Relationship between cow milk yield and milk quality indicators

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Abstract. In the Sverdlovsk region, purebred bull producers of the Holstein breed of German, Danish and Canadian selection and the breeding stock of the domestic black-and-white breed of the Ural offspring were used for improvement. The Ural offspring of the black-and-white breed was distinguished by high milk yield and fat mass fraction and protein mass fraction in milk. In 2002, the Ural type of the Holstein black-and-white cattle was officially registered in the Ural region. This type has significant differences from the original rocks. The purpose of the article is to study the relationship between milk yield and milk quality indicators in cows-daughters of the Holstein black-and-white cattle of the Ural type from different Holstein bulls. However, it can be noted that there is a positive relationship with an average and high level of correlation between milk yield for the first lactation and fat mass fraction in milk, milk yield for lactation and protein mass fraction in milk, and between fat mass fraction and protein mass fraction in milk in the groups of bull daughters from producers Emen and Reverse. For the group of daughters of the bull Jesmen, a high negative correlation was found between milk yield per lactation and fat mass fraction in milk, an average negative correlation between milk yield and protein mass fraction in milk, and a low positive correlation between fat mass fraction and protein mass fraction in milk. Correlation coefficients change with age. For the second lactation, the correlation coefficients differed from those established for the first lactation. So, they went to negative between milk yield and fat mass fraction in milk in the daughters of all evaluated bulls, between milk yield and protein mass fraction in milk remained the same, but decreased. The correlation coefficient between the quality indicators of milk in bull's daughters changed to negative. Selection of cows by milk yield for the first lactation will allow you to get an increase in milk yield for full-age lactation.

1. Introduction

Uninterrupted and sustainable supply of the population with high-quality food products, including milk, is the main necessity in ensuring the health of the nation and food security of any country. Increasing the production of high-quality livestock products, milk and dairy products, is one of the most important tasks for the development of animal husbandry all over the world, which is becoming increasingly
important both with the growth of the population of our planet, in particular our country, and meeting the needs of mankind for food. In this regard, the development of this industry is given great national economic importance [1-7]. An increase in the productivity of cows is inseparably associated with an improvement in milk quality, which has a significant impact on the quality of finished dairy products [8-18]. The main dairy breed in the country remains the black-and-white, which has been improved over the past few decades through the widespread use of the gene pool of the world’s best Holstein breed. In the Sverdlovsk region, purebred bull producers of the Holstein breed of German, Danish and Canadian selection and the breeding stock of the domestic black-and-white breed of the Ural offspring were used for improvement [12-16]. The Ural offspring of the black-and-white breed was distinguished by high milk yield and fat mass fraction and protein mass fraction in milk. In 2002, the Ural type of Holstein black-and-white cattle was officially registered in the Ural region. This type has significant differences from the original rocks [17-28]. The study of the relationship between milk yield and quality indicators of milk in cows-daughters of Holstein black-and-white cattle of the Ural type from different Holstein bull producers is relevant and of practical importance.

The purpose of the research is to study the relationship between milk yield and quality indicators of milk in cows-daughters of Holstein black-and-white cattle of the Ural type from different Holstein bulls.

2. Materials and method
The studies were carried out in one of the breeding reproducers of the Sverdlovsk region for breeding black-and-white cattle of the Ural type. The study included all heifers who completed lactation in 2019. They were divided into groups according to origin: group 1 consists of cow-daughters of the bull producer Emen 105018721 of Reflection Sovering 198998 line; group 2 of Jesmen 105303281 of Vis Back Ideal 1013415 line; group 3 of Reverse 2708 Montvik Chieftain 95679 line. The data of zootechnical and breeding registration of the Selec program, acts of control milking were used. The milk productivity of cows was assessed by control milking once a month, the quality indicators of milk were examined in an average milk sample once a month from each cow. The amount of milk fat and milk protein was calculated according to generally accepted methods. The conditions for feeding and keeping replacement heifers were the same.

3. Results
Currently, the farm uses the daughters of bull producers belonging to 6 lines: 3 lines belong to Holstein, 1 line to Dutch and 2 lines to black-and-white breeds of the Ural offspring. Of greatest interest are the descendants of bull producers of Holstein lines (Reflection Sovering 198998, Montvik Chieftain 95679, Vis Back Ideal 1013415), since they represent the main livestock of the herd. Among them, a significant part of the brood stock is represented by the descendants of bull producers Emen 105018721 of Reflection Sovering 198998 line; group 2 of Jesmen 105303281 of Vis Back Ideal 1013415 line; group 3 of Reverse 2708 Montvik Chieftain 95679 line.

Table 1 presents data on milk productivity of cows by lactation.

| Indicator | 1 lactation | 2 lactation | 3 lactation |
|-----------|-------------|-------------|-------------|
|           | Yield of milk, kg | MJ, % | IBD, % | Yield of milk, kg | MJ, % | IBD, % | Yield of milk, kg | MJ, % | IBD, % |
| Average   | Emen 105018721 | 7419 | 3.82 | 3.12 | 8909 | 3.84 | 3.15 | 10506 | 3.89 | 3.16 |
| Standard error, ± | 182.4 | 0.02 | 0.01 | 223.4 | 0.02 | 0.01 | 138.5 | 0.02 | 0.01 |
| Cv - coefficient of variation, % | 16.68 | 3.93 | 1.86 | 17.0 | 3.14 | 1.87 | 8.94 | 3.97 | 2.34 |
| Average   | Jesmen 105303281 | 7394 | 3.77 | 3.10 | 8334 | 3.80 | 3.13 | 9207 | 3.86 | 3.16 |
| Standard error, ± | 212.4 | 0.03 | 0.01 | 347.7 | 0.02 | 0.01 | 315.5 | 0.02 | 0.02 |
Cv - coefficient of variation, %  12.84  3.31  1.19  18.76  2.40  1.31  15.32  2.62  2.27

| Reverse 2708 |
|-------------|
| Average     | 6222  | 3.85  | 3.14  | 7717  | 3.83  | 3.14  | 7334  | 3.86  | 3.12  |
| Standard error, ± | 148.5 | 0.04  | 0.02  | 497.7 | 0.03  | 0.02  | 538.2 | 0.03  | 0.02  |
| Cv - coefficient of variation, % | 8.93  | 3.96  | 2.14  | 24.1  | 2.46  | 1.85  | 26.46 | 2.88  | 1.98  |

Higher rates of milk yield for 305 days of lactation had the cows - daughters of the bull producer Emen 105018721 of Reflection Sovering 198998 line. According to this indicator, they outperformed the daughters of other bulls producers for the first lactation by 25 - 1197 kg (0.3-16.1%) and for 3 lactation by 1299 - 3172 kg (12.4-30.2%) at P≤0.01 in favor of the daughters of the bull Emen. The cows from the bull Jesmen, however, the difference in the first lactation was insignificant and unreliable.

In the groups of daughters from the bulls Emen and Jesmen, there was an increase in milk yield in full-aged cows for 3 lactation, while the daughters of the bull Reverse had a decrease in milk yield for the third lactation by 383 kg or 4.96%, the difference is not reliable.

The relationship between milk yield and milk quality indicators was assessed by lactation.

Correlation coefficients between milk yield for lactation and milk quality indicators for the first lactation are shown in figure 1.

![Figure 1. The relationship between indicators of milk productivity of cows-daughters for the first lactation.](image)

The relationship of indicators depends on whether the daughter cows belong to a particular bull producer. There is a positive correlation between average and high levels of correlation between milk yield per lactation and fat mass fraction in milk, milk yield per lactation and protein mass fraction in milk, and between fat mass fraction and protein mass fraction in milk in groups of daughters of Emen and Reverse bulls. For The group of daughters of the bull Jesmen, there was a high negative correlation between milk yield per lactation and fat mass fraction in milk, an average negative correlation between milk yield and protein mass fraction in milk, and a low positive correlation between fat mass fraction and protein mass fraction in milk.

Data on the correlation of milk productivity characteristics of cows-daughters of the assessed Holstein bull producers for lactation 2 are presented in figure 2.
Figure 2. The relationship between indicators of milk productivity of cows-daughters for the second lactation.

For lactation 2, the correlation coefficients differed from those established for the first lactation. So, they went to negative between milk yield and fat mass fraction in milk in the daughters of all evaluated bulls, between milk yield and protein mass fraction in milk remained the same, but decreased. The correlation coefficient between the quality indicators of milk in bull's daughters changed to negative.

Figure 3 shows the correlation coefficients between milk characteristics in cows-daughters of bulls for lactation 3.

According to the third lactation, cows-daughters of all Holstein bull producers have a high negative correlation between milk yield and fat mass fraction in milk, and a low and average correlation between milk quality indicators. Changed to a negative correlation coefficient between milk yield and protein mass fraction in milk in the daughters of the bull Reverse and vice versa to a positive one in cows from the bull Jesmen.
Thus, it can be concluded that the relationship of milk productivity characteristics among themselves varies depending on the origin and age.

We found it interesting to assess the relationship between milk yield and lactation depending on age (figure 4).

Figure 4. The correlation coefficients for the yield of milk depending on lactation.

The greatest correlation exists between milk yield for the first and second lactation. Despite the fact that all the correlation coefficients were positive, they were higher for the daughters of bull producers Emen and Jesmen. The increase in productivity in the third lactation compared to the second has low correlation coefficients, which may be due to the need to restore the young body after intensive first lactation and the continued growth of the animal. The correlation coefficients between lactation 1 and 3 are higher and have average values, with the exception of the bull's offspring whose Reverse is at low values.

Based on the above, it can be concluded that the selection of cows for milk yield for the first lactation will allow you to get an increase in milk yield for full-age lactation.

4. Discussion
Based on the conducted research, when selecting animals, planning breeding work, it is necessary to take into account the origin of animals, namely, belonging to a particular bull producer. The relationship between milk yield indicators depends on the age and origin of cows. Similar studies have been conducted by N V Bogolyubova, V P Korotky, A S Zenkin, V A Ryzhov, N P Buryakov [23,24], Mymrin and Loretts O [21], O V Gorelik, O E Lihodeevskaya, N N Zezin, M Ya Sevostyanov and O I Leshonok [25-27].

5. Conclusion
To increase the genetic potential of productivity, select cows based on the results of milk yield in the first lactation. To improve the quality indicators of milk, it is necessary to select bull producers with high quality indicators for fat mass fraction and protein mass fraction in milk of maternal ancestors.

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