Efficiency of application of the probiotic "Enzymsporin" and grass flour of Jerusalem artichoke to increase the productivity of rabbits

E E Kurchaeva, AV Vostroilov, E A Vysotskaya, E S Artemov and I V Maksimov

Voronezh State Agrarian University named after Emperor Peter the Great, 1, Michurina str., Voronezh, 394087, Russia

E-mail: alena.kurchaeva@yandex.ru

Abstract. To assess the effectiveness of probiotic preparation "Enzymsporin" together with grass meal, green mass of Jerusalem artichoke, when fattening young rabbits, matched 180 rabbits (males) of "Hypharm" French breeding in conditions of the industrial complex of LLC "Lipetsk rabbit" which at the age of 45 days were divided into 3 groups on the principle of the groups – analogues. Fattening was carried out until the age of 105 days. Rabbits of the 1st group (control) received all-mash without additives. The rabbits in group 2 and group 3 were fed with the probiotic preparation "Enzymsporin" in a dosage of 0.6 g/kg of all-mash (rabbits of the 2nd group) and 1.0 g/kg of all-mash (rabbits of the 3rd group) together with grass meal, green mass of Jerusalem artichoke in a dose of 15.0% by weight of all-mash. At the age of 105 days, the rabbits of the 1st group (control) were characterized by live weight, which was less than the mass of animals of the 1st experimental group by 189.0 g, or by 5.95%, the 2nd experimental group - by 367.0 g, or 11.55%. Thus, the preparation "Enzymsporin" together with grass meal, green mass of the Jerusalem artichoke is a promising product from a number of probiotics used in animal nutrition and allows improving the productivity and meat quality of rabbits.

1. Introduction

In modern conditions, serious attention is paid to food safety [1]. One of the main biological risks in rabbit breeding enterprises is the high sensitivity of livestock to pathogenic microflora. This factor is largely due to the high concentration of the livestock per unit area and requires minimizing the reproduction of the microflora in the animal. Probiotics are widely used as feed additives, which, due to the production of active components, displace antibiotics, without reducing the biological value of the resulting raw meat, and in some cases even contribute to improving its quality indicators [2, 3]. Currently we widely use probiotic preparations of feed destination based on the culture Bac. subtilis of different species compositions used as a biological homeostasis corrector [4, 5, 6-9]. A probiotic preparation «Enzymsporin» produced in Russia and positively proven in the pig industry and poultry is unexplored in the sector of rabbit breeding. The probiotic preparation «Enzymsporin» was obtained on the basis of strains of bacteria B. Subtilis strain VKM V-2998D, VCR In-3058 D and B. Licheniformis strain VKM V - 2999D with the addition of whey powder. It has a pronounced antagonistic activity against Clostridium perfringens, Escherichia coli, Salmonella typhimurium, Salmonella enteritidis, Staphilococcus aureus, Shigella sp. and others. It also has immunomodulatory...
effects (activate macrophages, stimulate the production of interferon, synthesize immunoglobulins, antibodies during vaccination), which contributes to biological protection; produces digestive enzymes-amylase, lipase, protease, pectinase, endoglucanase, xylanase and phytase; increases the digestibility of feed. In this regard, it is important to study the effectiveness of its action on the body of rabbits together with plant raw materials, including resources of Jerusalem artichoke, which is one of the promising areas of creation of fodder. Jerusalem artichoke has a high yield, unpretentiousness to soil and climatic conditions and is widely grown as a fodder or food crop. It is known that the green mass of the Jerusalem artichoke is characterized by a rich composition of nutrients, g/kg: crude protein – 17.95, crude fat – 1.37, crude fiber - 18.8, crude ash – 6.83, nitrogen-free extractive substances – 39.24. This also includes the amino acids aspartic acid – 13.7, glutamic acid – 23.2, proline – 10.6, valine and 8.0, leucine and – 11.7, phenylalanine – 7.4 [10]. That causes a certain interest for the use of its component as a complete granulated feed for rabbits.

The purpose of the research was to study the effectiveness of combined use of the probiotic drug "Enzymsporin" and grass meal, green mass of Jerusalem artichoke in the composition of all-mash by the productivity of rabbits in the conditions of the industrial complex of LLC "Lipetsk rabbit".

2. Materials and methods

To assess the effect of the probiotic preparation "Enzymsporin" on fattening young rabbits we matched 180 rabbits (males) "Hypharm" of French origins, which at the age of 45 days were divided into 3 groups on the principle of the groups – analogues. In each group, 60 rabbits were selected from clinically healthy animals. Fattening was carried out until the age of 105 days. The research was conducted in the conditions of the industrial complex of "Lipetsk rabbit" in 2019. As the main diet we used the all-mash PZK-92, obtained on the basis of grain crops, sunflower meal, wheat bran, grass meal and premix KVP P90-1K. Rabbits of the 1st group (control) received feed without additives. The rabbits of group 2 and group 3 were fed with the probiotic preparation "Enzymsporin" in a dosage of 0.6 g/kg of feed (rabbits of group 2) and 1.0 g/kg of feed (rabbits of the 3rd group) together with grass meal, green mass of Jerusalem artichoke (15% by weight of feed). Optimization of recipes complete all-mashes for fattening livestock of young rabbits was performed using the software module "Feed Optima" in terms of the LLC "Forage resources" (Voronezh). The production of complete granular feed was carried out in the conditions of JSC "VEKZ" (Voronezh). Dynamics of live weight was taken into account by individual weighing. To determine the meat efficiency we slaughtered 3 heads of the rabbits from each group, evaluation of meat quality was carried out according to standard methods [11] in terms of the research base state VIVIFIC RAAS and the center for collective use of VSUET (Voronezh).

Determination of amino acids was carried out using the HPLC chromatograph "Stayer" by reversed phase chromatography in gradient mode. Amino acid analysis of muscle tissue was performed by hydrolysis of samples according to GOST 13496.21 2015 and GOST 13496.22-90.

3. Results and discussion

In the industrial complex of LLC "Lipetsk rabbit" the experiments were conducted to determine the optimal dose of studied preparation together with grass meal, green mass of Jerusalem artichoke in clinically healthy livestock rabbits of French selection "Hypharm" in accordance with the proposed scheme of feeding for 60 days (from the moment of jiggling before slaughter).

The intensity of growth reflects the nature and level of feeding of young rabbits (table 1).

Different doses of addition of probiotic preparation "Enzymsporin" in the feed mixture with simultaneous input of grass meal, green mass of Jerusalem artichoke in an amount of 15.0% had a different impact on the safety of livestock. Maximum safety (100.0%) was recorded in the 3rd group of rabbits, the ration of which was supplemented with the probiotic preparation "Enzymsporin" at a dosage of 1.0 g/kg of feed, whereas in group 1 (control) the safety made up 90.0%.
A similar influence of the input of the probiotic preparation "Enzymsporin" was on the intensity of growth of young rabbits. Upon reaching the age of 105 days, the rabbits of the 1st group (control) were characterized by live weight, which was less than the mass of individuals of the 1st experimental group by 189.0 g, or 5.95 %, the 2nd experimental group - by 367.0 g, or 11.55 % (table 1).

Higher absolute growth was recorded in rabbits of the 2nd and 3rd groups and amounted to 2372.0 and 2561.0 g, respectively. In the control group, the absolute increase amounted to 2210.0 g. The highest average daily gains were characterized by the number of rabbits of 2nd and 3rd groups (42.68 and 39.53 g, respectively), which suggests a more intensive course of metabolic processes in the organism on the background of complex application of probiotic preparation and grass meal, green mass of Jerusalem artichoke. This superiority in the average daily gains of the 2nd and 3rd groups relative to the control group of rabbits was 7.33 and 15.88%, respectively. This effect confirms the positive influence of the introduced probiotic preparation "Enzymsporin" in the optimal dose (1.0 g/kg of feed) of the preservation, growth rate and average daily gains of livestock rabbits.

Digestion processes are not limited to the main function-digestion of nutrients and their absorption into the blood. It is proved that digestion influences the whole animal organism through intermediate and general metabolism [12-17]. By the number and chemical composition of substances taken by animals, the number and composition of excreted feces, we can judge on the degree of digestibility and general metabolism [12-17]. By the number and chemical composition of substances taken by animals, the number and composition of excreted feces, we can judge on the degree of digestibility and general metabolism [18-21]. Nutrient digestibility of diets in all animals ranged from 41.19 % to 75.31 % (table 2).

The coefficients of digestibility in the experimental groups were significantly higher. The 2nd group consumed feed with the addition of the probiotic preparation "Enzymsporin" (0.6 g/kg of feed) and grass meal, green mass of Jerusalem artichoke (15.0% by weight of raw materials): raw protein by 7.08%, crude fiber by 3.99%, of dry matter by 8.39%, organic matter by 4.09% (P<0.99). Digestibility of crude protein in the 3rd group of rabbits consuming feed with the addition of probiotic preparation "Enzymsporin" (1.0 g/kg of feed) and grass meal, green mass of Jerusalem artichoke (15.0% by weight of raw materials) amounted to 66.24%, control – 56.14%. Crude fiber was digested by rabbits in group 3 by 48.34%, in group 1 - by 40.20% (P<0.99). Dry matter was digested by rabbits by 72.86%, organic matter – by 73.47%, which indicates a more efficient use of nutrients in the diet enriched with paste from the green mass of amaranth (10.0%) and EF complex.

### Table 1. Dynamics of live weight of rabbits, g (X±s)

| Age, days | Group 1 (control) | Group 2 (1st experimental group) | Group 3 (2nd experimental group) |
|-----------|-------------------|---------------------------------|---------------------------------|
| 1         | 52.00±0.11        | 50.00±0.17                      | 49.00±0.19                      |
| 45        | 965.0±22.67       | 992.0±16.11*                   | 981.0±21.24**                  |
| 105       | 3175.0±19.11      | 3364.0±21.10                   | 3542.0±18.54                   |
| Average daily growth | 36.83±0.45 | 39.53±0.62                     | 42.68±0.71                     |
| Safety, % | 90.0              | 95.0                            | 100.0                           |

*P<0.95**P<0.99

### Table 2. Digestibility of nutrients (X±s, n=3), %

| Indicator       | Group 1 (control) | Group 2 (1st experimental group) | Group 3 (2nd experimental group) |
|-----------------|-------------------|---------------------------------|---------------------------------|
| Crude protein   | 56.14±1.45        | 63.22±1.30*                     | 66.24±1.17*                     |
| Crude fiber     | 40.20±2.34        | 44.19±1.57*                     | 48.34±1.49**                    |
| Dry matter      | 62.15±1.40        | 70.54±2.63**                    | 72.86±1.25*                     |
| Organic matter  | 68.36±1.27        | 72.45±1.56**                    | 73.47±2.54*                     |

*P<0.95**P<0.99
The slaughter showed that in the 3rd group of rabbits the carcass yield was 64.73 %, which is more than in the control and 1st groups by 11.94 and 10.65%, respectively (table 3).

Table 3. Morphological composition of carcasses (n=3)

| Indicator             | Group 1 (control) | Group 2 (1<sup>st</sup> experimental group) | Group 3 (2<sup>nd</sup> experimental group) |
|-----------------------|-------------------|---------------------------------------------|---------------------------------------------|
| Pre-slaughter live weight, g | 3020.0±21.24      | 3160.0±20.14                                | 3340.0±12.47                                |
| The mass of hot carcass, g   | 1708.0±20.15      | 1810.0±22.37                                | 1960.0±19.22                                |
| Lethal output, %            | 56.55±0.13        | 57.28±0.25                                  | 58.68±0.18                                  |
| Meatines                | 3.90±0.47         | 4.65±0.65                                   | 4.82±0.52                                   |

Rabbits of the 2<sup>nd</sup> group surpassed the control group of animals mass of hot carcass on 140.0 g (4.63%), 3<sup>rd</sup> group – on 320.0 g (10.59%). The calculated index of meatines showed that rabbits that received the probiotic supplement "Enzymsporin" at a dosage of 1.0 g /kg of feed (group 3) together with grass meal, green mass of Jerusalem artichoke contributed to the increasing mass fraction of protein in muscle and reduction of fat mass fraction. The least amount of fat was observed in rabbits of the 3<sup>rd</sup> group which received the probiotic preparation "Enzymsporin" at the dosage of 1.0 g per 1 kg of feed. Also, the maximum amount of ash substances was observed in rabbits of the 3<sup>rd</sup> group. The results of chemical analysis of the rabbit muscle tissue are presented in table 4. It should be noted that the meat of the rabbit – hybrid obtained by industrial crossing of breeds of New Zealand red and Soviet chinchilla contains more protein (23.80%) than the average rabbit meat does (21.0%) [22-25].

Table 4. Chemical composition of rabbit muscle tissue (n=3)

| Indicator                 | Group 1 (control) | Group 2 (1<sup>st</sup> experimental group) | Group 3 (2<sup>nd</sup> experimental group) |
|---------------------------|-------------------|---------------------------------------------|---------------------------------------------|
| Mass fraction of moisture, % | 72.68±0.55        | 72.50±0.29                                  | 71.88±0.33                                  |
| Mass fraction of crude protein, % | 22.00±0.42        | 23.00±0.34                                  | 23.82±0.67                                  |
| Mass fraction of crude fat, % | 3.87±0.59         | 3.03±0.25                                   | 2.79±0.23                                   |
| Mass fraction of crude ash, % | 1.45±0.07         | 1.47±0.01                                   | 1.51±0.03                                   |

Table 5. Content of essential amino acids of rabbit muscle tissue, in mg / 1 g of crude protein, (n=3)

| Amino acid            | Ideal protein, FAO/WHO (2011) | Group 1 (control) | Group 2 (1<sup>st</sup> experimental group) | Group 3 (2<sup>nd</sup> experimental group) |
|-----------------------|-------------------------------|-------------------|---------------------------------------------|---------------------------------------------|
| Valine                | 40.00                         | 48.00             | 45.00                                       | 46.25                                       |
| Isoleucine            | 30.00                         | 57.00             | 66.00                                       | 70.30                                       |
| Leucine               | 61.00                         | 75.00             | 77.30                                       | 79.20                                       |
| Lysine                | 48.00                         | 87.70             | 96.20                                       | 99.97                                       |
| Methionine+Cysteine   | 23.00                         | 41.80             | 43.20                                       | 43.72                                       |
| Threonine             | 25.00                         | 53.90             | 54.80                                       | 59.30                                       |
| Phenylalanine +Tyrosine| 41.00                         | 80.00             | 87.00                                       | 85.40                                       |
| Histidine             | 16.00                         | 25.00             | 27.60                                       | 30.40                                       |
| Tryptophan            | 6.60                          | 11.10             | 11.40                                       | 12.45                                       |
The results of amino acid analysis of rabbit muscle tissue are presented in table 5. The content of lysine - 99.97 %, leucine, valine, histidine, phenylalanine favorably differs in the direction of increasing.

We carried out organoleptic evaluation of the meat and broth of rabbit control, and test groups showed a positive effect of the probiotic feed additive "Enzymsporin" and grass meal, green mass of the Jerusalem artichoke on the formation of the sensory profile of boiled meat and broth.

The highest score was characterized by samples of boiled meat and broth obtained from the carcasses of the 2nd experimental group (8.5 and 8.0 points, respectively). Samples of boiled meat and broth obtained from the carcasses of rabbits of the control and first group did not differ significantly (7.6 – 7.8 and 7.4 - 7.6 points, respectively).

4. Conclusion
Thus, the inclusion of the complete feed probiotic "Enzymsporin" and grass meal, green mass of Jerusalem artichokes for the rabbits contributed to the improvement of productivity and had a positive effect on qualitative characteristics of raw meat.

5. Acknowledgments
The authors express their gratitude to the staff of "Lipetsk rabbit" for their help in conducting the research, support and valuable comments.

References
[1] Fudina E V 2015 Development of agriculture and food security of Russia Successes of modern science 5 55 – 57
[2] Derkanosova N M, Ponomareva I N, Shurshikova G V and Vasilenko O A 2018 Application of fuzzy set theory for integral assessment of agricultural products quality Journal of Physics: Conference Series. Mathematical simulation and data processing 1015(3) 32026
[3] Derkanosova N M, Shurshikova G V and Vasilenko O A 2018 Classification Methods in Predicting the Consumers’ the Response to New Product Types IOP Conference Series: Materials Science and Engineering, 463 (4) 42103
[4] Birolo M, Trocino A, Tazzoli M and 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
[5] Ustinov L 2011 Complex line for the production of granulated all-mash Feed 2 47-48
[6] GOST 32897 - 2014 2016 All-mash for fur animals, rabbits and nutria. General specifications (Moscow: Standartinform)
[7] Guidelines for the evaluation of feed quality and nutrition 2002 (Moscow)
[8] Kladovshikov F V and Samkov Y A 1975 Guidelines Study of digestibility of feed nutrients, nitrogen and energy balance in fur animals (Moscow)
[9] Klimenko A S 2009 Efficacy of probiotic preparation "Subtilis" in the diet of rabbits / rabbit Breeding and animal husbandry 2 6-7
[10] Anikienko T I 2007 Chemical composition and fodder value of Jerusalem artichoke grown in Krasnoyarsk region Vestnik Krasgau 2 122-125
[11] Antipova L V, Glotova I A and Rogov I A 2001 Methods of research of meat and meat products (Moscow: Kolos)
[12] Avdienko V V, Zabashta N N and Golovko E N 2016 Rabbit Meat using extensive and moderately intensive cultivation technology Collection of scientific works of the all-Russian research Institute of sheep and goat breeding 1(9) 9-11
[13] Giang H H, Viet T Q, Ogle B and Lindberg J E 2012 Growth performance, digestibility, gut environment and health status in weaned piglets fed a diet supplied with a complex of lactic acid bacteria alone or in combination with Bacillus subtilis and Saccharomyces boulardii Living Sci 143 132-41
[14] Kolotygina I I 2016 Use efficiency in the feeding the dry animal feed *Youth and science* 1 64
[15] Kurchaeva E E, Vostroilov A V, Derkanosova N M, Kashirina N A, Artemov E S, Maksimov I V and Pushchenko V L 2018 Meat productivity and quality of rabbit meat using probiotic additives and sorbents *Research Journal of Pharmaceutical, Biological and Chemical Sciences* 9 (6) 1386-1394
[16] Kurchaeva E E, Vostroilov A V, Artemov E S, Kashirina N A, Kalashnikova S V and Maksimov I V 2018 Probiotic preparation to increase meat productivity and physiological status of the rabbits *Research Journal of Pharmaceutical, Biological and Chemical Sciences* 9 (5) 2239-2247
[17] Landikhova E L and Osipova N V 2007 Influence of the optimized feeding on productive qualities of rabbits of breed Soviet chinchilla *New in science of XXI century. Interuniversity scientific collection* 5 22-25
[18] Lange P 2010 Production of granular all-mash *All-mashes* 6 67-68
[19] Makartsev N G 2012 *Feeding of farm animals* (Kaluga: Publishing house "Noosphere")
[20] Molchanova E N and Sukanek G M 2013 Evaluation of the quality and value of food proteins *Storage and processing of agricultural products* 1 16-22
[21] Shencova E S, Panin I G, Grechishnikov V V and Panin A I 2015 Assessment of errors in content of nutrient and biologically active substances in the all-mash production *Bulletin of VSUET* 4 109-115
[22] Smirnova I R and Chuvakin R A 2017 To the use of compound feed in the rabbit rations/ Materials of the International (extramural) scientific-practical conference *The development of science in the modern world* 31-34
[23] Smolentsev S Yu, Volkov A K, Papunidi E K, Yusupova G R, Nikolaev N V, Larina Y V and Romanova N K 2018 Meat Productivity of Cattle Depending on the Composition of the Ration *RJPBCS* 9(4) 1247-1251
[24] Ulitko V E, Pykhtina L A, Desyatov O A, Semenova J V, Savina E B and Aritkin A G 2018 Meat Productivity And Meat Quality Of Broilers After The Use Of Preprobiotic Additives In Their Diets - *RJPBCS* 9(4) 182-187
[25] Zhedik I Yu and Zabolotnykh V M 2016 The Influence of natural zeolite of mine of the deposit on mineral and vitamin composition of rabbit meat *Bulletin of Krasnoyarsk state agrarian University* 6 (117) 144-148