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Preventing Shipping Stress in Imported Heifers with the Use of Immunocorrection

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Abstract*: *Dependence of selective mobilization of sympathoadrenal, serotonin- and histaminergic body systems, morphological and biochemical profiles of blood, activity of transamination enzymes and factors of nonspecific resistivity on the background of using biopreparations aimed at preventing shipping stress and commercialization of the bioresource potential of imported heifers on the pressing environmental and technological stress factors has been disclosed. On the background of using biological products, improvement of the reproductive qualities of heifers was noted, the age of fruitful insemination, age at first calving, insemination index, and service period decreased, and fertility during first heat increased.

Index Terms*: *Biological Preparation Prevention-N-C, Bioresource Potential, Catecholamine, Histamine, Holstein Heifers, Serotonin, Shipping Stress.

I. INTRODUCTION

Intensification of dairy cattle breeding greatly enhances the interbreed competition, which results in expansion of the breeding range and increasing the population of animals of the most competitive breeds [1]-[3]. Improvement of cattle in Russia and, mostly, dairy cattle is achieved through the wide use of highly productive breeds of the world's gene pool, Holstein in particular. As you know, Holstein cattle features high milk yields and good technological qualities compared to other dairy cattle breeds [4]-[7]. In Russia, the most significant increase in the population of Holstein cattle has occurred in recent years, due to the increased import of the breeding stock from Europe and North America [8]-[11].

During the transportation of animals, physical, mental and vestibular loads result in significant changes of many physiological processes in the organism, which lead to increased muscle tone, diuresis, and defecation, increased reflectory excitability and sweating [12]-[14]. Inhibition of endocrine and, especially, the immune system is observed, the adaptive-protective capabilities of the organism exhaust. The risk of development of pathological conditions, gastrointestinal and respiratory diseases increases sharply, the most pronounced of which is shipment fever, which results in the death of animals. The influence of stress factors increases significantly in case of failure to comply with the veterinary-sanitary rules of animals' transportation [15]-[20].

In the context of the foregoing, for preventing shipping stress, it is most appropriate to prescribe immunomodulators to imported heifers together with antibacterial preparations [21]-[24]. Their joint use has a double effect on the pathogen: the antibacterial preparation substantially inhibits the functional activity of the pathogen, and makes it more sensitive to phagocytosis, while the immunomodulator stimulates the immunological reactivity of the organism and the functional activity of the phagocyte, increasing its ability to absorb and kill the pathogen, which greatly improves the clinical effect. Such preparations are the developed complex biological products PS-7 and Prevention-N-C [25]-[30].

The research was aimed at preventing shipping stress in imported heifers and commercialization of the bio-resource potential of Holstein cattle by activating the nonspecific resistance of the organism with biological preparations PS-7 and Prevention-N-C.

II. MATERIALS AND METHODS

The experimental part of the research was performed at a milk-production facility that specializes in breeding dairy Holstein cattle in accordance with the plan of scientific research of the Chuvash State Agricultural Academy. The objects of the research were Holstein heifers imported from the USA. Three groups of heifers were selected for the scientific and economic experiment by the principle of analogs with regard to the clinical and physiological state, age and live weight, 10 animals in each. With the aim of preventing shipping stress in heifers, and for commercialization of the reproductive and productive qualities of cows, biopreparations developed by the scientists of the Chuvash State Agricultural Academy were used, namely, PS-7 and Prevention-N-C [15], [16]. Animals in the 1st experimental group were injected intramuscularly with biopreparation PS-7 in the dosage of 10 ml twice 7 days before transportation and 2 days after import, in the 2nd experimental group — with preparation Prevention-N-C in the same dosage and time, in the reference group, the animals did not receive any biological preparations

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III. RESULTS AND DISCUSSION

The determined dynamics of changes in the body temperature, heart rate, respiratory movements, and the respiratory rate allow making the conclusion that by the 10th day after shipping, heifers in the reference group continued experiencing stress. The use of biological preparations PS-7 and Prevention-N-C for the animals before shipping ensures efficient functioning of the system responsible for adaptation, and prevents shipping stress, as evidenced by minor changes in body temperature, heart and respiration rate in the heifers in the experimental groups.

The content of catecholamines in blood components in the animals in the experimental and the reference groups (Table I) 10 days before shipping was unreliably different and ranged between 119.6 ± 0.60 and 131.9 ± 1.05 c.u. Studying the blood of heifers in the reference group after shipping revealed an increased concentration of catecholamines in the platelets from 129.4 ± 2.91 to 151.7 ± 1.61 c.u., in neutrophilic leukocytes — from 127.3 ± 1.31 to 146.1 ± 1.28 c.u., in lymphocytes — from 130.1 ± 0.64 to 142.2 ± 0.92, and in the blood plasma — from 119.6 ± 0.60 to 134.1 ± 0.56 c.u., i.e., by 17.2 %, 14.8 %, 9.3 %, and 12.1 %, respectively. These data indicate the occurrence of stress reactions in the animals in the reference group.

Table I. Dynamics of catecholamines, c. u.

Group	Catecholamines in blood components			
	platelets	neutrophils	lymphocytes	plasma
before shipping				
Experimental 1	131.4 ± 1.3	131.9 ± 1.05	130.0 ± 0.93	123.6 ± 0.59
Experimental 2	128.9 ± 1.36	126.0 ± 0.92	129.5 ± 0.89	121.7 ± 0.98
reference	129.4 ± 2.91	127.3 ± 1.31	130.1 ± 0.64	119.6 ± 0.60
after shipping				
Experimental 1	130.2 ± 0.52**	134.4 ± 0.87**	132.6 ± 0.72**	122.1 ± 0.56**
Experimental 2	127.4 ± 1.01***	125.7 ± 1.28***	125.4 ± 0.92***	120.9 ± 0.68***
reference	151.7 ± 1.61	146.1 ± 1.28	142.2 ± 0.92	134.1 ± 0.56

Note: ** P < 0.01, *** P < 0.001.

At the same time, the concentration of catecholamines in blood components of the heifers in the experimental groups not veraciously differed from the initial level and was veraciously lower than in the reference by 8.1 – 16.0 % (P < 0.01 – 0.001). The dynamics of changes in the concentration of serotonin in blood components of the heifers are shown in Table II.

Table II. Dynamics of serotonin, c. u.

Group	Serotonin in blood components			
	platelets	neutrophils	lymphocytes	plasma
before shipping				
Experimental 1	310.0 ± 2.56	306.4 ± 2.79	323.6 ± 2.41	300.6 ± 1.82
Experimental 2	303.8 ± 3.44	308.7 ± 3.37	324.9 ± 3.79	296.9 ± 1.09
reference	304.4 ± 2.23	308.6 ± 2.02	318.2 ± 2.31	295.3 ± 1.99
after shipping				
Experimental 1	323.4 ± 2.26**	324.3 ± 2.63**	330.2 ± 2.97**	316.1 ± 2.79***
Experimental 2	327.7 ± 2.13**	329.1 ± 2.47***	331.4 ± 2.65**	317.9 ± 2.59***
reference	316.5 ± 2.44	311.9 ± 2.70	322.9 ± 2.22	303.7 ± 2.07

Note: * P < 0.05; ** P < 0.01; *** P < 0.001.

From this table it follows that concentration of serotonin in blood components of heifers before shipping nonveraciously ranged in platelets from 303.8 ± 3.44 to 310.0 ± 2.56 c.u., in neutrophils — from 306.4 ± 2.79 to 308.7 ± 3.37, in lymphocytes — from 318.2 ± 2.31 to 324.9 ± 3.79, and in plasma — from 295.3 ± 1.99 to 300.6 ± 1.82 c.u. After shipping, an unveracious increase was noted in the level of serotonin in blood components of the heifers in the reference group: in platelets — by 4.0 %, in neutrophils — by 1.1 %, in lymphocytes — by 1.5 %, and in plasma — by 2.8 %. However, in the blood components of heifers in the 1st experimental group, the content of serotonin increased by 2.1 – 4.0 %, in the 2nd experimental group — by 2.6 – 5.5 % (P < 0.01 – 0.001), compared to the reference. The concentration of histamine in the blood components of heifers is shown in Table III.

Table III. Dynamics of histamine, c.u.

Group	Histamine in blood components			
	Platelets	Neutrophils	Lymphocytes	Plasma
before shipping				

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Experimental 1	462.5 ± 2.25	437.1 ± 2.83	432.4 ± 3.22	362.3 ± 3.25
Experimental 2	460.3 ± 2.83	443.0 ± 2.20	430.3 ± 2.99	360.5 ± 2.60
reference	461.9 ± 3.49	437.5 ± 3.86	430.2 ± 2.13	369.5 ± 2.75
after shipping				
Experimental 1	465.4 ± 2.96**	440.8 ± 3.20***	444.5 ± 2.86**	363.6 ± 3.08**
Experimental 2	460.6 ± 2.28***	446.4 ± 2.10***	437.1 ± 2.31**	362.5 ± 3.63**
reference	472.5 ± 2.72	459.9 ± 2.49	450.5 ± 2.66	377.6 ± 4.85

Note: ** P < 0.01; *** P < 0.001.

From this table, it follows that the dynamics of changes in the level of histamine in platelets, neutrophils, lymphocytes, and plasma were similar to that of catecholamines. Histamine concentrations in blood components of the animals in the experimental and the reference groups before and after shipping were not veraciously different. After shipping, an increased by 2.2 – 5.1 % content of histamine was noted in blood components of the heifers in the reference group (P < 0.01). Histamine concentrations in blood components of the heifers in the experimental groups before and after shipping were not veraciously different. It should be noted that histamine content in platelets, neutrophils, lymphocytes, and blood plasma of the animals in the experimental groups was lower than that in the reference group by 1.5 and 4.2 % (P < 0.01 – 0.001).

The dynamics of bioamines in platelets, neutrophils, lymphocytes, and plasma in the imported heifers were the evidence of the fact that animals experienced stress, which was accompanied by adequate emission of bioamines from the locations of deposition: catecholamines — by 9.3 % – 17.2 %, histamine — by 2.2 – 5.1 %, and serotonin — by 1.1 – 4.0 % (P < 0.05 – 0.001). Intramuscular injection of preparations PS-7 and Prevention-N-C to the shipped animals reduces the concentration of catecholamines in blood components of the animals in the 1st and the 2nd experimental groups by 7.2 – 16.5 % and 10.9 – 19.1 %, and histamine — by 1.3 – 4.3 % and 2.6 – 4.1 %, compared to the reference group, and, conversely, increases the concentration of serotonin by 2.2 – 4.1 % and 2.6 – 5.5 % (P < 0.01 – 0.001). Selective mobilization of the sympathoadrenal, serotonin- and histaminergic systems of the organism is the evidence of the corrective effect of biopreparations PS-7 and Prevention-N-C on the mechanisms of forming the biochemical adaptation of the organism to the shipping conditions.

Studying the physiological status of the heifers in the reference group on the 1st day after shipping revealed an increase in the body temperature by 0.86°C, in the heart rate — by 6.0 heartbeats/min, and breath – by 5.8 movements/min (P < 0.01), red blood cell count – by 1.51×10^{12}/l, in hemoglobin — by 21.9 g/l, and leucocytes — by 11.79×10^{9}/l (P < 0.001). In the leukocyte formula, eosinopenia, lymphopenia, and neutrophilia were noted with leftward nucleus shift. The decreased concentration was noted: of total protein — by 13.8 %, of albumin — by 27.8 %, and of gamma-globulin — by 9.3 % (P < 0.01 – 0.001). Transportation of animals decreases the phagocytic, lysozyme and bactericidal activity of blood and immunoglobulin level and, conversely, increases the activity of transamination enzymes (P < 0.001). This pattern of the physiological status characterizes the effect of strong stress on the organism.

The use of biologic preparations PS-7 and Prevention-N-C has a favorable effect on the adaptation of imported heifers to the shipping conditions by mitigating or preventing the effects of stressors on the physiological status. Changes in the blood morphological composition on the background of intramuscular injection of biopreparations may be characterized as enhancement of protective and adaptive reactions of the organism of animals on the effect of shipping stress. While the number of erythrocytes in the blood of heifers in the experimental groups was lower, compared to the reference, by 12.4 and 12.6 %, of hemoglobin — by 13.4 and 12.2 %, of leukocytes — by 62.3 and 56.9 %, of stab neutrophils – 5.5% and 6.4%, and of segmentonuclear neutrophils — by 12.1 and 11.90 %, the number of monocytes, on the contrary, was higher — by 0.29 and 0.33 %, of eosinophils — 1.6 and 2.1 times, and of lymphocytes — by 16.7 % and 16.5 %.

The use of biological preparations mitigates the negative changes in the protein metabolism, with a slight decrease in the total protein level and an increase in the globulin fraction of protein, especially gamma globulin — by 3.6 and 4.2 %. A reduced activity of transamination enzymes AST and ALT, compared to the reference, was noted.

The use of biologic preparations reduces the effects of stressors on the cellular and humoral factors of the nonspecific resistance of the organism of the animals in the experimental groups (Table IV). Their parameters of nonspecific resistance restore within 10 days, and the duration of adaptation to adverse shipping factors reduces.

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Table IV. Nonspecific resistance of heifers' organisms

Indicator	Time of research	Group		
		reference	Experimental 1	Experimental 2
Bactericidal activity, %	before shipping	61.0 ± 0.87	60.4 ± 0.84	61.7 ± 0.77
	1 day after shipping	33.6 ± 1.03	46.7 ± 1.04*	48.1 ± 1.29*
	5 days after shipping	43.8 ± 1.23	52.3 ± 1.23*	53.2 ± 2.32*
	10 days after shipping	59.9 ± 1.56	59.8 ± 1.34	60.4 ± 1.87
Phagocytic activity, %	before shipping	58.0 ± 1.70	58.2 ± 1.07	58.8 ± 1.83
	1 day after shipping	31.8 ± 2.15	47.3 ± 1.85*	47.6 ± 1.78*
	5 days after shipping	42.6 ± 1.63	52.6 ± 1.23*	52.3 ± 1.36*
	10 days after shipping	55.6 ± 2.24	57.6 ± 1.56	58.2 ± 1.58
Phagocytic index	before shipping	6.4 ± 0.51	7.2 ± 0.37	7.4 ± 0.24
	1 day after shipping	3.8 ± 0.32	5.8 ± 0.45*	5.8 ± 0.37*
	5 days after shipping	5.6 ± 0.45	6.2 ± 0.48*	6.4 ± 0.46*
	10 days after shipping	6.2 ± 063	7.0 ± 0.52	7.2 ± 0.52
Lysozymic activity, %	before shipping	23.3 ± 0.72	23.0 ± 0.87	23.1 ± 0.77
	1 day after shipping	12.2 ± 0.76	20.4 ± 0.97*	19.4 ± 0.86*
	5 days after shipping	16.3 ± 1.32	22.5 ± 1.2*	21.2 ± 1.13*
	10 days after shipping	21.8 ± 1.12	23.4 ± 1.0	22.9 ± 0.92
Immuno-globulins, mg/ml	before shipping	24.2 ± 0.99	23.5 ± 0.50	25.2 ± 1.20
	1 day after shipping	15.2 ± 1.01	19.2 ± 0.87*	20.0 ± 1.44*
	5 days after shipping	18.3 ± 1.23	21.5 ± 1.12*	22.3 ± 1.53*
	10 days after shipping	22.5 ± 1.56	24.6 ± 1.32	25.4 ± 1.32

Note: * P < 0.05 – 0.01.

The reproductive qualities of the heifers in the experimental groups are shown in Table 5. On the background of using biological products, improved reproductive qualities of the heifers from the 1st and the 2nd experimental groups were noted: the age of fruitful insemination shortened by 1.35 and 1.53 months, the age of first calving — by 1.0 and 1.2 months, the insemination index reduced 1.42 and 1.93 times, the service period — by 8.8 and 12.2 days, and fertilization rate in the first heat increased 1.7 and 2.0 times (P < 0.05 – 0.01), compared to the reference.

Table V. Reproductive qualities and live weight of the animals

Indicator	Group		
	Reference	Experimental 1	Experimental 2
The number of animals	10	10	10
The age of fruitful insemination, months.	19.45±0.41	18.1±0.35	17.92±0.30
Live weight at the moment of the first insemination, kg	396.5±9.10	390.3±8.40	386.7±8.70
Duration of pregnancy, days.	285.4±2.01	289.1±2.13	287.4±2.17
The age of first calving, months.	28.7±0.37	27.7±0.32	27.5±0.33
Insemination index	2.7 ± 0.44	1.9 ± 0.27*	1.4 ± 0.21**
Service period, days	111.3±3.96	102.5±3.12	99.1±2.98
Fertilized heifers:			
during the first heat	3	5	6
during the second heat	4	4	4
during the third heat	3	1	-

Note: * P < 0.05; ** P < 0.01.

Biological preparations PS-7 and Prevention-N-C contribute to more complete commercialization of the bioresource potential of the productive qualities of imported heifers. The heifers in the 1st and the 2nd experimental groups excelled their peers in the reference group in terms of the milk yield over 305 days of lactation by 109 and 125 kg, or by 1.71 and 1.96 % (P < 0.05), in terms of the mass fraction of fat in milk — by 0.16 and 0.27 %, and in terms of protein content — by 0.04 and 0.07 %, respectively. On the background of preventing shipping stress in imported heifers with biological products PS-7 and Prevention-N-C, improved physicochemical characteristics of milk of the heifers were noted, which met the set requirements.

IV. CONCLUSION

Thus, biological preparations PS-7 and Prevention-N-C prevent shipping stress in heifers, and ensure the most complete commercialization of the bioresource potential of the reproductive and productive qualities of heifers through selective mobilization of the sympathoadrenal, serotonin- and histaminergic systems of the organism, the morphological and biochemical profiles of blood, activity of transamination enzymes and the factors of nonspecific resistivity, with a more pronounced appropriate effect of Prevention-N-C.

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