Improvement of rabbit productivity using probiotics and herbal supplements

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Abstract. The use of probiotic supplements that normalize the microbiocenosis and enhance the resistance to pathogenic microflora can increase safety and meat productivity of farm animals. The aim of the article is scientific and practical substantiation of the increase in rabbit productivity using girasole beet pulp and the “Sporothermin” probiotic complex. The effects of the “Sporothermin” girasole beet pulp on safety, productivity, physiological status and chemical composition of rabbit meat were studied. 30 cross-bred rabbits aged 45 days were selected. The control group received the basic ration consisting of the PK-90 feed; the experimental groups received the PK-90 feed which included the probiotic complex “Sporothermin” (0.6 g/kg and 1.0 g/kg) and girasole beet pulp (10% to the feed weight). The quality of meat was evaluated at the age of 120 days after the control slaughter in the amount of 3 heads from each group. The data of morphological composition showed that rabbits of the experimental groups had a larger muscle tissue mass than rabbits of the control group by 9.07% and 20.15%, respectively. The analysis of the muscle tissue composition showed that the use of the Sporothermin at a dosage of 1.0 g/kg and girasole beet pulp at a dosage of 10% to the feed weight increases the average daily gains and meat productivity, improves the chemical composition which was confirmed by testing the data in the conditions of the industrial company “Lipetsk rabbit” and assessing physicochemical, functional, technological and organoleptic indicators of the resulting meat raw materials.

1. Introduction

In Russia, the most topical issue is production of high-quality animal products. The goal can be achieved through full feeding contributing to the growth rate, productivity and lower feed costs per unit of production. Manufacturers should abandon feed antibiotics that accumulate in the body of animals. In the conditions of industrial production of agricultural products, abandonment of antibiotics can cause mass diseases of animals. It is necessary to search for alternatives to feed antibiotics which can improve the resistance of animals to diseases [1-4].

Implementation of intensive breeding technologies in the rabbit breeding industry, an increase in livestock increased the anthropogenic and microbiological load on rabbits and caused impaired digestion, metabolism, reduced productivity and intestinal infections [5, 6].

The problem can be solved by using herbal supplements and probiotic complexes that improve the bioavailability of nutrients of feed and increase the safety of livestock without antibiotics used for therapeutic and prophylactic purposes.
The technology of livestock production aggravates the problem of full feeding. Poor feeding, veterinary and sanitary conditions of livestock buildings decrease the resistance of animals to various diseases. As a result, dysbacteriosis and immunodeficiency develop, the incidence rate increases, productivity decreases, and mortality increases [7-9]. All these consequences can be eliminated using probiotics.

The purpose of the work is to justify an increase in productivity of rabbits using girasole beet pulp and the probiotic complex Sporothermin as part of the biologically valuable compound feed.

2. Materials and methods
The main part of the experimental research consisted of scientific experiments conducted from 2017 to 2018 in Voronezh State Agrarian University at the Faculty of Veterinary Medicine and Livestock Technology and at the Research Center of the State Academy of Agricultural Sciences and the Center for Collective Use (Voronezh).

The objects of research were cross-bred rabbits obtained by selecting Soviet chinchilla and New Zealand red breeds aged 45 days. They were divided into the control and experimental groups consisting of 10 heads. Scientific and economic experiments were carried out according to the generally accepted methods [10] using the method of balanced groups-analogues. There were preparatory and accounting periods. Experimental groups consisted of clinically healthy animals. The maintenance and feeding of rabbits were in compliance with zoohygienic and zootechnical norms.

The rabbits of the control group were fed with full granulated feed PC-90; the experimental groups received feed rations based on the PC-90 feed (obtained on the basis of grain crops, sunflower cake, wheat bran, grass meal from alfalfa and KVP P90 premix -1K) which included the probiotic supplement Sporothermin (3·10^9) at a dosage of 0.6 and 1.0 g/kg of feed, as well as girasole beet pulp at a dose of 10% to the feed weight. The rations were optimized using the KormOptima program (KormoResurs LLC, Voronezh). Chemical analysis of feed and excretion products, hematological blood parameters were performed using standard laboratory methods.

When conducting the experiments, the total feed consumption was taken into account. The amount of feed spent was determined weekly by weighing the specified feeds and recalculating their nutritional value.

The dynamics of body weight was calculated by weighing the animals. To determine the meat productivity, three heads of rabbits from each group were slaughtered according to the VISH method. The meat productivity of rabbits was determined by weighing the carcasses after carrying out the control slaughter at the age of 120 days and cutting the carcasses. On the basis of the carcass deboning, the morphological composition of the rabbit carcass was determined and the meat index was calculated. The chemical composition, the biological value, physicochemical parameters of the herbal supplements, and rabbit meat were assessed in accordance with the recommendations [11].

3. Results and discussion
Probiotic preparations are widely used as components of full granulated animal feed. Sporothermin probiotics which is a combination of lyophilized microorganisms of the genus Bacillus subtilis and Bacillus licheniformis (at least 3·10^9 CFU/g, as a filler for lactose) was used for our study [12, 13].

In order to increase the nutritional value of compound feeds, girasole was used. The feed equivalent of girasole is 13.3 which corresponds to 22.2 feed units in 100 kg of green mass.

The girasole pulp is a valuable feed component. It is a secondary raw material of inulin water extraction production. Table 1 presents the chemical composition of the girasole pulp (VIR’S Novost) grown in Voronezh region.

The use of plant supplements with a high content of dietary fiber and biologically active components [14, 15] is of interest. The girasole pulp can be referred to this category of sorbents. A distinctive feature of the girasole pulp is a high content of carbohydrate (more than 22%), including monosaccharides and dietary fiber.
Table 1. Chemical composition of girasole beet pulp, VIR’s Novost variety, %

| Indicator           | girasole beet pulp (dry) |
|---------------------|--------------------------|
| Moisture            | 15.5 ± 0.05              |
| Dry matter          | 84.5 ± 0.07              |
| Crude protein       | 15.3 ± 0.12              |
| Raw fat             | 0.48 ± 0.04              |
| Carbohydrates       | 22.8 ± 0.02              |
| Ash                 | 2.8 ± 0.19               |
| Calcium, g / kg     | 5.1 ± 0.11               |
| Phosphorus, g / kg  | 2.6 ± 0.34               |
| Feed units          | 0.95 ± 0.09              |

The full granulated animal feed containing Sporothermin and girasole pulp was developed in the conditions of “Shkurat” company (Voronezh) based on the developed compound feed recipes.

In vivarium conditions, the All-Russian State Agrarian University evaluated the effectiveness of full granulated feeds enriched with probiotics and girasole pulp in the feed rations of young rabbits. The nature and level of feeding reflects the dynamics of live weight. 120 day-old rabbits of the control group had a lower body weight (Table 2).

Table 2. The growth rate for young rabbits

| Age, days | Group | Probiotic "Sporothermin" + girasole beet pulp, 10% to the weight of combined feed |
|-----------|-------|----------------------------------------------------------------------------------|
|           | group 1 | experimental group 1 | experimental group 3 |
|           | control group | 0.6 g/kg of feed | 1.0 g/kg of feed |
| 1         | 40.20 ± 0.11 | 40.30 ± 0.12 | 40.50 ± 0.13 |
| 45        | 970.0 ± 0.16 | 991.0 ± 0.19 | 980.0 ± 0.21 |
| 60        | 1557.0 ± 21.47 | 1597.0 ± 16.54 | 1641 ± 19.20 |
| 90        | 2304.0 ± 17.04 | 2366.0 ± 20.12 | 2674 ± 17.38 |
| 120       | 3250.0 ± 20.17 | 3398.0 ± 20.14 | 357 ± 26.00 |
| % Control | 100.0 | 103.23 | 110.03 |
| Average daily gain, g | 30.40 ± 0.79 | 32.09 ± 0.60 | 34.61 ± 0.37 |
| % Control | 100.0 | 105.55 | 113.84 |
| Safety, % | 70.00 | 90.00 | 100.00 |

For the entire period of the experiment, the largest live weight was observed in rabbits of group 3 which received Sporothermin at a dose of 1.0 g/kg together with girasole pulp at a dose of 10% of the feed weight. In the experimental groups compared to the control one, the live weight gain was significantly higher by 10.15% and 4.31. The safety of rabbits was 100%, while in the control group, it was 70% due to the increase in the resistance of the organism. Probiotics normalized digestion processes and improved the feed conversion. Clinical and physiological indicators of rabbits fed with probiotic preparations were determined. A slight increase in the heart rate and respiration was observed. It is due to the maximum intake of biologically active substances in the rabbit organism, but these indicators were within the physiological norm.
The blood composition is an important indicator of the physiological state associated with vital functions, including productive qualities of animals. We have studied the biochemical blood parameters (Table 3) to confirm the positive effect of Sporthermin combined with girasole pulp on the body.

| Indicator                  | Group                    | Probiotic "Sporothermin" + girasole beet pulp, 10% to the weight of combined feed |
|----------------------------|--------------------------|-----------------------------------------------------------------------------------|
|                            |                          | 0.6 g/kg of feed                                                                 |
|                            |                          | 1.0 g/kg of feed                                                                 |
| Total protein, g/l         | At the beginning of the experiment (45 days) | 69.71 ± 0.17                                                                  |
|                            |                          | 69.74 ± 0.22                                                                  |
|                            |                          | 70.36 ± 0.28                                                                  |
| Globulins, g/l             | At the end of the experiment (120 days)   | 34.58 ± 0.19                                                                  |
|                            |                          | 34.50 ± 0.14                                                                  |
|                            |                          | 34.60 ± 0.21                                                                  |
| Albumins, g/l              |                          | 35.13 ± 1.10                                                                  |
|                            |                          | 35.24 ± 1.14                                                                  |
|                            |                          | 35.76 ± 1.20                                                                  |

In animals of the experimental groups aged 120 days, serum protein increased by 8.52 and 6.54%. Morphological blood parameters, in particular hemoglobin, increased by 5.76 g/l or 5.19% and 6.81 g/l or 6.75%.

The content of erythrocytes increased as well which indicates an improvement in the oxygen supply and intensification of metabolic processes (Table 4).

| Indicator                  | Group                   | Probiotic "Sporothermin" + girasole beet pulp, 10% to the weight of combined feed |
|----------------------------|-------------------------|-----------------------------------------------------------------------------------|
|                            |                          | 0.6 g/kg of feed                                                                 |
|                            |                          | 1.0 g/kg of feed                                                                 |
| Erythrocytes, $10^{12}$/l  | At the beginning of the experiment (45 days) | 4.62 ± 0.14                                                                    |
|                            |                          | 4.60 ± 0.16                                                                     |
|                            |                          | 4.67 ± 0.12                                                                     |
| Leukocytes, $10^{9}$/l      | At the end of the experiment (120 days)   | 6.74 ± 0.14                                                                    |
|                            |                          | 6.80 ± 0.18                                                                     |
|                            |                          | 6.83 ± 0.14                                                                     |
| Hemoglobin, g/l            |                          | 110.94 ± 1.10                                                                   |
|                            |                          | 111.12 ± 1.20                                                                   |
|                            |                          | 112.28 ± 1.21                                                                   |

At the end of the experiment, a control slaughter was performed and the morphological composition was assessed according to the generally accepted method (Table 4). In the experimental groups, the slaughter yield was 56.19% and 58.13%, while in the control group it was 55.37% (Table 5). In the
experimental groups, the muscle tissue mass exceeded that in the control group by 9.07 and 20.15%, respectively.

**Table 5. Results of the control slaughter and the morphological composition of rabbit carcasses**

| Indicator                      | Group                                      | Group 2          | Group 3          |
|--------------------------------|--------------------------------------------|------------------|------------------|
|                                | group 1                                   | experimental group 1 | experimental group 2 |
|                                | control group                             | Probiotic "Sporothermin" + girasole beet pulp, 10% to the weight of combined feed |
|                                |                                            | 0.6 g/kg of feed  | 1.0 g/kg of feed |
| Pre-slaughter live weight, g   | 3079.0 ± 11.14                            | 3221.0 ± 9.30    | 3320.0 ± 11.44   |
| Mmass of the hot carcass, g    | 1705.0 ± 21.11                            | 1810.0 ± 22.15   | 1930.0 ± 15.40   |
| In % to the control group      | 100.0                                     | 106.15           | 113.19           |
| Slaughter yield, %             | 55.37 ± 0.41                              | 56.19 ± 0.47     | 58.13 ± 0.58     |
| Fat mass - raw, g              | 118.0 ± 4.51                              | 114.0 ± 2.66     | 108.0 ± 2.31     |
| Pulp mass, g                   | 1300.0 ± 22.11                            | 1418.0 ± 33.15   | 1562.0 ± 32.34   |
| In % to the control group      | 100.0                                     | 109.07           | 120.15           |
| Bone mass, g                   | 287.0 ± 3.47                              | 278.0 ± 3.55     | 260.0 ± 4.16     |
| Meat index                     | 4.52 ± 0.18                               | 5.10 ± 0.42      | 6.00 ± 0.35      |

This increase is associated with an increase in nutrient transformation of the feed ration, the use of Sporothermin combined with girasole, an increase in the production of enzyme systems which contributed to a more rapid deposition of nutrients and increased the protein content of muscle tissues. The balanced diets have a direct impact on the chemical composition of rabbit meat forming its nutritional and biological values.

**Table 6. The chemical composition of rabbit meat**

| Indicator                | Group                                      | Group 2          | Group 3          |
|--------------------------|--------------------------------------------|------------------|------------------|
|                          | group 1                                   | experimental group 1 | experimental group 2 |
|                          | control group                             |                  |                  |
| Moisture content, %      | 72.31 ± 0.17                              | 72.37 ± 0.22     | 70.93 ± 0.28     |
| Mass fraction of dry matter,% | 27.69 ± 0.33                         | 27.60 ± 0.41     | 29.07 ± 0.38     |
| Mass fraction of protein,% | 19.40 ± 1.05                            | 20.23 ± 1.14     | 21.76 ± 1.20     |
| Mass fraction of fat,%    | 7.27 ± 0.33                               | 6.40 ± 0.17      | 6.31 ± 0.22      |
| Mass fraction of ash,%    | 1.02 ± 0.04                               | 1.00 ± 0.06      | 1.00 ± 0.02      |

The highest protein content was observed in the rabbit meat of the 3rd experimental group (Table 5) which is due to the transformation of nutrients into the protein component of the muscle tissue under the action of Sporothermine. A decrease in the fat content indicates an increase in the nutritional value of meat.

The evaluation of the functional and technological properties of rabbit meat (moisture-binding capacity, water-holding capacity, fat-hardening capacity, emulsifying capacity and emulsion stability) revealed a clear positive trend (Table 6). The MBC level in the experimental groups exceeded that in the control group by 3.69% and 9.98%, respectively which can be explained by a higher protein content and a lower fat content in the meat.
The most important indicator is the WHC and FHC which characterize the ability of myofibrils proteins to form a protein-fat matrix. These indicators are variable and depend on the type of feeding and fatness of the rabbit. Research has shown that the WHC (5.48% and 9.67%) and the FHC (1.34% and 8.25%) of the experimental groups exceed those in the control group.

| Indicator                        | Group 1 control group | Group 2 experimental group 1 | Group 3 experimental group 2 |
|----------------------------------|-----------------------|------------------------------|-----------------------------|
| Moisture-binding capacity, %     | 60.31 ± 0.19          | 62.54 ± 0.42                 | 66.33 ± 0.54                |
| Water-holding capacity, %        | 57.60 ± 0.39          | 60.76 ± 0.21                 | 63.17 ± 0.32                |
| Fat-holding capacity, %          | 62.40 ± 1.37          | 63.24 ± 1.34                 | 67.55 ± 1.28                |
| Emulsifying capacity, %          | 30.27 ± 0.61          | 31.40 ± 0.47                 | 33.81 ± 0.29                |
| Emulsion stability, %            | 48.22 ± 0.48          | 51.10 ± 0.56                 | 52.30 ± 0.32                |

The organoleptic evaluation of meat and broth showed a positive effect of the combined use of Sporothermin and girasole pulp on the aromatic profile of meat and broth. Samples of boiled meat and broth produced from carcasses of the third group (8.3 points and 7.9, respectively) had the highest points.

The pH values of rabbit meat of the experimental groups were within 5.83 - 5.85 units, the reaction with CuSO4 was negative, the content of amino ammonium nitrogen was 0.93 - 0.95 units. Thus, the physico-chemical indicators of meat corresponded to those for fresh meat with normal autolytic processes and maturation.

4. Conclusion
The use of the probiotic complex Sporothermin and girasole pulp as part of combined feed is technologically justified and prevents problems associated with a decrease in safety and productivity of livestock.

The selected dosages of the probiotic complex and girasole pulp J reduced the cost of feeding by 1.42 E FU. The profits increased by 3616.0 rubles. The level of profitability increased by 12% in relation to the control group (23%) in the conditions of the industrial complex of Lipetsk region.

5. Acknowledgements
The authors are grateful to the dean of the faculty of veterinary medicine and animal husbandry technology of Voronezh State Agrarian University Alexander Aristov, the staff of “Lipetsk Rabbit” LLC for assistance in conducting research, support and valuable comments.

References
[1] Cunha S, Mendes Â, Rego D, Meireles D, Fernandes R 2017 Effect of competitive exclusion in rabbits using an autochthonous probiotic World Rabbit Sci. 25 123–134
[2] Kurchaeva E E, Vostroilov A V, Artemov E S, Kashirina N A, Kalashnikova S V, Maksimov I V 2018 Probiotic preparation to increase meat productivity and physiological status of the rabbits Res. J. of Pharmaceutical, Biological and Chem. Sci. 9(5) 2239–2247
[3] Shabunin S V, Bessonova L P, Parshin P A 2019 Veterinary-sanitary aspects of preventing the risk of infectious diseases Achievements of Science and Technology of Agrarian and Industrial Complex. 33(1) 34–37 DOI: 10.24411/0235-2451-2019-10108
[4] Shevchenko A I 2013 Natural resistance of poultry meat and its pharmacocorrection with probiotics and synbiotics Agricultural Biology 2 93–98
[5] Nozdrin G A, Ivanova A B, Nozdrin A G 2006 Probiotics on the basis of Bacillus Subtilis and their role in maintaining the health of animals of different species Siberian J. of Agricultural Sci.. 7 64–68

[6] Cheremushkina I V 2014 The role of prebiotics in restoring the intestinal biocenosis in dysbiosis Experimental and Clinical Gastroenterology. 2(102) 83a

[7] Amaravadi S Ch, Mallam M, Manthani Gn Pr, Komireddy K R 2012 Effect of dietary supplementation of probiotics and enzymes on the haematology of rabbits reared under two housing systems Vet. World. 5(12) 748–753

[8] Birolo M, Trocino A, Tazzoli M, Xiccato G 2017 Effect of feed restriction and feeding plans on performance, slaughter traits and body composition of growing rabbits World Rabbit Sci. 25 113–122

[9] Cheremushkina I V, Korneeva O S 2017 Innovative biotechnology probiotic feed additives and immunostimulatory effects Res. J. of Pharmacy and Technol. 10(4) 1165–1167

[10] Kurchaeva E E, Vostroilov A V, Derkanosova N M, Kashirina N A, Artemov E S, Maksimov I V, Pashchenko V L 2018 Meat productivity and quality of rabbit meat using probiotic additives and sorbents Res. J. of Pharmaceutical, Biological and Chem. Sci. 9(6) 1386–1394

[11] Antipova L V, Glotova I A, Rogov I A 2004 Methods of use of meat and meat products (Moscow: KolosS) 576 p.

[12] Kishnyaykina Ye A, Zhuchaev K V 2018 Influence of dietary supplements on the quality indicators of broiler meat Achievements of Science and Technology of Agrarian And Industrial Complex. 32(8) 70–72 DOI: 10.24411/0235-2451-2018-10819

[13] Rassolov S N 2018 The use of chamomile extract for growing young rabbits Achievements of Science and Technology of the agro-Industrial Complex 32(12) 57–58 doi:10.24411/0235-2451-2018-11217

[14] Rubchenkov P N, Zakharova L L, Zhorov G A, Obryvin V N 2014 Effect of sorbing complexes on the quality indicators of rabbit meat fed with radionuclides and heavy metals with food Veterinary Science, Livestock and Biotechnology. 4 38–42

[15] Sukhanova S F, Kornienko I G 2017 Meat productivity and meat quality of geese when Agrimos is included in the compound feed Achievements of Science and Technology of Agriculture. 31(9) 68–71