Growth and development of calves of different genetic background in the pre-weaning period

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Abstract. Development of a living organism, including periods of its development, follows certain laws. All mammals have a pre-weaning period. In calves, the pre-weaning period lasts 6 months. This period is known to be one of the most important, since at this time the body, firstly, adapts to new environmental conditions, and secondly, starts to live on typical feeds. The calf growth depends on many factors, including genetic ones. The study of the dynamics of live weight in calves in the pre-weaning period with regard to their genetic background is of practical relevance. The farm uses bulls of both Holstein black-motley cattle of domestic selection and Holstein breed of foreign selection. A general pattern in monthly live weight increase has been found for descendants of all the bulls. At the same time, the growth rate in groups of calves sired by different bulls differed by months of rearing. In calves sired by the bull Mers, the absolute weight gain by months of rearing ranged from 10.0 kg (4 months) to 36.0 kg (6 months), that is, the growth failure in the previous period was compensated for by increased growth rate in the next month. At the same time, calves sired by the bulls Gavano, Cassio and Bentley showed a uniform absolute weight gain by months of rearing. In general, calves sired by the bulls Cassio and Gavano grew better. They were superior to other calves in the absolute weight gain over the entire period, which attained 138.5 and 132.2 kg, and it was higher by 6.3–20.9 and 5.3–14.6 kg or 4.5–15.1% and 4.0–11.0%, respectively.

1. Introduction

Uninterrupted and sustainable supply of high-quality food products, including milk, is the key to health of the nation and food security of any country. An increased output of high-quality milk and dairy products is one of the vital tasks in the development of livestock production worldwide, which is becoming crucial due to both the global growth of the population, in particular in our country, and the need to satisfy humanity’s food demands. In this regard, the development of this industry is of great
economic relevance [1–7]. Increase in cow productivity is inseparably linked with improvement of the milk quality, which has a significant impact on the quality of finished dairy products [8–18]. All over the world, dairy breeds are used for milk production, including related breeds such as black-motley, Holstein and Dutch, which differ in economically beneficial traits depending on climatic and ecological, and feed conditions of the breeding zone, and the breed gene pool [19–20]. One of the most important tasks in breeding dairy cattle is to raise young replacement animals, especially in the pre-weaning period, which determines health of the animal and its adaptive traits. Many factors, including hereditary ones, affect the growth and development of calves. Widespread use of Holstein bulls of foreign selection raises the question for livestock scientists about the impact of the stud bull on growth and development of heifers raised for herd replacement [21–23]. Assessment of the impact of the bull on the growth of heifer daughters is of practical relevance, especially in the dairy industry.

The study aimed to assess the impact of the stud bull on the growth of heifer daughters in the pre-weaning period.

2. Materials and methods
The study included all replacement heifers of the pre-weaning period born in 2018 on the farm for breeding black-motley cattle in Sverdlovsk region. They were divided into 8 groups depending on the genetic background and the bull used on the farm. Each group consisted of 15 (bull Mers) to 55 (bull Sayan) bull’s heifer daughters, which were grown under the same feeding and keeping conditions. We used data from zootechnical and breeding records of the SELEX database, and acts of monthly weighing. Growth parameters, absolute, average daily and relative weight gain, and growth rate were calculated using generally accepted methods.

3. Results
A commercial farm is engaged in breeding of highly productive Holstein black-motley cattle of the Ural type obtained using the gene pool of Holstein bulls of foreign selection, the world’s best dairy breed.

A general pattern of monthly increase in live weight has been found for descendants of all the bulls (figure 1).

Despite almost similar live weight of heifers at birth (changes ranged from 28.2 to 29.6 kg or 1.4 kg in descendants of the bulls Bentley and Das, respectively), they differed significantly in rearing results up to 6 months of age. The difference in live weight at birth between heifers sired by different bulls (De-Su, Gavano, Bentley) was significant at P≤0.05 in favor of calves sired by the bull Das. At the age of 6 months, the difference in live weight in the groups increased and ranged from 147.1±3.63 to 167.8±1.89 kg or 20.7 kg (14.07%). Calves sired by the bull Das exhibited the lowest indicators, and calves sired by the bull Cassio showed the highest indicators. Calves sired by the bull Gavano took the second place in the weight gain.

Despite a regular increase in the live weight in heifers with age, different patterns of the live weight change can be observed within a group of heifers sired by a particular bull. This can be illustrated by the analysis of changes in the absolute weight gain in heifer daughters of the bulls. Heifer daughters of the bulls Dasa, Sayan and Gavano grew uniformly by months of rearing. Changes in the absolute weight gain by months of rearing in these groups were found insignificant.
Heifers sired by the bull Das exhibited a lower absolute weight gain in the first and sixth months of life. In the remaining months of rearing, they weighed 18.4–21.4 kg. In heifers sired by the bull Sayan, the absolute weight gain during the pre-weaning period amounted to a maximum of 3.0 kg and a minimum of 0.8 kg. In heifers sired by the bull Gavano, the weight varied from 1.7 to 0.1 kg. The absolute weight gain of all heifers, except for daughters of the bulls De-Su and Mers, was greater than that observed in the first month. Regular pattern of changes in the absolute weight gain were noted for all groups of heifers, but different groups exhibited different periods of these changes attaining 1, 2 or 2 months, depending on the genetic background. Thus, in calves sired by the bull Mers, the absolute weight gain by months of rearing ranged from 10.0 kg (4 months) to 36.0 kg (5 months), that is, the growth failure in the previous period was compensated for by an increase in the growth rate in the next month. At the same time, calves sired by the bulls Gavano, Cassio and Bentley exhibited continuous changes at the age of 2 and 3 months. They were superior to other calves in the absolute weight gain over the entire period, which amounted to 138.5 and 132.2 kg, and it was higher by 6.3–20.9 and 5.3–14.6 kg or 4.5–15.1% and 4.0–11.0%, respectively. A common pattern was noted for all heifers – regular growth.

Figure 2 illustrates the difference in the absolute weight gain in the groups of heifers.
Thus, in calves sired by the bull Mers, the absolute weight gain by months of rearing varied from 10.0 kg (4 months) to 36.0 kg (6 months), that is, the growth failure in the previous period was compensated for by the increased growth rate in the next month. At the same time, calves sired by the bulls Gavano, Cassio and Bentley showed a uniform absolute weight gain by months of rearing. In general, calves sired by the bulls Cassio and Gavano were found to grow better. They were superior to other calves in the absolute weight gain over the entire period, which amounted to 138.5 and 132.2 kg, and it was higher by 6.3–20.9 and 5.3–14.6 kg or 4.5–15.1% and 4.0–11.0%, respectively.

The growth rate of calves is most often estimated with regard to the average daily weight gain. In our case, heifers sired by the studied bulls exhibited sufficiently high average daily weight gain over the entire pre-weaning period.

Figure 3 shows changes in the average daily weight gain of calves depending on the bull.

The calculation of the average daily weight gain of heifers by months of rearing confirmed the above conclusions that the growth rates were different depending on the bull, despite sufficiently high growth rates of calves in the pre-weaning period and almost similar average daily weight gain over the entire period. The difference between the groups with the lowest and highest daily average weight gain attained 116 g (17.8%) over the entire period. A significant difference in the average daily weight gain was noted for the groups of calves sired by the bulls Gavano and Cassio and heifer daughters of the bull Das at P≤0.05–P≤0.01 in favor of the former.

Within the groups, the highest difference was recorded for heifer daughters of the bull Mers – 589.6 g (59.8%) by months of rearing, and the most insignificant difference was noted for heifer daughters of the bull Sayan – 95 g (12.9%).

The relative weight gain indicates the growth rate.

Figure 4 shows changes in the growth rate of heifers with age.

The obtained data show that the growth rate decreases with age. This is a general pattern of development for all animals. It was found that in the first month after birth, the calves grew very intensively and gained from 46.4 to 56.4% of the mass. After that, the relative weight gain was observed to reduce to 12.6–16.0% as the age of the animals decreased. In general, during the pre-weaning period, the relative weight gain exceeded 100 percent and attained 133–140%. In the groups of calves sired by the bulls Gavano and Cassio, these indicators were higher (figure 5).
Thus, the farm focuses on intensive rearing of young replacement animals during the pre-weaning period. The growth rate of calves depends on the bull and individual traits, and shows common patterns of growth and development.

4. Discussion
Rearing of heifers in the pre-weaning period plays a significant role in the technology of rearing young replacement animals. For breeding of Holsteinized black-motley cattle of the Ural type, the commercial farm uses bulls of Holstein breed of foreign selection to rear highly productive animals for herd replacement and pedigree cattle sale. The study shows that the bull has an effect on the growth of calves in the pre-weaning period. Despite rather high growth rates of heifers, the highest indicators were noted for heifer daughters of the bulls Gavano, Cassio and Bentley. Similar studies were conducted by F.G. Kayumov, V.I. Kosilov, N.P. Gerasimov, O.A. Bykova [20], I.V. Tkachenko, V.F. Gridin, S.L. Gridina [19], S.L. Gridina, V.F. Gridin, O.I. Leshonok [18] and others.
5. Conclusion
All the heifers exhibited common patterns of growth and development. The intensity and rate of the growth of heifers in the pre-weaning period depend on inherited traits, namely, on the bull, and individual traits. The bulls of Holstein breed of foreign selection provide intensive rearing of heifers in the pre-weaning period. The best were heifers sired by the bulls Gavano, Cassio and Bentley.

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