Крім того, володіючи досить низьким енергоспоживанням, вони дуже економічні. За однакової інтенсивності світла на одиницю площі така лампа дозволяє заощадити до 85% електроенергії порівняно з лампою розжарювання і до 50% порівняно зі звичайними лампами денного світла, зважаючи на те, що термін роботи їх в кілька разів довший.

Із використанням у раціонах годівлі БВМД ТМ «Силач» спостерігається підвищення продуктивності промислового стада курей-несучок та встановлено переваги застосування препарату в межах програми високоефективного вирощування й експлуатації птиці.

## СПИСОК ВИКОРИСТАНОЇ ЛІТЕРАТУРИ:

1. Бородай В.П. Вивчення економічності в птахівництві. *Ефективне птахівництво*. 2009. № 8. С. 6–8.
2. Степаненко І.А. Характеристика генетичних ресурсів птиці у птахогосподарствах України. *Сучасне птахівництво*. 2009. № 8 (81). С. 5–9.
3. Агапова Є.М. Проблеми забезпечення якості продукції птахівництва. *Сучасне птахівництво*. 2010. № 6. С. 8–10.
4. Ярошенко Ф.О Підвищення ефективності виробництва продуктів птахівництва. *Вісник аграрної науки*. 2004. № 1. С. 63–66.
5. Любенко О.І., Кривий В.В. Підвищення якості харчових яєць в умовах виробництва філії «Чорнобаївське» Приватного акціонерного товариства «Агрохолдинг Авангард». *Таврійський науковий вісник*. Херсон. 2019. № 107. С. 209–212.
6. Пономаренко І.П., Буряк Р.І., Мельник В.В. Фактори впливу на якість продукції птахівництва. *Сучасне птахівництво*. 2010. № 11. С. 18–19.

**UDC 639.21:597.552.512.3.043:616-071:612.1**
**DOI https://doi.org/10.32851/2226-0099.2021.119.25**

# MORPHOLOGICAL COMPOSITION OF THE BODY AND CHEMICAL COMPOSITION OF TROUT MEAT DEPENDING ON AMINO ACID LEVELS IN FEED

***Kondratiuk V.M.*** *– Candidate of Agricultural Sciences, Associate Professor, Associate Professor at the Department of Pshenychnyi Animal Feeding and Feed Technology, National University of Life and Environmental Sciences of Ukraine*
***Ivaniuta A.O.*** *– Candidate of Technical Sciences, Postgraduate Student at the Department of Technology of Meat, Fish and Marine Products, National University of Life and Environmental Sciences of Ukraine*

*The article studies the effect of the use of complete feed with different levels of lysine and methionine on the morphological composition of the body and chemical composition of the meat of commercial rainbow trout. The aim of the experiment was to establish the effect of different levels of amino acid nutrition of commercial rainbow trout on these indicators. For this purpose, five experimental groups were formed by the method of analogues. The experiment lasted 210 days and was divided into two periods: equalization (10 days) and basic (200 days). During the equalization period, the experimental fish consumed feed of the control group. In*

*the main period of the experiment, the level of lysine and methionine in the production feed ranged from 2.5 to 2.9% and from 0.8 to 1.0%, respectively.*

*Feeding of rainbow trout during the study period was performed 4-6 times a day, during the day 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. The growing of commercial two-year-old trout was carried out in ponds with a stocking density of 50 specimens/m$^2$ and a water level in them of 1 m. The total number of trout in experimental studies was 25 thousand specimens. Conditions for keeping experimental fish met the regulatory requirements in salmon farming.*

*It was found that with the increase in the weight of two-year-old trout, the weight of muscle tissue and the yield of edible parts increases. Different levels of lysine and methionine in the diets of young rainbow trout, during their growing affects in different ways the weight of internal organs. It is proved that the increase in the levels of lysine to 2.9% and methionine to 0.95% in the diets of rainbow trout during the growing periods contributes to the increase in the weight of the liver, stomach and intestines.*

*The results of experimental studies showed that the muscle tissue of rainbow trout, regardless of the influence of the studied factor, is characterized by a high protein content (21.8-24.9%). Elevated levels of lysine and methionine during the growing period contributed to a decrease in crude protein content in muscle tissue. Feeding two-year-old rainbow trout with complete feed with different methionine and lysine content does not significantly affect the content of dry substance, ash and minerals in muscle tissue.*

***Key words:*** *rainbow trout, fish feeding, compound feeds, lysine, methionine, amino acid nutrition, morphological indicators, marketable qualities, chemical composition.*

***Кондратюк В.М., Іванюта А.О. Морфологічний склад тіла та хімічний склад м'яса форелі залежно від рівнів амінокислот у комбікормах***

*У статті досліджено вплив використання повнораціонних комбікормів із різним рівнем лізину та метіоніну на морфологічний склад тіла та хімічний склад м'яса товарної райдужної форелі. Метою досліду передбачалося встановити вплив різних рівнів амінокислотного живлення товарної райдужної форелі на згадані показники. Для цього за методом аналогів сформовано п'ять піддослідних груп. Дослід тривав 210 діб та поділявся на два періоди: зрівняльний (10 діб) та основний (200 діб). У зрівняльний період піддослідна риба споживала комбікорм контрольної групи. В основний період досліду рівень лізину і метіоніну у продукційному кормі коливався від 2,5 до 2,9% і від 0,8 до 1,0% відповідно.*

*Годівлю райдужної форелі в період досліджень проводили 4–6 раз на добу, в денний час через рівні проміжки. Необхідну кількість корму розраховували відповідно до показників індивідуальної маси риб та температури середовища на час їх годівлі. Вирощування товарних дволітків проводили в ставах за щільності посадки 50 екз./м$^2$ та рівня води в них 1 м. Загальна кількість особин форелі в експериментальних дослідженнях становила 25 тис. екз. Умови утримання піддослідних риб відповідали нормативним вимогам у лососівництві.*

*Установлено, що зі збільшенням маси дволітків форелі маса м'язової тканини та вихід їстівних частин зростає. Різний рівень лізину і метіоніну у раціонах молоді райдужної форелі під час їх вирощування по-різному впливає на масу внутрішніх органів. Доведено, що підвищення у раціонах райдужної форелі рівня лізину до 2,9% і метіоніну до 0,95% упродовж періодів вирощування сприяє збільшенню маси печінки, шлунка та кишківника.*

*Результати проведених експериментальних досліджень показали, що м'язова тканина райдужної форелі (незалежно від впливу досліджуваного фактора) характеризується високим вмістом білка (21,8–24,9%). Підвищення рівня лізину та метіоніну протягом періоду вирощування сприяло зниженню вмісту в м'язовій тканині сирого протеїну. Годівля дволітків райдужної форелі повнораціонними комбікормами з різним вмістом метіоніну та лізину суттєво не впливає на вміст у м'язовій тканині сухої речовини, золи та мінеральних речовин.*

***Ключові слова:*** *райдужна форель, годівля риб, комбікорми, лізин, метіонін амінокислотне живлення, морфологічні показники, товарні якості, хімічний склад.*

**Relevance of the article and analysis of recent research and publications.** The nutritional and biological value of fish raw materials is a major factor in its use as a food product. Fish is characterized by a high content of vital compounds for the human body, such as acrylic acid nitrile, including lysine, leucine, essential fatty acids, including unique eicosapentaenoic and deoxyhexanoic, fat-soluble vitamins, macro-and micro-

nutrients in balanced human proportions [1-6]. According to a number of researchers, methionine, which has a lipotropic, antisclerotic effect, is of special importance [7–10]. Many scientists claim that the content of methionine in fish is one of the first places among protein products of animal origin [11–14].

Analyzing the degree of influence of the feed factor in the diets of rainbow trout on metabolic processes, it is important to study the marketable qualities of fish, namely the morphological and structural composition of two-year-old rainbow trout, depending on growing conditions.

Accordingly, studies of the use of complete feeds with different levels of lysine and methionine on the morphological composition of the body and the chemical composition of the meat of commercial rainbow trout are necessary and of great economic importance.

**Material and methods of research.** Experimental studies on two-year-old rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792) were conducted in the fishery "Shipot" located at Perechyn district of Transcarpathian region.

The purpose of the scientific and economic experiment was to establish the influence of different levels of amino acid nutrition of marketable rainbow trout on the indicators of its marketable qualities and chemical composition of muscle tissue.

For this purpose, five experimental groups were formed by the method of analogues (Table 1).

Table 1

**Scheme of scientific and economic experiment**

| Fish group | Stocking density at the beginning of the experiment, specimens / m² | The average weight at the beginning of the experiment, g | Experiment periods | | | |
|---|---|---|---|---|---|---|
| | | | equalization (10 days) | | basic (200 days) | |
| | | | content in 1 kg of feed,% | | | |
| | | | lysine | methionine | lysine | methionine |
| 1- control | 200 | 53.9±3.17 | 2.7 | 0.9 | 2.7 | 0.90 |
| 2- experimental | 200 | 53.4±2.86 | | | 2.5 | 0.80 |
| 3- experimental | 200 | 54.2±3.74 | | | 2.6 | 0.85 |
| 4- experimental | 200 | 52.7±3.29 | | | 2.8 | 0.95 |
| 5- experimental | 200 | 54.0±3.06 | | | 2.9 | 1.00 |

During the equalization period, the experimental fish consumed feed of the control group, where the levels of lysine and methionine were the same and met the established norms [16]. In the main period, fish of all groups received a similar diet, except for the level of lysine and methionine in it. The mentioned amino acids were added in one or another proportion, as provided by the scheme of the experiment.

The nutritional value of experimental production feeds is shown in table 2.

Feeding of rainbow trout during the study period was performed 4–6 times a day, during the day 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.

The growing of commercial biennials was carried out in ponds with a stocking density of 50 specimens/m² and a water level in them of 1 m. The total number of trout in

experimental studies was 25 thousand specimens. Conditions for keeping experimental fish met the regulatory requirements in salmon farming [16].

Table 2

**Content in 1 kg of feed, %**

| Indicator | Group | | | | |
|---|---|---|---|---|---|
| | 1-st | 2-nd | 3-rd | 4-th | 5-th |
| Exchange energy, MJ | 17.00 | 17.00 | 17.00 | 17.00 | 17.00 |
| Crude protein | 48.00 | 48.00 | 48.00 | 48.00 | 48.00 |
| Crude fat | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 |
| Crude fiber | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 |
| 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 | 2.50 | 2.60 | 2.80 | 2.90 |
| Methionine | 0.90 | 0.80 | 0.85 | 0.95 | 1.00 |
| Vitamin A, thousand IU | 10 | 10 | 10 | 10 | 10 |
| Vitamin $D_3$, thousand IU | 3 | 3 | 3 | 3 | 3 |
| Vitamin E, mg | 200 | 200 | 200 | 200 | 200 |

Marketable qualities of rainbow trout were determined by the main indicators of size and mass composition of raw materials – the 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 in accordance with GOST 1368 (2003) [17].

Mass fraction of ash – by weight method, after mineralization of the product sample in a muffle furnace at a temperature of 500-600 ° C in accordance with DSTU 8718: 2017 [18]. The method is based on the removal of organic substance from a sample of the analyzed product by incineration and determination of ash by weighing.

The mass fraction of lipids by the Soxhlet method according to DSTU 8718:2017, which is that the fat is weighed after its extraction with a solvent from a dry sample in the Soxhlet apparatus, based on determining the change in sample weight after solvent extraction of fat [18].

Mass fraction of protein according to GOST 7636-85 – determination of total nitrogen by the Kjeldahl method [19]. Ashing of the samples was performed on Velp Scientifica series DK6 (Italy) with a vacuum pump (JP). Distillation was performed on a steam distillation apparatus Velp Scientifica UDK 129 (Italy).

The content of calcium and phosphorus was determined in accordance with DSTU ISO 11885:2005 by the method of atomic emission spectrometry with inductive plasma [20]. The method is based on the ability of free atoms of elements in gases to emit light energy at a wavelength characteristic of each element.

The research results were processed by the method of variation statistics using the software STATISTICA 7.0. and MS Excel using built-in statistical functions.

**Research results.** In order to rationally use fish raw materials, we conducted a study of the morphological and structural composition of biennials of rainbow trout, depending on the growing conditions. The research results are shown in table 3.

Analyzing the degree of influence of the feed factor in the diets of rainbow trout on metabolic processes, the marketable qualities of fish were studied. For the analysis of marketable qualities 5 fish were selected from the control and experimental groups, with the average weight per group.

Analysis of data on the mass composition of rainbow trout indicates a certain stability of the relative mass of the skin and internal organs. With the achievement of high indicators of live weight, there is an increase in the relative mass of muscle tissue and a slight decrease in the yield of inedible parts (indicators of the 5th group). This in turn leads to an increase in the yield of edible parts, the difference between the control and the indicators of the 5th group is statistically significant ($p < 0.05$).

In general, it has been found that as the weight of two-year-old trout increases, the mass of muscle tissue and the yield of edible parts increases.

Table 3

**Commercial qualities of rainbow trout, n=5, M±m**

| Indicator | Group | | | | |
|---|---|---|---|---|---|
| | 1-st | 2-nd | 3-rd | 4-th | 5-th |
| Fish weight, g | 291.5± 9.03 | 254.9± 8.41* | 279.4± 8.22 | 310.2± 9.43 | 306.5± 8.87 |
| Head weight, g | 48.72± 2.33 | 43.97± 2.12 | 45.02± 2.36 | 50.1± 2.69 | 51.24± 3.01 |
| Fins weight, g | 18.19± 1.54 | 16.42± 1.21 | 16.88± 1.89 | 19.10± 2.03 | 18.83± 2.47 |
| Bone weight, g | 17.61± 1.98 | 17.48± 1.39 | 18.57± 1.24 | 20.67± 1.69 | 20.37± 1.67 |
| Muscle weight, g | 153.5± 10.01 | 118.94± 8.14* | 139.93± 9.02 | 166.08± 7.96 | 163.32± 6.35 |
| Skin weight, g | 19.96± 2.03 | 18.01± 1.65 | 21.03± 1.97 | 24.34± 2.69 | 22.83± 2.03 |
| Internal organs weight, g | 16.14± 1.87 | 13.24± 1.47 | 15.48± 1.52 | 18.79± 1.76 | 16.98± 1.81 |
| Edible parts weight, g | 173.46± 8.12 | 136.95± 9.04* | 160.96± 6.32 | 190.42± 6.25 | 186.15± 5.69 |
| Edible parts yield, % | 59.1 | 51.7 | 57.2 | 60.8 | 60.3 |
| Inedible parts weight, g | 120.04± 6.32 | 127.95± 5.21 | 120.44± 4.21 | 122.78± 4.98 | 122.55± 3.25 |
| Inedible parts yield, % | 40.9 | 48.3 | 42.8 | 39.2 | 39.7 |

*p<0,05 – compared with the 1st group

The results of our studies indicate that different levels of lysine and methionine in the diets of young rainbow trout, during their growing has a different effect on the mass of internal organs (table 4).

There is a significant difference in the weight of such parts as the liver, stomach and intestine between the fish of the control and experimental groups. In particular, it was found that the increase in the diet of rainbow trout lysine to 2.9% and methionine to 0.95% during the growing season contributes to an increase in the mass of the liver, stomach and intestines. Thus, the weight of the liver, stomach and intestines in fish

of the 4th experimental group was 16.4%, respectively; 14.4% and 20.9% higher compared to similar indicators in the trout of the control group ($p < 0.05$; $p < 0.01$).

Table 4

**Mass of internal organs of two-year-old rainbow trout, g, n=5**

| Indicator | Groups | | | | |
|---|---|---|---|---|---|
| | 1-st | 2-nd | 3-rd | 4-th | 5-th |
| Heart | 1.02±0.01 | 1.20±0.06* | 1.21±0.09 | 1.32±0.09* | 1.28±0.06** |
| Liver | 4.14±0.33 | 3.72±0.30 | 4.63±0.63 | 4.82±0.53 | 4.74±0.71 |
| Kidneys | 1.88±0.06 | 1.76±0.07 | 1.89±0.07 | 1.93±0.07 | 1.90±0.09 |
| Stomach | 4.31±0.29 | 3.82±0.31 | 4.50±0.92 | 4.93±0.36 | 4.88±0.82 |
| Intestine | 4.79±0.37 | 2.74±0.22* | 3.31±0.49* | 5.79±0.22* | 4.18±0.64 |

*p<0,05; **p<0,01 compared with the 1st group

Feeding two-year-old rainbow trout of the 2nd group during the period of growing with complete feed with low lysine and methionine content, compared with the control, caused a decrease in the mass of the liver, stomach and intestines, respectively (according to the experimental scheme) by: 11.1%; 12.8% and 74.8% ($p<0.05$).

The use for feeding rainbow trout during the period of growing complete feed with a content of 2.6% lysine and 0.85% methionine (group 3) was accompanied by a probable decrease in intestinal mass by 44.7%, a slight increase in liver and stomach mass, respectively, by 11.8% and 4.4% compared with such indicators in the control group.

In general, it was found that the highest rates of internal organs weight were found in fish of the 4th group, which during the growing period was fed complete feed with a higher content of lysine by 0.1% and methionine – by 0.05%.

The next step was the study of a comprehensive assessment of fish raw materials for the content of essential nutrients, biological value of proteins and biological efficiency of fats are shown in table 5.

Table 5

**The chemical composition of the muscle tissue of commercial rainbow trout, %, n=5**

| Indicator | Groups | | | | |
|---|---|---|---|---|---|
| | 1-st | 2-nd | 3-rd | 4-th | 5-th |
| Water | 72.8±1.88 | 73.1±1.91 | 72.3±1.77 | 71.8±1.68 | 72.1±1.63 |
| Dry substance | 27.2±1.22 | 26.9±1.31 | 27.7±1.44 | 28.2±1.51 | 27.9±1.48 |
| Crude protein | 22.6±0.52 | 21.8±0.93 | 21.9±1.12 | 24.6±0.64* | 24.9±0.78* |
| Crude fat | 4.12±0.22 | 4.01±0.30 | 3.98±0.28 | 3.84±0.44* | 3.92±0.51 |
| Ash | 1.49±0.11 | 1.51±0.03 | 1.54±0.13 | 1.56±0.15 | 1.63±0.19 |
| Calcium | 0.72±0.09 | 0.66±0.08 | 0.74±0.10 | 0.79±0.09 | 0.76±0.08 |
| Phosphorus | 0.13±0.01 | 0.14±0.02 | 0.17±0.01* | 0.15±0.02 | 0.14±0.03 |

*p<0,05; compared with the 1st group

Analysis of the data in Table 5 showed that the muscle tissue of rainbow trout, regardless of the influence of the studied factor, is characterized by a high protein content (21.8-24.9%).

The results of our research show that the use of compound feeds with different levels of amino acid nutrition in the diets of rainbow trout biennials during their growing has different effects on the chemical composition of muscle tissue.

Thus, the increase in lysine and methionine levels during the growing period contributed to a decrease in the content of crude protein in muscle tissue. In the muscle tissue samples of fish of the 2nd and 3rd experimental groups, the crude protein content was 3.7% and 3.2% lower, respectively, compared to the same indicator of the fish of the control group.

It has been found that feeding rainbow trout biennials with complete rations with the same level of protein and energy, but with different content of amino acids such as methionine and lysine, does not significantly affect the content of dry substance, ash and minerals in muscle tissue.

At the same time, when feeding the fish of the 4th group of complete feed with increased by 0.1% lysine content and 0.05% methionine, an increase in muscle content of crude protein and dry substance by 1.0% and 2.0%, respectively, as well as a decrease in crude fat content – by 0.28%, compared with the control group. However, the content of ash, calcium and phosphorus in the muscle tissue of this group did not differ significantly.

The increase in the level of amino acid nutrition of trout of the 5th group was also accompanied by an increase in the content of crude protein, dry substance and ash in the muscles, compared with those of the control group analogues. It was found that as the dry substance content in the muscles increases, the content of organic matter in them increases, and the main part of it is protein. The protein content in muscles of trout of the 4th and 5th experimental groups exceeded the control analogues and fish of the 2nd and 3rd experimental groups.

In general, during the growing period, the greatest nutritional value was characterized by the muscle tissue of rainbow trout biennials, which were fed feed with a high content of lysine by 0.1% and methionine – by 0.05%.

**Conclusions.** It was found that the weight of the liver, stomach and intestines in fish of the 4th experimental group was 16.4%, respectively; 14.4% and 20.9% higher compared to similar indicators in the trout of the control group.

As a result of research, it was found that the weight of internal organs have the highest indicators of fish of the 4th group, which during the growing period were fed complete feed with a high content of lysine by 0.1% and methionine – by 0.05%.

It is proved that when feeding fish of the 4th group of complete feed with increased by 0.1% lysine content and 0.1% methionine, there was an increase in muscle protein content of crude protein, dry substance by 1.0% and 2.0% respectively and a decrease in crude fat content – by 0.28%, compared with fish of the control group.

Trout of the 4th and 5th experimental groups in terms of protein content in muscles exceeded the control analogues and fish of the 2nd and 3rd experimental groups.

## REFERENCES:

1. Jobling M. Fish nutrition research: Past, present and future. *Aquaculture International.* 2016. № 24. P. 767–86.

2. Mahmud S., Chakraborty C., Das M. Performance of rainbow trout (Oncorhynchus mykiss) fed on different dietary protein with fixed energy ratio. *Asian-Australasian Journal of Animal Sciences.* 1996. № 9 (1). P. 31–35.

3. Cowey C. B. Nutrition: estimating requirements of rainbow trout. *Aquaculture*. 1992. № 100. P. 177–189.

4. Alami-Durante H., Cluzeaud M., Duval C. Early decrease in dietary protein:energy ratio by fat addition and ontogenetic changes in muscle growth mechanisms of rainbow trout: short- and long-term effects. *British Journal of Nutrition.* 2014. № 112. P. 674–687.

5. Bureau D.P., Kaushik SJ., Cho CY. Bioenergetics. In Fish Nutrition, 3rd ed., [J.E. Halver and R.W. Hardy, editors]. San Diego, CA: Academic Press. 2003. P. 1–59.

6. Khan K., A. Rodrigues, M. Cleber. Dietary protein quality and proper protein to energy ratios: a bioeconomic approach in aquaculture feeding practices. *Latin American Journal of Aquatic Research*. 2019. № 47(2). P. 232–239.

7. Бобель І.Ю., Півторак Я.І. Стратегія ефективності годівлі форелі кормами Alleraqua. *Науковий вісник Львівського національного університету ветеринарної медицини та біотехнологій імені С.З. Ґжицького*. 2018. Т. 20. № 84. С. 88–92.

8. Kim J.D., Kaushik S.J. Contribution of digestible energy from carbohydrates and estimation of protein/energy requirements for growth of rainbow trout (Oncorhynchus mykiss). *Aquaculture.* 1992. № 106 (2), P. 161–169.

9. Єгоров Б.В., Фігурська Л.В. Стан та перспективи розвитку форелівництва у рибоводних господарствах України. *Зернові продукти і комбікорми*. 2011. № 2. С. 37–39.

10. Наукове обґрунтування раціональної годівлі риб : довідково-навчальний посібник / І.М. Шерман та ін. Київ : Вища освіта, 2002. 126 с.

11. Соврачев К.Ф. Основы биохими и питания рыб. Москва : Легкая и пищевая промышленность, 1982. 247 с.

12. Glencross B.D., Booth M., Allan G.L. A feed is only as good as its ingredients – a review of ingredient evaluation strategies for aquaculture feeds. *Aquaculture Nutrition*. 2007. № 13. P. 17–34.

13. Karabulut H.A., Yandi I., Aras N.M. Effects of different feed and temperature conditions on growth, meat yield, survival rate, feed conversion ratio and condition factor in rainbow trout (*Oncorhynchus mykiss*) fingerlings. *Journal of Animal and Veterinary Advances.* 2010. № 9 (22), P. 2818–2823.

14. Van Larebeke M., Dockx G., Larondelle Y. et al. Relative influence of dietary protein and energy contents on lysine requirements and voluntary feed intake of rainbow trout fry. *British Journal of Nutrition*. 2018. № 119. P. 42–56.

15. Плохинский Н.А. Руководство по биометрии для зоотехников. Москва : Колос, 1969. 246 с.

16. Канидьев А.Н. Инструкция по разведению радужной форели. Москва : ВНИИПРХ, 1985. 59 с.

17. ГОСТ 1368-2003. Рыба. Длина и маса. Межгосударственный стандарт. [Чинний від 01.01.2005]. Издательство стандартов, Москва, 2004. 14 с.

18. ДСТУ 8718:2017. Риба та рибні продукти. Методи визначення золи та мінеральних домішок. [Чинний від 01.01.2019]. Технічний комітет стандартизації «Рибне господарство». Київ, 2017. 15 с.

19. ДСТУ 8030:2015 Риба та рибні продукти. Методи визначення білкових речовин. [Чинний від 01.01.2017]. Технічний комітет стандартизації «Рибне господарство». Київ, 2015. 17 с.

20. ДСТУ ISO 11885:2005 Якість води. Визначання 33 елементів методом атомно-емісійної спектрометрії з індуктивно-зв`язаною плазмою. [Чинний від 01.01.2008]. Інститут сцинтиляційних матеріалів НАН України, Харків, 2007. 18 с.