group were Aller Performa 2 mm, Aller 45/15 XS 3 mm and Aller 45/15 XS 4.5 mm (table 1).

Table 1 The chemical composition of feed used during the study

Specification	Feed type		
	Aller Performa 2 mm for 5-6 months age	Aller 45/15 XS 3 mm for 6-8 months age	Aller 45/15 XS 4,5 mm for 8-12 months age
Crude protein %	45	45	45
Crude fat %	20	15	15
SEN %	16	21	21
Ash %	8	8	8
Fiber %	2	2.5	2.5
Gross energy (Kcal/MJ)	5171/21.6	4924/20.5	4924/20.5
Convertible energy (Kcal/MJ)	4145/17.3	3887/16.2	3887/16.2
Vitamin A (UI)	3750	2500	2500
Vitamin D3 (UI)	750	500	500
Vitamin E (mg)	225	150	150

To determine the growth dynamics, the total gain and the average daily gain, were made gravimetrics and meristics measurement in every month of the experiment, being studied in a randomized mode, with 100 specimens from each batch. For determination of bioproduct indices, were slaughter by 20 trout from each batch, also randomly chosen from breeding ponds.

RESULTS AND DISCUSSION

Growth and development of trout requires knowing the minimum and maximum values of environmental parameters, specific to the exploited species. Between these limits, is

highlighted the comfort conditions, when the intensity of physiological processes, expressed through growth and development, recorded the highest level. In accordance with previously stated, growth dynamics of rainbow trout (*Oncorhynchus mykiss*) exploited in the two systems, presented different values (table 2). Considered indices for evaluating the growth dynamics is total gain and average daily gain. Analyzing the two indices track overall (total gain and average daily gain), we can conclude that during the 240 days of study, total gain for the lot of recirculating system was 295.09 g., and average daily gain was 1.23 g/day. Values are significantly higher to those obtained in Fiad Tout Farm (79.57 g for total gain and 0.33 g/day for average daily gain). The two groups studied were part of the same population, with no genetic differences and feed use and feeding rate was identical. Explanation of the extremely large differences in the growth dynamics between the two groups, can be made only on account of two factors: environmental conditions (table 3) and food intake, in turn influenced by environmental factors and rearing technology adopted. In this regard, however, values found in the literature differ greatly, being influenced of several factors: environmental condition characteristic of various salmonid farms, construction method adopted, feed and feeding frequency [12] last but not least, by the genetic heritage of fishes [15]. Thus, Popescu [11], stated weight of 100 g for trout a one year old, and 300-450 g at the three years age, while other states are much different authors: 65-100 g at 1.8 years age [10], 250-350 g at two years age [2], or 175 g at 2.2 years age [9]. These differences can also be made on account of improvement methods applied, like transgenesis, induced polyploidy or obtain by monosex populations [8].

Table 2 Growth dynamics of rainbow trout (*Oncorhynchus mykiss*) rearing in the two systems

Nr. crt	Rearing system	Age (months)	Body weight (gr)				Total gain (gr)	Average daily gain (gr)
			Initial		Final			
			X±sx	V%	X±sx	V%		
1	Recirculating system n=100	5	22.69±0.65	28.48	64.31±1.57	24.44	41.62	1.38
2		6	64.31±1.57	24.44	112.89±2.15	19.04	48.58	1.62
3		7	112.89±2.15	19.04	164.51±4.33	26.35	51.62	1.72
4		8	164.51±4.33	26.35	194.73±2.49	12.79	30.22	1.01
5		9	194.73±2.49	12.79	230.23±7.94	34.24	35.50	1.18
6		10	230.32±7.94	34.24	275.58±7.14	25.95	45.26	1.51
7		11	275.58±7.14	25.95	317.78±9.39	29.00	42.20	1.40
8		12	317.78±9.39	29.00	-	-	-	-
Growth dynamics / total study			**22.69±0.65**	**28.48**	**317.78±9.39**	**23.33**	**295.09**	**1.23**
1	Fiad Trout Farm n=100	5	22.71 ± 0.25	26.78	36.20 ± 0.40	11.01	13.49	0.45
2		6	36.20 ± 0.40	11.01	41.22±0.68	19.10	5.02	0.17
3		7	41.22±0.68	19.10	48.06 ± 1.14	23.82	6.84	0.23
4		8	48.06 ± 1.14	23.82	58.53±1.89	22.09	10.47	0.35
5		9	58.53±1.89	22.09	74.85±2.15	21.14	16.32	0.54
6		10	74.85±2.15	21.14	90.13±2.33	23.88	15.28	0.51
7		11	90.13±2.33	23.88	102.28 ± 2.56	25.01	12.15	0.40
8		12	102.28 ± 2.56	25.01	-	-	-	-
Growth dynamics / total study			**22.71 ± 0.25**	**26.78**	**102.28 ± 2.56**	**25.01**	**79.57**	**0.33**

Table 3 Values of main physico-chemical parameters of water in the two rearing systems

Parameter	Locația	UM	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
Temperature	RAS	^{o}C	14.45	15.50	16.25	16.80	16.90	16.30	14.55	13.70
	FTF	^{o}C	6.15	8.40	11.00	17.85	20.75	17.50	8.90	4.10
Dissolved oxygen	RAS	mg O_2/l	9.85	9.80	9.45	9.40	9.40	9.50	9.75	10.10
	FTF	mg O_2/l	9.30	8.95	8.45	7.75	6.75	7.05	7.85	9.05
pH	RAS	-	6.9	6.9	6.8	7.0	6.9	7.0	6.8	6.8
	FTF	-	7.3	7.2	7.1	7.2	7.4	7.3	7.2	7.3

RAS-recirculating aquaculture system
FTF- Fiad Trou Farm

In this study, regarding by the possibilities to rearing rainbow trout (*Oncorhynchus mykiss*) in recirculating systems, we also determined the slaughter yield, a major morpho-productive indices, both for the fish processing industry, both for direct consumer (table 4). To this have been slaughtered by mechanical stunning, by 20 specimens of rainbow trout from each batch. To determine the carcasses weight, were removed only viscera from abdominal cavity, being preserved heads, fins, skin and gills, whereas it is the presentation mode of gutted trout. The gills were preserved because they are direct indicators of the status of fish freshness. Tabular data reflecting the favorable value of the slaughter yeld of trout in recirculating system (90.29%), compared with those of the Fiad Trout Farm (89.22%). The literature mentions different values of this bioproduct indicator (72,33-75,85%) [1], (74,7-85,8%) [4], (56,50-62,40%) [7], but in the most cases, anatomic segments were removed. But these can be found by the trout studied by us.

Table 4 Mean and variability of slaughter yield for rainbow trout (*Oncorhynchus mykiss*) reared in the two systems

Rearing system	n	Initial weight (g)		Carcass weight (g)		Slaughter yield (%)	
		X±sx	V%	X±sx	V%	X±sx	V%
RAS	20	312.48±1.77	5.46	282.15±1.68	5.74	90.29±1.27	4.93
FTF	20	228.34±1.69	5.22	203.73±1.48	5.15	89.22±1.04	4.89

RAS-recirculating aqua system
FTF- Fiad trout farm

It was also determined that the share holders of anatomical segments (viscera, heads, bones, fins, scales and skin) from total weight of trout taken in study (fig. 1,2). Because fish meat processing industry but in the same time and the final consumer, is interested to obtain a large quantity of meat in the carcass, and a smaller share of other anatomical segments (secondary products) [13], we observed favorable results for the recirculating systems group. These results reflect the influence of rearing system on bioproduct indices of rainbow trout (*Oncorhynchus mykiss*).

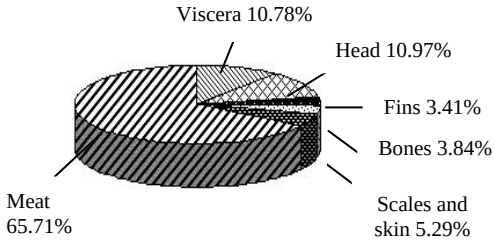

Fig. 1 The share holders of anatomical segments (Fiad trout farm)

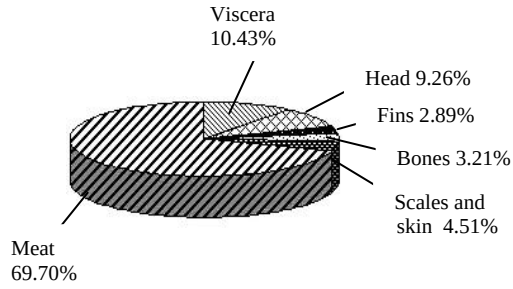

Fig.2 The share holders of anatomical segments (RAS)

Regarding the percentage distribution of meat, depending on the considered anatomically segment (fig.3), there is a higher proportion of dorsal muscle for trout from Fiad trout farm (48.97%), compared with trout from recirculating system (46.17%). This is offset however by abdominal and intercostal muscle weight, which in the case of trout from recirculation system is 43.01%, compared with trout from Fiad trout farm (40.07%). In terms of caudal peduncle muscle weight, there no were significant differences between the two groups (10.96% - Fiad trout farm, respectively 10.82 – recirculating system) (fig. 4,5).

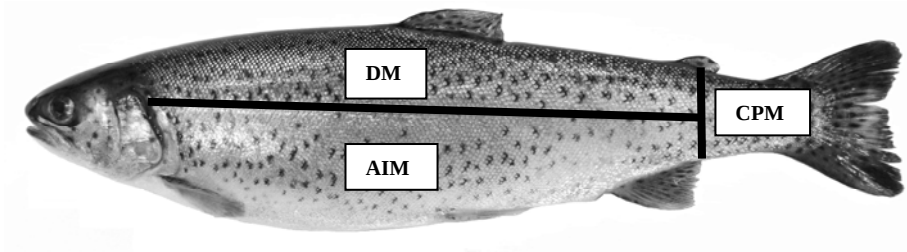

Fig. 3 Distribution of meat depending on the considered anatomically segment
DM – dorsal muscle; AIM – abdominal and intercostal muscle; CPM – caudal peduncle muscle

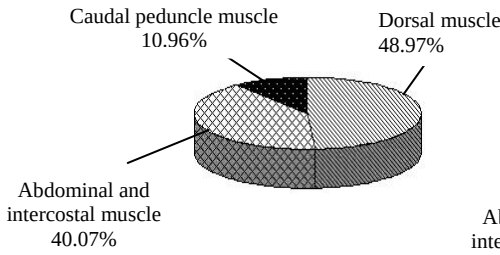

Fig. 4 Percentage distribution of meat (Fiad trout farm)

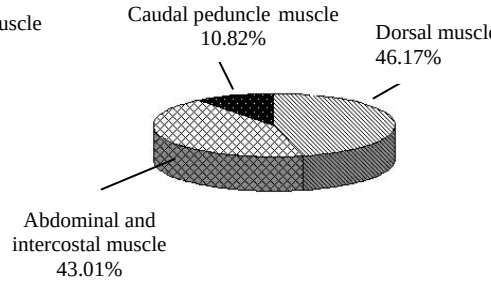

Fig. 5 Percentage distribution of meat (RAS)

These changes of meat weight in carcass depending on the considered anatomically segment, must be attribute to excessive fattening state of trout from the recirculation system. This state of excessive fattening is the result of reduced space for motion from recirculating system and low energy consumption. In this way, the fat reserves were deposited in the abdominal and intercostal muscles.

CONCLUSIONS

The results of this study confirm the possibility of rearing the rainbow trout (*Oncorhynchus mykiss*) in recirculating systems, in terms of ensuring the biological requirements of species. It was found a high growth dynamics compared to that of Fiad trout farm, what you can get more production cycles in one year. Also, while maintaining environmental parameters at the optimal value throughout the year, will be possible to obtain staged productions, in any season, being provided market demand for fresh produce. The state of excessive fattening of trout from recirculating system, is beneficial, because fats from fish being used in the treatment of cardiovascular diseases in human. In this direction are necessary investigation regarding on the structure of these fats, and our future research will address these issue.

ACKNOWLEDGMENT

Thancks Mr. Engineer Ioan Sărmaş, manager from Fiad-Telcişor salmonid complex, for all their support, moral and material, without which this study would have been impossible. Also, thank our colleague Engineer Rareş Ranga, which contributed to the development of recirculating system.

REFERENCES

[1] Akhan S., Ocumuş I., Sonay D. Fatma, Koçak N., Growth, Slaughter, Yield and Proximate Composition of Rainbow Trout (*Oncorhynchus mykiss*) Raised Under Commercial Farming Condition in Black Sea. Kafcas Univ Vet Fak Derg, 2010, 16 (B): 291-296.

[2] Bud I., Ionescu O., Vlădău V.V., Pop S.N., Peştii din apele reci-Păstrăvii. Ed. Risoprint, Cluj-Napoca, 2007.

[3] Bud I., Vlădău V.V., Reka Ştefan, Pop S.N., Ladoşi Daniela, Contributions Concerning the Species and Age Influence on Fish Meat Qualitative Index. Bulletin UASVM Animal Science and Biotechnologies, 2008, 65(1-2): 288-292.

[4] Bugeon J., Lefevre Florence, Cardinal Mireille, Uyanik A., Davenel A., Haffray P., Flesh Quality in Large Rainbow Trout With High or Low Fillet Yield. Journal of Muscle Foods, 2008, 21(4): 702-721.

[5] David P., Pop A., Popovici V., Considerations Upon Energetic Efficiency of a Recirculating Aquatic Systems (RAS) For Super Intensive Fish Culture. AACL Bioflux, 2009, 2(2): 153-159.

[6] Ineno T., Tsuchida S., Kanda M., Watabe S., Thermal Tolerance of a Rainbow Trout (*Oncorhynchus mykiss*) Strain Selected by High-Temperature Breeding. Fisheries Sciences Journal, 2005, 71: 767-775.

[7] Karabulut H.A., Yandi I., Aras N.M., Effects of Different Feed and Temperature Conditions on Growth, Meat Yield, Survival Rate, Feed Conversion Ratio and Condition Factor in Rainbow Trout (*Oncorhynchus mykiss*) Fingerlings. Journal of Animal and Veterinary Advances, 2010, 9(22): 2818-2823.

[8] Oroian T.E., Principii în ameliorarea peştilor. Ed. Risoprint, Cluj-Napoca, 2007.

[9] Păsărin B., Salmonicultura practică. Ed. Alfa, Iaşi, 2007.

[10] Păsărin B., Stan T., Misăilă C., Elemente de salmonicultură. Ed. Karro, Iaşi, 2004.

[11] Popescu A. Sânziana. Cercetări privind structura costurilor şi a veniturilor în ferme ciprinicole, salmonicole şi sturionicole. Teză doctorat, USAMVB Timişoara, 2009.

[12] Rasmussen R.S., Jokumsen A., Digestibility in selected rainbow trout families and relation to growth and feed utilisation. Aquaculture International Journal, 2009, 17: 187-197.

[13] Rønsholdt B., McLean E., Quality Characteristics of Fresh Rainbow Trout as Perceived by the Danish Processing Industry. Aquaculture International, 1999 7: 117-127

[14] Sandblom E., Axelsson M., Effects of Hypoxia on the Venous Circulation in Rainbow Trout (*Oncorhynchus mykiss*), Comparative Biochemistry and Physiology, 2005, 140(2): 233-239.

[15] Vlaic A., Genetica peştilor. Ed. Risoprint, Cluj-Napoca, 2006