

RESEARCH PAPER

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**THE INFLUENCE OF FEEDING TO THE PRODUCTION
CHARACTERISTICS OF STANDARD (*ONCORHYNCHUS MYKISS*
WALBAUM, 1792) AND GOLDEN (*ONCORHYNCHUS MYKISS*
STEVANOVSKI, 1987) RAINBOW TROUT**

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Abstract

The purpose of this research is to establish the differences between the production characteristics of the golden rainbow trout (*Oncorhynchus mykiss* Stevanovski, 1987) and the standard rainbow trout (*Oncorhynchus mykiss* Walbaum, 1792), that are bred in the fish farms “Banjica” and “Vrutok” – Gostivar, Republic of Macedonia.

The examinations have been done in the aforementioned fish farms “Banjica” and “Vrutok” – Gostivar, and the entire production cycle has been comprised:

- incubating of the fertilized fish roe and its placement in incubators for the process of incubation, the course of the incubation, the beginning of peeling and the period of resorbing of bilious bag of the larva;
- first feeding of fish and the entire breeding period of the offspring in the fish farm “Banjica”, as a first breeding phase;
- second production period - the fish fattening in fish farm “Vrutok” reaching the final consuming weight of fish.

The nutrition of fish is performed with extruded food, a product of the company Skreting SpA, Mozzekane - Verona, Italy, with a granulation of the food depending of the individual weight of fish that is being fed.

The final period marked as a second phase i.e. the fattening period has provided the following production results:

- As of golden rainbow trout, it has been registered a total production of marketable size golden rainbow trout in amount of 4.365,43 kg with an individual weight of 258.60 kg, while as of standard rainbow trout it has been registered a total fish production in amount of 3.541,21 kg, which is less for 824.22 kg or 23.28 %.

-The individual weight per piece regarding golden rainbow trout measured in the same period results as 258.60 g, appearing as 40.80 g larger compared with the standard rainbow trout (217.8 g) or 18.73 %.

Key words: *rainbow trout, nutrition*

Introduction

Salmonid fish farms cover small areas, but have almost unlimited production capabilities primarily dependent on the amount of water flow. The fish are fed with exclusively ready standardized food, and if the temperature of the water supplying the fish farm has satisfactory values, the production may be realized throughout the year. The breeding policy mainly includes marketable rainbow trout as well as breeding of other trout species intended for fish stocking or for sport fishing. The production of marketable trout ranged from less than 100 tons/ha in low productive fish farms, to over 400 tons/ha to higher productive fish farms.

Rainbow trout (*Oncorhynchus mykiss* Walbaum, 1792) belongs to the family Salmonidae and is one of the most famous bred in cold-water fish farms in R. Macedonia (Stevanovski, 2003; Stevanovski & Hristova, 2010) and worldwide. This fish species generally inhabits cold springs, streams, rivers and lakes, but due to its rapid growth and high quality meat it is widely prevalent in aquaculture in many countries.

Golden rainbow trout (*Oncorhynchus mykiss* Stevanovski, 1987) is a product line derived from the standard rainbow trout. The development of this species resulted accidentally back in 1987, but all that was preceded by systematic work in the field of selection of parent material obtained by fish stocking material for regular production of marketable rainbow trout in Vrutok fish farm. Developing golden rainbow trout is due to selection of the parent material of fish farm "Vrutok" - Gostivar, where genetic

improvement of the existing identification material from rainbow trout was operated, which is continuously being grown since 1964 in this fish farm and no other fish inference from other farms has been permitted.

The selection was conducted with the guidance of Prof. d-r Vangel Stevanovski. The golden trout was obtained as a result of spontaneous mutation caused by the gene for color. The very first formation of the production line regarding golden trout from Vrutok were aimed towards getting offspring by crossing the male with golden yellow color and female with standard color from the current rainbow trout, bred on the farm. In the process of operation it has been determined that the golden yellow color is hereditary and the inheritance appeared as 50: 50. The further selection and directions of operation were done towards consolidating production features of the newly acquired product line.

Materials and methods

The purpose of this study is to determine the differences between the production features of golden rainbow trout (*Oncorhynchus mykiss* Stevanovski, 1987) and the standard rainbow trout (*Oncorhynchus mykiss* Walbaum, 1792), bred in the fish farms "Banjica" and "Vrutok" - Gostivar, Republic of Macedonia.

The examinations have been done in the aforementioned fish farms "Banjica" and "Vrutok" – Gostivar, and the entire production cycle has been comprised of:

-incubating of the fertilized fish roe and its placement in incubators for the process of incubation, the course of the incubation, the

beginning of peeling and the period of resorbing of bilious bag of the larva;

-first feeding of fish and the entire breeding period of the offspring in the fish farm “Banjica”, as a first breeding phase;

-second production period - the fish fattening in fish farm “Vrutok” reaching the final consuming weight of fish.

The nutrition of fish is performed with extruded food, a product of the company Skreting SpA, Mozzekane - Verona, Italy, with a granulation of the food depending of the individual weight of fish that is being fed.

The fish were housed in breeding pools for holding of offspring in “Banjica” fish farm.

The pools are concrete, rectangular and are provided with sufficient quantity and quality of

fresh water, with an average temperature of the water 12.50°C throughout the year.

The density of holding the offspring ranged from 1500 to 7500 pieces/m³, as of the beginning of the first feeding until reaching 30 or 35 g of individual weight.

The fish fattening was performed in fish farm “Vrutok” as well. The fish were placed in concrete pools supplied with sufficient quantity and quality of fresh water, with an average temperature of the water between 7 – 12⁰C throughout the year.

The density of the holding throughout the fattening period in “Vrutok” was 7.8 - 35.96 kg/m³ fish



Fig.1,2. Golden rainbow trout (*Oncorhynchus mykiss* Stevanovski, 1987)



Fig.3. Fish farm “Banjica” (Gostivar, Macedonia)

Fish farm "Banjica" is a specialized facility for production of offspring. As for this purpose, it comprises all the necessary production facilities for continuous production - technological operations, beginning from keeping the parent material, incubation hall, Percy pools for breeding offspring in strictly controlled conditions, and holding offspring to individual weight of 30 g/piece. This fish farm is supplied with clean and quality water of the captured source that the pipeline reaches the fish farm. The water temperature throughout the year is 12.5°C. The concentration of oxygen is ranging between 8.50 - 8.75 mg /l.

"Vrutok" fish farm is a cold-water fish farm aimed exclusively for fish fattening. The intake of water from Vardar river springs is set in a distance of 950 m - open flow of the water from the source to the fish farm. The water temperature varies in the range of 6-12°C, depending on the season. The concentration of oxygen ranges from 9.35 - 9.75 mg/l. The production pools are rectangular, concrete and cascaded with the possibility for threefold use of the same inlet water.

The fish nutrition was completed with extruded fodder mix, a product supplied by Skreting SpA, Mozzekane - Verona, Italy. As for the feeding nutrient, different granulated type of food has been used depending on the weight category of fish. The calculation of the daily portion is based on the specific conditions of the fish farm (water temperature and oxygen amount) of the total mass of fish and weight of individual fish. The number of daily meals is adapted towards the age of the fish.

The research was conducted in two groups, namely:

- A - golden rainbow trout;
- B - standard rainbow trout.

During the tests the authors monitored the following issues:

- Duration of incubation;

- Start of peeling;
- End of the peeling;
- Start of the first feeding;
- Growth in the first breeding phase (offspring);
- Quantity of consumed food for the first phase;
- Food consumption per kilogram of growth;
- Production losses in the first phase;
- Growth of fish in the second fattening phase;
- Total consumption of food;
- Food consumption per kilogram of growth;
- Production losses in the second fattening phase.

The production results were analyzed on the specific growth rate (SGR - Specific Growth Rate), which is calculated according to the formula:

$$SGR = \left[\frac{\ln w_1 - \ln w_0}{t} \right] \times 100, \text{ where}$$

- $\ln w_1$ - natural logarithm of the final body mass of the fish;
- $\ln w_0$ - natural logarithm of the beginning body mass;
- t - duration of the testing per days.

Results and discussion

The analysis of the production characteristics is made over a completely produced roe rotation until the production of marketable weight which provided the following parameters:

a) Product characteristics:

- Incubation period from fertilization to final incubation;
- A period of absorption bilious bag and the beginning of the first feeding with additional food - starter;
- A period of breeding the offspring, from the beginning of the first feeding until reaching 30 g of individual weight at the age of 4-5 months;
- Fattening period until reaching of marketable weight.

The incubation period is the duration of the incubation process of fertilized roe and its planting in incubators for incubation. During this period of incubation of roe, the costs are allocated for roe care and application of protective disinfectants in one hand, and for determining the length of the incubation period in both groups of fish on the other.

As for this purpose 100,000 grains fertilized roe were planted in and the planting was done on the same day – 05.01.2015. The roe planting was performed in cabinet type incubators. The water temperature in the

spawning ground was constant and at 12.5°C. The incubation period was completed in 31 days from the date of the planting. The peeling started on 06.02.2015 and was completed in two days. The first feeding of larvae began with resorption of the bilious bag from 1/3 and raising most of the fish to the free water pillar. During this period the larvae are transferred to the Percy pool. The nurturing started on 16.02.2015. The young fish were fed with a complete fodder mixture of extruded product of the company "Skreting" with the following chemical composition:

Table 1. Chemical composition of the food for feeding the offspring

Type of food	Granulation (mm)	Chemical characteristics (%)					
		Proteins	Fat	Ash	Cellulose	Phosphorus	Metabolic energy (MJ/kg)
Nutra 4.0	0,3-0,5	58	12	9,8	0,5	1,5	18,8
Nutra 3.0	0,4-0,8	55	16	10,0	0,6	1,45	18,7
Nutra 2.0	07-1,1	54	18	10,0	0,6	1,45	19,4
Nutra 0	1,0-1,7	54	18	10,0	0,6	1,45	19,4
Nutra MPM	1,0 – 1,3	52	20	10,0	0,6	1,40	19,6
Nutra T	>1,7	52	20	9,5	0,7	1,40	19,7

The daily portion is determined according to the specific conditions in the fish farm (temperature and water quality), and the total weight of fish fed, which is a 7% from the weight of the fish for the initial feeding within seven days. Later on, the rate was reduced by 5%, 3.5% and 2.5% depending on food consumed and the individual weight of fish.

The frequency of feeding was initially set at 10 portions during the day, and then at 6, 4 and 3

depending on the age and the individual weight of fish.

The breeding period started at the beginning of the first feeding of young fish whereas two groups of 20,000 individuals were formed and placed in two separate Percy pools. Both groups A and B constituted 20,000 individuals from the golden rainbow trout and standard rainbow trout.

Table 2. Offspring breeding period

Parameters	GROUP					
	A			B		
	kg	Amount	Individual weight (g)	kg	Amount	Individual weight (g)
Start 16-02-2015	4.40	20.000	0.22	5.00	20.000	0.25
I st control	7.72	19.300	0.40	7.50	19.240	0.39

7 days						
II nd control 14 days	14.70	18.875	0.78	12.20	18.770	0.65
III rd control 14 days	18.00	18.724	1.50	25,40	18.432	1.38
IV th control 21 days	68.58	18.537	3.70	61.10	18.238	3.35
V th control 21 days	96.54	18.388	5.25	88.47	18.055	4.90
VI th control 21 days	156.63	18.108	8.65	130.25	17.965	7.25
VII th control 21 days	362.60	17.560	20.65	302.39	17.530	17.25
VIII th control 21 days	620.40	17.403	35.65	512.79	17.025	30.12
Realized total growth (kg)	616.00	/	/	507.80	/	/
Total of food consumed(kg)	585.10	/	/	507.80	/	/
Consumed food per kg/ growth	0.95	/	/	1.10	/	/
Production loss (amount)	/	2.597	/	/	2.975	
Production loss (%)	12.98	/	/	14.87	/	
Days of feeding until 25-04-2015	140	/	/	140	/	

Table 3. Consumed food per granulations for first breeding period

Parameter	Group A	Group B
Nutra 4.0 starter	2.5	2.5
Nutra 3.0 starter	8.7	8.7
Nutra 2.0	16.3	16.3
Nutra 0	41.5	38.6
Nutra MPT	80.3	75.7
Nutra T	220.3	215.2
Optiline 1	215.5	207.5
Total	585.1	507.8

Second fattening phase

Fish fattening has continued to the farm "Vrutok" according to production technology of them fish farm and work organization. For this purpose the fish were placed in two pools with the following technical dimensions: 35 m length: 4 m width: 0, 80 m depth, i.e. a total volume of 112 m³.

The density of planting was 155 pieces/m³ for group A and 152 pieces/m³ for group B as initial planting.

The fish feeding in both groups was carried out with exactly the same food from the company "Skreting", with the following chemical composition (Table 4).

The fish were kept in completely identical ambient conditions which are a characteristic for fish farm "Vrutok".

(temperature and oxygen concentration), as well as total body weight of the individual fish and fish weight.

The determining of daily portions was based on specific conditions of the water

Table 4. Chemical composition of fattening food

Type of food	Diameter (mm)	Chemical composition of food (%)					Metabolic energy (MJ/kg)
		Proteins	Fat	Ash	Cellulose	Phosphorus	
Optiline 1P	2,5	46,0	22,0	10,0	1,2	1,30	19,8
Optiline 2P	4,0	44,0	24,0	9,3	1,5	1,20	20,2

Table 5. Production results in fattening phase

Parameters	GROUP					
	A			B		
	kg	Amount	Individual weight (g)	kg	Amount	Individual weight (g)
Start of planting 26-04-2015	/	/	/	/	/	/
kg fish/beginning	620.40	17.403	35.65	512.79	17.025	30.12
I st control in 30 days	878.45	17.201	51.07	766.30	16.769	45.70
II nd control	1.495,90	17.096	87.50	1.199,50	16.590	72.30
III rd control	2.095,50	17.009	123.20	1.818,70	16.459	110.50
IV th control	3.025,57	16.931	178.70	2.424,11	16.346	148.30
V th control	4.365,43	16.881	258.60	3.541,21	16.259	217.80
Total realized growth (kg)	3.745,03			3.028,42		
Total consumed food (kg)	4.082,08			3.573,54		
consumption of food per fish of growth	1.09			1.18		
Production loss (amount)		522			766	
Production loss (%)	2.99			4.49		
Total period of feeding until 27-09-2015	150 days			150 days		
Daily growth (g)	1.49			1.25		

The breeding of golden rainbow trout as a pure culture and standard rainbow trout in identical ambient conditions and consuming entirely

equal food have shown significant production results that appear as it follows (Table no 5)

- For the period of breeding of 140 days in the first phase, the cultivation of offspring from the beginning of the first feeding until the age of 35.65 g individual weight, i.e. 620.40 kg total production of fish (group A) and 30.12 g individual weight, i.e. 512.79 kg total production of fish (group B), the individual weight in golden rainbow trout appears bigger in 18.36% (5.53 g absolute individual weight) than the standard rainbow trout.

- The total production of offspring was 620.4 kg of golden rainbow trout which is higher for 107.61 kg than standard rainbow trout, or a total of 20.98%.

- The consumption of food of golden rainbow trout for this period of breeding is 0.95 kg per kg of growth, which was lower by 15.78% compared to the consumption of food in standard rainbow trout, 1.10 kg per kg of growth.

The final period marked as the second phase of fattening period presented the following production results:

- As for the golden rainbow trout a total production of marketable fish reached from 4.365,43 kg with individual weight of 258.60 kg, whereas in the standard rainbow trout a total production of fish reached 3.541,21 kg, which is lower by 824.22 kg, or 23,28%;

- The individual weight per fish in golden rainbow trout for the same period was 258.60 g, which is 40.80 g higher than the standard rainbow trout (217.8 g), i.e. 18.73%.

Conclusion

Salmonid fish production in Republic of Macedonia is mainly based on the cultivation of rainbow trout in salmonid fish farms therefore the supply on the market is consisted of mainly one species of fish bred in fish farms, and small quantities of trout generated from indigenous brown trout and ohrid trout. The selection and formation of the golden

rainbow trout significantly increases assortment supply to the market and caused greater attention of the consumers. Although it is the same type of trout, however the difference in color of the body is presenting it as more tempting and demanded by consumers, and in a relatively short period of time this product has stabilized and earned its place in the Macedonian market and among the consumers in general.

The interest of producers is of particular importance not only in terms of drawing attraction for the increased supply on the market, but also in terms of production characteristics that make it especially valuable for breeders of fish in salmonid aquaculture production. As for this range, which can freely be named as a separate subspecies of rainbow trout with significantly different morphological and physiological characteristics that distinguish the original standard rainbow trout which was derived, the production advantages are:

- Higher increase rate of 18.73% compared to standard rainbow trout (258.6 g/217.8 g);

- Lower production costs per kg fish for 12.70% compared to the standard rainbow trout;

- Shorter time for reaching marketable weight of 250 g/piece in 15 to 20 days, compared to the standard rainbow trout.

Leterature

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