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Original Paper

Effect of feeding conditions on the quality traits of rainbow trout

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The effect of use of feed mixture with different protein levels on the morphological composition of the body and the amino acid content of trout meat proteins is studied in the article. For this purpose, five experimental groups were formed by the analog method. The study lasted 210 days and was divided into two periods: equalizing (10 days) and basic (200 days). In the equalizing period, the trial fish consumed feed of the control group. In the basic period, the level of protein in the feed of trout of the experimental groups was regulated by changing individual components of the feed. Feeding of rainbow trout in the study period was performed 4–6 times a day, in the day time at regular intervals. The required amount of feed was calculated according to the indicators of individual fish weight and ambient temperature at the time of feeding. Rearing of commercial two-year-old ones was performed in ponds with an area of 100 m^2 at a fish-holding density of 50 specimens m^{-2} and a water level of 1 m. The analysis of the received results of the amino acid content of fish raw products showed that the proteins of rainbow trout were complete and contained all essential amino acids. Among the essential amino acids in meat, lysine, leucine + isoleucine predominates. It has been established that increasing of the protein level in the diets of rainbow trout in the rearing period up to 52% promoted increase in the content of essential amino acids in its meat. The results of the calculation of the coefficients of utilization of amino acid content (U) and indicators of comparable excess ($\sigma\chi$) indicate a high possibility of utilization of amino acids and show that trout meat proteins are well taken up by the human body. The total number of trout in experimental studies was 25 thousand specimens. The use of feed with high crude protein content in the period of commercial rainbow trout rearing improves their commercial properties, while fish feeding with feed with crude protein content at the level of 44% leads to a decrease in their productivity.

Keywords: rainbow trout, fish feeding, protein, morphological composition, amino acid content.

1 Introduction

The rational use of feed with different levels of protein affects the performance of rainbow trout purposefully, nutritional and biological value, size and mass composition and as a result – the efficiency of fish production (Aba et al., 2012; Barnes et al., 2015; Huysman et al., 2019; Khan et al., 2019).

Not only its chemical composition, technochemical and biochemical properties, but also morphological composition of the body, which depends according to scientists on its species, age, sex, physiological condition, time and place of capture, rearing technology, terms and storage conditions, and mostly from protein nutrition are the important indicators of the rainbow trout quality (Parker et al., 2015; Treft et al., 2017; Walker et al., 2017).

Volumes of commercial trout farming in Ukraine is ten times lower than in such countries

Europe, such as France, Denmark and others. With the modern market began to fill more and more

rainbow trout weighing 0.5 kg and above, imported from abroad. Accordingly, the breeding of rainbow trout is relevant and important

According to a number of researchers, the presence of high quality protein in fish diets is one of the key factors for obtaining optimal amino acid content of trout meat proteins (Huysman et al., 2019; Jones et al., 2020; Gaylord et al., 2008).

Thus, the study of morphological composition of the body and amino acid content of trout meat proteins

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depending on the protein levels in feed in the modern industrial conditions of fish farms in Ukraine is relevant and necessary.

2 Material and methods

2.1 Preparation and Conduct of the Study

Experimental studies on two-year-old rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792) were conducted in the farm "Shipot" of the Perechynsky district of the Zakarpatska Oblast.

Five experimental groups were formed by the analog method (Table 1). In the equalizing period of the study that lasted 10 days, the trial fish consumed feed of the control group. In the basic period of the study (200 days) the protein level in the feed of trout of the experimental groups was regulated by changing the individual components of the feed (using combined mathematical methods of optimization of the calculation in the program AgroSoft WinOpti).

The nutrient density of experimental production feed is shown in table 2.

Feeding of rainbow trout in the study period was performed 4–6 times a day, in the day time at regular intervals. The required amount of feed was calculated according to the indicators of individual fish weight and ambient temperature at the time of feeding.

Weighing of the experimental trout was performed every 10 days. Weighing of the fish was performed on electronic scales in a calibrated container with water, with an accuracy of 0.1 g. Rearing of commercial two-year-old ones was performed in ponds with an area of 100 m^2 at a fish-holding density of 50 specimens m^{-2} and a water level of 1 m. The total number of trout in experimental studies was 25 thousand specimens. The housing conditions of the experimental fish met the regulatory requirements in salmon farming.

The research results were processed using the software STATISTICA 7.0. and MS Excel with the use of built-in statistical functions.

Arithmetic mean (*M*) and its error (±m), standard deviation (*s*), difference probability (*td*) and significance level (*p*) were determined during processing of experimental data.

Table 1 Scheme of scientific and economic experiment

Group	Fish-holding density at the beginning of experiment (specimens m^{-2})	Average weight at the beginning of experiment (g)	Periods of the experiment	
			equalizing (10 days)	basic (200 days)
			content of crude protein in 1 kg of feed (%)	
1 – control	50	55.3 ±2.48	48	48
2 – experimental	50	56.1 ±2.13		44
3 – experimental	50	54.8 ±2.37		46
4 – experimental	50	55.1 ±3.13		50
5 – experimental	50	54.5 ±2.99		52

Table 2 Content in 1 kg of feed (%)

Indicator	Groups				
	1	2	3	4	5
Metabolic energy (MJ)	17.00	17.00	17.00	17.00	17.00
Crude protein	48.00	44.00	46.00	50.00	52.00
Crude fat	18.00	18.00	18.00	18.00	18.00
Crude fiber	2.40	2.45	2.71	2.91	2.77
Calcium	1.80	1.80	1.80	1.80	1.80
Total phosphorus	1.20	1.20	1.20	1.20	1.20
Lysine	2.70	2.70	2.70	2.70	2.70
Methionine	0.90	0.90	0.90	0.90	0.90
Vitamin A (thous. IU)	10	10	10	10	10
Vitamin D_3 (thous. IU)	3	3	3	3	3
Vitamin E (mg)	200	200	200	200	200

The following designations are adopted for indicators of the significance level of the probability criterion (p) in the tables: *p <0.05, **p <0.01, ***p <0.001 compared with the control group.

2.2 Methods

The length composition of the fish was carried out on live material according to the scheme for salmonid fish (Pravdin, 1939).

The evaluation was performed according to the main fish and ichthyologic parameters: body weight, industrial body length, head length, maximum and minimum body height, tail fin length. Measurements were performed with a measuring tape to the nearest 0.1 cm. Individual weighing was performed on electronic platform balance with an accuracy of 1.0 g. Fresh fish in the quantity of 5 specimens with an average weight per group was used for the study. The productive characteristics of fish were analyzed and determined based on the measurement results (Savostyanova, 1974).

Commercial properties of rainbow trout were determined by the main indicators of size and mass composition of raw products – weight of fish, head, fins, bones, muscle tissue, bones, skin and internal organs. The study was performed by weighing on electronic scales VLTK-500. Based on the obtained weighing data, the ratio of the weight of individual parts of its body to the weight of the whole fish was determined according to GOST 1368 (2003).

The weight part of amino acids was determined by ion-exchange liquid-column chromatography on the automatic analyzer T 339 made by Microtechna (Czech Republic), tryptophan was determined by colorimetric method with preliminary alkaline hydrolysis (Skurikhin, 1988).

2.3 Calculations

Amino-acid score, potential biological value of protein (BVP), coefficient of difference of amino-acid score (CDAAS), coefficient of utilization of amino acid content (U), coefficient of excess content of essential amino acids (σ) are determined by calculation method (Lipatov, 2002).

$$AC_i = \frac{AK_{np}}{AK_{cm}} \cdot 100$$

where:
AC_i – score of essential amino acid (%); AK_{np} – content of essential amino acid in 1 g of the studied protein (g 100 g^{-1}); AK_{cm} – content of the same essential acid in 1 g of "ideal" protein (g 100 g^{-1})

The limiting acid was considered to be the one with the lowest score. The potential biological value (BVп) of protein (%) was determined according to the formula:

$$BC_n = \frac{8 \cdot AC_л}{\Sigma AC_i} \cdot 100$$

where:
AC_l – amino-acid score of limiting acid (%); ΣAC_i – sum of amino-acid scores of essential amino acids (%)

Based on the obtained value BV_n the value of the coefficient of difference of amino-acid score was calculated (*CDAAS*):

$$CDAAS = 100 - BV_n$$

3 Results and discussion

When processing fish, it is important to know the ratio of edible and inedible parts and to have an idea of various organs and tissues of fish (Voorhees et al., 2019; Karabulut et al., 2010). The obtained data on weight composition of fish are required for selection of the type of processing and breaking-down (Table 3).

As a result of the experimental data it is established that feeding of commercial two-year-old rainbow trout with feed with various content of crude protein promotes not only change of indicators of mass gaining, but also affects commercial properties. Similar statements were highlighted in the works of scientists (Jobling, 2016; Alami-Durante et al., 2010). Thus, feeding of trout with feed with a crude protein content of 52% (experimental group 5) contributed to a probable increase in fish weight, and as a consequence, an increase in muscle mass. The muscle mass of trout from experimental group 5 was 198.87 g, which is 28.3% more than in the control group. The specified difference is statistically significant.

It is established that feeding of two-year-old trout from group 2 during the rearing period with complete feed with low crude protein content, compared to the control group, affects the mass gaining of muscle tissue, bones and yield of edible parts significantly. In this context, no significant difference in skin weight between analogues of these groups was found. The muscle mass in fish of group 2 was 10.4% lower than in the control group (p <0.01). Similar regularity was found in the yield of edible parts and bone mass. In particular, the yield of edible parts and bone mass in trout of experimental group 2 were 10.9% and 10.3% (p <0.001), respectively, lower than in analogues of the control group.

Table 3 Commercial properties of rainbow trout, $n = 5$

Indicator	Groups				
	1	2	3	4	5
Fish weight (g)	296.4 ± 8.25	268.6 ±7.43*	281.5 ±8.23	316.9 ±7.89	334.8 ±7.89**
Head weight (g)	49.2 ±1.23	44.59 ±1.62*	46.45 ±1.72	48.16 ±2.43	50.22 ±2.09
Fin weight (g)	18.37 ±0.88	16.65 ±0.93	16.89 ±0.83	20.28 ±0.98	23.77 ±1.03
Bone weight (g)	19.56 ±0.93	17.73 ±0.58**	18.02 ±0.35	21.55 ±0.75	24.11 ±0.69**
Muscle weight (g)	155.02 ±2.15	140.48 ±1.93**	146.38 ±1.88*	173.02 ±2.05***	198.87 ±2.03***
Skin weight (g)	20.16 ±1.03	18.26 ±1.15	16.89 ±1.22	21.87 ±1.31	23.77 ±1.09
Weight of internal organs (g)	16.30 ±0.6	13.43 ±0.9*	14.92 ±0.8	18.38 ±0.9	20.09 ±1.05*
Weight of edible parts (g)	175.18 ±2.15	158.74 ±1.93***	163.27 ±2.08**	194.89 ±2.33***	222.64 ±2.45***
Yield of edible parts (%)	59.10 ±2.44	48.2 ±1.93**	58.1 ±1.95	61.5 ±2.03	66.5 ±2.06*
Weight of inedible parts (g)	121.22 ±1.92	109.86 ±1.83	118.23 ±2.01	122.01 ±1.86	112.16 ±1.47**
Yield of inedible parts (%)	40.9 ±2.56	51.8 ±1.94	41.9 ±2.03	38.5 ±1.97	33.5 ±1.66*

*p <0.05; **p <0.01 compared with group 1

Table 4 Weight of internal organs of two-year-old rainbow trout (g), $n = 5$

Indicator	Groups				
	1	2	3	4	5
Heart	0.95 ±0.01	0.78 ±0.08	0.86 ±0.09	1.06 ±0.06	1.17 ±0.02***
Liver	4.04 ±0.28	3.22 ±0.18*	3.58 ±0.43	4.41 ±0.12	5.02 ±0.21*
Kidneys	1.79 ±0.06	1.48 ±0.03	1.64 ±0.05	2.02 ±0.01	2.41 ±0.09***
Stomach	4.27 ±0.22	3.49 ±0.19*	3.88 ±0.41	4.95 ±0.19*	5.42 ±0.24**
Intestine	5.25 ±0.24	4.46 ±0.23*	4.96 ±0.59	6.11 ±0.22*	6.17 ±0.29*

*p <0.05; **p <0.01; ***p <0.001 compared with group 1

When feeding of trout of group 4 in all age periods of rearing with complete feed with 2% increase in protein content, there was an increase in the mass of edible parts by 11.3%, the yield of edible parts by 2.4%, compared with analogues of the control group. However, no significant difference was found in the mass of bones, skin, internal organs of fish of the control group and group 4.

Therefore, on the basis of the conducted studies it is established that the use of feed with high crude protein content in the period of commercial rainbow trout rearing improves their commercial properties, while fish feeding with feed with crude protein content at the level of 44% leads to a decrease in their productivity.

The idea of development of its internal organs (Table 4) gives a more complete description of rainbow trout reared in industrial conditions using different levels of protein nutrition.

The use of feed with high crude protein content in feeding of rainbow trout led to a significant change in the weight of liver, kidneys, stomach and intestine (Teimouri et al., 2013). The scientists attribute this phenomenon to the fact that the digestive system of trout responds to changes in physico-chemical characteristics of feed quickly enough (Glencross et al., 2007; Crank et al., 2019).

Thus, the weight of liver, kidneys, stomach and intestine in fish from experimental group 5 was respectively by 24.2%; 34.6; 26.9 and 17.5% higher compared to similar indicators of fish from the control group. In all cases, the difference was statistically significant (p <0.05; **p <0.01; ***p <0.001).

It was also established that feeding of young rainbow trout in the periods of rearing with complete feed with a reduced level of crude protein up to 48%, did not affect the weight of internal organs significantly, although there was a slight decrease.

The increase of the level of protein nutrition in the diet of fish from group 4 contributed to increase in the weight of liver and kidneys compared to the control group, although no significant difference was found. At the same time, increase in heart weight by 11.6%, stomach weight by 11.9% (p <0.05) and intestine weight by 16.3% (p <0.05) was found, compared to the control group.

Feeding of trout from group 2 in the period of rearing with complete feed with crude protein content at the level of 44% compared to the control group was accompanied by decrease by 20.3% (p <0.05) of the liver weight, by 18.3% (p <0.05) of the stomach weight and by 17.7% (p <0.05) of the intestine weight. There was no significant difference in the relative weight of heart and kidneys in trout from the 2nd and control group, although the weight of the latter was slightly higher.

Studies of the amino acid content of fish raw products were conducted by us on two-year-old rainbow trout of autumn catching (Table 5).

The essential amino acids that are not synthesized in the body are of particular value, and a human can get them only with food, as evidenced by the results of scientific studies of predecessors (Rodehutscord et al., 2000; Kaushik et al., 1995). These tables show the presence of all essential amino acids in proteins of rainbow trout meat. The highest total content of essential amino acids was observed in experimental group 5–11.91 g per 100 g of product.

The lysine predominates among the essential amino acids in all experimental groups and control group. The lysine in the human body regulates hemopoiesis, is a substrate for long-term memory, stimulates mental performance, eliminates impaired abilities, supports the immune system, promotes bone and connective tissue repair (Alami-Durante et al., 2014; Van Larebeke et al., 2018). The aspartic acid, alanine and glycine are dominant among nonessential amino acids in the control and experimental groups.

The ratio of EAA to NEAA for proteins of trout from experimental group 5 corresponds more with the standards of dietary intake compared to proteins of fish from experimental groups 1–4.

The analysis of the amino acid content of fish raw products showed that the proteins of rainbow trout were complete and contained all essential amino acids. Among the essential amino acids in meat, lysine, leucine + isoleucine predominate.

It has been established that increasing of the protein level in the diets of rainbow trout in the rearing period up to 52% promoted increase in the content of essential amino acids in its meat. Thus, in terms of the content of essential amino acids in meat, fish from Group 5 surpassed the analogues from the control group by 37.3%.

Table 5 Amino acid content of rainbow trout meat proteins, mg per 100 g of product, n = 5

Indicator	Groups				
Essential amino acids	8.67	8.26	9.15	10.61	11.91
Valine	1.73 ±0.04	1.76 ±0.05	1.80 ±0.06	1.84 ±0.07	2.1 ±0.09**
Leucine + isoleucine	1.84 ±0.09	1.76 ±0.07	1.82 ±0.03	2.31 ±0.11*	3.8 ±0.12***
Lysine	2.35 ±0.16	2.12 ±0.09	2.31 ±0.09	2.46 ±0.10	2.9 ±0.09*
Methionine	0.59 ±0.05	0.54 ±0.01	0.61 ±0.02	0.76 ±0.04*	1.1 ±0.04***
Threonine	1.16 ±0.03	1.14 ±0.02	1.28 ±0.01	1.54 ±0.05***	2.1 ±0.03***
Phenylalanine	0.76 ±0.01	0.74 ±0.01	0.95 ±0.02	1.21 ±0.03***	1.4 ±0.04**
Tryptophan	0.24 ±0.01	0.20 ±0.01	0.38 ±0.03**	0.49 ±0.03***	0.51 ±0.03***
Nonessential amino acids	11.61	10.51	12.02	13.44	13.01
Alanine	1.5 ±0.06	1.3 ±0.04	1.7 ±0.05*	1.9 ±0.07**	2.03 ±0.09**
Arginine	1.22 ±0.04	1.26 ±0.03	1.31 ±0.06	1.39 ±0.05	1.4 ±0.06*
Histidine	0.74 ±0.02	0.68 ±0.02	0.79 ±0.06	0.84 ±0.07	0.66 ±0.04
Proline	0.54 ±0.03	0.52 ±0.01	0.63 ±0.02	0.81 ±0.05**	0.80 ±0.05**
Serine	1.33 ±0.101	1.21 ±0.210	1.46 ±0.211	1.53 ±0.196*	1.53 ±0.106
Glutaminic acid	1.14 ±0.07	1.19 ±0.131	1.16 ±0,121	1.06 ±0.158	0.9 ±0.06*
Aspartic acid	2.12 ±0.102	1.83 ±0.114	1.92 ±0.098	2.21 ±0.127	1.88 ±0.105
Glycine	1.43 ±0.103	1.14 ±0.129	1.24 ±0.214	1.83 ±0.147*	1.95 ±0.196*
Cystine	0.93 ±0.03	0.84 ±0.02	1.03 ±0.09	0.92 ±0.06	0.65 ±0.04***
Tyrosine	0.66 ±0.02	0.54 ±0.01	0.78 ±0.02	0.95 ±0.06**	0.94 ±0.06**
Ratio of EAA to NEAA	0.75:1	0.78:1	0.76:1	0.79:1	0.92:1

*p <0.05; **p <0.01; ***p <0.01 compared with group 1

Feeding of fish from experimental group 4 in all age periods of rearing with complete feed with high crude protein content up to 50% compared with the control group also increased the content of essential amino acids in trout meat by 1.94 mg 100 g^{-1} or by 22.3%.

It was established that the increase in the amount of essential amino acids in trout meat from experimental groups 4 and 5 was due to increased content of such amino acids as valine, isoleucine + leucine, lysine and threonine.

The use of complete feed with low protein content (experimental group 2) for feeding of young rainbow trout in all periods of rearing was accompanied by decrease of content of essential amino acids in meat by 5.0% compared with that indicator of analogues from the control group, which was caused by decrease in the content of individual amino acids.

The results of experimental studies also showed that feeding of young trout with feed with a crude protein content of 46% was accompanied by a slight increase in the content of essential amino acids compared to this indicator in the control group. Thus, the content of essential amino acids in the meat of fish from experimental group 3 was 9.15 mg 100 g^{-1}, which is by 5.5% more than in the analogues of the control group. This was accompanied by the presence of a significant number of such amino acids as lysine, valine, isoleucine + leucine.

It should be noted that the highest content of essential amino acids was found in the meat of trout from experimental group 5, which at all ages was fed with complete feed with a high protein content up to 52%.

Among the essential amino acids, lysine is the most important. The analysis of the study results showed that the use of feed with different levels of crude protein for feeding of rainbow trout caused a change in the amount of lysine in meat. In particular, in meat of fish from group 5, which was fed with feed with increased crude protein content up to 52%, there is an increase in lysine content compared to the control group by 23.4% (2.9 mg 100 g^{-1}) (p <0.05), while the decrease of crude protein levels up to 46% in the feed for young fish from experimental group 3, did not cause changes in its content in muscles.

Fish rearing on feed with a crude protein content at the level of 44% (group 2) caused a decrease in lysine content in meat, respectively, by 10.8–36.8% compared with analogues from experimental groups 1, 3, 4 and 5.

It should be noted that protein increase by 4 % in the diet of young fish from experimental group 5 contributed to increase in the methionine content in meat by 86.4% (p <0.05). Similar regularity was also observed in the content of threonine in rainbow trout meat. Thus, the content of threonine in meat of fish from experimental group 5 was probably higher (by 81.0 %) compared to indicators of the analogues in the control group.

Amino acids such as serine, arginine, alanine, are hydrophilic amino acids that determine a moisture-retaining capacity of fish meat (Voorhees et al., 2018). As can be seen from the above data, the proteins of fish raw products contain a sufficient amount of these amino acids, which allows to estimate the relatively high moisture-retaining capacity of its meat.

As a result of biochemical studies of the amino acid content of rainbow trout meat it was established that increase in protein nutrition led to an increase of alanine, serine, glycine and tyrosine in meat.

Based on the studies performed, it was established that the use of feed with increased crude protein content (52%) in the period of commercial rainbow trout rearing caused an increase of the ratio of EAA to NEAA in meat of two-year-old fish, what increased its biological value significantly.

The amino acid content of proteins is an important indicator of the protein quality, which characterizes the balance of amino acids (FAO, 2016). The calculation of the amino acid content of rainbow trout proteins and its compliance with the ideal protein are presented in Table 6.

Phenylalanine and tyrosine, lysine, leucine are the dominant amino acids of proteins of the fish raw products.

The amino acid score is the main indicator that characterizes the biological value of protein (Azevedo et al., 2005). Characteristics of the amino acid score of rainbow trout meat proteins are shown in Table 7.

These tables show that isoleucine and leucine are the limiting amino acids in Groups 1–4. In experimental group 5, the content of all essential amino acids is not inferior to the recommended values.

Indicators and criteria of biological value (BV) were calculated for assessment of the nutritional adequacy of protein components of rainbow trout meat in relation to the potential degree of their availability (Table 8).

According to the calculations of potential biological value, the highest level of amino acid balance (77%) was observed in trout meat proteins of experimental group 5. In the control sample, the potential biological value is 58%. According to the CDAAS, trout meat proteins from experimental group 5 will be used to a greater extent potentially, which in comparison with proteins of groups 1–4 have a lower value of this indicator - 23% vs. 41–50%, respectively. the coefficients of utilization of amino acid

Table 6 Assessment of conformity of the amino acid content of rainbow trout proteins with the Ideal protein according to the scale of the UN Food and Agriculture Organization/World Health Organization (g 100 g^{-1} of protein), *n* = 5 (means the number of experimental groups, together with the control)

Amino acid	Groups					Ideal protein according to the UN FAO/WHO
	1	2	3	4	5	
Valine	8.53	9.38	8.50	7.65	8.43	5.0
Isoleucine	3.26	3.38	3.01	3.46	5.49	4.0
Leucine	5.81	6.00	5.35	6.14	9.76	7.0
Methionine + cystine	7.50	7.35	7.75	6.99	7.02	3.5
Threonine	5.72	6.07	6.04	6.40	8.43	4.0
Phenylalanine + tyrosine	7.00	6.82	8.17	8.98	9.39	6.0
Tryptophan	1.18	1.07	1.79	2.04	2.05	1.0
Lysine	11.59	11.29	10.91	10.23	11.64	5.5
Total	50.59	51.36	51.52	51.89	62.21	36

Table 7 Amino acid score of rainbow trout proteins (%), *n* = 5 (means the number of experimental groups, together with the control)

Amino acid	Groups				
	1	2	3	4	5
Valine	170	188	170	153	169
Isoleucine	82	85	75	87	137
Leucine	83	86	76	88	139
Methionine + cystine	214	210	221	200	201
Threonine	143	152	151	160	211
Phenylalanine + tyrosine	116	114	133	150	157
Tryptophan	118	107	179	204	205
Lysine	211	205	198	186	212
Total	1,137	1,147	1,203	1,228	1,431

Table 8 Indicators of biological value of rainbow trout meat proteins, *n* = 5 (means the number of experimental groups, together with the control)

Indicator	Groups				
Text	1	2	3	4	5
Potential biological value (BV_p) of the protein, %	58	59	50	57	77
Coefficient of difference of amino-acid score (CDAAS), %	42	41	50	43	23
Coefficient of utilization of AA content of protein U, fraction	0.58	0.59	0.53	0.60	0.79
Coefficient of comparable excess σc, g/100 g of standard protein	0.26	0.23	0.32	0.24	0.10

content (U) and indicators of comparable excess (σc) indicate a high possibility of utilization of amino acids and show that trout meat proteins are well taken up by the human body. In this context, the coefficients of utilization of amino acid content and comparable excess of experimental group 5 were as close as possible to the recommended values and amounted to 0.79 of the fraction and 0.10 g 100 g^{-1} of standard protein, what confirmed the highest biological value of trout meat proteins, that consumed feed with a crude protein level of 52%.

4 Conclusions

As a result of the studies it was established that feeding of trout with feed with a crude protein content of 52% (experimental group 5) contributed to an increase in fish and muscle weight.

It was established that the increase in the amount of essential amino acids in rainbow trout meat from experimental groups 4 and 5 was due to increased content of such amino acids as valine, isoleucine + leucine, lysine and threonine.

It was studied that feeding of young trout with feed with a crude protein content of 46% was accompanied by a slight increase in the content of essential amino acids compared to this indicator in the control group.

The analysis of calculations of potential biological value indicates the highest level of amino acid balance (77%) in trout meat proteins of experimental group 5. In the control sample, the potential biological value is 58%.

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