Technological aspects of the use of complete granular all-mashes in the diet of rabbits

E E Kurchaeva, A V Vostroilov, A V Aristov, E A Vysotskaya 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 improve the nutritional value and digestibility in recipes of all-mashes the following feed additive was introduced: a paste of green mass of amaranth in doses of 10.0 and 15.0% and complex “Enzymesporin” - “Fungistat-GIC” (EF) at doses of 1.0 and 2.0 g/kg of all-mash, respectively. The studies of the effectiveness of complete granular all-mash were carried out on the livestock of young rabbits of the Soviet chinchilla breed at the age of 45 days, selected on the principle of groups – analogues and divided into 3 groups. The study was conducted in vivarium conditions of the VSAU in 2018. The control group of rabbits received a basic ration consisting of fodder PZK-92-60-18, rabbits of the experimental group received feed with the addition of the paste of green mass of amaranth and “Enzymesporin” - “Fungistat-GIC” (EF). Meat quality assessment was carried out at the age of 105 days after control slaughter in the amount of 3 heads from each group. It is established that rabbits of experimental groups digest nutrients of all-mashes better in comparison with control peers that further had positive influence on indicators of their meat productivity. The introduction of feed additives used in the all-mashes allowed increasing its digestibility by 8.5-10.0%, and also contributed to a higher transformation of feed nutrients into the protein component of muscle tissue.

1. Introduction

The problem of providing the population with food, including food of the animal origin, is one of the most important tasks for the further welfare of our society.

To maintain the growth of livestock production, including rabbit breeding, it is necessary to use balanced and complete feed enriched not only with vitamin and mineral premixes, but with feed protein, the lack of which in the diet reduces the productivity of animals, adversely affects the physiological status of breeding facilities and feed use.

Rabbit breeding is in a very disadvantageous position: on the one hand, intensive development, increased productivity is required, and on the other hand - an increasing deficit of balanced feeds enriched with protein, on which, mainly, the productivity of rabbits depends. But due to the steady trend of rabbit breeding development in Russia, new technological solutions are required to ensure the fodder base, including the use of new internal resources - sources of feed protein, which include green plants, including the green mass of amaranth. Despite the relatively low protein concentration, the green mass of amaranth is a promising source of feed protein, which has a high nutritional value. The green mass of amaranth it contained: crude protein 15.6 - 16.75% (in the leaves up to 30%), fat – 2.4-
2.8%, fiber – 16.0-21.7%, calcium at 2.1 to 2.6% , phosphorus 0.2-0.21%, carotene 160.0-200.0 mg, which in turn confirms the relevance of its use as a protein feed resource [1].

The technology of livestock production is directly related to the aspects of complete feeding, keeping animals, which together allows obtaining competitive products of high quality.

The current situation to reduce the volume of agricultural production, the lack of complete and biologically valuable feed, their significantly high cost, as well as poor veterinary and sanitary condition of livestock premises lead to a sharp decrease in the resistance of animals to various diseases. As a result the development of dysbiosis and immunodeficiency states, a growing percentage of morbidity, reduced productivity, and increased mortality [2-5] were observed. This negative point can be eliminated with the help of probiotic drugs of different species composition, introduced into the composition of feed mixtures and granular all-mashes. Balanced by basic nutrients, feed resources provide an increase in productivity by 10-18%, and when enriched with biologically active substances, their efficiency increases to 20.0-25.0%.

Objective: of the study is: to assess the effectiveness of the use of complete granular all-mashes for rabbits enriched with plant protein and complex "probiotic - sorbent" in order to improve the productivity and quality of the products.

2. Materials and methods
The optimization of recipes of complete all-mashes for livestock fattening of young rabbits was performed using the software module "Feed optima" in terms of the LLC "Forage resource" (Voronezh). To improve the nutritional value and digestibility of feed in the recipes we introduced supplements: a paste of green mass of amaranth in doses of 10.0 and 15.0% and complex "Enzymosporin" - "Fungistat-GPK" (EF) at doses of 1.0 and 2.0 g/kg of feed, respectively. The production of complete granular feed was carried out in the conditions of JSC "VEKZ" (Voronezh).

The moisture content in the produced compound feed was determined by drying; hygroscopic moisture - at a temperature of 100-105°C to constant mass; mass fraction of crude protein – by Kjeldahl method (GOST 13496.4-93); crude fat – in conventional Soxhlet apparatus (GOST 13496/15-2016), crude fiber (GOST ISO 6865-2015), crude ash – in accordance with GOST 32933-2014.

The experiment on feeding rabbits with granulated feed was carried out on the basis of the faculty of veterinary medicine and livestock technology of the Voronezh State University in an indoor room equipped with experimental cages for rabbits. The experiment to determine the eatability of pellets was carried out for 11 days on 9 rabbits of 3 months of age, in specially equipped cells with pallets in order to avoid losses of granules in specially equipped cells with pallets in order to avoid their losses [6-10]. Balance experience conducted by direct method consisted of 2 periods: preliminary and accounting, each for a period of 7 days. In the preliminary period we specified daily amount eaten of granulated feed, in the accounting period the daily were collected portion of the pellets, the was prescribed remains and excretions (feces, urine). Dynamics of live weight was taken into account by individual weighing. To determine the meat efficiency of conducted the slaughter at the 3 heads of the rabbits from each group; evaluation of meat quality was carried out according to standard methods in terms of the research base state VIVIFIC RAAS and the center for collective use of UGUET (Voronezh).

3. Results and discussion
The components used for the production of feed, according to the content of nutrients should ensure the normal development of the body of rabbits and their productivity. Therefore, a number of components were introduced into feed, including vitamins, trace elements in the composition of premixes, probiotic additives that contribute to the normalization of the physiological status of breeding objects [2, 14, 16].

The following components were used in the calculation of recipes: grain raw materials, products of its processing, cake, meal, herbal flour, raw materials of animal and mineral origin. As a binder, grain
molasses was used, obtained as a result of hydrolysis of grain components that are part of the recipes. Liquid grain molasses contains 30.0-35.0% of solids. It has a high energy nutritional value, improves carbohydrate-protein balance of the diet and has a positive effect on the animal health.

The obtained all-mash on organoleptic indicators met the requirements of GOST 32897-2014 (table 1) [11].

| Indicator                  | PZK-92-60-18 (control) | PZK-92-67/1-18 | PZK-92-67-18 |
|----------------------------|------------------------|----------------|--------------|
| Mass fraction of moisture, % | 14.0                   | 13.8           | 13.9         |
| Diameter of granules, mm    | 4.7                    | 4.7            | 4.7          |
| Granularity, %              | 7.6                    | 7.4            | 7.5          |
| Passage through a sieve with 2 mm holes, % | 9.0 | 8.0 | 8.0 |

Table 2. Dynamics of live weight of rabbits, g (X±S)

| Age, days | The 1st group (control) | The 2nd group (the 1st experimental group) | The 3rd group (the 2nd experimental group) |
|-----------|-------------------------|------------------------------------------|------------------------------------------|
| 1         | 49.58±0.12              | 49.60±0.16                               | 49.78±0.15                               |
| 45        | 987.0±22.67             | 997.0±18.51 *                            | 991.0±21.29 **                           |
| 105       | 3080.0±20.17            | 3159.0±22.20                             | 3425.0±21.19                             |
| Average daily growth        | 34.88±0.75              | 36.03±0.82                               | 40.56±0.74                               |

*P<0.95**P<0.99

The dynamics of live weight reflects the nature and level of feeding of young rabbits. It was found that upon reaching the age of 105 days rabbits of the 1st group (control) were characterized by a live mass that was less than the mass of individuals of the 2nd group by 79.0 g, or 2.56 % (P < 0.95), the 3rd group-by 345.0 g, or 11.20% (P < 0.99) (table 2). The use of probiotic additives also had a positive effect on the average daily growth, the maximum value of which was observed in rabbits of the 3rd group and amounted to 40.56 g.

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 organism of an animal through intermediate and general metabolism [12-14]. By the number and chemical composition of substances taken by animals, the number and composition of excreted feces is judged on the degree of digestibility and the role of the digestive tract in metabolism. Nutrient digestibility of diets in all animals ranged from 41.19 % to 75.31 % (table 3).
The coefficients of digestibility in the experimental groups were significantly higher: in the 2nd group which consumed PZK-92-67/1-18: crude protein by 17.07%, crude fiber by 13.79%, dry matter by 13.09%, organic matter by 11.76% (P<0.99). Digestibility of crude protein in the 3rd group, of rabbits consumed PZK-92-67-18 made 68.66%, control 53.24%. Crude fiber was digested by rabbits of the 3rd group, of rabbits consumed PZK-92-67-18 by 50.64%, the 1st experimental group by 46.16% (P<0.99). Dry matter was digested by rabbits by 74.95%, organic matter by 75.41%, 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 3. Digestibility of nutrients (X±s, n=3), %

| Indicator          | The 1st group (control) | The 2nd group (The 1st experimental grup) | The 3rd group (The 2nd experimental grup) |
|--------------------|-------------------------|-----------------------------------------|-----------------------------------------|
| Crude protein      | 53.24±1.15              | 62.80±1.10                              | 68.66±1.14                              |
| Crude fiber        | 41.19±2.18              | 46.16±2.51                              | 50.64±2.19                              |
| Dry matter         | 64.42±1.45              | 73.21±1.73                              | 74.95±1.65                              |
| Organic matter     | 66.34±1.30              | 74.48±1.26                              | 75.41±2.24                              |

High biological plasticity and adaptability to a variety of conditions distinguishes rabbits from all farm animals. It should be noted that insufficient and unbalanced feeding leads to a delay in the growth of individual parts of the body of animals, especially reduced output of muscle tissue and increases the proportion of bone and connective tissue. Therefore, the results of the study of the morphological composition of rabbit carcasses allow more accurately characterizing the changes that occur against the background of the use of complete granular feed with the addition of plant, probiotic additives and sorbents [15, 16].

The analysis of the morphological composition of chilled rabbit carcasses showed that the inclusion of granular feed enriched with paste from the green mass of amaranth and EF complex (probiotic sorbent) in the diet of rabbits had a beneficial effect on the output of muscle tissue (table 4). The pre-slaughter live weight, as well as the mass of the hot carcass of rabbits of the experimental groups was higher compared to the mass of animals of the control group.

The highest pre-slaughter weight was in the 3rd group of rabbits and was 3170.0 g. As compared with the control group of rabbits pre-slaughter weight at the 3rd group was 330.0 g more than or of 11.61% compared with the 2nd group at 150.0 g, or of 4.97% (P<0.95). In the 3rd group of rabbits the carcass yield was 59.68%, which is more than in the control and 2nd groups by 4.83 and 1.07%, respectively.

The rabbits of group 2 were superior to animals of group 1 (control) group on the mass of hot carcass on 212.0 g (13.60%; P<0.95), 3rd group – on 334.0 g (of 21.43%, P<0.99). A similar pattern was observed in the output of muscle tissue obtained after boning. Rabbits of the control group were inferior to the peers of the experimental groups by 1.99 and 5.04%, respectively.

Table 4. Morphological composition of carcasses (n=3)

| Indicators             | The 1st group (control) | The 2nd group (1st experimental group) | The 3rd group (2nd experimental group) |
|------------------------|-------------------------|---------------------------------------|---------------------------------------|
| Pre-slaughter live weight, g | 2840.0±24.19            | 3020.0±21.66**                        | 3170.0±12.47*                        |
| The mass of steam carcass, g | 1558.0±17.27             | 1770.0±27.14*                        | 1892.0±11.07**                       |
| Lethal output, %       | 54.85±0.15              | 58.61±0.21*                          | 59.68±0.17                          |
| Meatiness              | 4.26±0.78               | 4.55±0.62                            | 4.90±0.55                           |

*P<0.95**P<0.99
The calculated index of meatiness showed that rabbits of the 3rd test group received granulated feed PZK-92-67-18 have a larger index of meatiness - 4.90 compared to the rabbits of the 2nd group received granular feed PZK-92-67/1-18 and the control received feed PZK-92-60-18 – 4.55 and 4.26 units, respectively.

Meat quality indices directly depend on the chemical composition and energy value [15, 16]. Table 5 shows the chemical composition of the rabbit meat.

| Indicator           | The 1st group (control) | The 2nd group (The 1st experimental group) | The 3rd group (The 2nd experimental group) |
|---------------------|-------------------------|------------------------------------------|-------------------------------------------|
| Mass fraction of moisture, % | 73.50±0.44              | 73.00±0.54                               | 71.50±0.58                                |
| Mass fraction of protein, % | 19.37±0.21              | 20.22±0.23                               | 21.55±0.40                                |
| Mass fraction of fat, %     | 6.10±0.42                | 5.74±0.22                                | 5.60±0.41                                 |
| Mass fraction of ash, %     | 1.03±0.02                | 1.04±0.07                                | 1.05±0.04                                 |

The assessment of functional and technological properties of rabbit meat (MBC (water binding capacity), WHC (water holding capacity), the FHA (fat holding ability), EA (emulsifying ability), and SE (stability of emulsion)) also showed a clear positive trend (table 6).

Table 6. Functional and technological parameters of rabbit meat

| Indicator                | The 1st group (control) | The 2nd group (1st experimental group) | The 3rd group (2nd experimental group) |
|--------------------------|-------------------------|----------------------------------------|----------------------------------------|
| Moisture binding capacity, % (MBC) | 60.55±0.12              | 62.14±0.41                             | 64.35±0.55                             |
| Water-holding capacity, % (WHC)   | 58.20±0.31              | 61.72±0.24                             | 63.67±0.63                             |
| Fat Holding ability, % (FHA)     | 61.40±1.35              | 62.25±1.39                             | 65.15±1.27                             |
| Emulsifying ability, % (EA)      | 28.17±0.60              | 30.47±0.41                             | 32.41±0.27                             |
| Emulsion stability, % (ES)       | 46.42±0.42              | 50.12±0.22                             | 51.40±0.44                             |

MHC was at a fairly high level and exceeded the control group by 3.69 % and 9.98%, respectively, which can be explained by the higher protein content and lower fat content in the meat of the experimental group of rabbits.

The most important indicator from the point of view of evaluation of technological potential of rabbit meat is WHC and FHA, which characterize the ability of proteins of myofibrils to form a protein-fat matrix. These indicators are variable and depend on the type of feeding and fatness of the rabbit. Studies found that the WHC (by 5.48 % and 9.67 %) and the FHA (1.34 % and 8.25 %) of the experimental group than the control group rabbits.

The presented organoleptic evaluation of the meat and broth of rabbits of control and test groups showed a positive effect of joint use of paste of green mass of amaranth, the probiotic preparation "Enzysporin" and the sorbent-catalyst toxins "Fungistat - GPK" on the formation of the sensory profile of boiled meat and broth [17-18]. As a result of the tasting it was determined that the highest score was
characterized by samples of boiled meat and broth obtained from the carcasses of group 3 (8.4 points and 8.0, respectively).

4. Conclusion
Complex use probiotic preparation "Enzymsporin" and the sorbent – catalyst toxins "Fungistat-GPK" with the addition of the paste of amaranth green mass into the feed is technologically justified and also allows avoiding a number of problems associated with a decrease of safety and productivity of livestock. The developed complete granular all-mash with the addition of feed additives will increase their digestibility by 8.5-10.0%, and also contribute to a higher transformation of feed nutrients into the protein component of muscle tissue.

Acknowledgments
The authors express their gratitude to Alexander V. Aristov, the Dean of the faculty of veterinary medicine and animal husbandry technology of Voronezh State Agricultural University named after the Emperor Peter I for the help in research, support and valuable comments, as well as the staff of state VIVIFIC RAAS and the centre for collective use of UGUET (Voronezh).

References
[1] Vysochina G I 2013 Amaranth (Amaranthus l.) Chemical composition and prospects of use (review) Chemistry of plant raw materials 2 5-14
[2] Revazov CH V 2017 Digestibility of nutrients in rabbits of California breed Scientific life 1 69-75
[3] 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 chapter 6 (117) 144-148
[4] Kurchaeva E E, Vostroilov A V, Derkanosova N M, Kashirina N A, Artemov E S, Maksimov I V and Pashchenko 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
[5] 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
[6] Guidelines for the evaluation of feed quality and nutrition 2002 (Moskow)
[7] Kladovshikov F V and Samkov Y A 1975 Study of digestibility of feed nutrients, nitrogen and energy balance in fur animals (Moscow)
[8] 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
[9] Lange P 2010 Production of granular all-mash All-mashes 6 67-68
[10] Ustinov L 2011 Complex line for the production of granulated all-mash Feed 2 47-48
[11] GOST 32897 - 2014 2016 All-mash for fur animals, rabbits and nutria. General specifications (Moskow: Standartinform)
[12] 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
[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] Birol 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

[15] *Diet protein quality evaluation in human nutrition* 2013: Report of an FAO Expert Consultation available at: http://www.fao.org/3/a-i3124e.pdf

[16] 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

[17] Derkanosova N M, Shelamova S A, Ponomareva I N, Shurshikova G V and Vasilenko O A 2018 Parameters modelling of amaranth grain processing technology *IOP Conference Series: Materials Science and Engineering. Simulation and automation of production engineering (Tomsk)* 327 (2) 22023

[18] 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