Productive qualities of Holstein black-and-white cattle of different genotypes according to kappa-casein

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Abstract. In Sverdlovsk region Holstein black-and-white cattle of the Ural type are bred, which are represented by highly productive animals with a high genetic potential for productivity. The aim of the work was to study the effect of genotypes of the kappa-casein gene on milk productivity and quality indicators of milk from Holstein black-and-white cattle of the Ural type. Most of the cows had the AA kappa-casein genotype, and they had the worst indicators of technological properties in terms of cheese suitability. The best technological properties of milk are possessed by cows with the BB kappa-casein genotype. There were only 4.2% of such animals among those examined. The highest milk yield in 305 days of lactation was observed in cows with the genotype for BB kappa casein (9595 ± 314.3 kg), which is 373 kg and 537 kg more, or 3.9 and 5.6% more than in animals with AA and AB genotypes, respectively. The indicators for the mass fraction of fat and mass fraction of protein in the milk of cows of different genotypes for kappa-casein were the same. There was a tendency to an increase in the protein content in the milk of cows with the BB genotype and a decrease in the mass fraction of fat in the milk of cows with the AB genotype. Thus, more nutrients, namely milk fat with the same content in milk, were obtained in the group of first-calf heifers with the BB genotype (380 ± 13.19 kg). They also had a higher yield of milk protein (311 kg), which is more than in other groups by 13 and 19 kg.

1. Introduction
Providing the population with high-quality, nutritious food of animal origin is the most important task facing workers engaged in agricultural production [1-3]. One of these products is milk, food created by nature itself. It differs in that it can be used in the diet of any person, regardless of age, health status. This is also a raw material for dairy products, the range of which increases annually, which ensures the health of the nation, ensuring the population’s priorities in a particular product and food security of any country [4-7]. In this regard, special attention is paid to the development of dairy cattle breeding, since the main amount, more than 97% of the total production, of a valuable food product and raw material for the dairy industry - milk, is obtained from cattle. Strict requirements for its quality are imposed on milk; therefore, along with increasing the productivity of cattle, tasks are set to improve the quality indicators of milk [8-18]. In the production of certain types of dairy products, it is treated as a raw material, and along with quality requirements, an additional assessment is carried out for its technological properties.

There are special requirements for the production of cheese. It is known that they also depend on the breed of cows. In addition, such a property of milk as cheese suitability is determined by the presence of kappa-casein in milk. In turn, kappa-casein, which is one of the fractions of casein, and the gene that
controls its formation in milk, has 10 allelic variants. Of these, in cattle, two genotypes were identified, which are most common: A and B, in three different combinations of genotypes - AA, AB, and BB.

Determination of the genotype of cows for kappa-casein can be a test of the technological properties of milk, especially in terms of cheese suitability. According to the results of scientific research, the polymorphism of the kappa-casein gene is associated with the protein content in milk, its technological properties, the quality and yield of dairy products with high protein content [19-21]. For the production of milk, dairy cattle of both domestic and foreign selection are used, the main livestock of which is represented by the domestic black-and-white breed. In the past few decades, for its improvement, the gene pool of the world’s best dairy breed, the Holstein, has been widely and widely used, and continues to be used. The long-term use of foreign breeding bulls of the Holstein breed has led to the creation of a large array of Holstein cattle in various climatic and ecological forage zones of the country, which also differs in economically useful and biological characteristics, which is due to the breed resources of cattle in the breeding zone and the country and the origin of stud bulls involved in crossing [22-25]. In Sverdlovsk region, the breeding stock of the black-and-white breed of the Ural offspring was covered with the seed of stud bulls of Canadian, Danish and German selection. As a result, large, highly productive animals with a high genetic potential for productivity and well adapted to industrial milk production were obtained. In 2003, the Ural type of black-and-white cattle was officially registered with a Holstein blood ratio of 75% [26-30]. It is of interest to study the effect of the genotypes of the kappa-casein gene on milk productivity and quality indicators of milk from Holstein black-and-white cattle of the Ural type, which is relevant and of practical importance.

2. Materials and method

The research was carried out in the conditions of one of the breeding factories for breeding Holstein black-and-white cattle of the Ural type. The study included cows that completed the first milk secretion. They were divided into groups depending on the genotype for kappa-casein AA, AB, BB. For the analysis, the data of zootechnical and pedigree registration of the base “Seleks” were used. Milk productivity was taken into account by carrying out control milking once a month, quality indicators of milk: MJ and MDB in milk, which were checked monthly from each cow in the conditions of the dairy laboratory of JSC “Uralplemcenter” of Sverdlovsk region. The milking capacity coefficient and correlation coefficients were calculated.

3. Results and Discussion

The farm is engaged in breeding highly productive Holstein black-and-white cattle of the Ural type with a high proportion of Holstein blood (more than 91%). In 2019, 9677 kg of milk was received from 1400 cows, MJ and MJB in milk - 3.96 and 3.23%, respectively. The live weight of full-grown cows is 634 kg.

61.3% of 284 cows had the AA genotype (figure 1).

![Figure 1. The ratio of cows by kappa-casein genotypes, %](image-url)
Figure 1 shows that a larger number of cows had a kappa-casein of AA genotype, and they have the worst technological properties in terms of cheese suitability. The best technological properties of milk are possessed by cows with the BB kappa-casein genotype. There were only 4.2% of such animals among those examined.

Cows with different kappa-casein genotypes differed in milk yield per lactation (figure 2).

![Figure 2. Milk yield for 305 days of lactation, kg.](image)

The figure clearly shows that the cows with the genotype for BB kappa-casein (9595 ± 314.3 kg) had the highest milk yield in 305 days of lactation, which is 373 kg and 537 kg more or 3.9 and 5.6% more than in animals with AA and AB genotypes, respectively. Heifers with the AB genotype had the lowest milk yield. The difference was significant between the indicators of milk yield in cows with AB genotype and BB genotype in favor of the latter at P≤0.05.

As a result of the research, no significant differences were found in the quality indicators of milk in cows with different genotypes for kappa-casein (figure 3.).

![Figure 3. MJ and MDB in cow’s milk, %](image)
The indicators for MJ and MDB in the milk of cows of different genotypes for kappa-casein were found to be the same. There was a tendency to an increase in the protein content in the milk of cows with the BB genotype and a decrease in MJ in the milk of cows with the AB genotype. If the increase in MDB in the milk of cows with the BB genotype can be associated with their technological properties of milk, then the decrease in MJ in milk is most likely explained by the individual qualities of the animals.

The quality indicators of milk and milk yield per lactation are associated with such as the amount of milk fat and milk protein obtained during lactation or the yield of nutrients with milk (figure 4).

![Figure 4. Yield of nutrients with milk, kg.](image)

The data on the yield of nutrients with milk of cows per lactation shows that this indicator is more influenced by milk yield than the quality indicators of milk. Thus, more nutrients, namely milk fat with the same content in milk, were obtained in the group of first-calf heifers with the BB genotype (380 ± 13.19 kg). They also had a higher yield of milk protein - 311 kg, which is more than in other groups by 13 and 19 kg.

Our data on the high productivity of Ural-type cows of Holstein black-and-white cattle are confirmed by the studies of many authors N.V. Bogolyubova, V.P. Korotky, A.S. Zenkin, V.A. Ryzhov, N.P. Buryakov [26,27], V. Mymrin and O. Loretts [24], O.V. Gorelik, O.E. Lihodeevskaya, N.N. Zezin, M.Ya. Sevostyanov and O.I. Leshonok [28-30]. Animals with different genotypes for kappa-casein differ in the level of milk productivity, which is also confirmed by E.V. Matushkina (E.V. Razhina), O.G. Loretz [19-21].

4. Conclusion
For the foregoing reasons, it can be concluded that the farm uses highly productive Holstein black-and-white cattle of the Ural type. The largest number of the first-calf heifers has the AA kappa-casein genotype (61.3%). The highest productivity indices - milk yield for 305 days of lactation were observed in the first-calf heifers with the genotype of BB kappa-casein.

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