Improving the quality of broiler chicken meat without the use of antibiotics

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Abstract. The article presents impact study results of probiotic feed additives "Laktumin-1" and "Laktuvet-1" on growth, productive characteristics of broiler chickens of the "Cobb-500" cross and quality their meat. Study of meat quality and productivity of the chickens raised by technology without the use of antibiotics on the basis of experimental vivarium of Volga Region Research Institute of Manufacture and Processing of Meat-And-Milk Production was carried out in October 2020. The chickens were divided into three groups of one hundred chicks each and were raised up to 37 days of age. As a result of the studies, it was found that from the first ten-day period of the experiment, broiler chickens receiving "Lactumin-1" and "Laktuvet-1" surpassed the analogs of the control group in live weight. In the experimental meat samples taken from their pectoral muscles, protein content was higher than in the control group.

1. Introduction

White meat is traditionally used in human nutrition, including children and dietetic food, helps to normalize metabolism, quickly recover from surgery and serious traumas. Poultry meat is easily digestible, an excellent source of protein, considered an essential building block of a human body. This meat is economically available, easy to digest, and an excellent source of protein. This causes a stable increasing demand for it in the Russian Federation and increase in assortment of meat products based on it [1].

At the same time, modern mass breeding of chickens is associated with a large overcrowding of livestock, risks of infection and, as a result, a decrease in productivity and deaths of animals in large agricultural enterprises, complexes, holdings, which, in turn, necessitates the use of antibiotics. However, some producers, along with the use of antibiotic for prevention of seasonal diseases, use them as drugs to increase productivity of animals and poultry. Such a large-scale use of antibiotics in livestock production technology leads not only to increase of antibiotics content inside animals, but also to their transfer to meat and eggs. Ultimately, due to biomagnification, such drugs accumulate in human body, that increases risk of spread of pathogenic microorganisms, bacteria and viruses resistant to many types of antibiotics. That is why today the question of the use of antibiotic therapy in the
practice of poultry farming to prevent various infections remains controversial, and the search of alternatives to these substances is becoming actual topic for research [2, 3, 4, 5].

Currently, a large amount of experimental data indicates that probiotics can function as such an alternative since they are immunomodulators, capable to correct dysbacteriosis, regulation of microbiological processes in the digestive tract, treatment and prevention of diseases of gastrointestinal tract of alimentary and infectious etiology [3, 6-10].

Special attention among probiotics deserves lactulose – a synthetic disaccharide consisting of galactose residues and fructose molecules, which are structural isomers of lactose. In small intestine, there are no disaccharidases, which are necessary for hydrolysis of lactulose, so it is not adsorbed reaches large intestine unchanged. At the same time, being a prebiotic, it has a positive effect on growth of beneficial intestinal microflora, in particular bifidobacteria and lactobacilli.

On the basis of lactulose, domestic research centers have developed a number of successfully used drugs. "Lactumin-1" is a feed additive for feeding farm animals and poultry, which is a composition of natural biologically active substances obtained by combining honey extract from fresh Jerusalem artichoke tubers, dry milk molasses with lactulose and succinic acid. It is an outwardly homogeneous mass amber or brown color, without foreign smell and taste, except for those caused by the components of the composition. The presence of a crystalline lactose precipitate is allowed. The developer of the feed additive "Lactumin-1" is Volga Region Research Institute of Manufacture and Processing of Meat-And-Milk Production, Volgograd. The manufacturer of the additive is the Scientific-Implementation Center "New Biotechnologies" LLC, Volgograd.

"Laktuvet-1" - is a composition of organic acids with a prevailing content of lactic - 5.2% and citric 2.3%, as well as nitrogen-containing peptide substances. The additive contains up to 97% of dry matters, including lactulose - 14.6%, lactose - at least 25.2%, monose (galactose, glucose) - at least 12.5%, calcium - 3.4-4.4%, phosphorus - 1.4-1.7%, potassium - 0.7-1.7%, magnesium - 0.5-0.7% and other macro- and microelements. The feed additive does not contain genetically engineered modified products. Content of harmful impurities does not exceed maximum permissible standards in force in the Russian Federation. The developers of feed additive "Laktuvet-1" are Engineering Center of Institute of Living Systems of North-Caucasus Federal University and Dairy company "Stavropolskiy". The bifidogenic additive "Laktuvet-1" is used as a feed additive in the process of raising farm animals and poultry at a recommended dosage of 0.2-0.4 g per kg of live weight.

Feed additives "Lactumin-1" and "Laktuvet-1" enable to activate natural mechanisms and physiological processes in gastrointestinal tract of animals and poultry, better assimilate feed, increase natural bioconversion of feed in their body, which will directly affect the growth rate.

In practice, there are already examples of the use of lactulose-containing preparations in the diet of poultry. A good increase in live weight was observed in the broiler chickens - by 2.9-3.2% higher than in the control group, which also made it possible to reduce feed costs per unit of live weight gain by 2.9-3.1% in the experimental groups.

In this regard, scientific research aimed at production of chicken without the use of antibiotics and their partial replacement with lactulose-containing preparations is gaining high relevance.

The aim of this work is to study the effect of probiotic feed additives "Laktumin-1" and "Laktuvet-1" on growth, productive characteristics of broiler chickens of the "Cobb-500" cross and quality their meat.

2. Materials and methods

Study of broiler meat quality produced by technology without the use of antibiotics on the basis of experimental vivarium of Volga Region Research Institute of Manufacture and Processing of Meat-And-Milk Production was carried out in October 2020 on broiler chickens of the Cobb 500 cross. The chickens were divided into three groups of one hundred chicks each and were raised up to 37 days of age.

Poultry were fed manually with dry complete compound feed. Chickens of the control group were given standard dry compound feed, experimental group 1 - to standard compound feed were added
"Lactumin-1" at 0.5% by weight of compound feed, the experimental group II - "Laktuvet-1" at 0.5% by weight of compound feed. The first two days chickens was allowed to eat plenty and then daily feed intake was controlled. The slaughter was executed on 37th day of the experiment. To study physical-chemical properties (content of protein, fat, moisture, ash) and amino acid composition of meat the samples of pectoral and femoral muscles were taken.

Meat analysis was carried out in laboratory of Volga Region Research Institute of Manufacture and Processing of Meat-And-Milk Production in according with following methods: GOST 31470-2012 "Poultry meat, by-products and semi-finished products from poultry meat. Methods of organoleptic and physical-chemical research"; GOST 33319-2015 "Meat products. Moisture Determination Methods"; GOST 23042-2015 "Meat and meat products. Methods for determination of fat content"; GOST 25011-2017 "Meat and meat products. Methods for determination of protein content"; GOST 31727-2012 "Meat and meat products. Method for determination of total ash content". To determine amino acid composition, the method of measuring mass fraction of amino acids was used on system Kapel-105M.

3. Results and discussion

The feed additives used in the experiment had a positive effect on live weight gain of broiler chickens, which is shown in Table 1.

### Table 1. Dynamics of live weight.

| Age, days | Group          | Control         | Experimental I | Experimental II |
|-----------|----------------|-----------------|----------------|----------------|
| 1         | Live weight    | 43.0 ± 0.14     | 42.9 ± 0.17    | 42.89 ± 0.22   |
| 10        |                | 191.0 ± 1.9     | 201.4 ± 2.1*** | 201.8 ± 1.7*** |
| 20        |                | 824.2 ± 11.6    | 880.4 ± 10.9*** | 890.3 ± 9.8*** |
| 30        |                | 1442.1 ± 17.4   | 1522.0 ± 16.7*** | 1530.2 ± 15.84*** |
| 37        |                | 2246.7 ± 19.35  | 2365.7 ± 18.64** | 2386.7 ± 19.21** |
| 1-37      | Average daily gain | 59.56 ± 0.14   | 62.35 ± 0.21*** | 63.35 ± 0.18*** |
| Relative growth rate | 1.925 | 1.929 | 1.929 |

Starting from the first decade of the experiment, broiler chickens of experimental groups I and II surpassed the analogs of the control group by 5.44 (P ≥ 0.999) and 5.65% (P ≥ 0.999); 20 days - by 6.82 (P ≥ 0.999) and 8.02% (P ≥ 0.999); 30 days - by 5.54 (P ≥ 0.999) and 6.11% (P ≥ 0.999); 37 days - by 5.29 (P ≥ 0.99) and 6.23% (P ≥ 0.99), respectively. Over the entire period of the experiment, broiler chickens of the I and II experimental groups in terms of average daily gain were higher compared to the analogs of the control group - by 4.68 (P ≥ 0.999) and 6.36%. The calculation of relative growth rate of broiler chickens up to 37 days of age was higher in the experimental groups compared to the control. After corresponding period of keeping, physical-chemical studies of chicken meat were carried out. The results are shown in Table 2.

Experimental meat samples taken from breast muscles of broilers of experimental groups I and II contained more protein than the control group by 0.54 and 0.89% (P ≥ 0.95), respectively. However, moisture in meat samples obtained from broiler chickens of experimental groups I and II was less by 0.60 and 1.00% compared to the control group.

In the study of femoral muscles, it was found that broiler chickens of experimental groups I and II exceeded the analogs of the control group in protein content by 0.54 and 0.66% (P ≥ 0.95), fat - by 0.03 and 0.07% respectively. However, in terms of moisture content in the femoral muscles, poultry of experimental groups I and II were inferior to the analogs of the control group by 0.58 and 0.75%.
Table 2. Physical-chemical characteristics (n = 3).

| Index                  | Control     | Experimental I | Experimental II |
|------------------------|-------------|----------------|-----------------|
| **Pectoral muscles**   |             |                |                 |
| Protein content, %     | 23.71 ± 0.14 | 24.25 ± 0.23  | 24.60 ± 0.22*   |
| Fat content, %         | 1.33 ± 0.03  | 1.35 ± 0.04   | 1.42 ± 0.05     |
| Moisture content, %    | 73.7 ± 0.34  | 73.10 ± 0.24  | 72.70 ± 0.27    |
| Total ash content, %   | 1.26 ± 0.08  | 1.30 ± 0.06   | 1.28 ± 0.07     |
| **Femoral muscles**    |             |                |                 |
| Protein content, %     | 18.7 ± 0.12  | 19.24 ± 0.22  | 19.36 ± 0.17*   |
| Fat content, %         | 8.35 ± 0.24  | 8.38 ± 0.33   | 8.42 ± 0.31     |
| Moisture content, %    | 71.91 ± 0.37 | 71.33 ± 0.36  | 71.16 ± 0.29    |
| Total ash content, %   | 1.04 ± 0.07  | 1.05 ± 0.06   | 1.06 ± 0.05     |

One of the most important indicators assessed when establishing quality of raw meat is determination of content of nonessential and irreplaceable amino acids. Table 3 shows essential amino acids content in femoral muscles of broiler chickens of the studied groups.

Table 3. Protein amino acid rate of femoral muscles.

| Amino acid composition, g/100 g | Control | Experimental I | Experimental II |
|---------------------------------|---------|----------------|-----------------|
| Threonine                       | 81.23   | 83.26          | 85.26           |
| Tyrosine                        | 120.34  | 124.23         | 126.34          |
| Cystine                         | 180.26  | 182.21         | 184.35          |
| Valine                          | 73.26   | 75.46          | 77.41           |
| Methionine                      | 95.64   | 95.73          | 96.28           |
| Phenylalanine                   | 136.67  | 138.19         | 140.21          |
| Isoleucine                      | 91.67   | 92.34          | 93.54           |
| Leucine                         | 88.75   | 89.13          | 91.24           |
| Lysine                          | 157.76  | 159.25         | 160.24          |
| Tryptophan                      | 143.53  | 145.18         | 147.62          |

As can be seen from the data in table 3, broiler chickens of experimental groups I and II, grown with the use of probiotic feed additives, surpass the analogs of the control group in terms of content of almost all studied amino acids in meat. The same dynamics was observed in study of pectoral muscle of broiler chickens.

When calculating the protein-quality indicator of the femoral muscle of broiler chickens - ratio of nonessential amino acids to essential amino acids, it was found that chickens of experimental groups I and II exceeded the analogs of the control group by 0.17 and 0.34, and in the case of pectoral muscle by 0.26 and 0.41 respectively.

Serum analysis showed that broiler chickens of experimental groups I and II exceeded analogs of the control group in terms of content of albumin and glucose. Globulins and phosphorus contents in the control group more than the analogs experimental groups I and II.

The organoleptic assessment carried out on a 5-point scale showed that taste and aroma of bouillon and chicken meat of experimental groups I and II exceeded the control group in terms of the overall score when assessing the broth by 0.13 and 0.21 points, and meat - by 0.16 and 0.26 points, respectively.
4. Conclusion
An experiment on growing broiler chickens of the Cobb-500 cross using lactulose-containing feed additives "Lactumin-1" and "Laktuvet-1" was carried out. As a result of the studies, it was found that from the first ten-day of the experiment, broiler chickens receiving "Lactumin-1" and "Laktuvet-1" surpassed the analogs of the control group in live weight by 5.44 and 5.65%; 20 days - by 6.82 and 8.02%; 30 days - by 5.54 and 6.11%; 37 days - by 5.29 and 6.23%, respectively; in the experimental meat samples taken from their pectoral muscles, the protein contained more than in the control group by 0.54 and 0.89%, and in femoral muscles - by 0.54 and 0.66%, respectively.

High biological value of the broiler chickens meat obtained in the experimental groups receiving feed lactulose-containing additives "Lactumin-1" and "Laktuvet-1", in comparison with the control group, was confirmed as a result of analysis of amino acid composition, organoleptic evaluation and calculation results of protein-quality indicator.

All foressed allows us to recommend the use of biologically active feed additives in feeding broiler chickens to obtain high-quality meat.

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