Influence of paratypical factors on productive qualities of Holstein cows

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Abstract. The problems of adaptation of a highly productive Holstein breed to new natural and climatic conditions and using their productive qualities are relevant. In order to study the influence of paratypical factors on the productive characteristics of Holstein cows, productive qualities of Holstein cows and their paternal half-sisters brought from the USA were compared. It has been established that during their first, second and third lactation periods, Holstein cows had better milk yield parameters than their paternal half-sisters brought from the USA. In Holstein cows, values of repeatability and heritability of milk yield parameters were higher than in their half-sisters. The influence of the “Region of reproduction” factor was observed for the milk yield per lactation. To the least extent, it was observed for the mass fraction of protein. The highest frequency, heritability, and factoriality of milk yield parameters were observed in Pilot’s daughters.

1. Introduction

In recent years, many regions of the Russian Federation have been importing the Holstein breed which is the most abundant dairy breed[1-6]. The problem of adaptation of this highly productive breed to new feeding and housing conditions arises. Some farms for the repair of dairy herds of Holstein black-and-white breed regularly bring young stock from abroad which is reflected in the production cost, because the costs of feeding heifers in Russia are less than those in the USA, Canada and Western European countries. In addition, if the level of milk production of imported animals does not exceed the yield of on-farm reproduction animals, the purchasing cost does not pay off.

It is necessary to compare milk productivity values for on-farm reproduction cows and imported heifers. The article aims to compare reproductive qualities of Holstein cows and their paternal half-sisters brought from the USA.

2. Materials and methods

A comparative study of productive qualities of Holstein cows and their half-sisters brought from the United States was carried out during the period of 2014-2018 at the Agro-Soyuz farm of Chegem District of Kabardino-Balkaria located in the foothill zone (altitude is 430 m, average annual air temperature is + 8.6 °C, humidity is 78%). The farm keeps animals in barns built according to the American technology with adjustable microclimate parameters. For feeding cows, they use their own feed mixtures consisting
of succulent fodder, roughage and concentrates with various vitamin-protein-mineral supplements. Cows are milked three times using milking machines. The Agro-Soyuz farm accounts the milk yield on a daily basis.

3 control and 3 experimental groups including 25 animals wereformed. The control groups included daughters of three Holstein bulls: Ray Mar Legend 139164598, Pilot 63811814 and Sharkey 131184495 born at the Agro-Soyuz farm. Experimental groups were formed from the daughters of these sires brought from the United States.

The age repeatability of milk productivity indicators was studied using the repeatability coefficient (rw). The coefficient of heritability (\(^2\)) and the influence of the organized factor (\(\eta^2\)) on milk productivity of experimental cows were calculated by the N.A. Plokhinsky’s algorithms (1969). The significance of differences between the groups was taken into account based on the Student’s and Fisher’s criteria.

3. Results and discussion

Age-related changes in milk yield are presented in Table 1.

Table 1. Milk yield during lactation of daughters of different servicing bulls, kg

| Nickname and inventory number | lactation1 | lactation2 | lactation3 |
|-------------------------------|-----------|-----------|-----------|
|                               | controlgroup | Experimental groups | controlgroup | Experimental groups | controlgroup | Experimental groups |
| Ray-MarLegend 139164598       | 25 ± 282 | 25 ± 285 | 17 ± 334 | 16 ± 353 | 12 ± 372 | 10 ± 411 |
| Pilot 63811814                | 25 ± 271 | 25 ± 267 | 16 ± 331 | 15 ± 370 | 11 ± 375 | 10 ± 408 |
| Sharkey 131184495             | 25 ± 294 | 25 ± 297 | 15 ± 349 | 15 ± 373 | 12 ± 389 | 11 ± 420 |

It was found that in the first-calf cows of the control groups, the daughters of Pilot showed the highest milk yield per lactation; this indicator was higher than that of the daughters of Ray-Mar Legend by 127 kg or 1.5% (P <0.95) and higher than that of the daughters of Sharkey by 461 kg, or 5.5% (P<0.95). In the animals of the experimental groups, the milk yield of the descendants of Pilot was higher by 38 kg (0.5%) and 278 kg (3.4%). It turned out to be statistically unreliable (P <0.95). Having compared the milk yield for half-sibling cows from the control and experimental groups during their first lactation, the superiority of animals of the control groups was identified. The most contrasting differences were in the descendants of Pilot - 429 kg (5.1%); the smallest differences were in the descendants of Sharkey - 246 kg (3.0%). Daughters of Ray-Mar Legend from the control group surpassed the yield of their half-sisters from the experimental group by 340 kg, or 4.1%. However, these differences were not statistically significant (P <0.95). Analysis of the milk yield for the second lactation in the control groups showed the superiority of the daughters of Pilot over the daughters of Ray-Mar Legend (113 kg, or 1.3%) (P <0.95), and Sharkey (507 kg, or 5.9%) (P <0.95).

The superiority of the descendants of Pilot over the descendants of other bulls was preserved in the experimental groups: the mil yield was higher than that of the daughters of Ray-Mar Legend and Sharkey by 23 kg (0.3%) and 321 kg (3.8%) respectively. There were no statistically significant differences (P <0.95). The comparison of the half-sisters from the control and experimental groups shows the superiority of the control groups: 354 kg (4.1%) in the daughters of Pilot, and 168 kg (2.0%) in the daughters of Sharkey. The daughters of Ray-Mar Legend from the control group outnumbered the second lactation of their half-sisters from the experimental group by 246 kg, or 3.0%. The differences were not statistically significant (P<0.95).
During the third lactation, the highest yields showed the daughters of Pilot surpassing the daughters of Ray-Mar Legend by 96 kg, or 1.1% (P <0.95), and the daughters of Sharkey by 498 kg, or 5.8% (P <0.95). The superiority of the daughters of Ray-Mar Legend over the daughters of Sharkey was 402 kg, or 4.7% (P <0.95). In the cows of the experimental groups, the highest milk yield was observed in the descendants of Pilot. Their superiority over the daughters of Mar Legend and Sharkey were 59 kg (0.7%) and 405 kg (4.8%), respectively. The milk yield of the daughters of Ray-Mar Legend exceeded that of the daughters of Sharkey by 346 kg, or 4.1%. All the differences were not statistically significant (P <0.95). The differences between half siblings from the control and experimental groups were not as pronounced as in the experimental group compared to the control group. For example, the superiority of the daughters of Ray-Mar Legend was 142 kg, or 1.6%, while the differences between half siblings from the control and experimental groups were not as pronounced, with a difference of 86-179 kg (1.0-2.0%) in favor of the half-sisters from the control groups. The greatest differences were observed in the descendants of Pilot - 179 kg, or 2.0%, while the differences between half siblings from the control and experimental groups were not as pronounced, with a difference of 86-179 kg (1.0-2.0%) in favor of the half-sisters from the control groups. The superiority of Ray-Mar Legend’s descendants from the control group over his descendants from the experimental group was 142 kg, or 1.6%. At the same time, the differences were not statistically reliable (P <0.95).

In breeding, the age recurrence of the main breeding traits is very important. It helps the future selection efficiency.

Table 2 shows the coefficients of age-related frequency of milk yield, the mass fractions of fat and protein in the descendants of three sires. It was found that the highest frequency of milk yield was observed during the adjacent lactation periods. At the same time, in the control groups, the $r_w$ value was higher than in the half-sibling cows from the experimental groups.

### Table 2. Frequency rate ($r_w$) for milk productivity parameters in daughters of different servicing bulls

| Parameter      | Ray-Mar Legend | Pilot | Sharkey |
|----------------|----------------|-------|---------|
|                | 139164598      | 63811814 | 131184495 |
| Lactation      |                 |       |         |
| Lactation      | contro l group | Experim enta l groups | contro l group | Experim enta l groups | contro l group | Experim enta l groups |
| 13             | 0.56           | 0.52   | 0.59    | 0.57   | 0.51   | 0.48   |
| 2 - 3          | 12             | 0.55   | 0.50   | 0.57   | 0.54   | 0.47   | 0.43   |
| 13             | 0.35           | 0.32   | 0.37   | 0.33   | 0.32   | 0.29   |
| 12             | 0.70           | 0.65   | 0.74   | 0.69   | 0.68   | 0.63   |
| Fatcontent     | 0.72           | 0.70   | 0.75   | 0.72   | 0.70   | 0.67   |
| 2 - 3          | 13             | 0.55   | 0.53   | 0.57   | 0.55   | 0.52   | 0.50   |
| 12             | 0.73           | 0.70   | 0.79   | 0.75   | 0.71   | 0.68   |
| Proteincontent | 0.75           | 0.71   | 0.77   | 0.72   | 0.69   | 0.65   |
| 2 - 3          | 13             | 0.51   | 0.45   | 0.54   | 0.49   | 0.47   | 0.41   |

The similar trend is observed in the mass fractions of fat and protein. The greatest repeatability of the traits, both within the control and experimental groups was in the Pilot’s daughters being in the range of 0.33-0.59 by the milk yield; 0.55-0.75 by milk fat; 0.49-0.79 by the protein content.

In the control groups, the heritability coefficient ($h^2$) of all parameters was higher than that in the experimental groups (Table 3). The most pronounced heritability was typical of the mass fraction of fat ($h^2 = 0.56, P> 0.99$), while the least pronounced one was typical of the mass fraction of protein ($h^2 = 0.23, P <0.95$).

The factorial causation of different parameters of milk productivity in three servicing bulls is presented in Table 4.

The effect of the factor “Region of reproduction” was the most significant for the milk yield per lactation ($\eta_{12}^2 = 10.24 – 17.38 \%, P>0.95$), and the least significant for the mass fraction of protein ($\eta_{12}^2 = 0.02-2.91 \%, P<0.95$). It is obvious that the large value $\eta_{12}^2$ indicates a relatively large contrast of
differences in the parameters between half siblings from the control and experimental groups. Under the influence of the “Region of reproduction” factor, Pilot’s daughters differed more significantly than the daughters of other sires.

Table 3. The coefficient of heritability ($h^2$) parameters of dairy productivity in experimental cows

| Parameter                  | Control groups | Experimental groups | Total  |
|----------------------------|----------------|---------------------|--------|
| Udoy                       | 0.35           | 0.22                | 0.31   |
| Fat content                | 0.56           | 0.35                | 0.47   |
| Milk fat                   | 0.43           | 0.30                | 0.38   |
| Mass fraction of protein   | 0.23           | 0.18                | 0.21   |
| Milk protein               | 0.41           | 0.28                | 0.36   |

$x$– $P>0.95$; $xx$– $P>0.99$

Thus, in the control groups, repeatability and heritability of milk yield parameters were higher than in the experimental groups. The influence of the “Region of reproduction” factor was observed for the milk yield per lactation, and to the least extent for the mass fraction of protein. Among the descendants of the servicing bulls, the highest frequency, heritability and factorial conditionality of the milk yield parameters were typical of Pilot’s daughters.

Table 4. Share of influence ($\eta^2$) of the heifer-half-siblings reproduction region on productivity, %

| Nickname and inventory number | Milk yield | Fat content | Lactic fat | Protein content | Lactic protein |
|-------------------------------|------------|-------------|------------|----------------|----------------|
| Ray-Mar Legend 139164598      | 13.82      | 1.29        | 9.85       | 0.02           | 11.47          |
| Pilot 63811814                | 17.38      | 3.87        | 19.05      | 2.91           | 18.12          |
| Sharkey 131184495             | 10.24      | 2.51        | 5.33       | 1.49           | 6.76           |

4. Conclusion
These data indicate that young animals of internal reproduction having reached the productive age have a higher level of milk productivity than animals of related origin (half siblings) introduced into the farm being heifers.

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