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Growth Rate And Commercial Qualities Of The Muscle Tissue Of Rainbow Trout With Hydrolysate Of Soya Protein Used For Feeding

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Abstract

The article is dedicated to studying the efficiency of using pancreatic hydrolysate of soya protein for feeding rainbow trout. The fish-breeding biological indicators of trout breeding, chemical and amino acid composition of the muscle tissues in the experimental groups have been analyzed. The results show that adding pancreatic hydrolysate of soya protein to the feed for rainbow trout has beneficial effect on its growth rate, preservation, and feeds' conversion. The amino acid composition of the protein in the trout muscle tissues has been compared to the daily minimum need of an adult human organism in amino acids. Trout growing provided biologically complete food protein that promoted normal physical development of the human organism, increased performance efficiency and resistance to adverse external influences, as well as resistance to infections.

Keywords: rainbow trout, pancreatic hydrolysate of soya protein, biologically complete protein, amino acid composition, feeding.

INTRODUCTION

At present, the shortage of dietary protein is one of the most important problems in the world. On the average, one inhabitant of the Earth gets only about 60 g of protein per day, while the norm is 70 g. One of the possibilities of solving this problem may be intensive development of the aquaculture, as well as increasing production volumes of food fish products in industrial conditions [1, 2, 3].

The use of fish and seafood in the diet as a source of protein promotes normal growth and mental development of children, prevents hemodyscrasia, disorders of fats and vitamins' metabolism, and increases resistance to infections, colds and some other diseases [4, 5].

Fish products have dietary properties. After heat treatment, fish flesh becomes juicy and lax; it easily gets impregnated with the digestive juice, which promotes better digestion and absorption by the human organism [6, 7].

Proteins of fish flesh, compared to proteins of the meat of warm-blooded animals, feature high (up to 97%) digestibility. This is because myosin in the fish flesh, which makes up the main mass of proteins in the muscle tissue, denaturates easier under the influence of heat, and is digested in the gastrointestinal tract of the human organism sooner than myosin in the meat of landliving animal [8].

One of the most useful fish for human health is rainbow trout. 100 g of cooked rainbow trout contain 22.9 g of protein [9].

The need of human organism in protein largely depends on the qualitative composition of amino acids, primarily essential ones. The lower the biological value of protein is, the more protein is required to satisfy the needs of the organism [10, 11].

METHODS

Scientific studies aimed at determining the chemical and amino acid composition of muscle tissues of the rainbow trout fed on pancreatic hydrolysate of soya protein were performed on the basis of FSUE Teplovskiy Fish Hatchery at workmen's settlement Novye Burasy in the Saratov region, Russian Federation (52 07'56" N; 46 04'17" E).

The research was aimed at assessing the efficiency of using pancreatic hydrolysate of soya protein for feeding rainbow trout, and its influence on the product quality.

The study was aimed at analyzing the growth rate; assessing the commercial quality of rainbow trout; and studying the chemical and the amino acid composition of the muscle tissues.

The subject of the research was approved by the Council for Grants of the President of the Russian Federation, and supported by the Grant of the President of the Russian Federation for State Support of Young Russian Scientists (No. MK-6216.2018.11).

Rainbow trout juveniles (1+) were taken for the research by the principle of analogues, with the average weight of 55.5 g, and two groups, reference and experimental ones, were formed, 310 bions in each. The reference group received full-ration granular mixed feed, while the experimental group received the same feed with the addition of pancreatic hydrolysate of soya protein (Table 1). The duration of the experiment was 24 weeks.

During the research, rainbow trout was fed 6 times a day at regular intervals in the daytime. Granulated combined feed with diameter of granules appropriate to the weight of the study object was used for feeding. Feed composition and its nutritional value corresponded to the period of fish growing. The daily rate of the feed was calculated weekly, with regard to water temperature and fish weight. Feed consumption and fish preservation were determined daily.

For enriching the feed with pancreatic hydrolysate of soya protein, the Abiopeptide feed additive manufactured by LLC A-Bio, Pushchino, Moscow region, was used. The additive was introduced into the feed by spraying at the rate of 1.0 ml per 1.0 kg of live weight of fish. This additive contains 20-30% of free amino acids (lysine, methionine, arginine, tyrosine, phenylalanine, histidine, valine, proline, threonine, serine, alanine, glycine, leucine and isoleucine), and 70-80% of lower peptides.

Trout were kept in 3.0x0.7x1.0 m trays. Water was continuously fed from the well into the trays, whereby the water temperature was at 14-16 ^{0}C, and oxygen content did not fall below 10 mg/l.

The growth rate was characterized by fish weight dynamics, and the absolute and the average daily gain [7]. The absolute increase was calculated by the difference between the initial and the final weight of the fish per period.

The average daily gain and the specific growth rate (Cw) were calculated using the following formula:

$Cw = \frac{2(Mn-Mo)}{(Mt+Mo)t}100\%$,

where *t* was the period duration in days.

Feed consumption was calculated for the overall experiment as the ratio of the amount of feed introduced into in the fish tank to the unit of weight gain.

$$C = \frac{Ev}{R}$$

where *Ev* was the amount of introduced feed, kg;

R was the obtained yield, kg.

The chemical composition of the muscle tissues was determined according to the standard methods.

Initial moisture was determined according to AFNOR NF V04-401 Meat, meat products and fishery products - Determination of moisture content.

Crude ash was determined according to GOST 31727-2012 (ISO 936:1998). Meat and meat products. Determination of total ash.

Fat was determined by the skim residue according to GOST 23042-2015. Meat and meat products. Methods of fat determination.

Protein was determined according to the Kjeldahl method.

Calcium was determined according to GOST R 55573-2013. Meat and meat products. Determination of calcium by titrimetric methods.

Phosphorus was determined by the colorimetric method according to GOST 32009-2013 (ISO 13730:1996). Meat and meat products. Spectrophotometric method for determination of total phosphorous content.

Nitrogen-free extractive substances were determined by the method of calculation.

Amino acids were identified using precolumn modification with 6-Aminoquinoline-N-hydroxy-succinimidyl carbamate - AccQ according to the method of Waters AccQ-Tag with the use of a set of WAT 052880 reactants. This method ensures specific quantitative modification of the primary amino groups, amino acids, and amino sugars; it is characterized by high sensitivity and high separation efficiency.

The obtained experimental data were biometrically processed with due regard to the recommendations of Tarchokov T. T., Maksimov V. I. Yuldashbaev Y. A. (2016) in MS Excel 2013.

Table 1 – Scheme of the scientific research

Group	Number of bions	Type of feeding
Reference	310	Main diet (MD)
Experimental	310	MD + 1.0 ml of soya protein hydrolysate per 1 kg of fish weight

RESULTS

For assessing the fish grow rate, the live weight gain is of paramount importance; the obtained data are shown in Table 2.

During the period of growing, the average weight of 1 rainbow trout reached the commodity weight; the weight of fish in the experimental group was by 12.17% higher than in the reference group. Survivability of fish during the research period was kept high, but in the experimental group it was higher by 2.2%, compared to the reference group. Fish in the experimental group consumed the feed more intensively; therefore, the total consumption during the experiment in this group was 9.9% higher than that in the reference, while the amount used per 1 kg of trout weight gain in the experimental group, due to higher growth of ichthyomass, was lower by 6.9%.

Table 2 – Indicators of rainbow trout productivity

Indicator	Group	
	Reference	Experimental
Ichtyomass at the beginning, kg	17.16	17.21
Ichtyomass at the end, kg	92.82	106.55
Absolute growth, kg	75.66	89.34
Average daily growth, %	1.07	1.14
Feed used per group, kg	116.04	127.56
Feed used per 1 kg of weight gain	1.53	1.43
Survivability, %	96.5	98.7

For assessing the effect of pancreatic hydrolysate of soya protein on the metabolic processes in the organisms of fish, 10 samples of muscle tissue of rainbow trout from each group with the average weight of approximately 300 g were chemically analyzed (Table 3).

Table 3 – Chemical composition of rainbow trout muscle tissue, %

Indicator	Group	
	Reference	Experimental
Humidity	73.30±0.76	71.09±0.81
Dry matter	26.70±0.12	28.91±0.13*
Protein	19.36±0.99	22.30±0.36*
Fat	4.66±0.13	4.13±0.10*
Ash	1.40±0.02	1.54±0.14
Calcium	0.59±0.07	0.81±0.03*
Phosphorus	0.10±0.01	0.10±0.01

a) *P≥0.95

The analysis results showed that the introduction of pancreatic hydrolysate of soya protein into the feed contributed to obtaining significant differences between the experimental groups in terms of content of dry matter, protein, fat and calcium. The muscle tissue of rainbow trout in the experimental group contained more dry matter by 8%, protein - by 15.2%, and calcium - by 37.0%, and fat content was lower by 11.2%, compared to the reference group.

For studying the biological value of protein samples of rainbow trout muscle tissue, the content of proteinogenic amino acids was determined. The obtained results were compared to the daily needs of the human organism (Table 4).

Analysis of the obtained data shows that muscle tissue of rainbow trout grown in industrial conditions is balanced by 16 proteinogenic amino acids. It should be noted that the amino acid composition of the muscle tissue of trout in the experimental group was saturated by 51% more than that in the reference group. The daily requirement of the human body in essential amino acids can be satisfied with the diet of 300 g of muscle tissue of the rainbow trout from the experimental group. At the same time, to satisfy this need, the human organism has to consume over 400 g of the muscle of the fish in the reference group.

DISCUSSION

Adding pancreatic hydrolysate of soya protein into the combined feed for rainbow trout when growing trout in industrial conditions contributes to improving the growth rate and reduces feed cost per 1 kg of fish weight.

The biological value of food protein depends entirely on the extent of its absorption by the organism, which is determined by its amino acid composition. Using pancreatic hydrolysate of soya protein, fish with the amino acid composition similar to the optimal, which provides physiologically adequate nutrition for the human organism, can be grown.

Table 4 – Amino acid composition of the muscle of marketable fish, %

Amino acid	Group		Daily need of the human organism, g/day	
	Reference	Experimental	Rous, Mesy, Block [7]	RF, 2004 [4]
Essential				
Lysine	2.0±0.7	2.7±0.9	5.2	4.1
Methionine+Cystine	1.0±0.1	1.7±0.3	3.8	1.8
Arginine	1.3±0.7	2.1±0.5	-	6.1
Histidine	0.6±0.1	0.9±0.2	-	2.1
Phenylalanine	1.1±0.2	1.5±0.3	4.4	4.4
Threonine	1.0±0.4	1.7±0.5	3.5	2.4
Valine	1.2±0.1	1.9±0.2	3.8	1.8
Leucine+Isoleucine	2.9±0.08	4.2±0.1	12.4	6.6
Nonessential				
Proline	0.6±0.1	1.6±0.2	-	4.5
Serine	0.9±0.2	1.9±0.4	-	8.3
Alanine	1.5±0.4	2.2±0.3	-	6.6
Glycine	1.0±0.4	1.5±0.5	-	3.5
Glutamic acid	1.7±0.3	2.6±0.3	-	13.6
Aspartic acid	1.9±0.2	2.3±0.3	-	12.2
TOTAL	19.1	28.85	33.1	78.7

CONCLUSION

The introduction of pancreatic hydrolysate of soya protein to the combined feed for rainbow trout helps reducing the cost of feed per 1 kg of weight gain by 6.9%, and increasing the growth rate by 12.17%, survivability by 2.26%, and protein content in the muscle tissue by 15.2%. It also has positive effect on its biological value.

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