Simmental cattle breed lactation features of various productive types

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Abstract. This article presents the results of studying the course of lactation of Simmental cows of various constitutionally productive types: dairy, milk-meat, and meat-and-milk in the conditions of the SEC "Abodimovskiy" on lactating (1-3 lactation) cows of the Simmental breed of German selection. There were studying the quantitative indicators and milk composition. There was calculating the lactation stability coefficients (LCC). The study's findings were as follows that the nature of the lactation curve for dairy and dairy-meat constitutionally productive types of Simmental cattle can be recognized as "high unstable". It indicates that these cattle types are more milk productivity prevalence than meat. The nature of the lactation curve of the meat and dairy type of cattle is characterized as "moderately stable". It shows a clear difference from the first two constitutionally productive types.

1. Introduction

In terms of distribution in the world's countries, the Simmental breed, which successfully combines milk and meat productivity, occupies one of the leading places. There are about 36 million heads in European countries alone, which is about 22% of all Simmental cattle in the world. Among the Simmental cattle, there are two types of animals - dairy and meat and meat and dairy. However, at present, in most countries of the world, the Simmental breed has become increasingly divided into two specialized types of dairy and meat [1].

The Simmental breed is a breed of a combined direction of productivity: high meat productivity is combined with dairy, which is quite comparable to the productivity of purely dairy breeds while ensuring balanced feeding and keeping technology. Competitive advantages of Simmental are the long duration of economic use, resistance to udder mastitis and leukemia, high fertility, adaptability to all industrial and climatic conditions, suitability for tethered and loose, stall and pasture conditions [2].

In the Karachay-Cherkess Republic conditions, when analyzing the milk productivity of Simmental cows of dairy, dairy-meat, and meat-dairy types for three lactations, it was found that the highest milk yield, the amount of milk fat and protein were obtained from dairy-type cows. The peak of milk production was noted in cows of all types in the third month of lactation. Dairy cows with a yield of 785 kg in the third month of lactation surpassed their dairy and meat type peers by 8.7% and meat and dairy by 33.5% [3, 4, 5].

Along with the quantitative assessment of milk productivity, for farms specializing in breeding Simmentals, milk quality (protein and fat content) is also important. The presence or absence of seasonal
fluctuations in the composition is important for milk processors. In this regard, important information can be obtained by analyzing the lactation process, milk composition, and the lactation curve's nature [6]. There is very little new data on the latter in modern literature. Studies of this process refer to the 50-60 years of the last century [7, 8], although now there is renewed interest in fluctuations in milk production during lactation, assessed by the term "persistence" [9].

2. Materials and methods
The experimental part of the work was carried out in the conditions of a breeding reproducer for the Simmental cattle breed of the SEC "Abodimovskiy", Saratov region on lactating (1-3 lactation) cows of the Simmental breed of Austrian selection. Based on the milkiness coefficient, the animals were divided into dairy (n = 18), dairy meat (n = 24), and meat-dairy (n = 15) constitutionally productive types. The classification of cows by intra-breed types was carried out according to the value of the milk production coefficient (MP) (table 1) [10].

Table 1. Distribution of experimental cows by intra-breed types.

| Age of cows         | MP value for cow types | Dairy meat type | Meat-dairy type |
|---------------------|------------------------|----------------|----------------|
|                     |                        |                |                |
| 1 lactation         | 6.8 or more            | 5.0-6.7        | 4.9 or less    |
| 2 lactation         | 7.7 or more            | 5.7-7.6        | 5.6 or less    |
| 3 lactating and older | 8.0 or more            | 6.0-7.9        | 5.9 or less    |

Cows of all groups during the entire study period were in the same conditions of feeding and keeping.

In the process of work, zootechnical research methods were used according to generally accepted methods. In particular, the following indicators were studied:

- lactation constancy coefficient (LCC), according to Furbner (1959) as revised by A. A. Aksennikova (1964) [7], calculated using formulas (1 and 2):

\[ \text{LCC 1} = \frac{Y_2}{Y_1} \times 100 \]  
\[ \text{LCC 2} = \frac{Y_3}{Y_1} \times 100 \]

where \( Y_1 \) – milk yield for the first period (1-3 months) of lactation;
\( Y_2 \) – milk yield for the second period (4-6 months) of lactation;
\( Y_3 \) – milk yield for the third period (7-9 months) of lactation;

- lactation stability indicator - LSI, calculated in the following way: milk yield for each subsequent month, from the second to the eighth inclusive, is calculated as a percentage of the previous month's milk yield. Each month's resulting indicators are summed up and divided by their total number of months taken into account. This value characterizes the stability of lactation.

For the study of milk, standard and generally accepted test methods were used.

- mass fraction of protein,\% - by formol titration - according to GOST 25179-2014;
- a mass fraction of fat,\% - according to GOST R ISO 2446-2011 by Gerber acid method.

The types of lactation curves were assessed using the A.S. Emelyanov (1953) [8].

3. Results and discussion
The results of accounting for milk productivity and milk composition for each experimental group of cows are in table 2.
Table 2. Milk productivity and milk composition of Simmental cows of various production types.

| Type               | Indicator          | Month of lactation |
|--------------------|--------------------|--------------------|
|                    |                    | 1  | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
| Dairy              | Milk per month, kg | 260 | 425 | 325 | 372 | 470 | 569 | 535 | 477 | 399 | 360 |
|                    | Fat, %             | 4.01 | 4.0 | 3.89 | 3.91 | 3.96 | 3.95 | 3.97 | 3.98 | 4.00 | 4.02 |
|                    | Protein, %         | 3.27 | 3.23 | 3.18 | 3.22 | 3.28 | 3.25 | 3.24 | 3.23 | 3.24 | 3.30 |
| Milk and meat      | Milk per month, kg | 242 | 330 | 305 | 310 | 430 | 496 | 512 | 430 | 361 | 301 |
|                    | Fat, %             | 4.14 | 4.11 | 4.08 | 4.08 | 4.00 | 4.05 | 4.07 | 4.03 | 4.00 | 4.06 |
|                    | Protein, %         | 3.35 | 3.30 | 3.25 | 3.21 | 3.23 | 3.21 | 3.23 | 3.31 | 3.38 | 3.33 |
| Meat and milk      | Milk per month, kg | 195 | 220 | 229 | 205 | 297 | 302 | 280 | 250 | 220 | 190 |
|                    | Fat, %             | 4.19 | 4.12 | 4.07 | 4.07 | 4.11 | 4.17 | 4.18 | 4.19 | 4.21 | 4.20 |
|                    | Protein, %         | 3.34 | 3.29 | 3.19 | 3.18 | 3.19 | 3.20 | 3.28 | 3.34 | 3.30 | 3.31 |

The milk yield for 305 days of lactation from dairy-type animals was 4192 kg/head with the average fat and protein indicators, respectively, 3.97 and 3.24%. The dairy and meat-type animals showed a milk yield of 3717 kg/head (11.4% lower) with an average of 4.06 and 3.28% of fat and protein. Milk and beef cows yielded 2388 kg/head of milk with a fat and protein content of 4.15 and 3.26%. Thus, the most important food components: protein and fat obtained during lactation, are in table 3.

Table 3. Estimated indicators of productivity of Simmental cows of various production types.

| Constitutionally productive type of animal | Milk yield in 305 days of lactation, kg/head in terms of basic fat, 3.4% | Received per lactation, kg |
|------------------------------------------|------------------------------------------------------------------------|---------------------------|
| Dairy                                    | 4192                                                                   | 4897.8                    | 166.4 | 135.8 |
| Milk and meat                            | 3717                                                                   | 4438.5                    | 151.0 | 122.0 |
| Meat and milk                            | 2388                                                                   | 2914.7                    | 99.10 | 77.8  |

Comparing milk yield in terms of basic fat content revealed a difference of 10.4% and 68.0% in favor of dairy cows versus dairy-meat and meat-and-milk types, which indicates the proximity of the first two types in the direction of productivity. It is confirmed by comparing the amount of fat and protein in milk yield obtained from dairy and dairy-beef cows. The difference is only 9.1 and 10.2%, respectively. Analysis of milk yield dynamics by months of lactation (figure 1) showed that the lactation curve's nature for milk and milk-meat types are almost identical, starting from the third month of lactation. However, in the second month in animals of the dairy type, a clear "surge" is seen, followed by a third-month decrease. The productivity of milk-type animals reaches the maximum level by the sixth month of lactation and then also sharply decreases.
Figure 1. Lactation curves of Simmental cows of various production types by months of lactation.

In animals of the dairy-meat type, the maximum productivity is noted in the sixth-seventh months of lactation. Still, then it decreases similarly to the nature of lactation of dairy cattle.

The type of lactation curve demonstrated by animals of the meat and dairy type differs from the first two at a lower level and in a smoother character. Up to the fourth month, the level of productivity is stable with an increase in 5-6 months to the maximum and subsequent gradual decline.

The calculated coefficients of lactation constancy (LCC 1 and LCC 2), characterizing lactation by periods, confirm the noted trends.

\[
\text{LCC}_1 \text{dairy type} = \frac{1261}{860} \cdot 100 = 139\% \\
\text{LCC}_2 \text{dairy type} = \frac{1262}{860} \cdot 100 = 139\% \\
\text{LCC}_1 \text{milk and meat type} = \frac{1440}{765} \cdot 100 = 141\% \\
\text{LCC}_2 \text{milk and meat type} = \frac{1153}{765} \cdot 100 = 148\% \\
\text{LCC}_1 \text{meat and dairy type} = \frac{705}{515} \cdot 100 = 125\% \\
\text{LCC}_2 \text{meat and dairy type} = \frac{630}{515} \cdot 100 = 115\%
\]

LCC 1 is equal to LCC 2 for dairy cattle, which means that the rise in milk productivity by 1.39 times in the first lactation period and its same decline in the final period obey the same linear relationship. A similar picture is observed for the LCC 1 and LCC 2 coefficients for dairy cattle.

The LCC 1 and LCC 2 values for meat and dairy cattle show that at a relatively moderate rate of increase in productivity (125%), its decline is much smoother (115%). It indicates a stable lactation course without sharp rises and falls, which is confirmed by the calculated indicators of lactation stability (table 4).

Table 4. Indicators of lactation stability of Simmental cows of various production types.

| Type             | Indicator                        | Month of lactation | Average |
|------------------|----------------------------------|--------------------|---------|
|                  |        | 2  | 3  | 4  | 5  | 6  | 7  | 8  |       |
| Dairy            | Milk per month, kg               | 425              | 325    | 372 | 470 | 569 | 535 | 477 |       |
|                  | Milk yield in % for the previous month | 100.0          | 76.5   | 87.6 | 110.6 | 133.9 | 125.9 | 112.3 |       |
|                  | LSI, %                           | 88.3            | 88.0   | 93.7 | 101.7 | 105.8 | 106.7 | 97.4 |       |
| Milk and meat    | Milk per month, kg               | 330              | 305    | 310 | 430 | 496 | 512 | 430 |       |
|                  | Milk yield in % for the previous month | 92.5           | 64.0   | 130.0 | 150.3 | 155.2 | 130.3 |       |       |
|                  | LSI, %                           | 96.3            | 85.5   | 96.6 | 107.4 | 115.3 | 117.5 | 103.1 |       |
Meat and milk yield comparison in terms of basic fat content revealed a difference of 10.4% and 68.0% in favor of dairy cows versus dairy and meat and meat and dairy types. It indicates the proximity of the first two types in the direction of productivity. That is also confirmed by an insignificant difference (9.1 and 10.2%) in fat and protein amount in milk yield obtained from dairy and dairy-beef cows.

It has been established that the nature of lactation curve for dairy and dairy-meat constitutionally productive types of Simmental cattle can be recognized as "high unstable". It indicates the proximity of these types of cattle in the direction of the prevalence of milk productivity. The nature of the lactation curve of the meat and dairy type of cattle is characterized as "moderately stable". It shows a clear difference from the first two constitutionally productive types. Simultaneously, the persistence for animals of dairy-meat and dairy types is 141 and 139%, respectively. And for meat and dairy, this figure is at the level of 125%.

4. Conclusion

The LSI value is the lowest for dairy cows and the highest for dairy and beef cattle, with 11.8%. According to K. Talman (2018), the persistence of lactation can be assessed by the change in milk productivity from 1 to 200 days of lactation [7]. That is, this concept is identical to the LCC indicator 1. Using the term "persistence", an indicator characterizing the course of the lactation curve, it can be stated that the maximum persistence is observed for animals of dairy-meat (141%) and dairy (139%) types. And for meat and dairy, this figure is at the level of 125%.

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