Improving the quality of broiler meat when using sea buckthorn meal in feed

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Abstract. Sea buckthorn berries and products of their processing, including meal, have certain prospects in improving broiler meat production. The present paper contains materials on feeding broilers with sea buckthorn meal in the amount of 0.4-0.6% of the basic diet of chickens. Meal was added to the feed of broilers starting with Day 14 and up to Day 49 of age. The feed intake (basic diet), clinical condition of chickens, daily weight gains and preslaughter live weight were considered. The study was carried out by comparing to the group of chickens of the same age that received additional 0.4-0.6% feed instead of 0.4-0.6% of sea buckthorn meal. At the age of 49 days all chickens were slaughtered for further study of meat characteristics comparing to meat of broilers of the control group. The use of sea buckthorn meal in feeds during 35 days in the amount of about 0.6% of the basic diet provided 11% increase of daily weight gain of broilers compared to the control group and improved consumer as well as veterinary and sanitary meat characteristics.

1. Introduction
Provision of population with food is one of top-priority problems of any state. Food security of a country determines the level of economic development of the society. The level of provision of population with meat and meat products, i.e. proteins of animal origin, is believed to be of greatest importance in development of agro-industrial sector enterprises. Further increase in meat production in many world countries, including Russia, is connected with development of broiler poultry farming, i.e. with maximum use of areas and feeds [1]. At that, genetic characteristics of broilers, chicken raising time periods and technologies are constantly improved [2-5]. There are many ways to improve broiler meat production, however, the main ones are use of different feed additives making it possible to improve use of feeds and increase recommended daily weight gains [6, 7]. Among many feed additives recommended for feeding broiler chickens natural and biological preparations that have the greatest impact on live
weight gain in conditions of existing process cycles while keeping high safety characteristics of poultry meat are considered to be valuable [8-10].

We believe that sea buckthorn berries and products of their processing, including meal, have certain prospects in increasing broiler meat production.

It was established a long time ago that birds and rodents of many species accommodate themselves to living in groves overgrown with sea buckthorn shrubs. All dwellers of sea buckthorn shrubs have a high biological activity, increased body weight and attractive appearance. This contributed to development of sea buckthorn juice and oil production. Aby-product sea buckthorn oil production is meal. Sea buckthorn meal is a valuable feed product that contains high-value proteins, hydrocarbons, fats, vitamins, and mineral substances. Sea buckthorn meal is rich in vitamins A, B, B2, B6, F, E, K, P, contains vegetable sugars, pigments, tanning substances, to copherols, fatty acids, phytoncides, flavonoids, sterols, macro- and microelements. Sea buckthorn protein contains many essential and non-essential amino acids. Therefore, sea buckthorn meal is considered to be a valuable feed that can be used as an additional source of biologically active substances in feeding broiler chickens. Pectic substances present in sea buckthorn meal are capable of regulating water regime in tissues and participating in renewal of cell walls in different organs. Presence of carboxyl groups of galacturonic acid ensures the ability of pectic substances to bind ions of heavy metals and other harmful substances in the gastrointestinal tract with formation of insoluble complexes excreted from the organism together with excrements. It was established that sea buckthorn meal is biologically active supplementary feeds–adaptogens participating in regulation of many functions of the bird organism, which have a high energy potential, increase broiler meat production and improve meat quality [11].

In the light of the above, it follows from the literature data of domestic and foreign researchers that sea buckthorn meal has a wide range of positive effects on the functional systems of the body of birds. But at the same time, we have not found any information about the use of this valuable feed raw material in broiler poultry farming and its impact on the quality indicators of poultry meat. Therefore, today, the testing of sea buckthorn meal on broilers and the identification of the possibility of its use in industrial poultry farming is of scientific and practical interest.

The aim of this work was to show the effect of using sea buckthorn meal when feeding broiler chickens to increase live weight and improve the veterinary and sanitary parameters of white and red meat carcasses.

2. Materials and methods

Hemoglobin parameters were determined in the blood using a Sali hemometer. When calculating the number of erythrocytes and leukocytes, a unified counting method was used in the Goryaev counting chamber. Determination of the sedimentation rate of erythrocytes was carried out by the unified Panchenkov method with recalculation the exposure for an hour. Determination of hematocrit was carried out by the hemoglobin cyanide method using a Hematocrim centrifuge CM 70 ELMI minicentrifuge (ELMI, Latvia).

After 35 days of the experiment, the broilers of the experimental and control groups at the age of 49 days were slaughtered. Organoleptic assessment of broiler meat was carried out by a commission on a 5-point scale. Broiler meat and by-products were examined according to the “Rules for Veterinary Inspection of Slaughter Animals and Veterinary and Sanitary Examination of Meat and Meat Products” [12], SanPiN 2.3.2.1078-01 Hygienic Requirements for the Safety and Nutritional Value of Food Products [13]. Microbiological studies were carried out according to standard methods: sampling according to GOST 31467-2012 [14].

To determine the number of mesophilic aerobic and facultative anaerobic microorganisms (KMAFnM), the initial and a number of 10-fold dilutions were prepared to such an extent that it was possible to determine the estimated KMAFnM in 1 cm³ of flush. Inoculations were carried out by the submerged agar method simultaneously in two Petri dishes (parallel determinations) of 1 cm³ of the corresponding serial dilutions. Agar melted and cooled to the temperature of 45±1°C meat-peptone agar 18±2 cm² was added to each Petri dish with inoculums no later than 15 min later, and the inoculums
was evenly distributed throughout the nutrient medium. Petri dishes with inoculations were placed on a horizontal surface until the nutrient medium solidified completely. After solidification of the medium, the inoculation dishes, turned upside down, were cultured in a thermostat at a temperature of 30±1°C for 72 ± 3 h after 24±1 h. To calculate the KMAFAnM, all grown colonies were taken into account in dilutions, the number of colonies in which was not more than 300 [15].

If necessary, for additional confirmation of the belonging of the identified bacteria that grew on liquid media with the formation of gas, subcultures were carried out to obtain isolated colonies by streaking on the surface of a crystal of violet neutral red bile lactose agar (VRBL-agar). The inoculations were incubated at 37±1°C for 24 h and the growth of typical and atypical colonies was noted [16].

For additional confirmation, at least five typical and atypical colonies were selected from Petri dishes with inoculations. Each selected colony was subcultured onto the surface of a nutrient agar slant. The inoculations were incubated at 37±1°C for 24 h. The belonging of the grown bacteria to coliform bacteria was determined in relation to the Gram stain, the absence of oxidase, and the fermentation of lactose.

When Salmonella was detected for a preliminary nonselective, 225.0±0.1 cm³ of peptone-buffer medium and 25 ± 0.1 g of meat samples were inoculated and incubated at 37±1°C for 18±2 h. For selective enrichment from the medium of preliminary non-selective enrichment, 0.1 cm³ cultures were subcultured into 10.0 ± 0.1 cm³ of Rappaport-Vassiliadis medium with soybeans (RVS-broth) and 1.0 cm³ cultures were subcultured into 10.0±0.1 cm³ into tetrathionate broth (Müller-Kaufmann). Inoculations in RVS broth were incubated at 41.5±1.0°C for 24±3 h, in tetrathionate broth (Müller-Kaufmann) were incubated at 37±1°C for 24±3 h. To isolate a pure culture after incubation on selective media, inoculum was inoculated on XLD-arap and bismuth-sulfite agar. For the identification of Salmonella, we used a set of test systems API 20E API 20E (Bio Merieux, France). Confirmation of the belonging of the isolated cultures to bacteria of the genus Salmonella was carried out by serological identification using the agglutination reaction [17].

The detection and determination of Staphylococcus aureus (S. aureus) was based on the method of inoculation of the analyzed product sample or its dilution in a liquid selective medium, incubation of the inoculations followed by subculture of the culture liquid on the surface of an agar selective-diagnostic medium, identification of typical and (or) supposed colonies, confirmation of their belonging to S. aureus by morphological, cultural characteristics and biochemical properties [18].

When gram-positive cocci (more often collected in bunches) were detected, coagulating rabbit blood plasma, forming catalase and acetoin, fermenting maltose under aerobic conditions and mannitol under anaerobic conditions, the conclusion was made about the presence of S. aureus in the analyzed sample.

To identify Listeria monocytogenes, a portion of meat (25±0.1g) was introduced into 225 cm³ of medium for preliminary enrichment of Fraser broth and cultivated at 30±1°C for 24±2 h. After incubation, samples in an amount of 0.1 cm³ were subcultured into 10 cm³ of Fraser broth (the second enrichment medium) and incubated at 37±1°C for 48 h [19].

After incubation, the test tubes were inoculated with a bacteriological loop from the culture liquid onto the surface of an agar selective diagnostic medium (PALKAM agar). The inoculation was incubated at 37±1°C for 24–48 h. After incubation, the inoculation plates were viewed and the growth of characteristic colonies was noted. In the absence of growth of Listeria colonies on agar medium, the study was stopped and it was concluded that there was no Listeria monocytogenes in the test product sample.

On PALKAM agar, after 24 h, listeria formed small grayish-green or olive-green colonies with a black halo with a diameter of 1.0 to 1.5 mm, sometimes with a black center.

When gram-positive short thin rods, catalase-positive, not reducing nitrates to nitrites, mobile at 22±1°C and immobile or weakly mobile at 37±1°C, were detected in the inoculations, it was concluded that bacteria of the genus Listeria were present in the analyzed sample.

To confirm the belonging of the identified colonies to the species L. monocytogenes, we used Listeria, a kit for the identification of bacteria of the genus Listeria 10300 (Bio Merieux, France).

Clostridium perfringens were detected according to GOST 7702.2.6-2015 [20]. The initial suspension (1 cm³) was placed in two Petri dishes and 15 cm³ of iron sulfite agar was poured and
incubated in an anaerostat at 37±1°C for 24...48 h. At least five colonies were subcultured into tubes with Kitt-Tarozzi medium and incubated at 37±1°C for 24...72 h. Black colonies surrounded by a black zone were classified as sulfite-reducing bacteria. To confirm the belonging of the isolated sulfite-reducing bacteria to the genus Clostridium, smear microscopy was performed, the absence of catalase activity and the presence of anaerobic growth were confirmed.

The quality indicators of meat were determined according to Russian normative documents [21-25]. To determine the mass fraction of moisture, the meat was minced. Then, the sample prepared for testing was placed in a glass jar with a ground stopper, with a capacity of 200...400 cm³, filling it completely, and kept at 3...5°C until the end of the test. The tests were carried out for 24 h. Sand was placed in the bottle in an amount approximately 2-3 times higher than the weighed sample of the product, a glass rod slightly longer than the diameter of the bottle (so that it did not interfere with closing the bottle with a lid) and dried in a drying oven in an open bottle at temperature (103 ± 2) °C, within 30 minutes. Then the bottle was closed with a lid, cooled in a desiccator to room temperature, and weighed. A sample (4...5 g) was added to a weighed weighing bottle with sand and re-weighed. The contents were poured into 5 cm³ of ethyl alcohol and stirred with a glass rod. The bottle was placed in a water bath at 80...90°C and, stirring with a stick, heated until the smell of ethyl alcohol disappeared. Then the sample was dried for 2 h in a drying oven at 103±2°C, cooled in a desiccator and weighed. Drying was continued until constant weight. Each re-weighing is carried out after drying for 1 hour at 103±2°C. The results of two successive weighing should not differ by more than 0.1% of the sample weight.

The mass fraction of moisture (x) in percent was calculated by the formula (1):

$$X = \left(\frac{m_1 - m_2}{m_0} \times 100\right) \div \left(\frac{m_1}{m_0}\right),$$  

where $m_0$ is the mass of the weighing container with sand and a stick, g; $m_1$ – the mass of a weighing container with sand, a stick to the sample, g; $m_2$ – weight of the weighing bottle with sand, stick and sample after drying, g.

The arithmetic mean of two parallel determinations was taken as the final result. The dry residue was calculated as 100% - mass fraction of moisture%. To determine the protein, we used the Kjeldahl mineralization of the sample, the distillation of ammonia into a sulfuric acid solution, followed by titration of the test sample.

The mass fraction of total nitrogen (X), in percent, was calculated by the equation (2):

$$X = \left(0.14 \times (V_1 - V_2)\right) \div m,$$

where $m$ is the mass of the sample, g; $V_1$ – volume of acid, consumed for titration of the test sample, cm³; $V_2$ – the volume of acid, consumed for titration of the control sample, cm³.

The mass fraction of total protein (X1), in percent, was calculated by the formula (3):

$$X_1 = 6.25 \times X,$$

where $X$ is the average mass fraction of total nitrogen in the test sample, calculated by the formula (1),%.

Determination of fat was carried out by the method of accelerated determination of fat, based on the extraction of total fat contained in meat, a mixture of chloroform and ethyl alcohol in a filter separating funnel. The amount of the extracted fat was determined by weighing. A sample of the product weighing (2.0 ± 0.2 g) was transferred into a filter separating funnel, 20 cm³ of an extracting mixture consisting of chloroform and ethyl alcohol in a ratio of 2:1 was poured in, and extraction was performed. Then 20 cm³ of the extract was transferred into a pre-dried and weighed weighing bottle. The bottle was dried for at least 10 minutes at 103±2°C, cooled in a desiccator over calcium chloride to room temperature and weighed on a balance. Next, the presence of non-lipid impurities was determined using chloroform.

The mass fraction of fat (X) in percent was calculated by the equation (4):

$$X = \left(\frac{(m_1 - m_2) \times 500}{(m \times 20)}\right) \times 100.$$


where \( m_1 \) is the mass of the container with fat, g; \( m_2 \) – weight of a weighing bottle with a non-lipid fraction, g; \( 50 \) is the total volume of the extract, cm\(^3\); \( m \) is the weight of the sample, g; \( 20 \) – volume of extract taken for drying, cm\(^3\). Calculations were carried out with an error of \( \pm 0.1\% \).

Determination of the content of extractive substances was carried out according to the formula: 100% minus the sum of dry fat-free substance, protein and mineral substances, and crude ash.

To determine ash content, the essence of the method is to determine the mass of the residue after incineration and subsequent calcination of the sample.

The mass fraction of crude ash (\( X \)) in percent in the test sample was calculated by the formula (5):

\[
X = \left( \frac{m_2 - m_0}{m_1 - m_0} \right) \times 100, \tag{5}
\]

where \( m_0 \) is the crucible mass, g; \( m_1 \) – the mass of the crucible with a sample before ashing, g; \( m_2 \) is – the mass of the crucible with ash, g.

The arithmetic mean of the results of two parallel determinations was taken as the final test result.

The mass fraction of crude ash (\( X_1 \)) as a percentage in terms of dry matter was calculated by the formula (6):

\[
X_1 = \left( \frac{X}{100} \right) \times \left( 100 - w \right), \tag{6}
\]

where \( X \) is the mass fraction of crude ash in the test sample, %; \( w \) – the moisture content of the test sample.

The reaction to ammonia and ammonium salts was based on the ability of ammonia and ammonium salts, when exposed to Nessler's reagent, to cause a yellow-brown color. The reaction was carried out with a meat extract.

To prepare the extract, pieces of meat were cut out from the surface and deep layers of the hip muscles, freed from fat, connective tissue, and ground. We took 5 g of the resulting minced meat, placed in a flask and poured 20 ml of distilled water, infused for 15 min with three times shaking, after which the extract was filtered through a paper filter. A 1 ml extract was pipetted into a test tube and 10 drops of Nessler's reagent were added. The contents of the tube were shaken, a change in the color and transparency of the extract was observed.

Meat was considered fresh if the extract acquires a greenish-yellow color and remains transparent (darks slightly). When the freshness of poultry meat was doubtful, the extract turned into an intense yellow color, sometimes with an orange tint; significant turbidity was observed with a thin layer of sediment precipitation after settling for 10-20 min. The extract of stale meat acquired a yellowish-orange color; rapid formation of large flocs precipitated was noted.

To determine the peroxidase, we used the method based on the ability of the peroxidase enzyme in the presence of hydrogen peroxide to oxidize benzidine with the formation of a blue-green compound. The reaction was carried out with an extract, for this purpose, 2 ml of extract and 4-5 drops of 0.2% benzidine solution were introduced into the test tube with a pipette, the contents of the test tube were shaken, after which two drops of 1% hydrogen peroxide solution were added and the change in the color of the extract was observed.

The meat was considered fresh if the extract acquires a blue-green color, turning into brown-brown within 1-2 minutes. If the meat was stale, the extract did not turn into the typical blue-green color or a brown-brown color was immediately formed.

To examine volatile fatty acids, we separated them from a sample of minced meat by steam distillation and determination of their amount with sodium or potassium hydroxide. The meat was considered fresh if the amount of volatile fatty acids per 100 g did not exceed 4.5 mg of KOH; doubtful freshness – 4.5-9 mg KOH, and stale – over 9 mg of KOH.

Preliminarily received rendered fat was applied to determine acid and peroxide numbers of fat. Meat was considered fresh if the acid number of fat in chilled and frozen carcasses did not exceed 1.

The pH of meat was determined by pH-211 Microprocessor pH Meter (Hanna Instruments, Germany) in an aqueous extract prepared in a ratio of 1:10. The mixture was infused for 30 min with periodic stirring and filtered through paper filter.
To provide the reaction with 5% copper sulfate, in a conical flask was placed 20 g of minced meat, added 60 ml of distilled water and thoroughly mixed. The flask was covered with glass and heated for 10 min in a boiling water bath. Then the hot broth was filtered through a thick layer of cotton wool 0.5 cm thick into a test tube placed in a glass of cold water. If protein flakes remained in the filtrate, it was filtered again through filter paper. After filtration, 2 ml of the filtered broth was poured into a test tube and 3 drops of 5% copper sulfate solution were added, shaken 2-3 times and kept for 5 min.

Broth of stale meat was characterized by the formation of flakes or a jelly-like clot of blue-blue or greenish color.

3. Results and discussion
During the experiment, broiler chickens from the experimental and control groups did not have clear differences in all parameters. During the experiment, the chickens of the experimental group, i.e. Chickens fed with sea buckthorn cake were more favorable compared to broilers in the control group. In the experimental group, feed consumption increased and the clinical activity of the herd was more pronounced. The hematological parameters of the broilers in the experimental group exceeded those of the chickens in the control group.

There was an increase in red cell count, level of hemoglobin and hematocrit, reduction of white cell count in blood of the experimental group broilers (table 1). It was found that the most pronounced changes were revealed in the number of erythrocytes and hemoglobin in the blood of chickens from the experimental group.

| Parameters            | Broiler groups       | Deviations |
|-----------------------|----------------------|------------|
|                       | Experimental         | Control    |            |
| Red cells, mln/ml     | 3.95±0.19*           | 3.52±0.14  | +0.43      |
| Blood hemoglobin, g/% | 114.27±4.57*         | 105.19±4.21| +9.08      |
| Hematocrit, %         | 32.71±1.31*          | 31.01±1.24 | +1.70      |
| White cells, ths/µl  | 21.76±0.87*          | 22.06±0.86 | -0.30      |

*р≤0.05

Chickens that were fed with sea buckthorn meal had a close live weight before the experiment (from 805 to 808 g). However, daily weight gains of broilers of the experimental group made up 68.2…68.9 g, while those of broilers of the control group - about 52.8…54.6 g.

The live weigh to experimental chickens at the age of 49 days reached 2,387…2,411 g, that of control broilers – 1,848…1,911 g, which made up 77.3…79.9% of the chickens weight that were fed with sea buckthorn meal. The survival rate of the control group chickens made up 98.34%, that in experimental one – 100%. No signs of any diseases were observed. Upon laught of all experimental and control broilers deviations in the chemical composition, physical and chemical and microbiological parameters were revealed. Chickens that were fed with sea buckthorn meal with their basic diet had a more attractive appearance in terms of the carcass shape and feathering. Most carcasses of the experimental group (72.5%) had figures of Category 1. At that, figures of category 2 of body condition were seen more often. Skeletal muscles on the carcasses of all broilers were well developed and had rather high organoleptic properties. The weight of eviscerated chickens of the experimental group was 11.2-11.3% higher than the weight of carcasses of control broilers. The slaughter yield in the experimental group made up 87.75%, in the control group– 83.95%.

The yield of breast muscles in experimental group carcasses reached 21.99%, that in control group carcasses– 20.27%. The water content in muscles of broilers fed with sea buckthorn meal was 1.16-1.59% less comparing to muscles of the control chickens. The content of protein was 0.77-0.89% higher, that of lipids - 0.55-0.68% higher, that of ash elements - 0.16-0.17% higher. The content of extractive substances in meat of experimental broilers was 0.18% higher. At that, the protein-fat ratio in meat of
chickens was more favorable in the experimental group and reached 4.8-5.7 (table 2).

Table 2. Parameters of chemical composition of broiler meat.

| Parameters              | Broiler groups | Deviations |
|-------------------------|----------------|------------|
|                         | Experimental   | Control    |       |
| Thigh muscles           |                |            |       |
| Water, %                | 70.85±2.98     | 72.44±3.11 | -1.59 |
| Protein, %              | 20.68±0.89     | 19.79±0.94 | +0.89 |
| Lipids, %               | 4.57±0.21      | 3.89±0.17  | +0.68 |
| Ash, %                  | 1.18±0.05      | 1.01±0.05  | +0.17 |

Breast muscles

| parameters              | Broiler groups | Deviations |
|-------------------------|----------------|------------|
|                         | Experimental   | Control    |       |
| Water, %                | 70.72±2.91     | 71.88±3.23 | -1.16 |
| Protein, %              | 21.49±1.02     | 20.72±0.97 | +0.77 |
| Lipids, %               | 3.72±0.16      | 3.17±0.14  | +0.55 |
| Ash, %                  | 1.18±0.51      | 1.02±0.04  | +0.16 |

*p≤0.05

The physical and chemical parameters of meat of experimental group chickens also significantly differed from meat of control broilers. The results of these studies are given in table 3.

Table 3. Results of physical and chemical analysis of meat of broilers.

| Parameter                        | Meat samples | Broiler groups | Deviations |
|----------------------------------|--------------|----------------|------------|
|                                  |              | Experimental   | Control    |       |
| pH of meat                       | red          | 6.29±0.29      | 6.02±0.29  | +0.27 |
|                                  | white        | 5.87±0.24      | 5.91±0.28  | -0.04 |
| Reaction with 5% copper sulphate|              |                |            |       |
|                                  | red          | –              | –          | –      |
|                                  | white        | –              | –          | –      |
| Reaction to peroxidase           |              |                |            |       |
|                                  | red          | +              | +          | +      |
|                                  | white        | +              | +          | +      |
| Water-binding capacity, %        |              |                |            |       |
|                                  | red          | 43.8±0.19      | 41.2±1.95  | +2.6   |
|                                  | white        | 44.8±2.17      | 42.6±1.98  | +2.2   |
| Volatile fatty acids, mg KOH/100 |              |                |            |       |
|                                  | g            | red            | 2.71±0.11  | 2.86±0.13 | -0.15  |
|                                  |              | white          | 2.14±0.09  | 2.28±0.12 | -0.14  |
| Fat peroxide value, % iodine     |              |                |            |       |
|                                  | red          | 0.04±0.002     | 0.05±0.02  | -0.01  |
|                                  | white        | 0.03±0.001     | 0.04±0.01  | -0.01  |
| Fat acidity value, mg KOH/g      |              |                |            |       |
|                                  | red          | 1.27±0.05      | 1.32±0.05  | -0.05  |
|                                  | white        | 1.22±0.05      | 1.26±0.05  | -0.04  |
| Boiling test on a 1 to 5 scale   |              |                |            |       |
|                                  | red          | 4.8±0.22       | 4.4±0.21   | +0.4   |
|                                  | white        | 4.7±0.22       | 4.5±0.22   | +0.2   |

*p≤0.05
The data given in table 3 show that supplemental feeding of chickens with meal did not contribute to a significant shift in pH of meat, did not change reaction with 5% copper sulphate solution and reaction to peroxidase. At that, the water-binding capacity of meat increased by 2.2-2.6%. The quantity of volatile fatty acids reduced by 0.14-0.15 mg KOH/100g, fat peroxide value reduced by 0.01, acidity value reduced by 0.04-0.05, the organoleptic evaluation of broth and meat was 0.20-0.04 points higher comparing to the control group.

The results of microbiological studies of broiler meat confirmed favorable impact of sea buckthorn meal on the organism of chickens (table 4). According to the results of microbiological studies, the meat of the experimental and control broilers did not have significant differences. However, coliform bacteria were more often detected in the meat of control chickens, and the total microbial contamination of such broilers was \((6.0-1.1) \times 10\) CFU / g higher than in the meat of broilers that received sea buckthorn meal.

### Table 4. Results of microbiological studies of broiler carcasses.

| Carcass No | Mesophyll aerobic and optional-anaerobic microorganisms, CFU×10²/g* | Coliform bacteria, 0.1 g | Salmonella, 25 g | Staphylococcus aureus, g | Listeria monocytogenes, 25 g | Clostridium perfringens, g |
|------------|---------------------------------------------------------------|------------------------|-----------------|-------------------------|----------------------------|--------------------------|
| 1          | 1.7±0.07                                                      | —                      | —               | —                       | —                          | —                        |
| 2          | 1.1±0.40                                                      | —                      | —               | —                       | —                          | —                        |
| 3          | 2.1±0.09                                                      | +                      | —               | —                       | —                          | —                        |
| 4          | 1.3±0.06                                                      | —                      | —               | —                       | —                          | —                        |
| 5          | 1.1±0.04                                                      | —                      | —               | —                       | —                          | —                        |
| 6          | 1.7±0.08                                                      | —                      | —               | —                       | —                          | —                        |

| Carcasses of experimental chickens |
|------------------------------------|
| 1  | 2.3±0.10                        | +                      | —               | —                       | —                          | —                        |
| 2  | 2.1±0.09                        | —                      | —               | —                       | —                          | —                        |
| 3  | 2.1±0.10                        | —                      | —               | —                       | —                          | —                        |
| 4  | 2.4±0.11                        | +                      | —               | —                       | —                          | —                        |
| 5  | 2.3±0.11                        | +                      | —               | —                       | —                          | —                        |
| 6  | 2.1±0.09                        | —                      | —               | —                       | —                          | —                        |

* p≤0.05

### 4. Conclusion

Analysis of the obtained data makes it possible to conclude that the intensity of fattening of broiler chickens can be increased by inclusion of up to 0.6% of sea buckthorn meal to the basic diet. In this case daily weight gains, live weight of broilers, carcass slaughter yield are increased and meat quality parameters and its biological safety for consumers are improved. With a low cost of sea buckthorn meal as by-product in sea buckthorn oil production this supplemental feed will enable increasing profit in raising broiler chickens during 49 days.

### References

[1] Souillard R, et al. 2019 Husbandry practices, health, and welfare status of organic broilers in France. *Animals (Basel)* 9(3) 97 DOI: 10.3390/ani9030097

[2] Grashorn M A 2010 Research into poultry meat quality. *Br. Poult. Sci.* 51(1) 60 DOI: 10.1080/00071668.2010.506761
[3] Cai K, Shao W, Chen X Y L, Nair C M N, Suman S P, Beach M C, Guyton С and Schilling M W 2017 Meat quality traits and proteome profile of woody broiler breast (pectoralis major) meat. Poultry Sci. 97(1) 337 DOI: 10.3382/ps/pex284

[4] Aksoy T, Çürek D İ, Narinç D and Önenç A 2021 Effects of season, genotype, and rearing system on broiler chickens raised in different semi-intensive systems: performance, mortality, and slaughter results. Trop. Anim. Health Pro. 53(1) 189 DOI: 10.1007/s11250-021-02629-y

[5] Çavuşoğlu E and Petek M 2019 Effects of season, genotype, and rearing system on broiler chickens raised in different semi-intensive systems: performance, mortality, and slaughter results. Arch. Anim. Breed 62(1) 335 DOI: 10.5194/aab-62-335-2019.

[6] Potapenko E V, Evdokimov I A, Oboturova N P and Serov A V 2015 Efficiency of adding essential micronutrients to the diet of broiler chickens. Foods and Raw Materials 3(2) 82 doi.org/10.12737/13122

[7] Al-Hijazeen M and Al-Rabadi G 2017 Dietary energy source affecting fat deposition mechanism, muscle fiber metabolic and overall meat quality. Regulatory Mechanisms in Biosystems 8(3) 433 DOI: 10.15421/021767

[8] Egorova T A and Lenkova T N 2015 Rapeseed (Brassica napus L.) and its prospective use age in poultry diet. Agrobiology 50(2) 172 DOI: 105389/agrobiology.2015.2.172rus [in Russian]

[9] Acamovic T 2001 Commercial application of enzyme technology for poultry production. World Poultry Sci. J. 57(3) 225 Doi: 10.1079/WPS20010016/

[10] Bedford M R and Morgan A J 2007 The use of enzymes in poultry diets. World Poultry Sci. J. 52(1) 61 DOI: 10.1079/WPS19960007

[11] Qin X, Zhang T, Cao Y, Deng B, Zhang J and Zhao J 2020 Effects of dietary sea buckthorn pomace supplementation on skeletal muscle mass and meat quality in lambs. Meat Science 166 108141 DOI:10.1016/j.meatsci.2020.108141

[12] Rules of Veterinary Inspection of Slaughter Animals and Veterinary and Sanitary Examination of Meat and Meat Products (Moscow: Agropromizdat) p 39 [in Russian]

[13] SanPiN 2.3.2.1078-01 ‘Hygienic requirements of safety and nutritional value of food products (1 July 2002)

[14] GOST 31470-2012 Poultry Meat, Edible Offal and Semi-processed Products. Methods for Organoleptic and Physico-chemical Examinations [in Russian]

[15] GOST R 50396.1-2010 Poultry Meat, Edible Offal and Ready-to-cook Poultry Meat. Method for Quantity Determination of Mesophilic Aerobic and Facultative-anaerobic Microorganisms [in Russian]

[16] GOST R 54374-2011 Poultry meat, poultry by-products and semi-finished products. Methods for the detection and determination of the number of bacteria of the group of Escherichia coli (coliform bacteria) [in Russian]

[17] GOST 31468-2012 Poultry meat, by-products and semi-finished products from poultry meat. Salmonella detection method [in Russian]

[18] GOST R 54674-2011 Poultry meat, by-products and semi-finished products from poultry meat. Method for the detection and determination of Staphylococcus aureus [in Russian]

[19] GOST 32031-2012 Food products. Methods for the detection of bacteria Listeria monocytogenes [in Russian]

[20] GOST 7702.2.6-2015 Poultry meat, by-products and semi-finished products from poultry meat. Method for detecting and quantifying sulfite-reducing clostridia [in Russian]

[21] GOST 31470-2012 Poultry meat, by-products and semi-finished products from poultry meat. Organoleptic and physicochemical research methods [in Russian]

[22] GOST 33319-2015 Meat and meat products. Determination of the mass fraction of moisture [in Russian]

[23] GOST 25011-2017 Meat and meat products. Protein determination [in Russian]

[24] GOST 23042-2015 Meat and meat products. Determination of fat [in Russian]

[25] GOST 31727-2012 Meat and meat products. Determination of the proportion of ash [in Russian]