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EFFECT OF FRESH PILCHARDS ON PRODUCTION PERFORMANCE IN RAINBOW TROUT (*Oncorhynchus mykiss* Walbaum) NUTRITION

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ABSTRACT

The study was to present the results of growing production of trout, which were conducted in full system pond with the surface of 4,164 ha, which is supplied with water of high quality, constant temperature 10 °C throughout the whole year. For the experiment we have used rainbow trout fry of an average weight of 88-90 g and length 190-210 mm. The experiment involved a total of 5240 individuals, which lasted 90 days. Nutrition of control groups was performed by standard industrial pellets, which contained 41.49% protein and 9.27% fat. Feeding the experimental group was performed with 75% standard industrial pellets and 25% of the meal is made fresh anchovies. This meal contained 36.49% protein and 8.89% fat. After 90 days we have achieved the following results: the experimental group achieved a total weight gain of 67.80 g (0.753 g/day), while the control group achieved total realized gain of 44.47 g(0.494 g/day). The total increase in length of fish in the experimental group was 41.19 mm (0.457 mm/day), while the fish in the control group achieved a total increase of 29.410 mm. Feeding coefficient expressed on dry matter (kg DM) after 90 days in the control group was 1.92, while in the experimental group was 1.16. The fresh anchovies in the amount of 25% of a meal gave gut results in the control group: increased weight gain of 47.94%, increased length growth of fish for 40.18% and reduced feed conversion 28.64% .

Key words: rainbow trout, anchovy, production results, profitability.

INTRODUCTION

Fish plays an important role in human nutrition. Due to its properties and favorable effect on human health it is highly appreciated and sought after in the market, Connor (2000); Kilibarda (2006). A number of advantages have been discovered in fish over other animal meat. Primarily, it is an important source of proteins, even up 15 to 24%, Cvrtila *et al*. (2006), and other nutrients necessary to human body, it causes zoonoses to a lesser extent, the content of additives, used in intensive poultry and pig production and production of this animals, is much lower. There are also many other advantages.

World fish catch has reached its maximum at the end of the last century. A growing demand for this food is provided by production of fish in aquaculture. In our area growing fish has had a long tradition. Even though fish is considered healthy food, the consumption of fish in our country is one of the lowest in Europe. The average annual consumption of fish in the world is 16.4 kg per person per year, while the consumption of fish in Serbia is 5 kg per person per year, Baltic *et al.* (2009).

In trout production, as aspects of livestock production, the composition and quantity of feed used in production, effect the growth, but also the quality of cultivated fish. Therefore, the costs of feeding are very important. For normal development and growth of trout species, as predators, high quality of protein in the pelleted food is required, which makes feeding quite expensive. This is reflected in the price of trout which is far above the price of other freshwater fish. This balanced meal with a favorable economic impact. Certainly, such feed must provide the growth rate lower feeding coefficient good fish quality and higher fish survival.

Good nutrition program with a quality feed is one of the decisive factors in the production of california trout. In order to achieve this goal, it is necessary to know the anatomical and physiological features of fish. Feeding depends on species, size, age and sexual maturity of fish. In addition, a significant role play physical, chemical and biological features of water, its temperature, dissolved oxygen, carbon dioxide, pH and ammonia, and for some fish phytoplanktons and zoo planktons. Most favorable temperature for a rapid trout growth and efficient feed conversion is 13-16^{o}C, Fijan (1975). In the ponds with this water temperature all year round california trout achieves the growth of 250 g per year. A decrease in temperature causes slow growth, and the growth stops at 3°C. High temperatures are also unfavorable, so at temperatures higher than 17^{o}C, the flow rate and oxygen are critical factors, and the feed availability is decreased. Trout die 24^{o}C if the water is saturated with oxygen.

The energy sources in feed are carbohydrates, fats and proteins. Proteins are the most important components of feed. Proteins are used primarily for growth. However, when feed is without essential amino

acids, proteins are used as energy source, which occurs when the content of energy, fat and carbohydrates are lesser than required. The amount of protein that provides optimal growth depends on water temperature. Thus, at 8.3^{o}C fish feed must contain 40% of protein, and at 14.4^{o}C even up to 55% of protein, which confirms the theories that the amount of protein needed for optimal growth at a lower temperature is smaller.

According to researcher Nešić (1963) the optimal amount of protein is 37.5% and 17.5% of fat. Total needs are higher at the beginning and decrease with the age of fish. For optimal growth fry fish must receive feed with a minimum protein content of 50%. For 6 to 8 weeks old fish the protein content can be 40%, and 35% for one-year old fish. Piper *et al*. (1982) recommend for young fish 15% of fat and 50% of proteins, for a year old fish 12% of fat and 40% of protein, but for older fish 9% of fat and 35% of proteins.

Fish feed must also contain the optimum amount of vitamins, Kochseder (1988); NRC (1993). Hypovitaminosis and vitamin deficiencies can cause great economic losses on salmon fish farms. California trout with weight lesser than 1 g requires 150 mg L-ascorbic acid/kg feed, Halver (1982). In the cases of selenium and vitamin E lack fish stop eating and develop only after 10 weeks, but frequently die. A complete lack of vitamin B6 in california trout causes mortality in 14 days, and vitamin B12 deficiency leads to low red blood cell maturation and low protein metabolism. Its lack causes a loss of appetite, stunted growth and anemia.

Minerals have primarily osmoregulatory and nutritional function. Their absorption and excretion is carried out through the skin, gills and digestive tract. Most frequent are the following minerals: calcium, phosphorus, magnesium, sodium, chlorine, potassium, sulfur, and in traces iron, copper, manganese, zinc, selenium, iodine and others. The growth rates of california trout largely depends on water temperature, although Ogino and Yang (1978) found out that zinc deficiency causes slow growth. The optimum amount of zinc for normal fish growth is 15-30 mg/kg of feed, while the amount of 5 mg causes slow growth and 1 mg/kg causes very weak growth, mortality, reduced digestibility of protein and carbohydrates, erosion of fins and others.

The task of this paper is to obtain more detailed information regarding production and economic performance and good health of fish when adding wet feed, fresh sardelles in an amount of 25% of meals comparing to the standard meals based on industrial pellet mixture.

For the purpose of this study the research was directed to examination the influence of fresh sardelles on production performance and health conditions of trout. The following production and economic results were monitored: body weight, weight gain (overall and daily), consumption (total and daily), conversion, health status and mortality.

MATERIALS AND METHODS

Examining the effect of feeding diet of different composition on the performance and health status of california trout was conducted in the experimental groups. The chemical analyses of feed was carried out and the experiment was done in a modern full system pond whith constan water temperature 10^{o}C round the year. California trout (Oncorhynchus mykiss Walbaum), own production, was used. For the experiment the trouts, the average length 190-210 mm and the average weight 88-90 g, were used. The experiment was conducted on 5288 fish divided into two groups with two replications (4 pools), and lasted 90 days. Fish were placed in small pools, size 7.0 x 1.0 x 0.8 m or 5.5 m. The volume of water was 2.4 m^3, and the water flow was 2 l/sec, i.e. 72 water changes per day. The pools were made of concrete, suitable for cleaning and disinfection.

The feeding was manual and the amount was given in four meals. The experimental group was fed with a combination of pellets and sardelles in ration 75% : 25% in a meal. The fresh or defrost sardelles made the amount of 25% of the meal in the first morning feeding, but other three meals were a standard pellet feed. The control group was fed a standard pelleted complete feed four meals a day.

The fish was measured at the beginning of the experiment. The length and average weight of fish, the index of density and flow index were determined. Every 30 days the growth in length and weight, eating ratio, feeding ratio, condition factor and mortality were monitored. A sample from each pool was extracted in a representative number of 200 pieces from different places of the pool. Fish was always measured under anesthesia, and Aethilii paraaminobenzoas (anestesin) at a concentration of 0.06% was used as a narcotic. The basic solution was prepared by dissolving 200 g of anestesin in 1 l of acetone. Working solution was prepared by adding 0.6 ml of basic solution for every liter of water. Fish length was measured in a separate box (ichtiometres) from the beginning of the head to the tail. After measuring the length, the weight was measured on a technical scale. Base on the results of measurements and the number of fish, the average weight and length was calculated. Density index was calculated (DI) and flow index (FI) using standard formulas. In addition to weight and length, the water flow through the pools in m^3 or l/s, Piper *et al.* (1982) was taken into account.

For the first month, the gain was programmed based on the data from the literature for trout growth and energy needs. In the next month the gain was programmed on the basis of the data corrected according to factor condition. The predicted length (PL) was

programmed by the calculated average length of the experimental trout (L), and theoretically predicted linear growth rate of trout for 30 days (1.67 cm) was added at water temperature of 10°C, using the formula (1) given by Kulišić (1988).

pL [cm] = L [cm] + 1.67 (1)
pL = predicted (expected) length
L = average fish length
In addition to the average length in the end of the period, a corresponding average mass (am) was calculated using the formula (2) given by Kulišić (1988). The tables according to Piper *et al.* (1982) were used.

am [g] = aL^3 [cm] x 0,0110758 (2)
am – average fish mass
aL – average fish length

Required amount of food was defined by using the known or presumed nutrient ratios. The dietary table was calculated daily.

Daily amounts of feed (F) calculated by the formula (3) of Haskell, (1959).

H [g] = FCR x dG x 300/L
H - % feed depends from fish weight daily
FCR - feed conversion ratio
dL - daily gain
300 - konstanta
L - fish length

RESULTS AND DISCUSSION

Feed for the control trout group the protein content was 41.49%, fat content 9.27% and 1.09% cellulose and the energy value was 9.95 MJ ME/kg. In a total amount 29.55% of protein was of animal origin, and 11.94% of plant origin.

Feed for the experimental group contained 36.49% of proteins, 8.89% of fat and 81% of cellulose. The energy value was 8.98 MJ ME/kg. Of the total amount 27.54% of protein was of animal origin and 8.95% of plant origin.

The total and daily weight gain and length gain of trout in groups in different periods is displayed in Table 1. From the results it can be seen that the experimental group achieved a gain of 67.80 g in 90 days of fattening, which is 47.94% more than in the control group of trout which, for the same period, gained 45.81 g. The total increase in length of trout in the experimental group was 41.19 mm, which is 40.18% higher than in the control group, where a growth of 29.41 mm was recorded.

Health status and mortality were monitored daily. From a total of 5240 trout, at the end of the experiment 301 was dead, which makes 5.69% (Table 3). In all test periods the lowest mortality rate was in the experiment group, while motality in the control group had a tendency to increase during the experiment. The experimental group had lower mortality (60.53%) compared to the control group. Although during the experiment there health status was not disturbed, mortality was high in all the groups. This can be explained by a dense plantation of fish that in our tests, which was 546 to 554 fish /m^3. Apostolski *et al.* (1983) and Dalbelo (1986) reported on mortality at the level of 2.74 and 0.56% in their experiments with a stand density of 175 and 50 fish/m^3. Kulišić *et al.* (1987) reported on mortality of 3.85% at a density of 194 fish/m^3.

Comparing our data with the data on the gain from the available literature, Kulišić *et al.* (1987) certain similarities were observed. Combined meal diet (pellet + worms) a daily increase of gain 0.034 mm was achieved, but in our research it was 0.045 mm when combined with eating a meal (pellet + sardellas). Daily weight gain in our experiment combined meal was 0.706 g, while Kulišić *et al.* (1987) give report on daily gain of 0.660 g.

Table 1. Total and daily weight and length gain of trout in the groups according to fattening periods.

	Group, mass gain, g		Groupe, length gain, mm	
	Control	Experimental	Control	Experimental
	0 – 30 days			
Total	14.570	15.820	10.310	11.110
Daily	0.485	0.527	0.343	0.370
	30 – 60 days			
Total	17.710	23.200	11.260	14.450
Daily	0.590	0.773	0.375	0.481
	60 – 90 days			
Total	13.530	28.780	7.840	15.630
Daily	0.451	0.959	0.261	0.251
	0 – 90 days			
Total	45.810	67.800	29.410	41.190
Daily	0.509	**0.753**	0.326	**0.457**

Table 2. Mortality according to groups and periods

	Control group	Experimental group
	0 – 30 days	
Number of fish	17	18
%	0.64	0.68
	30 - 60 days	
Number of fish	58	42
%	2.20	1.59
	60 – 90 days	
Number of fish	135	23
%	5.25	0.88
	0 – 90 days	
Number of fish	210	83
%	7.93	3.13

For an easier following, the results are shown in Table 1, according to groups and fattening period.

Table 3. Production results in groups of trout and fattening periods.

	Control group	Experimental group
0 - 30 days		
Total gain, kg	33.28	41.56
Consumption, kg ADM	77.87	86.48
Feed conversion, ADM	2.03	2.08
Consumption, kg DM	69.08	65.36
Feed conversion, DM	1.80	1.57
30 - 60 days		
Total gain, kg	45.51	59.97
Consumption, kg ADM	80.43	89.70
Feed conversion, ADM	1.76	1.49
Consumption, kg DM	72.88	68.93
Feed conversion, DM	1.60	1.15
60 - 90 days		
Total gain, kg	32.94	73.73
Consumption, kg ADM	79.52	88.20
Feed conversion, ADM	2.41	1.20
Consumption, kg DM	72.06	66.52
Feed conversion, DM	2.19	0.90
0 - 90 days		
Total gain, kg	115.54	173.70
Consumption, kg ADM	237.82	264.38
Feed conversion, ADM	2.13	1.52
Consumption, kg DM	214.02	200.81
Feed conversion, DM	1.92	1.16

Feed conversion obtained in the present study can be compared with the data by Mijailović *et al.* (1990). When combininig meal diet (pellet + fish offal, with or without the slaughterhouse confiscates) have provided feed conversion 1.97 to 1.80 kg, which is far more than in our experimental group in which the feed ratio was 1.16 kg.

The results were obtained in the groups kept under the same conditions, given the same nutrition and hygiene conditions. This points out that fresh feed of animal origin, especially in combination with dry pellet feed, has biological, nutritional, and of all, economic justification.

Conclusion: In the production of trout, the composition and quantity of feed consumed, significantly affect the growth, but also meat quality of cultivated fish. Therefore, the costs of feed is very important because it influences the cost of fish meat. Since the costs of feed make at least 60% of total production costs, it is necessary to substitute it with cheaper feed achieving desired economic outcomes.

The addition of sardelles in the amount of 25% of a meal gave gut results in the control group:
- Increased weight gain of 47.94%,
- Increased length growth of fish for 40.18%,
- Reduced feed conversion 28.64% and
- Reduced mortality for 60.58%

Using pelleted complete mixtures in the diet of trout, the economic results, typical for the conditions in Serbia, have been achieved, while the diet of trout with sardelles combined with dry pellet industry feed is biologically, nutritionally, medically and economically justified.

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