Activization of adaptogenesis and realization of meat qualities of Aberdeen-Angus bulls by biological products

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Abstract. The feasibility of using Prevention-N-E, a newly developed and tested biological product, in comparison with the previously tested PS-6 preparation in the adaptive technology of keeping specialized beef cattle of imported breeding, had been scientifically substantiated and experimentally proved. Under the conditions of production tests, biopreparations PS-6 and Prevention-N-E stimulated the production of red blood cells and increased the hemoglobin concentration in the blood of bulls, that is, improved hematopoiesis; they caused physiological eosinophilia, moderate neutropenia with a shift of the neutrophilic nucleus to the right and lymphocytosis; increased protein metabolism, mainly due to the synthesis of albumin and γ-globulin fractions; intensified nonspecific resistance of an organism. Against the background of the use of drugs in animals of the 1st and 2nd experimental groups, the incidence of the digestive and respiratory organs decreased by 1.4 and 2.3 times, the recovery time reduced by 3.36 and 4.88 days, accordingly, compared with the control (P <0.05 - 0.01). By the end of the growing period, the animals of the 1st and 2nd experimental groups exceeded in live weight control subjects by 6.6 and 9.2 kg, rearing by 10.4 and 14.8 kg, and fattening by 14.2 and 22.2 kg respectively (P <0.05 - 0.001). In the cuts of the carcasses of bulls of the 1st and 2nd experimental groups, there was a bigger amount of the highest grade flesh: in spin-breast - by 1.0 and 1.0 kg, in the lumbar - by 0.2 and 0.4 kg, and in the hip - by 2.3 and 4.2 kg (P <0.05-0.001), rather than in the control.

1. Introduction
The development strategy of beef cattle in the Russian Federation is aimed at increasing the share of domestic meat production in shaping meat resources in accordance with scientifically based consumption standards, increasing the competitiveness and investment attractiveness of the sub-
industry, and provides for solving the most important socio-economic task of providing the population with biologically valuable and good quality beef [1].

World experience shows that meeting the demand for beef in sufficient quantity is impossible without developed specialized beef cattle breeding, whose share in the total cattle population in Europe and North America ranges from 40 to 85%. In Russia, at present, beef production is 90% based on the sale of livestock of dairy and combined breeds [2-7].

The same methods of cattle breeding are used practically in all countries of the world, in all climatic zones. However, when transporting animals from continent to continent, from one country to another, even if the countries are close in climatic conditions, time and efforts of specialists are needed for the animals to adapt [8, 9].

To enhance the adaptation of imported specialized beef cattle to the natural temperature regime of the habitat and to realize the biological resource potential of the organism, the veterinary market offers a wide range of pharmacological agents, but many of them have chemical origin, the bioavailability of which is low [10-12]. In 1991, the research and development center of P.E. Ignatov developed a biogenic drug Dostimum, representing a 0.5% aqueous suspension of a purified yeast cell polysaccharide complex (glucan). The closest prototype for the problem to be solved is the immobilization of polysaccharides of yeast cells in 10-14% saline-injected solution of polyvinylpyrrolidone (RU 2137480 C1 A61 K 31/79, 35/72, 20.09.99) or in an agar gel (TU 10.07.236-91 on the production of the drug we obtain), which increases the activity of immunocompetent cells. The disadvantages of drugs include the absence of antibacterial activity of animal pathogens and insufficient stimulating activity against some parts of the immune system [13, 1].

Therefore, the development and introduction of complex, polytropic and cost-effective pharmacological tools based on natural raw materials to enhance the protective and adaptive functions of the body of beef cattle imported selection to adaptive technology of growing, additional growing and fattening and, as a result, realizing the biological potential of the organism, is an important issue of the modern veterinary science and practice [10, 14, 15].

The purpose of this work was the activation of adaptogenesis and the realization of the bioresource potential of specialized Aberdeen-Angus breed beef cattle with biological preparations PS-6 and Prevention-N-E.

2. Material and methods
The experimental part of the research work was carried out in the breeding reproducer LLC Agrofirma Myaskom, Lyskovsky district of the Nizhny Novgorod region, specializing in breeding Aberdeen-Angus breed beef cattle (2500 heads). In accordance with the research plan of the Chuvash State Agricultural Academy, processing of materials was carried out in the Lyskovsky interdistrict veterinary laboratory of the state-financed medical institution SFI “State Department of Lyskovsky District of the Nizhny Novgorod Region” and in the laboratory of the Department of Morphology, Obstetrics and Therapy of FSBEI HE Chuvash State Agricultural Academy from 2014 to 2017.

The objects of research were purebred bulls Aberdeen-Angus breed, imported from the United States (Virginia). In the scientific and production experience, three groups of bulls were formed on the principle of groups-analogues of 15 animals in each group, taking into account the physiological state, age, live weight. Animals of all groups in the rearing period up to 210 days old were kept on suction with mother cows in pens in the open air, and later in the rearing period up to 360 days old and in the fattening period up to 540 days old (duration of experiments) - in open areas under shelters, that is, by adaptive technology.

Hygienic conditions of keeping animals corresponded to natural temperature and humidity conditions of atmospheric air in all seasons of the year.

Diets for bulls during the periods of growing up to 210 days in pens, growing up to 360 days and fattening up to 540 days in open areas under canopies on adaptive technology provided the needs of the body in energy and nutrients, mineral elements and vitamins according to the norms of feeding. On average, the diet of suckling bulls up to 7 months of age consisted of 5.3 kg of alfalfa hay and 1.5 kg of
feed. The animals were fed twice a day: in the morning 60% of normal total giving of feed and in the evening – 40% of the feed. The structure of the diet for animals in the period from 7 to 12 months included: roughage – 13%, juicy food – 46.5%, concentrated – 40.5%. In the period from 13 months to the end of fattening the diet of bulls consisted of fodder mixture, in which the share of roughage was 10.5%, juicy – 39.0% and concentrated – 50.5%. Feed was given in amount of 4.0–4.5 kg per 1 head per day.

In order to intensify the adaptogenesis of beef cattle imported to the climatic conditions of the Nizhny Novgorod region and the most complete realization of the bioresources potential of the bull-calves organism under the conditions of the natural temperature of the habitat, environmentally safe complex biological products developed by scientists from FSBEI HE Chuvash GSHA, PS-6 and Prevention-N-E were used (V.G. Semenov, F. P. Petryankin, D.A. Nikitin et al.).

**PS-6** - a complex biological product, an aqueous suspension containing a polysaccharide complex of yeast cells immobilized in an agar gel with the addition of a benzimidazole derivative - (-) 2,3,5,6-tetrahydro-6-phenylimidazo [2,1-b ] -thiazole hydrochloride and bactericidal drug from the group of aminoglycosides - kanamycin monosulfate - 0.3-Amino-3-deoxy-alpha-D-glucopyranosyl- (1"6)-0- [6-amino-6-deoxy-alpha-D -glucopirinazyl- [1"4]) - 2-deoxy-D-streptamine (in the form of sulfate).

**Prevention-N-E** - a complex preparation, an aqueous suspension containing a saccharomyces cerevisiae polysaccharide complex immobilized in an agar gel with the addition of the benzimidazole derivative - (-) 2,3,5,6-tetrahydro-6-phenylimidazo [2,1-b ] -thiazole hydrochloride and macrolide bactericidal drug - erythromycin - [3R- (3R *, 4S *, 5S *, 6R *, 7R *, 9R *, 11R *, 12R *, 13S *, 14R *)] - 4 [(2,6-Dideoxy-3-O-methyl-3-0-methyl-alpha-L-ribohexopyranosyl)oxy]-14-ethyl-7,12,13-trihydroxy-3,5,7,9,11,13-hexamethyl-6-[3,4,6-trideoxy-3-(dimethylamino)-beta-D xylohexopyranosyl] oxy] oxycyclotetradec n-2,10-dione.

Animals of the 1st experimental group were injected intramuscularly with a biological preparation PS-6 at a dose of 3 ml for 2-3 and 7-9 days of life, the 2nd experimental group - Prevention-N-E at the indicated dose and at the same time, the control groups - biological preparations were not administered.

Growth, morbidity and preservation, clinical and physiological status, morphological and biochemical profile of the blood, as well as non-specific resistance of the body of bulls were studied for 1-, 210-, 240-, 360-, 450- and 540th days according to generally accepted veterinary medicine methods. After controlling slaughter, bulls were assessed for slaughter quality, and veterinary and sanitary examination of beef was carried out.

Research work was carried out using the following methods:

1) **clinical and physiological** – body temperature, heart rate and respiration were measured by conventional veterinary methods;

2) **hematological** - number of erythrocytes, concentration of hemoglobin, total number of leukocytes and types on the PCE 90 Vet automatic veterinary hematology analyzer were determined;

3) **biochemical** - level of total protein in blood serum was investigated - using an IRF-22 refractometer according to A.M. Akhmedov, protein spectrum - by turbidimetric method according to S.A. Karpyuk;

4) **immunobiological** - phagocytic activity of leukocytes was determined according to V.S. Gostev using the daily agar culture of St. aureus, lysozyme activity of blood plasma according to V.G. Dorofeychuk using daily agar culture M. lysodeiticus, bactericidal activity of blood serum according to O. V. Smirnova et al. using daily agar culture of E. coli, as well as the amount of antibodies in the serum of phototriodecolorimeter FKE-56M by D. A. Mac-Ewan et al.;

5) **zootechnical** - live weight and average daily gain of animals by monthly weighing were determined. Meat productivity and slaughter qualities were assessed by the results of the control slaughter of bulls (5 animals from each group) at the age of 540 days according to the standard technique. At the same time, pre-slaughter live weight, mass of hot and cooled carcass and internal raw fat, relative yield of carcass, fat, slaughter mass and slaughter yield were taken into account. After cooling for 24 hours, the right halves of the bulls carcasses were weighed and boned to determine the absolute and relative content of the flesh, fat, tendons and bones, flesh output by grades, in terms of carcass;
the meat index is the ratio between the flesh mass of the carcass and the bone mass, that is, the amount of flesh per 1 kg of bone;

6) **veterinary and sanitary examination** of meat by organoleptic (appearance, color, texture, smell, condition of fat and tendons, degree of bleeding), cooking sample (smell, transparency, taste of broth) and biochemical parameters (pH, amino-ammonia nitrogen, formal acid reaction, reaction to peroxidase and with copper sulfate) in accordance with the "Rules of veterinary examination of slaughter animals and veterinary-sanitary examination of meat and meat products" (M., 1988);

7) **spectrometric** - the content of heavy metals (lead, cadmium, arsenic, copper, zinc, mercury) was determined in muscle tissue using atomic absorption spectrophotometry;

8) **economic** - determined the effectiveness of activating the adaptogenesis of imported bulls with PS-6 and Prevention-N-E biological preparations according to the method of I.N. Nikitin et al.

Therapeutic and prophylactic efficacy of biological products was determined by monthly registration of the diseased (taking into account the diagnosis and duration of the disease) and culled animals according to the veterinary statistical reporting with the subsequent calculation of the Mellenberg coefficient using the formula

\[ MC = \frac{sick\_animals\_number \times duration\_of\_disease}{number\_of\_animals\_in\_group \times experiment\_duration} \times 100 \]

The digital material of the experiments was processed by the method of variation statistics on the reliability of the difference between the compared indicators (P <0.05-0.001) using the Microsoft Office Excel software package.

3. **Research results**

It was found that the double intramuscular injection of PS-6 and Prevention-N-E on 2nd...3rd and 7th...9th day of life in a dose of 3 ml did not affect the clinical and physiological state of the body.

During the growing period, both in the control and in the experimental groups, cases of bull diseases were identified, which are presented in the Table 1.

**Table 1. Incidence of bulls.**

| Indicator                        | Control | 1 experimental | 2 experimental |
|----------------------------------|---------|----------------|----------------|
| Number of animals in groups      | 15      | 15             | 15             |
| Got sick                         | 7       | 5              | 3              |
| Recovered                        | 7       | 5              | 3              |
| Duration of disease, day         | 7.23±1.26 | 3.87±1.14*    | 2.35±0.65*    |
| Morbidity, %                     | 46.6    | 33.3           | 20.0           |
| Mellenberg coefficient           | 1.61    | 0.61           | 0.22           |

It follows from the presented tabular data that the animals of the experimental groups decreased in the incidence of the digestive and respiratory organs by 1.4 and 2.3 times, the recovery time was reduced by 3.36 and 4.88 days. and the Mellenberg coefficient decreased by 2.6 and 7.3 times, respectively, compared with the control (P <0.05).

The selective mobilization of the morphological and biochemical profiles of blood, cellular and humoral factors of nonspecific resistance of the bulls body in the conditions of adaptive content technology in open areas has been revealed. Proven biological products have a wide range of bioeffect:

- stimulated the production of red blood cells and increased the concentration of hemoglobin in the blood of bulls, that is, improved hematopoiesis, but did not affect the production of white blood cells (table 2);
Table 2. Hematological parameters of bulls.

| Group of animals | Age, days | Erythrocytes, $\times 10^{12}$/l | Hemoglobin, g/l | Leukocytes, $\times 10^9$/l |
|------------------|-----------|-------------------------------|-----------------|-----------------------------|
| Control          | 1         | 8.18±0.24                    | 117±2.54        | 9.38±0.29                   |
|                  | 210       | 7.24±0.29                    | 106±2.30        | 7.27±0.38                   |
|                  | 240       | 7.45±0.21                    | 107±2.44        | 6.93±0.31                   |
|                  | 360       | 7.61±0.26                    | 110±2.22        | 7.04±0.37                   |
|                  | 450       | 7.68±0.24                    | 108±2.67        | 6.80±0.24                   |
|                  | 540       | 7.43±0.23                    | 109±2.51        | 6.66±0.32                   |
| 1 experimental   | 1         | 8.26±0.17                    | 119±2.62        | 9.22±0.24                   |
|                  | 210       | 8.14±0.26*                   | 118±2.35**      | 7.59±0.32                   |
|                  | 240       | 8.33±0.22*                   | 119±2.63*       | 7.41±0.34                   |
|                  | 360       | 8.47±0.24*                   | 121±2.48*       | 7.51±0.39                   |
|                  | 450       | 8.57±0.20*                   | 123±2.69**      | 7.32±0.24                   |
|                  | 540       | 8.24±0.19*                   | 120±2.35*       | 7.02±0.28                   |
| 2 experimental   | 1         | 8.10±0.21                    | 115±2.56        | 9.18±0.25                   |
|                  | 210       | 7.97±0.26                    | 116±2.36*       | 7.47±0.33                   |
|                  | 240       | 8.17±0.26                    | 118±2.40*       | 7.33±0.29                   |
|                  | 360       | 8.30±0.19                    | 119±2.11*       | 7.41±0.38                   |
|                  | 450       | 8.46±0.22*                   | 120±2.40*       | 7.16±0.32                   |
|                  | 540       | 8.15±0.19*                   | 118±2.57*       | 7.04±0.25                   |

* P<0.05, ** P<0.01.

- caused physiological eosinophilia, moderate neutrophilopenia with a shift of the neutrophilic nucleus to the right and lymphocytosis (table 3);

Table 3. Leukocyte formula of bovine blood.

| Group of animals | Age, days | Basophils, % | Eosinophils, % | Neutrophils, % | Monocytes, % |
|------------------|-----------|--------------|----------------|----------------|--------------|
| Control          | 1         | 0.2±0.20     | 0.4±0.24       | 2.0±0.32       | 22.4±1.03    |
|                  | 210       | 0.8±0.37     | 1.4±0.24       | 0.6±0.24       | 13.4±1.12    |
|                  | 240       | 0.8±0.37     | 1.2±0.49       | 1.2±0.37       | 15.0±1.67    |
|                  | 360       | 1.2±0.37     | 1.2±0.20       | 0.8±0.20       | 14.0±1.58    |
|                  | 450       | 1.6±0.51     | 1.6±0.24       | 0.6±0.40       | 9.8±1.59     |
|                  | 540       | 2.0±0.45     | 2.0±0.32       | 0.6±0.00       | 5.6±1.12     |
| 1 experimental   | 1         | 0.0±0.00     | 0.2±0.20       | 1.4±0.51       | 22.2±0.86    |
|                  | 210       | 0.2±0.20     | 2.0±0.32       | 0.2±0.20       | 7.4±1.57     |
|                  | 240       | 0.4±0.24     | 1.8±0.37       | 0.4±0.40       | 7.6±1.47     |
|                  | 360       | 0.6±0.40     | 2.2±0.37*      | 0.2±0.20       | 6.8±1.56     |
|                  | 450       | 0.8±0.37     | 2.8±0.7*       | 0.2±0.20       | 2.4±1.25     |
|                  | 540       | 0.8±0.37     | 3.4±0.40*      | 0.0±0.00       | 1.4±0.51     |
| 2 experimental   | 1         | 0.2±0.20     | 0.4±0.24       | 1.6±0.24       | 23.2±0.80    |
|                  | 210       | 0.4±0.40     | 2.2±0.37       | 0.4±0.24       | 6.6±1.60     |
|                  | 240       | 0.4±0.20     | 2.4±0.24       | 0.6±0.24       | 8.0±1.48     |
|                  | 360       | 0.4±0.40     | 2.8±0.49*      | 0.2±0.20       | 4.6±1.69     |
|                  | 450       | 0.6±0.24     | 3.2±0.49*      | 0.0±0.00       | 2.6±0.75     |
|                  | 540       | 1.0±0.32     | 3.6±0.51*      | 0.0±0.00       | 1.8±0.58     |
increased protein metabolism, mainly due to the synthesis of albumin and γ-globulin fractions (table 4);

**Table 4.** Dynamics of total protein and protein fractions in bovine serum.

| Group of animals | Age, day | Total protein, g/l | Protein fractions, g/l |  |
|------------------|----------|--------------------|------------------------|---|
|                  |          |                    | albumins               | α-globulins | β-globulins | γ-globulins |
| Control          | 1        | 62.8±1.30          | 26.5±0.81              | 13.5±1.22  | 13.2±0.65  | 9.6±0.87    |
|                  | 210      | 61.0±1.11          | 27.0±0.96              | 6.9±0.73   | 6.6±0.91   | 20.4±0.75   |
|                  | 240      | 61.4±1.15          | 28.1±0.97              | 6.9±0.63   | 7.1±0.89   | 19.3±0.71   |
|                  | 360      | 61.8±1.19          | 28.7±0.98              | 6.1±0.86   | 6.5±0.94   | 20.5±0.62   |
|                  | 450      | 61.7±1.17          | 29.7±1.03              | 5.5±1.14   | 5.1±0.91   | 21.3±0.64   |
|                  | 540      | 62.2±1.24          | 30.0±0.91              | 5.6±1.08   | 5.6±1.21   | 21.0±0.71   |
| 1 experimental   | 1        | 62.4±1.33          | 26.0±0.94              | 13.4±1.20  | 13.6±0.99  | 9.4±0.71    |
|                  | 210      | 65.8±1.12*         | 30.8±0.90*             | 5.3±0.82   | 5.4±0.61   | 24.2±0.71** |
|                  | 240      | 65.5±1.30*         | 31.6±0.99*             | 5.2±0.36   | 5.2±0.63   | 23.5±0.65** |
|                  | 360      | 66.3±1.27*         | 32.1±0.93*             | 5.4±0.91   | 5.1±0.75   | 23.8±0.89*  |
|                  | 450      | 66.5±1.25*         | 32.9±0.88*             | 4.7±0.86   | 4.5±0.70   | 24.3±0.90*  |
|                  | 540      | 66.7±1.10*         | 33.2±0.82*             | 5.5±0.92   | 4.7±0.42   | 23.3±0.60*  |
| 2 experimental   | 1        | 63.2±1.43          | 27.4±0.87              | 12.7±0.82  | 13.1±0.95  | 10.0±0.73   |
|                  | 210      | 64.7±1.16          | 31.4±0.95*             | 5.2±1.34   | 4.4±1.19   | 23.7±0.70*  |
|                  | 240      | 65.0±1.01*         | 32.6±1.01*             | 4.7±1.24   | 4.6±1.23   | 23.1±0.76** |
|                  | 360      | 65.6±1.16          | 33.0±1.02*             | 4.9±1.35   | 5.1±1.47   | 22.6±0.64*  |
|                  | 450      | 65.9±1.12*         | 33.6±1.03*             | 3.9±1.27   | 3.7±1.14   | 24.7±0.59** |
|                  | 540      | 66.2±1.04*         | 33.6±0.77*             | 4.6±0.94   | 4.2±0.85   | 23.9±0.55*  |

- activated cellular and humoral factors of nonspecific resistance of the organism.

The dynamics of the bull's body nonspecific resistance cellular and humoral links main indicators is shown in Figure 1 – 4.

**Figure 1.** Dynamics of phagocytic activity

**Figure 2.** Dynamics of lysozyme activity.
Figure 3. Dynamics of bactericidal activity.

Figure 4. Dynamics of immunoglobulins in blood serum.

The dynamics of live weight, average daily gain and growth rate of experimental groups bulls are presented in table 5.

**Table 5.** Dynamics of growth and development of bulls.

| Group of animals | Age, days | Live weight, kg   | Average daily gain, g | Coefficient of growth |
|------------------|-----------|-------------------|------------------------|-----------------------|
| Control          | 210       | 202.8±2.06        | 972±13.83              | 7.23                  |
|                  | 240       | 230.6±2.32        | 927±16.33              | 8.29                  |
|                  | 360       | 335.6±2.62        | 875±14.56              | 12.07                 |
|                  | 450       | 421.0±2.95        | 949±21.26              | 15.14                 |
|                  | 540       | 497.2±3.37        | 847±18.16              | 17.88                 |
| 1 experimental   | 1         | 28.0±0.63         | –                      | –                     |
|                  | 210       | 209.4±2.11        | 1008±13.45             | 7.48                  |
|                  | 240       | 238.4±2.14*       | 967±18.26              | 8.51                  |
|                  | 360       | 346.0±2.88*       | 897±16.77*             | 12.36                 |
|                  | 450       | 433.8±3.12*       | 976±22.88              | 15.49                 |
|                  | 540       | 511.4±3.44*       | 862±16.67              | 18.26                 |
| 2 experimental   | 1         | 27.4±0.75         | –                      | –                     |
|                  | 210       | 212.0±2.61*       | 1026±13.56**           | 7.73                  |
|                  | 240       | 242.6±3.06*       | 1020±20.00*            | 8.85                  |
|                  | 360       | 350.4±3.37**      | 898±10.00**            | 12.79                 |
|                  | 450       | 440.6±3.61**      | 1002±27.76             | 16.08                 |
|                  | 540       | 519.4±3.87**      | 876±21.49              | 18.96                 |

* P<0.05, ** P<0.01.

It was established that by the end of the growing period, the 210-day bulls of the 1st and 2nd experimental groups exceeded the live weight of control ones by 6.6 and 9.2 kg, respectively, of growing by 10.4 and 14, 8 kg and fattening - by 14.2 and 22.2 kg (P <0.05-0.01).
A similar pattern occurred in the nature of changes in average daily growth and growth rate (the ratio of body weight in certain age periods to that at birth) of the compared groups animals. Consequently, intramuscular administration of biological products to bulls stimulates their growth, due to increased protein metabolism (mainly albumin fraction of protein – plastic material) on the background of activation of cellular and humoral factors of nonspecific resistance of the body.

The research results of the slaughter qualities of calves are shown in the Table 6.

Table 6. Indicators of control slaughter of bulls.

| Indicator                              | Group of animals |
|----------------------------------------|------------------|
|                                        | Control | 1 experimental | 2 experimental |
| Live weight for the removal of fattening, kg | 497.2±3.37 | 511.4±3.44* | 519.4±3.87** |
| Pre-slaughter live weight, kg           | 483.4±3.56 | 498.8±3.95* | 505.4±4.13** |
| The steam mass carcass, kg              | 269.8±1.93 | 279.4±2.16* | 289.4±2.38*** |
| Carcass output, %                       | 55.8     | 56.0          | 57.3          |
| Weight of internal fat, kg              | 6.5±0.25  | 7.1±0.33      | 7.0±0.25      |
| Internal fat yield, %                   | 1.34     | 1.42          | 1.38          |
| Slaughter weight, kg                    | 287.1±2.06 | 301.2±2.60** | 308.4±2.66*** |
| Slaughter yield, %                      | 59.4     | 60.4          | 61.1          |

* P<0.05, ** P<0.01, *** P<0.001.

The results of the control slaughter showed that the bulls of the 1st (498.8±3.95 kg) and the 2nd (505.4±4.13 kg) experimental groups were superior to the ones of the control group (483.4±3.56 kg) by pre-slaughter body weight by 15.4 kg or by 3.2% (P<0.05) and by 22.0 kg, i.e. by 4.5% (P<0.01). It was established that the mass of the steam carcass of bulls grown on the background of intramuscular injection of PS-6, with further rearing and fattening in open areas under sheds, exceeded the same figures in the control by 9.6 kg or 3.5% (P<0.05), and with the use of a biological product Prevention-N-E - by 19.6 kg, i.e. by 7.3% (P<0.001). At the same time, the bulls of the 1st and 2nd experimental groups outperformed their ones in control by 1.0 and 1.7%.

The morphological composition of bull carcasses is presented in Table 7.

Table 7. Morphological composition of carcasses of bulls.

| Indicator                              | Group of animals |
|----------------------------------------|------------------|
|                                        | Control | 1 experimental | 2 experimental |
| Chilled carcass weight, kg              | 260.2±2.27 | 269.8±2.35* | 278.6±3.23** |
| The mass of the flesh, kg               | 206.8±2.35 | 214.8±2.33* | 222.4±3.11** |
| The yield of flesh, %                   | 79.48    | 79.61         | 79.82         |
| Including weight of fat                |          |              |              |
| by weight of flesh, kg                  | 15.4±0.58 | 16.3±0.31    | 16.1±0.29    |
| Fat yield, %                           | 5.92     | 6.04         | 5.78         |
| Tendon weight, kg                       | 8.9±0.17 | 9.2±0.12     | 9.3±0.17     |
| The yield of tendons, %                 | 3.42     | 3.41         | 3.34         |
| Bone weight, kg                        | 44.5±0.75 | 45.8±0.66    | 46.9±0.74    |
| Bone yield, %                          | 17.10    | 16.97        | 16.83        |
| Flesh yield per 100 kg of pre-slaughter live weight | 42.78±0.12 | 43.06±0.24 | 44.04±0.29** |
| Fleshing index                         | 4.65±0.15 | 4.69±0.11    | 4.74±0.08    |

* P<0.05, ** P<0.01.
The process of carcasses cooling inevitably leads to a loss of mass (drying), due to evaporation of moisture from 3.5% to 3.8%. Therefore, the mass of cooled carcasses of bulls of the control, 1st and 2nd experimental groups turned out to be lower, respectively, by 9.6 kg, 9.6 and 10.8 kg, rather than paired carcasses.

As a result of the carcasses deboning, it was established that, by the weight of the flesh of carcasses, the bulls of the 1st and 2nd experimental groups exceeded the ones of the control group by 8.0 and 2.4 kg, i.e. it was more by 0.28 kg (P>0.05), and in the 2nd experimental group – 44.04±0.29 kg, i.e. it was more by 1.26 kg (P<0.01) than in the control group – 42.78±0.12 kg. The meat index (the ratio between the mass of carcass flesh and bone mass, that is, the amount of flesh per 1 kg of bones) of the bulls of the 2 experimental group was 4.74, which is more than in the control and 1st experimental groups by 0.09 and 0.05.

Thus, we can conclude that the bull carcasses of all groups were distinguished by the good development of muscle and fat tissues. With an increase in the weight of the carcasses of experimental animals, the specific gravity of the flesh increased, while the bones, on the contrary, decreased. This indicates the well developed meat qualities of animals of all groups. The greatest amount of flesh differed in bull calves of the experimental groups, especially the 2nd one.

When assessing the meat productivity of the animal, not only the ratio of the carcass tissue is important, but also the ratio of the anatomical parts from which different varieties of meat.

Weight and output of cuts from carcasses of bulls are shown in Table 8.

It was established that bull carcasses of the 1st and 2nd experimental groups had an advantage in terms of the most valuable cuts mass: spin-breast - by 8.0 and 11.5 kg, lumbar - by 1.8 and 3.2 kg, hip - by 3.2 and 7.4 kg (P<0.01-0.001), respectively, than in the control. The yield of these cuts from the carcasses of bulls of the 1st and 2nd experimental groups was higher by 1.9 and 2.2%, by 0.2 and 0.3%, by 0.2 and 0.8%, respectively, than in control.

### Table 8. Weight and yield of cuts from carcasses of bulls.

| Indicator          | Group of animals | Control       | 1 experimental | 2 experimental |
|--------------------|------------------|---------------|----------------|----------------|
| Carcass weight, kg |                  | 260.2±2.27    | 269.8±2.35*    | 278.6±3.23**   |
|                    | including the cut: |               |                |                |
| cervical, kg       |                  | 29.1±0.15     | 27.2±0.23      | 26.5±0.24      |
| %                  |                  | 11.2          | 10.1           | 9.5            |
| humeroscapular, kg |                  | 48.7±0.21     | 47.2±0.12      | 47.6±0.22      |
| %                  |                  | 18.7          | 17.5           | 17.1           |
| spinal chest, kg   |                  | 74.9±0.72     | 82.9±0.54***   | 86.4±0.62***   |
| %                  |                  | 28.8          | 30.7           | 31.0           |
| lumbar, kg         |                  | 33.3±0.40     | 35.1±0.37*     | 36.5±0.60**    |
| %                  |                  | 12.8          | 13.0           | 13.1           |
| hip, kg            |                  | 74.2±0.59     | 77.4±0.62**    | 81.6±0.71***   |
| %                  |                  | 28.5          | 28.7           | 29.3           |

In order to determine the varietal composition of carcasses, the classification was used, according to which the beef was divided into 4 grades: the highest, I, II and fat one. The highest grade included pieces
of beef without visible tendon and fat particles, first grade - pieces containing no more than 6% of connective tissue, second grade - beef containing up to 20% fat and connective tissue, fatty beef includes pieces of meat with subcutaneous fat and marbling.

The grade of flesh of carcasses of experimental bulls is presented in Table 9.

Table 9. Grade of carcass bull meat.

| Indicator | Control | 1 experimental | 2 experimental |
|-----------|---------|----------------|----------------|
| The flesh mass, kg | 206.8±2.35 | 214.8±2.33* | 222.4±3.11** |
| The mass of the highest grade flesh, kg | | | |
| The yield of the highest grade flesh, % | 107.3±1.40 | 112.1±1.17* | 117.4±1.53** |
| The mass of the first grade flesh, kg | 51.9 | 52.2 | 52.8 |
| The yield of the first grade flesh, % | 50.5±0.53 | 50.5±0.59 | 50.3±0.60 |
| The mass of the second grade flesh, kg | 24.4 | 23.5 | 22.6 |
| Second grade flesh yield, % | | | |

* P<0.05, ** P<0.01, *** P<0.001.

It follows from the table that the highest content of the highest grade flesh was characterized by bulls carcasses of the 1st (52.2 ± 0.63 kg) and 2nd (54.7 ± 0.65 kg) experimental groups, respectively, by 3.2 and 5.7 kg compared with the control (49.0 ± 0.77 kg; P <0.05-0.001). The yield of high grade flesh was higher in animals of the experimental groups by 0.6 and 0.9%.

The results of trimming cuts are given in table 10

It follows from the table that the cervical cut along the seventh vertebra inclusive mainly consists of the flesh of the first and second grades. It was established that the bulls of the 1st and 2nd experimental groups were lower than the control ones in mass of first-grade flesh by 0.7 and 0.8 kg, of the second grade - by 0.7 and 0.9 kg, respectively (P> 0.05).

As a result of the varietal separation of the shoulder-cut cuts of bull-calves carcasses, it was found that the intergroup differences were insignificant (P> 0.05). The highest mass of top grade flesh was in the shoulder cuts of the 1st experimental group and amounted to 5.5 ± 0.12 kg, i.e. it turned out to be higher than that in animals of the control and 1st experimental groups by 0.3 and 0.1%, respectively.

The highest content of the highest grade flesh was characterized by spin-breast cuts of bull-calves of the 1st (9.5 ± 0.17 kg) and 2nd (9.5 ± 0.14 kg) experimental groups, which is 1.0 kg higher than in control (8.5 ± 0.21 kg; P <0.01). At the same time, in the experimental groups, the yield of the highest grade flesh was more by 0.1 and 0.3%. The first-grade flesh content in spin-breast cuts of bull-calves of the 1st and 2nd experimental groups was 3.2 and 2.5 kg more, the flesh yield was 0.3 and 0.1% compared to the control (P <0.001).

The highest-grade flesh was the highest in lumbar cuts of bull-calf carcasses of the 2nd experimental group - 4.7 ± 0.19 kg, which is 0.4 and 0.2 kg more, respectively, than in the control and 1st experimental groups. At the same time, the highest grade flesh exceeded that of the 1st experimental group bulls of the control and 2nd experimental groups ones, respectively, by 0.3 and 0.1%. In terms the first-grade flesh content, bulls of the 1st and 2nd experimental groups were superior to their ones in the control group by 0.8 (P >0.05) and 1.6 kg (P <0.05). The yield of the first grade flesh in the lumbar cuts of the experimental groups bulls was almost the same and amounted to 65.4%, 65.4% and 65.3% in the control, 1st and 2nd experimental groups, respectively.

The amount of the highest grade flesh in the hip bullhead cuts of the 1st (33.1 ± 0.49 kg) and 2nd (35.0 ± 0.53 kg) experimental groups was 2.3 and 4.2 kg more (P <0.01-0.001) than in the control (30.8 ± 0.38 kg). At the same time, the output of the highest grade flesh in the control group was 49.9%, in the 1st test group - 50.6% and in the 2nd test group - 48.7%. In terms of flesh content of the first grade, bulls of the 1st (27.5 ± 0.46 kg) and 2nd (32.0 ± 0.58 kg) experimental groups also exceeded their ones
in control (25.0 ± 0.29 kg) by 2.5 and 7.0 kg (P <0.01-0.001). And the yield of first grade flesh was higher in the experimental groups by 1.5 and 4.0%, rather than in the control.

| Table 10. Grade flesh of bulls carcass cuts. |
|--------------------------------------------|
| Indicator                                    | Control | 1 experimental | 2 experimental |
| Collar butt                                 |
| The flesh mass, kg                          | 24.6±0.37 | 23.2±0.42 | 22.9±0.31 |
| The mass of the first grade flesh, kg       | 14.7±0.29 | 14.0±0.36 | 13.9±0.34 |
| The mass of the second grade flesh, kg      | 9.9±0.22  | 9.2±0.25  | 9.0±0.35  |
| Scapulohumeral butt                         |
| The flesh mass, kg                          | 36.4±0.38 | 34.6±0.29 | 35.8±0.29 |
| The mass of the highest grade flesh, kg     | 5.4±0.11  | 5.1±0.05  | 5.5±0.12  |
| The mass of the first grade flesh, kg       | 22.8±0.34 | 21.8±0.33 | 22.6±0.42 |
| The mass of the second grade flesh, kg      | 8.2±0.16  | 7.7±0.09  | 7.7±0.12  |
| Spinal butt                                 |
| The flesh mass, kg                          | 55.6±1.03 | 62.0±0.80** | 60.9±0.46** |
| The mass of the highest grade flesh, kg     | 8.5±0.21  | 9.5±0.17** | 9.5±0.14** |
| The mass of the first grade flesh, kg       | 26.2±0.22 | 29.4±0.23*** | 28.7±0.27*** |
| The mass of the second grade flesh, kg      | 20.9±0.20 | 23.1±0.48** | 22.7±0.28*** |
| Lumbar butt                                 |
| The flesh mass, kg                          | 28.5±0.29 | 29.6±0.38 | 30.9±0.40** |
| The mass of the highest grade flesh, kg     | 4.3±0.12  | 4.5±0.17  | 4.7±0.19  |
| The mass of the first grade flesh, kg       | 18.6±0.37 | 19.4±0.26 | 20.2±0.39* |
| The mass of the second grade flesh, kg      | 5.6±0.26  | 5.7±0.24  | 6.0±0.23  |
| Hip butt                                    |
| The flesh mass, kg                          | 61.7±0.52 | 65.4±0.70*** | 71.9±0.92*** |
| The mass of the highest grade flesh, kg     | 30.8±0.38 | 33.1±0.49** | 35.0±0.53*** |
| The mass of the first grade flesh, kg       | 25.0±0.29 | 27.5±0.46** | 32.0±0.58*** |
| The mass of the second grade flesh, kg      | 5.9±0.15  | 4.8±0.18  | 4.9±0.20  |

Thus, the highest content of the highest grade flesh was characterized by carcasses and cuts, especially lumbar and hip, bulls of the 1st and 2nd experimental groups grown on the background of intramuscular injection of biologics in conditions of adaptation to the natural temperature and humidity regime of atmospheric air.

The results of assessing the quality of beef with organoleptic, biochemical and spectrometric indicators are given in Table 11.

In terms of organoleptic, biochemical and spectrometric indicators, beef complied with the requirements of the Technical Regulations of the Customs Union “On Food Safety” of the TP TC 021/2011 TP and Technical Regulations of the Customs Union “On the Safety of Meat and Meat Products” TP TC 034/2013 TR.
Table 11. Evaluation of the quality of beef.

| Indicator                                      | Control     | 1 experimental | 2 experimental |
|------------------------------------------------|-------------|----------------|----------------|
| **Organoleptic:**                              |             |                |                |
| the appearance and color of the surface        |             |                |                |
| muscles on the cut                             |             |                |                |
| consistency                                    |             |                |                |
| smell                                          |             |                |                |
| surface fat                                    |             |                |                |
| the condition of the tendons                   |             |                |                |
| transparency and flavor of the broth           |             |                |                |
| **Biochemical:**                               |             |                |                |
| pH (5.6 – 6.2)                                 | 5.78±0.03   | 5.76±0.02      | 5.74±0.02      |
| amino-ammonia nitrogen, mg                     | 1.21±0.01   | 1.19±0.01      | 1.20±0.01      |
| reaction to the peroxidase                     | negative    | positive       | negative       |
| reaction with copper sulfate                   | negative    | negative       | negative       |
| **Spectrometric, mg/kg**                       |             |                |                |
| lead (not more than 0.5)                       | 0.06±0.01   | 0.07±0.01      | 0.05±0.01      |
| cadmium (not more than 0.05)                   | not detected| not detected   | similar to control |
| arsenic (not more than 0.1)                    | not detected| similar to control | similar to control |
| copper (not more than 5.0)                     | 0.74±0.03   | 0.77±0.04      | 0.76±0.02      |
| zinc (not more than 70)                        | 25.4±0.24   | 26.0±0.16      | 26.4±0.21      |
| mercury (not more than 0.03)                   | not detected| similar to control | similar to control |

4. Conclusions
The results of studies on the use of biological products to enhance the protective and adaptive functions of the body of bulls to the conditions of adaptive technologies for growing, additional growing and fattening, and realizing the biological potential of the organism indicated that under the influence of PS-6 and Prevention-N-E, the adaptive plasticity of the body to low temperatures of the environment, hematopoiesis, cellular and humor factors of nonspecific resistance were activated, diseases of the respiratory and digestive organs were reduced, and growth accelerated, and meat productivity also increased. It should be noted that Prevention-N-E had a more pronounced stimulating effect on nonspecific resistance of the body, shows preventive effectiveness in these diseases of non-infectious etiology, improves the fattening and slaughter qualities of bulls.
The selective mobilization of the morphological and biochemical profiles of blood, cellular and humoral factors of bulls body nonspecific resistance in the context of adaptive content technology in open areas aimed at the adaptation of the organism was revealed.

It had been established that a double intramuscular injection of biopreparations PS-6 and Prevention-N-E to bulls on the 2nd ... 3rd and 7th ... 9th day of life at a dose of 3 ml did not affect the clinical and physiological state of the body, but increased the effectiveness of preventive measures. In animals, the incidence of the organs of the digestive and respiratory organs decreased by 1.4 and 2.3 times, the recovery time was reduced by 3.36 and 4.88 days, and the Mellenberg coefficient decreased by 2.6 and 7.3 times, respectively, compared with the control (P <0.05).

Against the background of an increase in non-specific resistance of the body of bulls under the influence of biopreparations, the activation of their growth and development has been established. By the end of the nursing period, 210-day bulls of the 1st and 2nd experimental groups outnumbered, by live weight, the control ones by 6.6 and 9.2 kg, and the rearing (360 days) by 10.4 and 14.8 kg and fattening (540 days) - by 14.2 and 22.2 kg (P <0.05-0.01).

It was found that bull calves of the 1st and 2nd experimental groups had an advantage in terms of the mass of the most valuable cuts: spin-breast - by 8.0 and 11.5 kg, lumbar - by 1.8 and 3.2 kg, hip - by 3.2 and 7.4 kg (P <0.01-0.001), respectively, than in the control.

The highest content of premium meat was characterized by bulls carcasses of the 1st (52.2 ± 0.63 kg) and 2nd (54.7 ± 0.65 kg) experimental groups, respectively, by 3.2 and 5.7 kg compared to control (49.0 ± 0.77 kg; P <0.05-0.001).

References

[1] Semenov V G, Kosyæv N I, Lavrentyev A Yu, Larionov G A, Evdokimov N V, Toboyev G M and Nikitin D A 2018 Inter. J. Engin. Tech. 7 pp 648–55
[2] Amerkhanov H A, Kochetkov A and Sharkaev V 2008 Dairy and beef cattle (Moscow) 1 pp 2–4
[3] Babushkin V A, Shemetyuk S A, Avdalyan Ya V, Zizyukov I V and Shchegolkov N F 2018 Bulletin of Michurinsky State Agrarian University (Michurinsk) 1 pp 62-4
[4] Japaridze T G 2008 Chief zootechnician (Moscow) 8 pp 39–41
[5] Dunin I M, Shichkin G I and Kochetkov A A 2014 Dairy and Beef Cattle (Moscow) 1 pp 2–5
[6] Dyuldina A V 2016 Dairy and Beef Cattle (Balashikha) 8 pp 31–3
[7] Legoshin G P 2003 Zootechnics (Moscow) 3 pp 24–6
[8] Gizatullin R S and Sedykhn T A 2016 Monograph (Saarbrücken) 119
[9] Goldobin M I, Grigoriev A G and Azatov R M 1994 Husbandry (Moscow) 11 pp 26–7
[10] Nikitin D A and Semenov V G 2013 Russian J. "Problems of veterinary sanitation, hygiene and ecology" (Moscow) 1(9) pp 59–63
[11] Topuria G M, Topuria L Yu, Donnik I M and Shkuratova I A 2017 Agrarian Bullet. Urals (Ekaterinburg) 9 (163) pp 67–70
[12] Shukanov A A 2000 Veterinary (Moscow) 10 pp 48–52
[13] Vasilyev V A, Semenov V G and Mudarisov R M 2014 European Conference on Innovations in Technical and Natural Sciences. Proceedings of the 1st International scientific conference «East West» Association for Advanced Studies and Higher Education (GmbH. Vienna, Austria) pp 176–81
[14] Gorlov I F, Slozhenkina M I, Zakurdaeva A A, Randelin A V, Mosolova D A and Miroshnik A S 2017 Recommendations (Volgograd) p 19
[15] Yakimov A V, Mudarisov F J and Salakhov V V 2016 Bullet. Ulyanovsk State Agrical. Acad. (Ulyanovsk) 3 (35) pp 165–9