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Original Article

Directed Calf Raising in the Conditions of Adaptive Technology

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Abstract

For the first time, based on complex research, a zoo technical justification for the use of PS-2 and PS-4 biostimulators in the technology of calf raising in individual boxes and pavilions is given to activate the body's adaptogenesis to cold and implement the productive qualities of young stock during rearing and fattening in typical premises. Intramuscular injection of PS-2 (polysaccharide complex of yeast cells immobilized in an agar gel by adding a benzimidazole derivative) and PS-4 (similar to PS-2 plus antibiotic of the cephalosporin) to calves in a dose of 3 ml at 2-3 and 7-9 days of life stimulates their growth and development during the raising, rearing, and fattening periods, thereby reducing the incidence of diseases. By the end of the growing, rearing, and fattening periods, the animals of the 1st and 2nd experimental groups outnumbered their control peers by 7.2 and 8.2 kg; 11.4 and 13.6 kg; as well as 13.8 and 16.8 kg, respectively (P<0.05-0.01). A similar pattern occurred in the nature of changes in exterior measurements and growth coefficient of animals of the compared groups. At the same time, in the calves of the 1st and 2nd experimental groups, respiratory and digestive diseases were reduced by 2.0 and 4.0 times, the recovery time was decreased by 3.47 and 5.12 days, and the Mellenberg coefficient was reduced by 3.7 and 12.1 times, compared to the control group (P<0.05). It was found that PS-2 and PS-4 increased the pre-slaughter weight of the young stock by 14.6 and 18.0 kg, the weight of the hot carcass by 12.8 and 15.8 kg, and the slaughter weight by 13.7 and 16.5 kg (P<0.05-0.01). Moreover, the weight of the half-carcasses of the young stock of the experimental groups, compared to the control group, was higher by 6.7 and 8.7 kg, the yield of meat by 5.4 and 6.9 kg, and of bones by 0.6 and 1.0 kg (P<0.05-0.001). With an increase in the weight of half-carcasses of the experimental animals, the specific weight of the meat increased, and the bones, on the contrary, decreased. Furthermore, the yield of meat of the highest and first grades in the animals of the experimental groups increased on the background of intramuscular injection of biostimulators when using PS-2 (by 0.6 and 0.3%; P<0.01) and PS-4 (by 0.9 and 1.1%; P<0.01). However, the second grade decreased by 0.9 and 2.0% (P>0.05), compared to the control group.

Keywords: Calves, Adaptive technology, Biostimulators, Growth, Development, Non-specific resistance

1. Introduction

Strategy and main direction of development of Russia's animal husbandry include addressing critical socio-economic problems of preservation of health of the population and providing it with food of high-quality domestic production to achieve food independence from imports of agricultural products.

The most important indicator of the quality of people's diet is the consumption of animal protein. If in the structure of consumption, Russia is approaching

world standards, then in terms of meat consumption per capita, it is still significantly inferior to the indicators of economically developed countries (United States: 120 kg, European Union: about 80 kg, Russia 63 kg, and the Chuvash Republic: only 50 kg). According to science-based standards of human nutrition, the need for meat products is 86 kg per year. It should be noted that since 2011 in the Russian Federation, the rational rate of meat consumption has been reduced by 12 kg per year and reached74 kg. Under the conditions of tension in the country's meat balance, taking into account the existing gap between the actual level of consumption of meat products and nutrition standards, dairy cattle bear the main burden in the implementation of the State program for the development of agriculture and the Doctrine of food security in the mid-term, since today, almost all beef is obtained from the fattening contingent of dairy herds (1). In line with the above, the development of resource-saving and science-intensive technologies for raising calves and fattening young animals based on modern scientific achievements and new technological solutions can significantly increase the provision of the population with competitive livestock products (primarily meat) and reduce the country's dependence on imports (2).

Raising calves in typical preventoriums and calf sheds, where an optimal microclimate is created and all the necessary therapeutic and preventive measures are carried out, does not guarantee their complete preservation. Accordingly, in some farms, the loss of young stock on the first day after birth reaches 50% or more. One of the factors of this can be both conditionally pathogenic and pathogenic, repeatedly transmitted microflora. The desire to prevent the impact of this microflora on the immature body of the calf caused the implementation of adaptive technology (3, 4). Keeping calves in individual boxes and pavilions in the open air deserves special attention as a reliable method of preventing diseases and improving the safety of young stock. From a scientific point of view, the method of "cold education" has advantages. When growing in low temperatures, calves breathe clean air of natural temperature and humidity without harmful gases with a minimum level of microbial contamination. Accordingly, animals are tempered, and neurovascular thermoregulation, as well as barrier and respiratory functions are improved, followed by an increase in the hair length and density, the general tonus and appetite, and the possibility of active breathing. All these help to increase the level of non-specific resistance of the body and the safety of calves. In different regions of Russia, about 2 million calves are raised with this technology every year with a safety of 95.5%-97.4% (5, 6). However, the lack of scientifically based methods of pharmaco prophylaxis of temperature stress, correction of adaptogenesis, and immunogenesis of animals using biostimulators hinders the realization of the potential of the "cold" calf rearing method and its widespread implementation into production (7-9).

In the conditions of multi-factor environmental and technogenic pressure on the body, ensuring the health and safety of calves at low ambient temperatures of adaptive breeding technology due to immunoprophylaxis of the body with biostimulators that are harmless and non-toxic do not accumulate in animal products, and do not pollute the environment; moreover, the implementation of productive qualities of young stock during subsequent rearing and fattening is an urgent problem of modern animal science and practice (10-12). This study aimed to provide a zootechnical justification for raising calves using adaptive technology with the use of PS-2 and PS-4biostimulators, followed by rearing and fattening of the young stock.

2. Materials and Methods

The experimental part of the research work was carried out on a model dairy farm "E Aidarbayev" in the Almaty region. The materials were processed at BI CR “Chuvash Republican Veterinary Laboratory” of the State Veterinary Service of CR, the laboratory of bio- and nanotechnology, and the laboratory of the department of morphology, obstetrics, and therapy of

FSBEI HPE "Chuvash State Agricultural Academy". The study was carried out under the budget program for 2018-20 (Code: BR06349627) transfer and adaptation of technologies on automation of technological processes of milk production based on a model dairy farm containing 1000 or more dairy cows.

The experiment was conducted as follows: Three groups of 15 calves-analogs were considered the experimental groups. Animals of all groups were kept in individual boxes a day after birth and up to 30 days of age, then up to 180 days of age in outdoor pavilions provided by adaptive technology, and subsequently up to 360 days of age in standard premises for rearing, and up to 540 days of age (duration of experiments) in premises for fattening young stock. The study was carried out on the background of balanced feeding on diets, developed by OOO "MIP "Academy-Bio" given the body's need for energy and major nutrients during the periods of raising calves, rearing, and fattening of the young stock under the standards and rations of the feeding of agricultural animals.

To fully realize the adaptive and productive potential of the body of calves in the conditions of low temperatures of the environment, biostimulators developed by scientists of FSBEI HPE Chuvash State Agricultural Academy, Russian Federation, included PS-2 (It is an aqueous suspension containing a polysaccharide complex of yeast cells of *Saccharomyces cerevisiae* immobilized in an agar gel with the addition of a benzimidazole derivative and bactericidal preparation of aminoglycoside group) and PS-4 (It is an aqueous suspension containing a polysaccharide complex of yeast cells *Saccharomyces cerevisiae* immobilized in an agar gel with the addition of a benzimidazole derivative and an antibiotic group of the cephalosporin group) (13). Animals of the 1st experimental group were intramuscularly injected with a PS-2 biostimulator at a dose of 3 ml on the 2-3 and 7-9 days of life, and the 2nd experimental group was injected with PS-4 at the same dose and at the same time.

Growth, development, clinical and physiological state, hematological profile, and non-specific resistance of calves were studied on the 1st, 15, 30, 60, 90, 120, 150, and 180th day, and the young stock on the 360th and 540th day of life according to the modern methods generally accepted in animal sciences.

During the experiment, four calves were sick in the control group, including two calves with bronchopneumonia and two calves with dyspepsia. In the 1st experimental group, one calf with the diseases of the upper respiratory tract and gastrointestinal tract, and in the 2nd experimental group, one animal with dyspepsia were observed (the incidence rates were 26.7%, 13.3%, and 6.7%, respectively). The recovery time of animals in the first, second, and third cases were 7.62±1.23, 4.15±1.04, and 2.50±0.00 days, respectively. That is, in the animals of the experimental groups, they were shorter by 3.47 and 5.12 days and occurred in a mild case than in the control group. In the control group, one calf fell, and in the experimental groups, all animals recovered. The obtained results indicate the pronounced preventive effectiveness of PS-2 and PS-4 preparations in the diseases of calves during the raising period.

2.1. Statistical Analyses

The data were processed in Excel and analyzed using the ANOVA procedure of SAS software (version 9.1), and the mean values were compared by Duncan's multiple comparison tests.

The statistical model was:

$Y_{ij} = \mu + T_i + \underline{e_{ij}}$

Y_{ij} = value of each observation,

μ = average,

T_i = effect of i treatment

and e_{ij} = error

3. Results

The parameters of microclimate in the premises for raising calves, rearing, and fattening young stock are presented in table 1.

Table 1. Parameters of microclimate in animal premises

Indicator	Premise				
	Calving pen	Boxes	Pavilions	For rearing	For fattening
Air temperature, ˚C	15.30±0.38	-2.10±0.23	-5.30±0.34	12.50±0.27	9.30±0.17
Relative humidity, %	71.40±1.20	79.30±1.37	76.8±1.25	73.50±1.03	74.60±0.97
Speed of movement, m/s	0.22±0.02	0.33±0.02*	0.38±0.04	0.26±0.02	0.29±0.03
Light coefficient	1:14	*	*	1:13	1:20
Daylight ratio, %	0.68±0.05	*	*	0.79±0.04	0.53±0.02
Ammonia concentration, mg/m^3	8.60±0.54	no	no	15.30±0.73	17.80±0.64
Hydrogen sulfide concentration, mg/m^3	4.70±0.32	no	no	5.30±0.18	5.00±0.21
Carbon dioxide concentration, %	0.15±0.01	0.05±0.01	0.07±0.01	0.19±0.01	0.24±0.02
Bacterial contamination, th/m^3	21.60±1.03	3.60±0.23	5.90±0.37	33.20±0.78	36.60±0.89
Dust content, mg/m^3	2.10±0.27	0.40±0.07	0.70±0.09	3.00±0.15	3.30±0.18

Note: * - No research was conducted

From the data in this table, it can be observed that the parameters of microclimate in individual boxes and pavilions provided by adaptive technology did not exceed the zoohygienic norms for relative humidity, speed of movement, bacterial contamination of the air, the content of ammonia, hydrogen sulfide, carbon dioxide, and dust; in addition, the air temperature was lower than the standard data by 16.1-19.3˚C. In other words, the calves were raised in the specified premises in the conditions of practically clean air at low ambient temperatures. The microclimate in the calving pen, as well as the premises for rearing and fattening of the young stock corresponded to the zoohygienic norms.

The scheme of feeding calves is designed to achieve their live weight at 90-day age of 90 kg at the expense of 175 kg of whole milk and 120 kg of the starter feed. The nutritional content of animal feeding diets is shown in table 2.

Table 2. Nutritional content of diets in different stages of growth

Indicator	In fact		Normally required		Availability (%)
	av[1]./day	Total	av./day	Total	
Raising period from 1 to 90 days					
EFU[2]	2.83	254.70	2.65	238.50	106.80
Crude protein, g	463.90	41751	470.50	42345	98.60
Digestible protein, g	397.80	35802	390.00	35100	102.0
Raising period from 90 to 180 days					
EFU	3.74	336.60	3.70	333.00	101.10
Crude protein, g	643.9	57951	645.00	58050	99.80
Digestible protein, g	442.3	39807	438.00	39420	101.00
Rearing period from 180 to 360 days					
EFU	5.90	1062.00	5.90	1062.00	100.00
Crude protein, g	871.90	156942	813.00	146340	107.20
Digestible protein, g	519.20	93456	504.00	90720	103.00
Fattening period from 360 to 540 days					
EFU	8.70	1566.00	8.70	1566.00	100.00
Crude protein, g	1287.30	231614	1047.00	188460	122.90
Digestible protein, g	784.60	141228	757.50	136350	103.50
Total EFU		3219.30		3199.50	100.60

[1]: average, [2]: Energetic feed units

On average, 3219.30 EFU was spent on animals at a rate of 3199.50 EFU, and the provision of rations for EFU was 100.6% during the raising calves, rearing, and fattening young stock. The feeding conditions of the animals corresponded to the norms and diets of feeding.

The dynamics of live weight and an average gain of young cattle in the control and experimental groups are presented in table 3. The table shows that the live weight of young stock of the 1st and 2nd experimental groups was higher than that in the control group (by the end of the raising period using adaptive technology, they were 7.2 and 8.2 kg ($P<0.01$), and by the end of the rearing and fattening periods, they were 11.4 and 13.6 kg ($P<0.05$), as well as 13.8 and 16.8 kg ($P<0.01$, respectively).

At the same time, the average weight gain in the animals of the experimental groups was significantly higher than that in the control group. On average, for the periods of raising, rearing, and fattening, the weights were 20.00 and 47.00 g; 23.00 and 30.00 g; as well as14.00 and 18.00 g ($P>0.05$), respectively. If at the 30-day age of calves, the growth coefficient in all groups was almost the same, then in subsequent research periods, it was higher in the experimental animals than in the control ones.

A similar pattern occurred in the dynamics of the exterior measurements of animals in the experimental groups. Therefore, the growth-stimulating effect of prescribing PS-2 and PS-4 biostimulators to calves in early postnatal ontogenesis was revealed (Table 3).

The slaughter qualities of experimental groups of animals are presented in table 4.

Table 3. Effect of different treatments on the dynamics of young stock growth of the experimental groups

Group of animals	Age (days)	Live weight (kg)	Average gain(g)	Growth coefficient
Control	1	31.00±1.10	–	–
	30	47.40±1.12	547.00±17.00	1.53
	60	67.20±1.24	660.00±22.11	2.17
	90	88.20±1.20	700.00±18.26	2.84
	120	109.40±1.21	707.00±12.47	3.53
	150	129.20±1.24	660.00±19.44	4.17
	180	151.40±1.44	740.00±26.67	4.88
	360	288.00±3.66	759.00±12.92	9.29
	540	424.60±3.31	758.00±27.65	13.69
1st experimental group	1	29.80±1.02	–	–
	30	47.80±1.16	600.00±18.26	1.60
	60	68.60±1.40	693.00±12.47	2.30
	90	91.00±1.22	747.00±17.00	3.05
	120	113.80±1.28*	760.00±19.44	3.81
	150	135.80±1.28**	733.00±18.26*	4.56
	180	158.60±1.36**	760.00±22.11	5.32
	360	299.40±3.19*	782.00±15.19	10.50
	540	438.40±4.33*	772.00±29.47	14.71
2nd experimental group	1	30.80±0.97	–	–
	30	48.40±1.12	587±22.61	1.57
	60	69.40±1.29	700±10.54	2.25
	90	90.80±1.07	713±13.33	2.95
	120	114.40±1.21*	787.00±22.61*	3.71
	150	136.00±1.45**	720.00±17.00*	4.41
	180	159.60±1.21**	787.00±24.94	5.18
	360	301.60±3.78*	789.00±17.26	9.79
	540	441.40±3.53**	776.00±25.86	14.33

* $P\leq0.05$, ** $P\leq0.01$.

Table 4. Effect of different treatments on the slaughter quality of the experimental groups

Indicator	Group of animals		
	Control	1st experimental group	2nd experimental group
Live weight when removing from fattening, kg	424.60±3.31	438.40±4.33*	441.40±3.53**
Pre-slaughter live weight, kg	417.80±2.94	432.40±3.56*	435.80±3.32**
Carcass weight, kg	209.40±2.44	222.20±1.85**	225.20±2.08**
Carcass yield, %	50.10	51.40	51.70
Weight of internal fat, kg	7.60±0.29	8.50±0.28	8.30±0.17
Yield of internal fat,%	1.82	1.96	1.90
Hide weight, kg	29.40±0.34	29.90±0.24	29.60±0.23
Hide yield, %	7.04	6.91	6.79
Slaughter weight, kg	217.00±2.70	230.70±1.83**	233.50±2.23**
Slaughter yield, %	51.90	53.30	53.60

* $P \leq 0.05$, ** $P \leq 0.01$

It was found that 540-day young stock of the 1st and 2nd experimental groups were superior to their control peers in live weight when removed from fattening by 13.8 and 16.8 kg ($P<0.05$), pre-slaughter live weight by 14.6 and 18.0 kg ($P<0.05$), the weight of hot carcass by 12.8 and 15.8 kg ($P<0.01$), and slaughter weight by 13.7 and 16.5 kg ($P<0.01$). There was no significant difference among the control, 1st, and 2nd experimental groups of animals regarding the weight of internal fat, hide, and their yield (Table 4).

The results of the study of the quality of young cattle carcasses are presented in table 5. The weight of half-carcasses of the young stock of the 1st experimental group in comparison with the control group was higher by 6.7 kg (6.5%) ($P<0.01$), and the corresponding value in the 2nd experimental group was 8.7 kg (8.5%) ($P<0.001$); moreover, the meat weight values in these groups were 5.40 kg (7.0%) ($P<0.01$) and 6.93 kg (9.0%) ($P<0.001$), respectively.

The bone mass of animals in the 1st experimental group increased by 0.63 kg (2.9%) ($P<0.05$), and in the 2nd experimental group, it was 1.01 kg (4.6%) ($P<0.01$), compared to the control group. The results of these studies indicate that with an increase in the mass of half-carcasses of experimental animals, the specific weight of the meat increased, and the bones, on the contrary, decreased. The meat yield per kg of animal bones of the 1st experimental group (3.68±0.02) was higher by 0.14 kg (3.9%) ($P<0.01$), and in the 2nd experimental group (3.69±0.02), it was obtained at 0.15 kg (4.2%) ($P<0.01$), compared to the control group (3.54±0.01).

The meat yield per 100 kg of pre-slaughter weight of animals of the 1st experimental group was determined at 38.16±0.22 kg (it was more by 1.25 kg; 3.4%; $P<0.01$), and in the 2nd experimental group, it was obtained at 38.57±0.27 kg (it was more by 1.66 kg; 4.5%; $P<0.01$), compared to the control group (36.91±0.18 kg).

The difference of the 1st and 2nd experimental groups with the control group was 0.6 and 0.3 ($P<0.01$) in the weight of the highest grade meat, as well as 0.9 and 1.1 ($P<0.01$) in the weight of the first-grade meat. The amount of yield of the second-grade meat was calculated by subtracting the trait in the 1st and 2ndexperimental groups, compared to the control that were 0.9 and 2.0 ($P<0.05$), respectively. Samples of animal meat from the comparison groups were identical in terms of organoleptic parameters. The meat biochemical indicators (e.g., pH of meat and the content of amino-ammonia nitrogen)of the control, 1st, and 2nd experimental groups of animals had the following values of 5.98±0.03, 5.86±0.01, and 5.80±0.01, as well as 1.16±0.02, 1.14±0.02, and 1.20±0.01 mg, respectively (Table 5).

Table 5. Effect of different treatments on carcass quality of experimental groups

Indicator	Group of animals		
	Control	1st experimental group	2nd experimental group
Chilled carcass weight, kg	205.40±2.44	218.80±1.85**	222.80±2.08***
Meat weight, kg	154.24±1.83	165.04±1.39**	168.10±1.57***
Meat yield, %	75.09	75.43	75.45
Bone weight, kg	43.54±0.34	44.80±0.38*	45.56±0.43**
Bone yield, %	21.19	20.47	20.45
Meat yield per kg of animal bones	3.54±0.01	3.68±0.02**	3.69±0.02**
Meat yield per 100 kg of pre-slaughter weight	3.54±0.18	3.68±0.22**	3.69±0.27**
Weight of the highest grade meat, kg	25.74±0.59	28.56±0.39**	29.66±0.60**
Yield of the highest grade meat, %	16.70	17.30	17.60
Weight of the first grade meat, kg	83.14±1.42	89.46±0.96**	92.38±1.28**
Yield of the first grade meat, %	53.90	54.20	55.00
Weight of the second grade meat, kg	45.36±0.68	47.02±0.53	46.06±0.59
Yield of the second grade meat, %	29.40	28.50	27.40
pH of meat	5.98±0.03	5.86±0.01	5.80±0.01
Amino-ammonia nitrogen, mg	1.16±0.02	1.14±0.02	1.20±0.01

* $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$

The PS-2 and PS-4 biostimulators used in the experiments did not have a negative impact on the physiological state of the young cattle when growing in the conditions of hypothermia adaptive technology, followed by rearing and fattening in typical premises. By the end of the raising period in 180-day animals of the experimental groups against the background of the use of PS-2 and PS-4 biostimulators, the concentration of hemoglobin (10.6 and 9.2 g/L) and the number of red blood cells (0.86 and 0.69×10^{12}/L) significantly increased in the blood, compared to those in the control data. By the end of the growing period (on day 360), these corresponding values were obtained at 14.4 and 12.0 g/L, as well as 0.89 and $0{,}78\times10^{12}$/l, and by the time of removal from fattening (on day 540), they were determined at 11.0 and 9.0 g/L, as well as 0.80 and $0{,}72\times10^{12}$/L, respectively ($P<0.05$).

The data obtained indicate that intramuscular injection of PS-2 and PS-4 stimulated the hematopoietic function of the young stock (Figures 1-2).

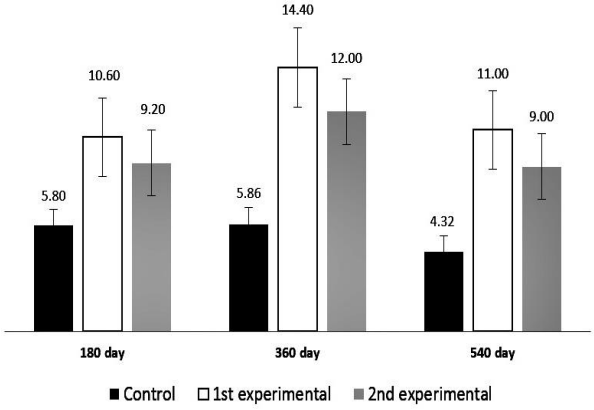

Figure 1. Effect of different treatments on the concentration of hemoglobin

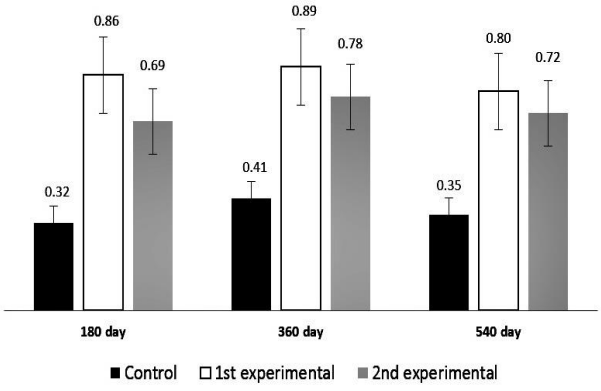

Figure 2. Effect of different treatments on the number of red blood cells

Under the influence of biostimulators, the activation of cellular and humoral factors of non-specific resistance of animals in the conditions of "cold" rearing of calves by the end of the raising period was higher than the control value. These values included the phagocytic activity of white blood cells (5.4 and 5.0%), lysozyme activity of plasma (3.2 and 2.6%), bactericidal activity of blood serum (4.3 and 3.6%), and the level of immune-globulins in blood serum (4.3 and 2.9 mg/ml) (P<0.05) (Figure 3).

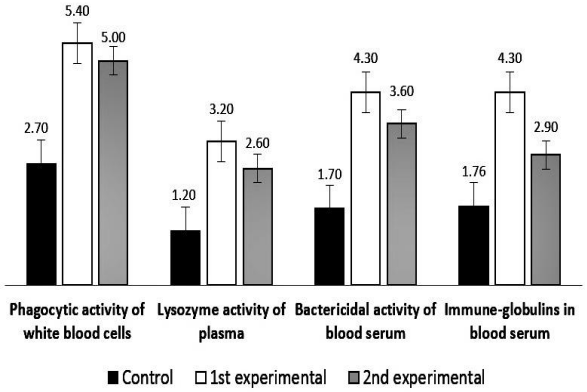

Figure 3. Effect of different treatments on the activation of cellular and humoral factors

The established relative eosinophilia in the blood of animals of the experimental groups indicates that PS-2 and PS-4 had an anti-stress reaction to the body under low temperatures of adaptive raising technology and during subsequent rearing and fattening in typical premises. If neutrophiles are considered by the stages of development, the blood of experimental animals for the entire period of research was dominated by segment nuclear forms of these granulocytes, and the number of these shaped elements during the observation was higher in the blood of animals of the 1st and 2nd experimental groups (at the end of the growing period: 3.4 and 3.2 %; rearing: 3.6 and 3.2%; and fattening: 3.8 and 3.8 %; P<0.05). These qualitative changes in the stages of development of neutrophiles indicate a shift of the neutrophile nucleus to the right (on the activation of cellular factors of non-specific resistance of animals under the influence of PS-2 and PS-4). After intramuscular injection of PS-2 and PS-4 biostimulators to calves of the 1st and 2nd experimental groups, an increase was observed in the production of red bone marrow lymphocytes-the main cellular elements of the immune system-during raising, rearing, and fattening, which indicated the stimulation of cellular and humoral immunity (Figure 4).

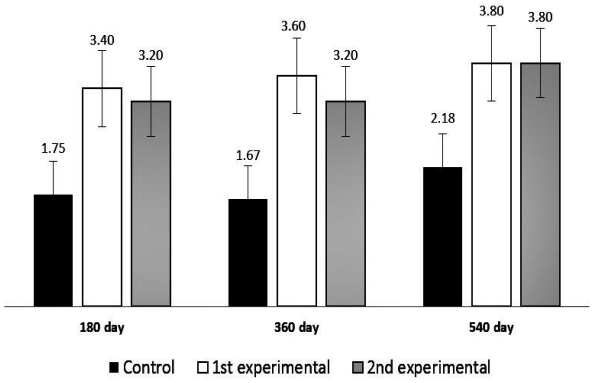

Figure 4. Effect of different treatments on the segment nuclear of neutrophiles

The level of total protein, albumins, and γ-globulins in the blood serum of young stock of the 1st and 2nd experimental groups during the observation period was significantly higher than those in the control group (at the end of the raising period, these values were 4.5 and 3.8 g/L;3.3 and 4.3 g/L; as well as3.3 and 2.1 g/L, respectively). A significant increase in the concentration of γ-globulins in the blood serum of animals of the experimental groups was caused by the activation of the mechanism of non-specific protection of the body under the influence of PS-2 and PS-4 (P<0.05) (Figure 5).

Figure 6 showed that the reserve alkalinity of the blood plasma of animals in the experimental groups throughout the studies was higher than that in the control group. Accordingly, a significant difference was established in the specified indicator of the acid-base state of the animals of the 1st experimental and

control groups 60, 90, 120, 150, 180, and 360 days after the experiments that were performed at 3.0, 2.4, 2.2, 2.4, 1.8, and 1.8 vol.% of CO_2, respectively (P<0.05). The difference between the corresponding data in the animals of the 2nd experimental and control groups was found to be significant on the 30, 90, 120, 150, and the 180th day after setting up the experiments (in the young stock of the 2nd experimental group, they exceeded the control ones by 2.6, 2.2, 1.8, 2.2, and 1.8 vol.% of CO_2; P<0.05, respectively). Therefore, the total capacity of the body's buffer systems was higher in the animals of the experimental groups.

The increase in the blood glucose levels in the calves of the 1st and 2nd experimental groups during raising was caused by the activation of carbohydrate metabolism in the body of these animals after intramuscular injection of PS-2 and PS-4.A positive effect of biostimulators was established on the mineral metabolism of animals. As a result, the concentrations of the total calcium in the blood serum of animals of the 1st and 2nd experimental groups were higher than those in the control groups (60 days after the experiment: 24.8 and 26.7%; 90 days after the experiment: 21.9 and 29.4%; 120 days after the experiment: 23.8 and 27.4%; and150 days after the experiment: 21.5 and 23.6%; P<0.05). A similar pattern was found in the dynamics of the concentration of inorganic phosphorus in the blood serum of experimental animals. The difference between the data in the calves of the experimental and control groups was significant 60, 90, 120, and 150 days after the injection of PS-2 and PS-4 by 0.35 and 0.29 mmol/L;0.26 and 0.23;0.31 and 0.27;as well as 0.28 and 0.24 mmol/L (P<0.05), respectively (Table 6).

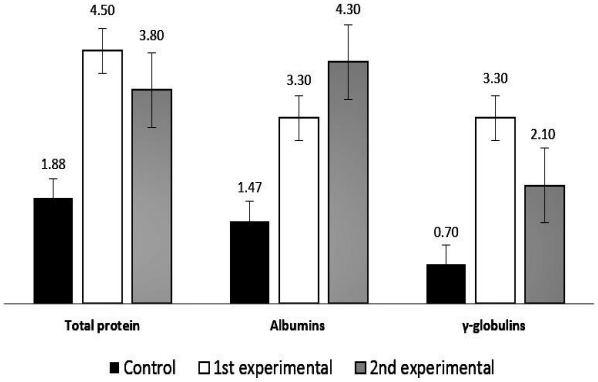

Figure 5. Effect of different treatments on thetotal protein, albumins, and γ-globulins

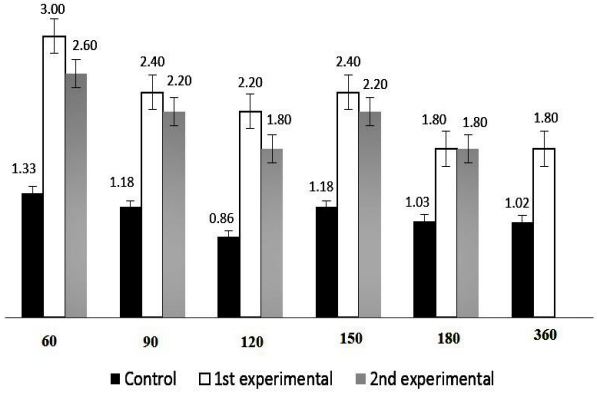

Figure 6. Effect of different treatments on thealkalinity of blood plasma of the experimental groups

Table 6. Effect of different treatments onthe concentration of total calcium and inorganic phosphorus in the blood

Age (days)	Calcium (%)			Phosphorus (mmol/L)		
	Control	1st experimental	2nd experimental	Control	1st experimental group	2nd experimental group
60	13.42	24.80*	26.70*	0.14	0.35*	0.29*
90	9.37	21.90*	29.40*	0.12	0.26*	0.23*
120	12.12	23.80*	27.40*	0.14	0.31*	0.27*
150	11.44	21.50*	23.60*	0.12	0.28*	0.24*

* $P \leq 0.05$

4. Discussion

Recently, the yeast immobilization technique has been used to maintain biological activity in the gastrointestinal tract. This technique has provided many opportunities for the industrial fermentation and animal feed industries. By limiting healthy and active yeast cells in the digestive tract, the density of beneficial cells are increased, and this technology, in addition to providing a rich source of protein, helps digest food. With the improvement of weight gain, carcass quality, and animal health, an effective step was taken to reduce the problems of this industry and the cost of food.

Some researchers have reported that yeast consumption increases feed intake while decreasing the daily feed of cows with *Saccharomyces cerevisiae* consumption has also been reported. In this study, the use of yeast had a significant effect on the feed consumption of cows (14-16). The results of this experiment were consistent with the findings of a study by Phillips and VonTungeln (17). The researchers reported that adding yeast to the diets of fattening calves resulted in a 30% weight gain in the calves. However, these researchers did not find any significant effect on calves under heat stress in another experiment. They stated that the reason for the variability of these results was not clear. Haddad and Goussous (18) also showed that *Saccharomyces cerevisiae* increased the growth of Awassi lambs. On the other hand, the results of the present experiment did not agree with the findings of a study by Koul, Kumar (19) because they did not find a significant effect on the growth of fattening calves that received yeast. Johnson and Rops (20) also reported that adding yeast to the diet of castrated cows over 35days had no significant effect on cows' performance. Animals that received yeast did not differ significantly from the control group in terms of growth rate. According to these researchers, explaining the insignificance of the results seems to be statistically difficult.

The results obtained from carcass traits are shown in tables 4 and 5. As can be observed, treatments with PS-1 and PS-4 had a significant effect on carcass traits (live weight, pre-slaughter live weight, carcass weight, slaughter weight, chilled carcass weight, meat weight, bone weight, and meat yield per kg of animal bones). In a study performed by Hinman, Sorensen (21), it was found that fattening calves that received a diet containing yeast for 28 or 197 days had a heavier carcass, compared to calves and cows. While the carcass quality of these calves was not affected by the consumption of yeast, and the results are consistent with the findings of the present study. On the other hand, these results were inconsistent with the findings of a study by Mir and Mir (22) on castrated cows.

The data showed that yeast consumption (Table 5) did not affect ruminal pH, and other researchers have also reported the same result (23, 24). There was no statistical difference among different treatments in terms of Amino-ammonia nitrogen. In general, ammonia concentrations in yeast-consuming animals are changed due to increased consumption by rumen bacteria and increased microbial protein production in their rumen. No changes in Amino-ammonia nitrogen were observed due to the method of using the treatments in this study by injection (25).

In the present study, yeast significantly increased plasma calcium and phosphorus concentrations, which have not been reported so far. However, the use of yeast reduces the concentration of elements. The reason for the decrease in calcium and phosphorus ions may be related to the cationic adsorption property of the yeast cell wall. The cell wall of yeasts tends to attach to certain functions and reduces their concentration. This binding can decrease the digestibility and absorption of these salts (26). In this study, due to the use of the injection method, an increase in these two elements was observed by heavy metals. The increase in these two elements was due to intramuscular injections ofPS-

2 and PS-4, which may have affected the calcium channels in the cell wall.

Plasma protein levels indicate the state of anabolism and protein catabolism in the body. Blood plasma protein levels at any given time are a function of hormonal balance, nutritional status, water balance, and other factors affecting animal health. Hemoglobin concentration, red blood cells, cellular and immune factors, neutrophils, total protein, albumins, and γ-globulins increased due to injections of PS-2 and PS-4. An increase in these blood biochemical factors increased the level of immunity of calves. The immune-stimulating consequence of SC was ascribed to the activity of βGs and MOs offered in yeast cell walls (27). This mechanism involves the stimulation of immune-competent cells, mainly by βGs (28). βGs activate intercellular defense mechanisms where macrophages, T-cells, and NK cells play a key role (29).

Probiotics, such as yeasts can multiply and develop as a living cell in the intestinal wall of animals and can also absorb antigens released by other dead microorganisms and stimulate the immune system and its components in various ways (30). The outcomes of experiments conducted on suckling lambs (31) and cattle (32, 33) show that yeast compounds have a positive effect on the animals' immune system; moreover, the values of white blood cells, hemoglobin, and lymphocyte were impressed by yeast (P<0.05). Therefore, PS-2 and PS-4 biostimulators activate the non-specific resistance of calves to the effects of low temperatures in the conditions of adaptive raising technology; as a result, they reduce respiratory and digestive diseases, and all these have a favorable effect on postnatal growth and development, and finally, on the meat productivity of young stock during rearing and fattening in typical premises. To increase the non-specific resistance and adaptive plasticity of the calves' body to the effects of low temperatures in the conditions of adaptive technology of raising and implementing the productive qualities of young stock during subsequent rearing and fattening, the recommendations include:1) intramuscular injection of PS-2 biostimulator to calves on 2-3 and 7-9 days of life in a dose of 3 ml each, and 2) intramuscular injection ofPS-4 biostimulator to calves on 2-3 and 7-9 days of life in a dose of 3 ml each.

It should be noted that PS-2 has a pronounced stimulating effect on the non-specific resistance of the animal body during raising, rearing, and fattening; in addition, PS-4 shows preventive effectiveness in the diseases of the respiratory and digestive organs, as well as improvements in the fattening and slaughter qualities of the young stock.

Authors' Contribution

Study concept and design: D. A. B. and V. G. S.
Acquisition of data: V. G. S.
Analysis and interpretation of data: N. B. S.
Drafting of the manuscript: S. A. M.
Critical revision of the manuscript for important intellectual content: D. A. B. and V. G. S.
Statistical analysis: V. G. T.
Administrative, technical, and material support: D. A. B. and V. G. S.

Ethics

All the procedures were approved by the Ethics Committee at the Chuvash State Agricultural Academy, Cheboksary, Chuvash Republic, Russia.

Conflict of Interest

The authors declare that they have no conflict of interest.

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