Quality control and safety of broiler chickens slaughter products amid hypotrophy

K D Dzhambulatova¹, R Sh Taiguzin¹, A A Torshkov¹, M V Zabolotnykh²

¹Department of Veterinary and Sanitary Expertise and Pharmacology, Orenburg State Agrarian University, 18, Chelyuskintsev st., Orenburg, 460014, Russia
²Department of Veterinary and Sanitary Expertise of Livestock Products and Hygiene of Farm Animals, Omsk State Agrarian University named after P.A. Stolypin, 1, Institutskaya square, Omsk, 644008, Russia

E-mail: kaf12@orensau.ru

Abstract. The article studies the effect of different probiotics on the concentration of heavy metals in the muscle tissue of broiler chickens amid hypotrophy and their correction with probiotics. The experiment was conducted on broiler chickens of Smena 7 cross at ZAO “Orenburg Broiler” of the Orenburg region. The feeding and maintenance of broiler chickens were the same. The feeding ration comprised complete compound feed. The difference was as follows: hypotrophic experimental groups additionally included probiotics Vetom 1.1 at a dose of 6 g/kg feed and Lactobifadol at a dose of 1.2 g/kg feed in the main diet starting from one day of age to 42 days of age. The results obtained enable to determine that the probiotics used have a significant effect on the chemical parameters of broiler chicken meat particularly amid hypotrophy. It has been established that probiotics reduce the concentration of toxic elements in muscle tissue. It has also been proven that these probiotics do not significantly affect the content of heavy metals in the muscle tissue of broiler chickens.

1. Introduction

The consumption of chicken meat is increasing all over the world, mainly because it is inexpensive, compared to other types of meat and its nutritional properties are suitable for human health. The meat quality in general and poultry meat quality in particular is an extremely complex concept that can be evaluated from various perspectives (shelf life, safety, nutrient content, etc.). The quality and composition of poultry meat is influenced by numerous factors, such as genotype, sex, age, diet, growing conditions and pre-slaughter processing of poultry, as well as probiotics used in feeding [1].

Various medications are used to treat hypotrophy. Despite this, the introduction of new prophylactic drugs into veterinary practice remains an important topic, since not all drugs have effective pharmacological properties, low toxicity and minor side effects [2]. Therefore, special attention is paid to drugs that are environmentally friendly, do not accumulate in tissues and do not cause allergies.

The biological and nutritional value of poultry products is due to the content of complete proteins, fat, essential amino acids, polyunsaturated fatty acids, as well as macro- and microelements in meat. In recent years, various preparations that are safe for living organisms have been used to improve products quality. Probiotics added to feed change the ratio of beneficial and harmful microorganisms of the poultry microflora, thereby adjusting the following digestion process: splitting, absorption and
assimilation of feed nutrients affecting the immune system [3]. The metabolic products of probiotics and their own microorganisms provide an optimal environment for the normal symbiosis of protozoan bacteria, and are effective in removing heavy metals from the poultry body.

The greatest possible food safety including poultry products safety is a vital problem. Heavy metals are food contaminants presenting a real threat to human health. Their high toxicity and ability to accumulate in the human body necessitates research on methods for removing these toxic elements from food products including poultry meat. However, the removal of heavy metal compounds from finished food products is very difficult and inevitably leads to a decrease in product quality [4].

Therefore, a certain scientific and practical interest is aroused by the study of the peculiarities adherent to the individual probiotics influence on the growth and development of poultry, their health and meat products quality.

2. Materials and methods
To achieve this goal, the scientific research was conducted on broiler chickens of Smena 7 cross at ZAO “Orenburg Broiler” of the Orenburg region. To carry out research on the principle of analogs, 4 groups of chickens were formed. Specifically, they were as follows: one control and three experimental groups including 25 heads each: 1st control – normotrophic chickens, 1st experimental – hypotrophic chickens, 2nd and 3rd experimental – hypotrophic chickens. Keeping conditions, stocking density, observance of optimal zoohygienic microclimate parameters, feeding and watering areas of birds of all groups were the same. Access to water and feed was free. Adequate feeding is the most important factor affecting the quality and safety of poultry meat. Therefore, it must comply with the required physiological norms. The difference with this regard was as follows: the hypotrophics of the 2nd experimental group from one day to 42 days of age additionally received the probiotic Vetom1.1 at a dose of 6 g/kg of feed in the main diet, and the hypotrophics of the 3rd experimental group received Lactobifadol at a dose of 1.2 g/kg feed [5].

The nutritional value of poultry meat was determined based on its chemical composition (water, protein, fat, ash).

The water content in the meat was determined by drying the sample to constant weight at a temperature of 105°C (GOST 9793-74), the amount of ash – by the method of gradual combustion of meat samples in a muffle furnace, the amount of fat – by the Soxhlet method (GOST 23042-36), protein – by the amount of total nitrogen by mineralization of the sample according to Kjeldahl (GOST 25011-81). In addition, the content of heavy metals was determined in the meat.

The experiment to analyze the concentration of heavy metal salts was conducted in accordance with state standards.

Studies on the determination of heavy metals were carried out on an atomic absorption spectrophotometer SHIMADZU AA-6200 on the basis of the interdepartmental analytical laboratory of the Orenburg State Agrarian University. The research data was statistically processed using generally accepted methods.

3. Results and discussion
It is commonly known that physiologically immature chickens differ significantly from a full-fledged bird in many ways. They are less active, stunted, consume less feed, live weight and average daily gain are several times lower than that of a healthy bird.

To assess the general effect of probiotics on the body of hypotrophic chickens, we studied such criteria as the dynamics of growth in live weight, biochemical and hematological parameters of blood, morphological parameters of internal organs, the state of metabolism, changes in the chemical composition of meat and organs (Table 1).

After each slaughter, the chemical composition of the meat of broiler chickens against the background of probiotics use was studied. When determining the chemical composition of the pectoral muscles, it was found that in terms of moisture, protein and fat content, the chickens of the third
experimental group had the maximum value in comparison with the analogs of the control group. The moisture difference in 14 days was 0.27%; on day 21 – 0.07%; on day 28 – 0.123%; on day 35 – 1.28%; on day 42 – 1.51%. The research results of the birds of the 2nd experimental group showed that there was also a difference in moisture content with the control results, specifically, on day 14 – 0.22%; on day 21 – 0.05%; on day 28 – 0.19%; on day 35 – 1.28%; on day 42 – 0.92%.

Table 1. Impact of Lactobifadol and Vetom 1.1. on chemical composition of broiler chicken meat

| Age, days | Groups | Control | 1st experimental | 2nd experimental | 3rd experimental |
|----------|--------|---------|------------------|------------------|------------------|
|          | Moisture, % |        |                  |                  |                  |
| 14       | 75.70±2.51 | 74.95±0.74 | 75.92±0.98 | 75.97±0.98 |
| 21       | 74.41±0.76 | 73.12±1.21 | 74.46±0.52 | 74.48±0.52 |
| 28       | 75.67±0.68 | 74.84±0.23 | 76.86±0.73 | 76.9±0.68 |
| 35       | 75.48±0.15 | 74.73±1.12 | 76.76±1.32 | 76.76±1.33 |
| 42       | 75.38±0.93 | 74.29±0.45 | 76.30±0.67 | 76.89±0.63 |
|          | Crude fat, % |        |                  |                  |                  |
| 14       | 4.16±0.50  | 4.09±0.13  | 4.38±0.20  | 4.4±0.27*     |
| 21       | 4.40±0.36  | 4.17±0.25  | 4.61±0.32  | 4.68±0.33    |
| 28       | 4.42±2.55  | 4.34±2.52  | 4.51±0.20  | 4.59±0.21    |
| 35       | 5.55±0.66  | 4.74±0.18  | 5.89±0.44  | 5.89±0.47    |
| 42       | 5.43±0.32  | 4.33±0.31  | 5.55±0.20  | 5.61±0.21    |
|          | Crude protein, % |   |              |              |                  |
| 14       | 14.85±0.15 | 14.12±0.70 | 14.65±0.21 | 14.67±0.27   |
| 21       | 14.29±0.34 | 14.27±0.08 | 14.36±0.35 | 14.78±0.34   |
| 28       | 14.39±8.31 | 14.21±8.25 | 14.80±0.08 | 14.98±0.08   |
| 35       | 15.58±0.51 | 15.15±0.48 | 16.0±0.38  | 16.0±0.47    |
| 42       | 15.85±1.52 | 15.77±0.20 | 16.48±0.49 | 16.48±0.41   |
|          | Crude ash, % |        |                  |                  |                  |
| 14       | 1.40±0.01  | 1.40±0.02  | 1.41±0.02  | 1.52±0.02*    |
| 21       | 1.39±0.01  | 1.38±0.05  | 1.40±0.02  | 1.42±0.02    |
| 28       | 1.42±0.82  | 1.41±0.81  | 1.42±0.02  | 1.48±0.02    |
| 35       | 1.38±0.06  | 1.37±0.08  | 1.38±0.79  | 1.58±0.81*   |
| 42       | 1.42±0.03  | 1.41±0.01  | 1.43±0.02  | 1.85±0.03*   |

The birds of the 1st experimental group had lower moisture values than the control ones. The difference was from 0.75 to 1.29%.

The dry fat content in the chickens of the 3rd experimental group also had the maximum indicators, at the age of 14 days it exceeded the value of this indicator in broilers in the control group by 0.28%; at 21 days of age it exceeded the control by 0.28%; at the age of 28 days – by 0.37%; 35 days – by 0.34% and 42 days – by 0.18%.

This indicator in chickens of the second experimental group on day 14 exceeded the value of this indicator in broilers in the control group by 0.22%; at the age of 21 days it exceeded by 0.21%; at the age of 28 days – by 0.09%; of 35 days – by 0.34% and of 42 days – by 0.22%.

In poultry of the 1st experimental group, there was a tendency of a decrease in this indicator in relation to the control, the difference of which in 14 days was 0.05%; on the 21st day – 0.23%; on the 28th day – 0.08%; on the 35th day – 0.81; on the 42nd day – 1.1%.

When studying the protein content in muscle tissue in the birds of the 3rd experimental group at the age of 14 days, there was a decrease in the indicator by 0.18 and in the birds of the 2nd experimental group – by 0.20% compared to the data of the control group of chickens. However, in the future, an increase in protein was observed, and the difference between the values of the experimental and
control groups on day 21 was 0.49%; on day 28 – 0.59%; on day 35 – 0.42%; on day 42 the difference reached 0.63% in representatives which received Lactobifadol, also on day 21 – 0.07%; on day 28 – 0.41%; on day 35 – 0.42%; on day 42, the difference reached 0.63% in broiler chickens, which received Vetom 1.1.

The protein content in poultry of the 1st experimental group was lower than in the analogs from the control, the difference of which varied from 0.02 to 0.55%.

The amount of raw ash in meat samples of broiler chickens on the 14th day of 1st, 2nd experimental and control groups was relatively the same. However, in the chickens of the 3rd experimental group on the 14th day, this indicator was 0.12% more than the control one. On the 21st day, the amount of ash in poultry of the 1st experimental group was less by 0.01%, and the 2nd and 3rd experimental groups were higher by 0.01% and 0.03%, respectively, compared with the data of the control group. The same tendency was observed on the 28th day. Specifically, the ash content in the poultry of the 1st experimental group was less by 0.01%, in the representatives of the 3rd experimental group it was more by 0.06% in comparison to the control. On the 35th and 42nd days, this indicator in broilers of the first group was lower than the experimental one by 0.01%. In poultry of the 2nd experimental group, the ash content in the muscles was the same at 35th day of age compared to the data in the control group, and at 42nd day of age it exceeded by 0.01%. In broiler chickens of the 3rd experimental group, this indicator exceeded the control results at the 35th day of age by 0.2%, and at the 42nd day of age – by 0.43%.

Of particular interest were the results of studies aimed to determine the effect of the probiotics under study on safety indicators and on the content of heavy metals in the muscle tissue of broiler chickens (Table 2).

Table 2. Chicken broiler meat safety indicators

| Indicators                  | Control       | 1st experimental | 2nd experimental | 3rd experimental |
|-----------------------------|---------------|------------------|------------------|------------------|
| Toxic elements (mg/kg)      |               |                  |                  |                  |
| Pb                          | 0.205±0.015   | 0.234±0.02       | 0.203±0.009      | 0.227±0.004      |
| Cd                          | 0.023±0.001   | 0.025±0.002      | 0.021±0.002      | 0.023±0.004      |
| Hg                          | not detected  |                  |                  |                  |
| As                          | 0.014±0.001   | 0.019±0.001      | 0.015±0.001      | 0.015±0.001      |
| Heavy metals (mg/kg)        |               |                  |                  |                  |
| Cu                          | 0.06±0.003    | 0.06±0.002       | 0.065±0.003      | 0.061±0.002      |
| Co                          | 0.05±0.002    | 0.04±0.0051      | 0.057±0.003      | 0.05±0.003       |
| Fe                          | 3.63±0.538    | 3.51±0.26        | 3.53±0.35        | 3.52±0.36        |
| Zn                          | 2.51±0.42     | 3.52±0.43        | 2.52±0.36        | 2.53±0.34        |
| Mn                          | 0.10±0.006    | 0.12±0.015       | 0.11±0.004       | 0.11±0.027       |
| Radionuclides (Bq/kg)       |               |                  |                  |                  |
| 137Cs                       | 1.107         | 1.119            | 1.110            | 1.112            |
| 90Sr                        | 4.79          | 4.95             | 4.91             | 4.91             |
| Microbiological indicators  |               |                  |                  |                  |
| QMAFAnM CFU/g               | 1x10^2        | 1x10^3           | 1x10^2           | 1x10^3           |
| Pathogenic microorganisms are not allowed in 25 g |
| Salmonella                  | not detected  |                  |                  |                  |
It was found that the least accumulation of such toxic elements as lead and cadmium was noted in the 2nd experimental group.

The greatest amount of arsenic was detected in the muscles of the chickens of the 1st experimental group and the excess of the concentration over the control and experimental groups with correction was 26.3% and 21% respectively.

The highest content of copper and cobalt was observed in the second experimental group, which was higher by 6.2 and 13.8% as compared to the data of the control group respectively. The content of copper and cobalt in the experimental and control groups was relatively equal.

The iron content in muscle samples from poultry from the control group was higher than that of the experimental groups and the difference was 2.8, 2.4 and 2.6% respectively.

Comparing the data on the indicators of zinc and manganese in muscle tissue samples, the highest content could be observed in broiler chickens of the 1st experimental group. The content of zinc and manganese in all other groups was relatively equal.

The highest cesium content was recorded in the femoral muscles of the 1st experimental group and amounted to 1.119 Bq/kg, which exceeded the 2nd experimental group by 0.8%, the 3rd – by 0.62 and the control one – by 1.1%. The accumulation of strontium was more marked in the femoral muscles of hypotrophic chickens and the difference in comparison with the control group was 3.3% and in comparison with hypotrophic ones after correction with probiotics – 0.8%.

The microflora of meat was represented by both saprophytic microorganisms, whose glycolytic activity was useful in the production of meat products, and pathogenic, which not only reduced the organoleptic characteristics of meat but could also cause food diseases. Poultry meat was contaminated with microorganisms after slaughter and primary processing: during scalding, removal of plumage, gutting and cooling.

The results of the microbiological study showed that the total microbial contamination of the meat of the chickens of the experimental and control groups did not have significant differences and did not exceed the permissible normative indicators QMAFAnM – no more than \(1.0 \times 10^4\) CFU/g. Pathogenic microorganisms were not detected in all muscle samples studied.

4. Conclusion
Currently, when assessing the quality of meat, special attention is paid to the content of various toxic elements, which can accumulate and pose a real danger to animal and human health. Probiotics Lactobifadol and Vetom 1.1. are effective feed additives in the composition of complete feed

The results obtained demonstrate that the probiotics used have a significant effect on the physicochemical parameters of the meat of broiler chickens, and especially amid hypotrophy.

Based on the data obtained, it can be concluded that these probiotics do not have a significant effect on the content of heavy metals in the muscle tissue of broiler chickens.

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