Assessment of cows of Yenisei intra-breed type of red-mottled breed on a complex of signs

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Abstract. The article is devoted to a comprehensive study of cows of the Yenisei inbreeding type of red-mottled breed. The paper studies the level of milk productivity in groups with different values of the production typicality coefficient and the relationship between the genotype and production typicality coefficient. It was established that the coefficient of production typicality can be used to predict productivity, optimize selection and create a model group of cows. The data obtained allowed us to determine the basic requirements for cows of the desired production types: average milk yield of 6487 ± 2020 kg of milk per 305 days of lactation in first-calf heifers and 7891 ± 419 kg in cows of the third lactation and older; live weight - for first-calf heifers 543-574 kg, adults - 616-684 kg. The formation of the herd should be carried out by animals of the desired production types, which will contribute to the creation of highly productive livestock and increase the efficiency of selection and breeding work to improve breeding and productive qualities. When creating a group of animals of the desired types, including for genomic selection, it is possible not to take into account the origin of the animals.

The provision of the population of Russia with dairy products and the development of dairy cattle breeding is the main objective of livestock farming. Moreover, the rational use of the productive potential of dairy cattle is important. The success of breeding and breeding work to improve existing and create new breeds and inbreed types is primarily determined by the development of the desired body type and direction of animal productivity. Requires animals that meet modern requirements for intensive milk production. Animals of the desired type should have the most pronounced economically useful signs: high milk yield, a high content of fat and protein in milk, a strong constitution. Such animals are sometimes called model [1-3] ones. Improvement of animals must be carried out according to a set of features, since unilateral selection leads to a decrease in productivity, a deterioration in the exterior-constitutional qualities. However, the more breeding traits, the less likely progress is for each of them. It should be borne in mind that any indicators based on multidimensional characteristics are more stable than univariate ones [4]. The coefficient of production typicality is an index combining productive qualities and exterior-constitutional features of cows. Recently, index breeding has been widely and effectively used in cattle breeding, but the solution of this issue requires further research and development in relation to specific breeds and inbreeds of cattle [5].

Ranking by the coefficient of production typicality of highly productive breeding cows allows creating the technological structure of the herd, organizing similar groups taking into account productivity, live weight, exterior, constitutional features and breeding and genetic parameters, organizing appropriate feeding and maintenance in production conditions [6]. As a result of this, it is
Important to use the production typicality coefficient to optimize the selection of cows of the Yenisei inbreeding type of red-motley breed according to a complex of breeding characteristics.

Taking into account the long-term effects of breeding measures, as well as other unaccounted factors that change the intrabreed structure, it is logical to assume the presence of genetic-automatic processes in breed populations [7], to identify which it is possible to use data from the polymorphism of blood group antigens.

The purpose of our research is to establish the informativeness of the production typicality coefficient to optimize selection and create a model group of cows. The work consistently analyzed: 1) the level of milk productivity in groups with different values of the production typicality coefficient, 2) the relationship of genotypes - production typicality coefficient.

The studies were carried out in JSC "Tubinsk" of Krasnoturansky district, Krasnoyarsk Territory, where there are more than 2,000 heads of dairy herds with an average annual milk yield of over 6,700 kg. The calculation of the coefficient of production typicality was performed according to 380 cows of the first and 46 cows of the third lactation. Taking measurements and weighing was carried out in the third month after calving, in the morning. High productivity of cows is provided by complete feeds at the rate of 67-70 feed units per head.

To determine the production typicality of animals in dairy cattle breeding, we used the formula advanced by T F Lefler (2007) to determine the production typicality of cows in a combined direction of productivity:

\[ CPT = \frac{Y \times IL}{W \times I} \]

where \( CPT \) is the coefficient of productivity; \( Y \) is milk yield for 305 days of lactation for the period of determining the production type; \( W \) is live weight for the period of determination of the production type; \( IL \) is long leg index; \( I \) is incidence index.

Production types of cows of the milk direction of productivity allocated by T F Lefler are as follows: ample milk - 4.01 and higher; high-milk - 3.71-4.0; milk - 3.61-3.70; low milk - 2.51-3.60; milk and meat - 2.01-2.5; meat-and-milk type - 1.50-2.0 [8-9].

The fact of similarity or difference (distance D) of cow groups with a different coefficient of production typicality was established by the index of R Maijala, G Lindstrom (1966) and M Nei (1978) [10-11]. The group homogeneity hypothesis was checked by Student's two-sample t-test for dependent (paired) samples of 57 blood group antigens [12].

The proportion of cows assigned to the high-milk, high-milk and dairy type was 56% (table 1). It was established that the cows of the first lactation of all production types reliably (P≥0.999) differed in the level of milk yield for 305 days of lactation in relation to the indicators of cows of a high-milk type. The milk yield of high-milk type cows exceeded the milk yield of high-milk and milk-type cows by 704 (10%) kg and 806 (11%) kg, respectively. According to the mass fraction of fat and protein, no significant differences between production types were revealed.

**Table 1.** Characteristics of cows of the first lactation of different production types, (M±m).

| Indicator                        | Ample milk | High-milk | Milk | Low-milk | Milk and meat | Meat and diary |
|----------------------------------|------------|-----------|------|----------|---------------|---------------|
| Number of heads, %               | 132        | 60        | 20   | 145      | 21            | 2             |
| Milk yield for 305 days, kg      | 7293±64.4  | 6588±84.6*** | 648±202*** | 6014±213*** | 4449±148***   | 3744±379***   |
| Fat fraction mass, %             | 4.16±0.014 | 4.22±0.02* | 4.18±0.03  | 4.17±0.07  | 4.26±0.04*    | 4.38±0.04***  |
| Mass fraction of fat, kg         | 303±2.71   | 278±3.86*** | 271±8.96* | 251±9.24*** | 189±6.21***   | 164±15.3***   |
The amount of milk fat and protein between the production types was highly reliable (P > 0.999). The amount of milk fat was the highest in cows classified as high-milk type and amounted to 303 kg. This is 8% and 10% more than in animals of high milk and milk types, respectively. The amount of milk protein was also the highest in cows of a generously dairy production type and amounted to 229 kg, which is 112 kg (49%) more than in meat and dairy type cows.

The live weight of cows of ample milk type is significantly lower than the live weight of dairy cows by 6% (P≥0.95), dairy and meat cows by 8% (P≥0.99) and meat and dairy cows by 15% (P≥0.999). It should be noted that with a decrease in the coefficient of production typicality from 4.06 to 1.69 (by 2.87 units), the live weight increased from 543 kg to 624 kg. The milk yield coefficient significantly differed depending on the production type of cows (P≥0.999). The highest milk yield coefficient was for high-milk-type cows - 1345 kg, which is 742 kg (55%) higher than for meat-and-milk type cows.

The group of cows of the third lactation consisted of 46 goals, of which 23 heads (50%) belonged to animals of the desired production type (table 2). The difference in milk yield for 305 days of the third lactation was between plentiful milk and other types: high milk - 803 kg (10%), milk - 469 kg (6%). The highest difference was between large milk and meat and milk - 4115 kg (49%), which was significant at the third threshold (P≥0.999). When comparing the mass fraction of protein and fat for different production types of cows of the third lactation, no significant differences were found (P<0.95). The difference in the amount of milk fat and protein between rich milk and other types was respectively: high milk - 29 kg and 24 kg (8% and 9%), milk - 4 kg and 11 kg (1% and 4%), low milk - 45 kg and 39 kg (13% and 15%), dairy and meat - 135 kg and 107 kg (39% and 41%), meat and dairy - 162 kg and 129 kg (47 and 49%). Thus, in the studied animals, the milk yield by the third lactation increased by 1067 kg compared to the milk yield of the first lactation, by 967 kg by high milk, by 1404 kg by milk, by 1081 kg by milk, by milk and meat and milk and milk 533 and 501 kg respectively. The unit of production typicality coefficient accounted for 1,434 kg of milk.

**Table 2.** Characteristics of cows of the third lactation of different production types, (M±m).

| Indicator                  | Ample milk | High-milk | Milk | Low-milk | Milk and meat | Meat and dairy |
|----------------------------|------------|-----------|------|----------|---------------|----------------|
| Number of heads cows, %    | 16         | 5         | 2    | 15       | 2             | 6              |
| Milk yield for 305 days, kg| 7557±512   | 7891±41   | 7095±655 | 4982±504** | 4245±1107*    |                |
| Fat fraction mass, %       | 4.18±0.05  | 4.32±0.0  | 4.22±0.23 | 4.21±0.02* | 4.31±0.09     |                |
| Mass fraction of fat, kg   | 316±20.3   | 341±22.4  | 299±26.9 | 210±20.2** | 183±48.1**    |                |
| Mass fraction of protein, %| 3.16±0.01  | 3.18±0.0  | 3.14±0.03 | 3.1±0.06  | 3.15±0.04     |                |
| The amount of              | 238±16.0   | 251±17.2  | 223±21.8 | 155±18.6** | 133±34.88*    |                |

Note: *- P≥0.95, **- P≥0.99, ***- P≥0.999 relative to heavy milk production type.
milk protein, kg
Live weight of cows, kg 633±31.8 684±26* 658±71.8 644±66 728±38.3**
Milk ratio, kg 1191±34.2** 1158±10 5 1078±72.7* 774±1.03** 587±150***

Note: * - P≥0.95, ** - P≥0.99, *** - P≥0.999 relative to heavy milk production type.

Milk-type cows had the smallest live weight of 616 kg. The difference in this indicator between the production types of cows of the third lactation was not significant (P≤0.95). But in comparison with the first lactation, we also noted its increase in high-dairy cows by 73 kg, in high-dairy cows by 64 kg, in dairy cows by 110 kg, low-dairy cows by 100 kg, dairy and meat cows by 64 kg and meat and dairy cows by 104 kg, i.e. for each unit of the production typicality coefficient, live weight increased by 38.6 kg. Differentiation of cows of JSC "Tubinsk" in accordance with the coefficient of production typicality showed that in the herd there were animals with low milk yield and high live weight, not included in the gradation of meat-and-milk production type.

There were few such species; we attribute this to the manifestation of the genotype of the Simmental breed, on the basis of which the red-motley breed was created. These animals are rearranged from the herd.

When comparing the milk coefficient with different production types, it was found that the highest rates were observed for the high-milk type cows – 1,360 kg, and the lowest for the meat-and-milk type cows - 587 kg.

Thus, with a decrease in the coefficient of production typicality, a regular decrease in milk yield and an increase in live weight of cows are observed. In cows of the first lactation, there was a decrease in milk yield from high-milk to meat-and-milk production type by 3,549 kg, while live weight increased by 81 kg, i.e. 574 kg of reduction in milk yield and 13.5 kg of increase in live weight per one gradation.

The distribution of cows according to the indicators of the third lactation, also according to gradations, showed the same pattern, but with more significant values. The milk yield decreased by 4117 kg or 68.6 kg per gradation, and the live weight increased by 112 kg or 15.3 kg per gradation. Thus, cows of different production types in JSC "Tubinsk" significantly differed in milk yield per 305 days, the amount of milk fat and protein, as well as live weight, which can be used in predicting the productivity of animals. In the context of lactation, the exterior and body indices of cows of different production types did not change significantly (0-6%). Milk productivity is significantly higher in cows of the third lactation. By the third lactation, milk yield increased by 13-22%, live weight by 10-19%, the amount of milk fat and protein increased by 11-26%.

For the possibility of selection and prediction of the milk productivity of cows, the value of its relationship with the coefficient of production typicality was determined (table 3).

Table 3. The relationship of the average herd coefficient of production typicality with productive indicators.

| Indicator | Production typicality coefficient 1 lactation | Production typicality coefficient 3 lactation |
|-----------|---------------------------------------------|---------------------------------------------|
| Number of heads | 380 | 46 |
| Milk yield for 305 days, kg | 0.76*** | 0.37*** |
| Mass fraction of fat, % | -0.04 | 0.23*** |
| Milk fat, kg | 0.74*** | 0.38*** |
| Mass fraction of protein, % | -0.11 | -0.22* |
| The amount of milk protein, kg | 0.71*** | 0.34*** |
| Milk yield for 305 days, kg | 0.24 | 0.90*** |
| Mass fraction of fat, % | -0.16 | -0.03 |
| Milk fat, kg | 0.21 | 0.89*** |
The mass fraction of protein, % -0.29
The amount of milk protein, kg - 0.19

Note: * - P≥0.95, ** - P≥0.99, *** - P≥0.999

The relationship between the coefficient of production typicality and milk yield for the first lactation is close, it was r = 0.76 (P > 0.999). Assessing the relationship between the coefficient of production typicality for the first lactation and milk yield for the third, it was noted that although it decreased to r = 0.24 (P < 0.95), it was preserved. An analysis of the relationship between the mass fraction of fat and protein with the production typicality coefficient for the first lactation showed that it is negative and low, respectively r = -0.04 and r = -0.11. The correlation between the coefficient of production typicality and the mass fraction of fat in the first and third lactations increased to r = 0.23, in the mass fraction of protein decreased to r = -0.22.

The correlation coefficients in the first lactation between the coefficient of production typicality and the amount of milk fat and protein are quite high - respectively, r = 0.74 and r = 0.71. The relationship between the amount of milk fat and protein during the first lactation and the coefficient of production typical for the third lactation decreased, but remained quite high r = 0.38 and r = 0.34, respectively. Repetability coefficients are reliable at the third threshold.

As a result of this, high correlation coefficients between productive indicators and the production typicality coefficient allow selection and prediction of cow productivity from the first lactation.

Among the biological parameters reflecting breeding changes, it is advisable to distinguish such genetic indicators as the frequency of genotypes, the index of genetic similarity and genetic distance. They are important in marker selection and in frequency-dependent selection. The genetic distance calculated by the frequencies of antigens of blood groups adequately reflects the characteristics of groups formed taking into account the magnitude of the index. So, the maximum distance is observed between the group of milk and dairy animals and is equal to D = 0.24; plentiful dairy and dairy and meat - D = 0.20, dairy and dairy and meat D = 0.19. The greatest similarity of cows of the Yenisei inbreeding type of different production typicality in animals of low-dairy and dairy-meat groups, the index of genetic similarity is 0.96.

Thus, the data obtained allowed us to determine the basic requirements for cows of the desired production types. As a “model” cow, one can take an animal with the following indicators:

- average milk yield of 6487 ± 2020 kg of milk for 305 days of lactation in first-calf heifers and 7891 ± 419 kg in cows of the third lactation and older;
- live weight - for first-calf heifers 543-574 kg, adults - 616-684 kg.

The herd formation should be carried out by animals of the desired production types (high-dairy, high-dairy, dairy), which will contribute to the creation of highly productive livestock and increase the efficiency of breeding and breeding to improve breeding and productive qualities. At this stage, in conditions of high genetic homogeneity, it is possible not to take into account the origin of animals when creating a group of animals of the desired types, including for genomic selection.

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