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OBSERVATIONS ON GROWTH PERFORMANCES OF RAINBOW CONSUMPTION TROUT

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Abstract

In the present study, the productive performance of the rainbow trout for consumption (one year and a summer trout – P_{1+}, two-year trout –P_2, two-year and one summer trout –P_{2+}) was analyzed, grew up in a fishing unit in south-eastern part of country. At the control fishing made bi-monthly, by weighing 100 fish of each pond and age category, the body weight was assessed, and based on it, the total and daily average gain in growth was established. Also, by sampling, the main body measurements were made and the body indices were calculated for the two summer trout. The primary somatometric data were processed statistically. The one year and a summer trout (P_{1+}) registered a good growth dynamic, resulting in a total average gain in growth of 150 g / fish starting from pond population to the autumn inventory and an average daily gain of 0.83 g / fish. In spring-autumn growth, body weight grew by about 4.33 times (from 45 g / fish in July to 195 g / fish on autumn stock). In the October-March growth period, the two-year rainbow trout (P_2) recorded a total average gain of 138 g / fish and a daily average gain of 0.92 g / fish, and the two-year and one summer trout (P_{2+}) achieved a total average gain of 102 g / fish and a daily average gain of 0.85 g / fish. The economicity of body mass accumulation was good (specific consumption of 1.18-1.20 kg of combined fodder). The main somatometric characteristics of two-year rainbow trout (P_2), demonstrates the proper body development and correctness of the body conformation of this age group, and the low variability coefficients (below 10%) highlight the high homogeneity of trout in pond. The two-summer rainbow trout showed optimal body indices values: fattening index = 1.67%, profile index = 3.61, quality index = 1.63, thickness index = 20.07%, carnosity index = 18.81%.

Key words: *rainbow trout, body weight, growth rate, body dimensions, body indices.*

INTRODUCTION

Salmoniculture occupies an important place in fish farming, position which in Romania is justified both on the environmental conditions favorable for this physiological requirements of salmonids fish (especially trout) and the physico-chemical and organoleptic special properties posed by the meat of the salmonids obtained by converting with maximum efficiency the poor quality food (animal and vegetable flour, slaughterhouse waste etc.).

In fish farms in our country, rainbow trout *(Oncorhynchus mykiss)* is of increasing importance due to its valuable biological and productive characteristics. The rainbow trout displays great adaptability, being less prudent to environmental conditions, tolerating lower oxygen content in water, wide variations in temperature and water transparency. It also shows increased resistance to diseases, intense growth rate and high efficiency of natural biomass and additional food capitalization (Bud et al., 2007).

The growth of rainbow trout in intensive system, enables strictly monitoring of the physico-chemical parameters of the water from the pools, of the feeding and consumption of food, assessment the behavior and general condition (body condition) of the fish and observing signs of illness, aspects leading to increased productivity and profit in a trout farm.

MATERIALS AND METHODS

Research done on a salmonids farm in the south-eastern part of the country aimed the assessment of the productive performances of the rainbow trout fitting for consumption (one year and a summer trout –P_{1+}, two-year trout –P_2, two-year and one summer trout –P_{2+}).

During the growth of the age groups mentioned above, twice a month was conducted control fishing, to monitor the state of maintenance (body condition) and the health condition of the fish and for establishing the rhythm of growth by weighing each 100 fish of each basin and age group. Also, daily observations were made about the behavior of the fish, the appetite expressed during feeding and the appearance of illness symptoms, which affects the growth process and causes number and economic losses.

Due to the fact that in the farm analyzed the greatest benefits are obtained by selling trout two years old (P_2), on 50 fish taken from different places in the water pools, gravimetric and corporal measurements were made: body length - total, standard, regulatory, commercial; the maximum and minimum height of the body; the large and small perimeter of the body; the length of the caudal peduncle (Lustun, 1985; Bud & Vlădău, 2004; Turliu, 2008). The obtained values were statistically processed (average was calculated, standard error of the average, variance, standard deviation, coefficient of variability) (Tacu, 1968; Sandu, 1995; Neagu, 2005), and the results were interpreted as absolute values and on their basis were calculated body indices (fattening index, profile index, quality index, thickness index, carnosity index) (Bud & Vlădău, 2004).

RESULTS AND DISCUSSION

The **body weight** parameter, determined by control weights, recorded the following dynamics in the analyzed age categories:

- the rainbow trout of one year and one summer (P_{1+}) showed at the beginning of the growth period the ***average weight*** of 45 g / fish, then in June it doubled its body mass and in the period July-September it registered a intensive rhythm of growth, reaching the weight of 157 g / fish. This intensive growth dynamics in the warm season is because of the water that reaches temperatures of 14-18ºC values corresponding to thermal optimum feeding favoring the maximum intensity of the trout. In the harvest inventory in autumn, the average weight per fish reached 195 grams (Table 1) and the average length of 24 cm.
- the rainbow trout two years old (P_2) started the growing and fattening period in order to be ready for marketing with the ***average weight*** of 195 g / fish, and in the spring of 2014 reached the average weight of 333 g per fish (Table 1) and average length of 30 cm.
- the rainbow trout two years and a summer old (P_{2+}) showed a very good productive performance, so that, in July 2014, has shown an average weight of 435 grams/fish (Table 1) and average length of 36 cm *versus* 333 g when the basin were populated.

Table 1. Dynamics weight of rainbow trout consumption

Age category	Weight at populating (g)	Control date and body weight (g)					Weight of harvesting (g)
		15/4/13	*17/5/13*	*10/6/13*	*15/7/13*	*12/8/13*	
P_{1+}	45	56	73	92	120	157	195
		15/10/13	*10/11/13*	*15/12/13*	*09/1/14*	*15/2/14*	
P_2	195	240	274	289	300	310	333
		10/4/14	*15/5/14*	*10/6/14*	*10/7/14*	-	-
P_{2+}	333	360	382	420	435	-	435

The obtained results denote the efficiency of the rainbow trout breeding technology in the analyzed unit, with a clear relationship between the quality and biological value of the fish material and the conditions ensured throughout the evolution of the trout.

In order to achieve this good body weight at the end of the growing period of the rainbow trout intended for consumption, the essential element, apart from maintaining the physico-chemical parameters of the water within the normal limits, is the feed system, since the food administered in optimal and rigorous quantities, but which are also qualitatively appropriate, by observing the percentage content of nutrients necessary for the correct functioning of the body, leads to the achievement of large body weights.

In good growth conditions (adequate feeding, optimal physico-chemical parameters of water), in some trout farms in Romania, the rainbow trout recorded at the age of 1.5 years the average weight of 310 g and at 2 years 435 g (Decei, 2001), values superior to those obtained in this study. Păsărin (2007) shows that the rainbow trout exhibits an intense growth rate and at the age of two years it reaches a weight of 250 g, a lower result the values currently set in this work.

Based on the initial weight of the biological material when first populating the pools and the final weight recorded at the end of the growth period, the growth rate of the rainbow trout was determined, namely: ***the overall average growth rate*** (final weight – initial weight) and ***average daily gain*** [(final weight - initial weight)/growth period]. The intensity of growth is of special importance, since it influences the growth duration of the trout and, implicitly, the spending over the entire evolutionary cycle of fish. The exploitation of trout aims at maximizing the accumulation of body mass, so that their valorization can be realized as early as possible, at a weight corresponding to the biological potential.

During the period of growth of the trout there were recorded average body weights values set in each controls fishing to highlight the dynamic of their growth (Table 1). The results presented in Table 1 show that all three categories of rainbow trout showed a very good growth rate, as follows:

- the rainbow trout one year and one summer old (P_{1+}) showed ***the total average growth rate*** of 150 g / fish since the pool population (July) to the autumn inventory and ***the average daily increase*** of 0.83 g / fish was achieved.

During the growth period (6 months), the trout increased their body mass of about 4.33 times, and the highest increase was found in the July-September period when the temperature of the water in the tanks has reached optimal values, corresponding to the maximum feeding intensity.

- the rainbow trout two years old (P_2) during the growing season from October to March, recorded ***the total average increase of*** 138 g /fish (the body weight increased about 1.71 times) and ***average daily gain*** of 0.92 g / fish. The better growth rhythm (+0.09 g / fish *versus* P_1), is due to the aging of the biological material.

- the rainbow trout two years and a summer old (P_{2+}) showed ***the total average increase*** of 102 g / fish, and ***the average daily gain*** of 0.85 g / fish. At the end of the growth period, the body mass increased about 1.31 times the original weight.

The consumption indigenous trout a year and a summer old (P_{1+}) reaches the mean body weights of 40-80 g and at two years and a summer old (P_{2+}), which is commonly sold, the average weight reached 175-180 g (Păsărin, 2007).

The results of the study demonstrate that body weight and growth rate of the consumption rainbow trout it at different ages, are far superior values for indigenous trout, which is why, rainbow trout is the most widespread salmonid in trout in our country, which at the same time exhibits greater resistance to diseases, tolerance towards the heavier conditions of growth, prolificacy and high precocity.

The body weight and the good growth rate of the trout recorded in the analyzed unit were due to rational feeding with OPTILINE grain combined feed, the 2P recipe for one year and one summer old trout and 3P recipe to grow and fatten the trout for two years and for the two years and one summer one, the last one representing the last stage of the production cycle. Feed was administered manually, in equal portions of 3 times per day, at the water surface, in a daily amount of 1-2% of the total weight of P_{1+} trout and 1.0-1.6% of the total weight of trout P_2 and P_{2+}, depending on the temperature variations of water (maximum consumption registered at water temperature 14-18^{0}C). Also, the positive result of the growth process was possible by providing an optimum level of physical and chemical parameters of the production environment (water flow about 0.1 l / m² / second, renewal of the water 4-5 times per day) and optimal growth density (150 fish P_{1+} and P_2 / m² pool spring, autumn, winter and 50-70 fish / m² during the summer).

Encouraged by the good quality of the biological material and the optimal provision of environmental conditions (food, growth density, water physic-chemical parameters,

prophylactic measures etc.), the high growth intensity allows the utilization of the rainbow trout for consumption at an age early production and thus ensure the profitability of fish production by reducing the cost of long-term maintenance of this age group in trout. The management applied effectively in the farm limited the losses, at only about 5-6% of total consumption trout.

The economic efficiency of trout breeding is influenced and conditioned by both the growth rate and the weight reached at the age of recovery as well as ***the specific feed consumption*** (the amount of feed needed to achieve a kilogram of growth).

The price of sale / purchase of the consumption trout increases or decreases depending on the costs incurred throughout the period of exploiting the fish, an important role in the structure of production costs starring amount of feed given during this period. The feed price depends on their nutritional quality given by the protein and energy value of the recipe, as well as the vitamin and mineral content indispensable to fish life.

In the trout farm analyzed, by calculating the total amount of feed given to the rate of increase achieved, relative to the total amount of recovered fish (trout about 25 tons per year P_{2+}) there was determined the ***coefficient of conversion*** of feed of about 1.18-1.20 kg, meaning that, to obtain a kilogram of trout, 1.18-1.20 kg of granular combined fodder is needed.

To improve feed conversion, it was necessary to permanently monitor the physico-chemical parameters of water in growing pools (especially temperature, oxygen content and pH of water), manual feeding for better fish behavior monitoring during their feeding, their appetite and their state of health, the observance of the population density of the basins, in order to eliminate stress in case of overcrowding.

Phenotypic characterization of the biological material analysis was conducted by somatometria, which involved carrying out the main ***body measurements*** in order to assess development of the body's overall trout two years old (P_2), the ratio of different body regions, the evolution of the growth and maintenance status. At the same time, the ***weighing*** of the analyzed fish was carried out. Subsequently, the primary data obtained were statistically processed and the values of the statistics and the measurements are presented in Table 2.

Table 2. The values of the main body dimensions of two-year rainbow trout (P_2)

Analyzed feature	Media ($\bar{X}$)	Standard error ($S_{\bar{X}}$)	Variance (S^2)	Standard deviation (S)	Coefficient of variation ($CV_{\%}$)
Total length trunk (cm)	30.32	0.20	2.17	1.47	4.84
Standard length trunk (cm)	27.10	0.13	0.95	0.97	3.57
Length statutory (cm)	28.35	0.11	0.61	0.78	2.75
Commercial length (cm)	23.10	0.06	0.21	0.45	1.94
Maximum height trunk (cm)	7.50	0.05	0.16	0.40	5.33
Minimum height trunk (cm)	3.20	0.04	0.10	0.31	9.68
Large perimeter trunk (cm)	16.60	0.07	0.27	0.51	3.07
Small perimeter trunk (cm)	7.45	0.06	0.19	0.43	5.77
Thick trunk (cm)	5.44	0.06	0.22	0.46	8.45
Caudal peduncle length (cm)	4.12	0.04	0.12	0.34	8.25
Head length (cm)	5.10	0.05	0.14	0.37	7.25
Body weight (g)	333	0.12	0.74	0.86	25

Total body length was determined by measuring the distance from the tip of the muzzle fish to the imaginary line joining the caudal fin lobes and showing the average value of 30.32 cm. As a result of the statistical calculations, it appears that this characteristic has a small variability coefficient (4.84%), which means that, the biological material analyzed has very good uniformity of this parameter.

Standard length of body of trout for two years is given by the distance measured from the tip of the muzzle to the end of the salve shell and for the 50 analyzed samples presented the

average value of 27.10 cm with a coefficient of small variability (3.57%).

Values obtained for *the regulatory length* (the distance measured from the middle of the eye to the tip of the caudal fin) and *the commercial length* (distance measured from the middle of the eye to the back base of the anal fin) were 28.35 cm, 23.10 cm respectively, with coefficient of variation of the field lying in the minimum variability. The regular length is about 1.07 times the total length of the body and the commercial length is about 1.31 times.

To assess the degree of depth of the trunk was determined by *the maximum height and the minimum height of the body,* given the distance measured from the edge of the dorsal to the ventral where the trunk is the highest, or where the depth is the lowest, more precisely the stems caudal. The average values obtained were 7.50 cm, 3.20 cm respectively, and therefore, the maximum height is in the range of 4.04 times the total length and the minimum about 9.48 times. The coefficient of variation has little value for the first attribute, and for the minimum height coefficient slightly increases at the boundary between the small and medium (9.68%).

The big perimeter and the small perimeter which define the circumference of the body measured by surrounding the trunk with the centimeter where the height a is maximum or minimum, recorded the average value of 16.60 cm and 7.45 cm respectively and the low values of the coefficient of variability indicate good homogeneity of the analyzed fish population. The small perimeter encompasses in the large perimeter about 2.23 times, and it is included in the total average body length of 1.83 times.

Thickness of trunk (bicostal diameter) is the distance measured where the body is the maximum convexity and helps shape the overall body conformation of the trout. This attribute showed the average value of 5.44 cm and the variability of about 8.5%. ***The body weight*** determined by weighing 50 rainbow trout two years old, showed an average of 333 g per fish and a high coefficient of variability. The body weight is good and exceeds the minimum weight at which the rainbow trout can be sold, that is, the commercial weight, which has an average value of 200 grams.

The results of the measurements suggest that the fish analyzed showed good fish body development for age and good homogeneity of characters somatic (coefficient of variation less than 10%), except the body weight.

To assess overall body development trout and determining the proportionality of various body regions, with somatometric results were calculated ***indices body*** (Table 3).

Table 3. The values of the main body indices of two-year rainbow trout (P_2)

Body index	Number of individuals measured	Body index value
Fattening Index	50	1.67%
Profile Index	50	3.61
Quality Index	50	1.63
Thickness Index	50	20.07%
Carnosity Index	50	18.81%

The fattening index = [Body Weight / (Standard length trunck)^3] x 100 = [333 / (27.10)^3] x 100 = 1.67%

Profile Index (format) = Standard length trunck/ Maximum height trunck = 27.10 / 7.50 = 3.61

Quality Index = Standard length trunck/ Large perimeter trunck = 27.10 / 16.60 = 1.63

Thickness Index = (Thick trunk / Standard length trunck) x 100 = (5.44 / 27.10) x 100 = 20.07%

Carnosity Index = (Head Length/Standard length trunck) x 100 = (5.10/27.10) x 100 = 18.81%.

CONCLUSIONS

The rainbow trout one year and a summer old (P_{1+}) showed good growth dynamics, materialized in a total average increase of 150 g / fish from basin populations to autumn inventory and the average daily of 0.83 g / fish. In the spring-autumn growth period, body weight increased by about 4.33 times (from 45 g / fish in July, to 195 g / fish inventory in the autumn).

In the October-March increase period, the rainbow trout two years old (P_2) recorded a

total average increase of 138 g / fish and a daily average gain of 0.92 g / fish, and rainbow trout for two years and a summer (P_{2+}) achieved a total average increase of 102 g / fish and a daily average gain of 0.85 g / fish. Therefore, from the beginning to the end of the growth, the body weight of P_2 rainbow trout increased by about 1.71 times (195 g / fish *versus* 333 g / fish), and the weight of rainbow trout P_{2+} increased about 1.1 times (333 g / fish *versus* 435 g / fish).

Proper technological management in trout farming (rational feeding of trout with superior quality and optimum feed, optimal provision of physico-chemical parameters of water etc.), a allowed to get a good coefficient of feed conversion (specific consumption) of 1.18-1.20 kg of combined fodder.

The main characteristics of the rainbow trout somatic two years (P_2) (total length trunck = 30.32 cm, standard length trunck = 27.1 cm, maximum height trunck= 7.5 cm, large perimeter trunck = 16.6 cm, thickness trunck = 5.44 cm etc.), demonstrates the proper development and correctness of the body conformation of this age group, and the low variability coefficients (under 10%) highlights the high homogeneity of trout in trout farming.

The body index values (fattening index = 1.67%, profile index = 3.61, quality index = 1.63, thickness index = 20.07%, carnosity index = 18.81%) denotes the harmony of body development, good body proportionality and high growth dynamics.

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