Prediction of fecundity of livestock by the level of adaptability in the ecological and climatic conditions of the Southern Urals

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Abstract. The article presents the results of studies on the natural resistance of castrated bull calves of Simmental breed in the Southern Urals and half-blood Holstein crossbreeds. The aim of the present study was to determine the adaptability of purebred and cross-breeding animals to a sharply continental climate when keeping them in an open feeding area. Assessment of the body's response to the influence of negative air temperatures was carried out according to the indicators of the natural resistance of the humoral and cellular parts of the immune system and hair condition – regularity of its shift, length, density and fractional composition. Significant differences in the determined indicators were revealed both depending on the genotype and on the season of the year. Simmentals exceeded their cross-breed peers in hair density from 1 cm² of skin, weight, and hair length. These differences are most pronounced in winter. Assessment of the humoral link of natural resistance showed significant intergroup differences. Simmental bull calves exceeded cross-breed peers in bactericidal blood activity depending on the season of the year by 1.28–2.87 %, in terms of lysozyme content – by 2.9–7.1 %. Intergroup differences were also revealed in the assessment of cellular factors of natural resistance. In spring, the activity of neutrophils increased in comparison with autumn and winter months in Simmental bull calves 6.4 and 7.3 times. The highest value of the phagocytic index was noted in winter period – 11.4–11.9 %. In summer, it decreases slightly. Intergroup differences in these indicators are slightly expressed.

1. Introduction

Farm animals, when grown in conditions close to natural, are constantly under the influence of adverse weather factors. As a result, a system of natural resistance is formed in their body that helps maintain homeostasis and causes adaptation to biotic and abiotic stresses [1, 2]. The humoral and cellular mechanisms of immunity, evolutionarily formed in traditional living conditions, are characteristic of local livestock breeds, such as, for example, Simmental, which is most widespread in the zone of sharply continental climate. Traditionally, animals of this breed spend most of the year on natural pastures, and in winter on open feedlots [3, 4]. In adverse climatic conditions, requirements for economically useful traits of animals of used breeds increase, giving preference to those of them that are characterized by increased resistance to specific weather conditions. Therefore, the problem of increasing the adaptive ability and stress resistance of the body gains special attention [5, 7]. With an unsatisfactory microclimate, the reactivity of the body is weakened, which is one of the causes of colds. Under the stressful effects of cold, a stage of resistance develops, which must be maintained by increasing the level of feeding [8, 9]. At the same time, some scientific studies indicate that keeping...
young cattle in conditions close to natural at low temperatures contributes to the earlier implementation of urgent adaptation and increased adaptation to the cold. There is an increase in general biotonus, improvement of neurovascular thermoregulation, barrier and respiratory functions of the body, which in general contributes to a high level of resistance, safety and productivity [10–12]. Determination of the reaction of young animals to extreme conditions of detention, genetically inherited ability to withstand adverse environmental factors (natural resistance) in practice allow making adjustments to design solutions for the construction of livestock facilities of a lightweight type, the technology of feeding and keeping animals [13, 14]. In recent years, in connection with the large-scale use of crossbreeding of local cattle with Holstein breed, a significant part of the livestock on the farms is represented by cross-breeding animals of different blood levels. The humoral and cellular factors of natural resistance of such animals are poorly understood [17–19].

The purpose of the study is to study the natural resistance of castrated bulls of Simmental breed and crossbreeds with Holstein breed when grown on an open feedlot in the conditions of the sharply continental climate of the southern Urals. In the seasonal aspect, the aim was to follow the dynamics of such indicators of non-specific immunity as bactericidal and betalitic activity of blood serum, the content of lysozyme in it.

2. Material and research methods
The object of the study is Simmental castrated bull-calves and crossbreeds obtained from crossing Simmental cows with Holstein bulls.

The scheme of the experiment. In the State Unitary Enterprise "Soviet Russia", which is the stronghold of the Federal State Budgetary Institution "Orenburg Research Institute of Agriculture", 2 groups of castrated bulls of the same age with 20 heads each were formed. Group I included pure-bred animals of the Simmental breed, the second group includes hybrids of the first generation with the Holstein breed. Castrated bulls were placed on an open feedlot in a corral, divided into two sections. Animal service and experimental studies were performed in accordance with the instructions and recommendations of the Russian Regulations. 1987 (order № 0755 of 12.08.1977 the USSR Ministry of Health) and «The Guide for Care and Use of Laboratory Animals (National Academy Press Washington, D.C. 1996)».

Research and observation were carried out in accordance with the classical methods adopted in zootechnology [20]. The diets were compiled according to detailed feeding standards. During the experiment, the technology of keeping and feeding the experimental animals was as close as possible to the economic ones. The diets consisted of feed produced in-house. To control the state of natural resistance, blood samples were taken from the jugular vein in autumn, winter, spring and summer, which coincided with the ages of 9, 12, 15, and 18 months in accordance with the methodological recommendations for testing natural resistance [21]. The bactericidal activity of blood serum was measured by the method of phytophonometry [22] in the modification by recording the optical density of the medium [23]. Beta lytic activity of blood serum was determined using a turbometric method based on the growth of hay bacillus [22]. The concentration of lysozyme in the blood was determined by the method using a live daily bacterial culture [25]. The state of cellular defense of the body was evaluated on the basis of calculations of the Wag and Hamburger phagocytic indices [26]. A bacterial suspension of the daily culture of Escherichia coli was used. The phagocytic index (phi) was calculated — the average number of microbial bodies absorbed by one active neutrophil and the percentage of phagocytosis — the proportion of neutrophils capable of absorbing microorganisms using a light microscope Biolar ILP 5AZ (Zeiss AG Germany). Hair condition: hair length and thickness were determined by measuring, weight by weighing, fractional composition by counting from 1 cm² of skin.

Equipment and hardware. The studies were carried out on the basis of the comprehensive analytical laboratory of the FSBSI "Orenburg Research Institute of Agriculture" using generally accepted methods.
3. Results and discussion
Bull-calves were exposed to changing autumn rainfall in the form of rain and wet snow, increased wind speed, and deteriorating sanitary conditions of places in corrals. Animals responded to these influences by mobilizing the body’s defenses, which affected the intensity of physiological functions. The bactericidal activity of blood serum at this time was higher than that in other seasons of the purebred animals by 1.08–2.24 %, in crossbreeds – by 0.21–2.46 % (P<0.01). In spring and summer periods of the year, it was higher than in winter by 0.67–1.01 %, respectively (P<0.01). The indicator of thermal adaptation is more pronounced in Holstein hybrids, which tolerate both low and high temperatures worse. Under favorable weather conditions, differences in BABC indices are less pronounced. The serum lysozyme concentration was subject to fluctuations depending on the season of the year. Its greatest number was recorded in the autumn period, as well as in spring and summer. In this case, certain regularity in the indicators is not traced.

High digital values in animals of all groups indicate a good resistance of the body to adverse environmental factors. The highest level of beta-lysines coincides with a period of decrease in the body's natural resistance. Comparing the indicators of the beta-lytic activity of blood serum and the concentration of lysozyme in it, it should be noted that these indicators have the advantage of pure-bred Simmental castrated bull-calves in all age periods and seasons of the year. According to the state of the hair cover, one can judge the animal’s adaptability to environmental conditions; its best development indicates an increased thermal adaptation of the specimen. Based on the results obtained, the structure of the haircover of Simmental castrated bulls in winter contained 3.7 % less hair and 4.8 % more fluffy hair than in crossbreeds (P<0.05). Purebred individuals recorded a large density of hair and its mass, especially in winter – by 22.4 %. The animals of the Simmental breed were distinguished by the best adaptability to the sharply continental climate of the Southern Urals.

The sharply continental climate of the Southern Urals with long cold winters with frosts of up to 50 °C and hot summers places high demands on animal breeding technology and economically useful traits of cattle breeds in the zone. At the same time, large areas of natural forage land, a diverse botanical composition of plants of different growing periods, and also quite developed grain farming predetermined the intensive development of animal farming, especially cattle breeding [27].

The cattle raised in the zone, represented mostly by Simmental breed, are well adapted to severe weather conditions. However, the holsteinization of local breeds, which has been ongoing for many years, although it has increased the milk production of cross-breeding animals, has led to a decrease in resistance to adverse environmental factors and diseases, especially to leukemia. They are demanding on the conditions of feeding and keeping, the microclimate. Their natural resistance, humoral and cellular defense factors are clearly not well understood.

The obtained experimental data indicate interspecific differences in the humoral and cellular links of immunity. Purebred Simmental castrated bulls exceeded hybrids in the functional activity of homeostasis regulation systems.

This is evidenced by the condition of the hair cover, which largely characterizes the degree of thermal adaptation. In most parameters, individuals of the Simmental breed had an advantage, which can be explained by their long-term cultivation in local specific climatic conditions.

4. Conclusion
The body’s natural resistance is an important indicator of its resistance to external environmental factors, biotic and abiotic stresses. The studies conducted allowed us to study and more fully evaluate the humoral and cellular links of the nonspecific immunity of purebred and cross-breeding animals when kept on an open feeding area in a sharply continental climate. A high thermal adaptive ability of
young animals of the studied genotypes to living conditions was revealed with higher values of bactericidal and lysozyme activity of blood serum, phagocytosis activity in Simmental specimen.

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