Duration of economic use of cows with different somatic cells concentrations in milk during the first lactation

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Abstract. The work investigated the relationship between lifetime productivity, age and reasons for culling of Ayrshire cows with different levels of somatic cell count in milk during the first lactation. The study established the influence of high concentration of somatic cells in the milk of first-calf heifers on average per lactation on lifelong milk yield and the age of culling. It was revealed that heifers with an average somatic cell content of less than 300 thousand/mL in milk reached the age of highest productivity. At higher values, maximum culling was observed in the 1st–2nd lactation. We obtained positive repeatability of the number of somatic cells in adjacent lactations. A study of the main reasons for the culling of cows with different numbers of somatic cells in milk showed that with a very high cell content, limb diseases and gynaecological diseases are most common. It has been substantiated that the prevention of udder diseases at the early stages of lactation contributes to a longer productive life of cows.

1 Introduction

Culling of cows at different stages of their production use is an integral part of breeding work. In this case, the duration of economic use should be taken into account. The efficiency of milk production largely depends on the indicator of the productive life of cows.

The duration of economic use, the age of culling, the level of milk productivity and their rational combination, factors for reducing the age of disposal are the topic of a large number of studies [1-7].

Our work is devoted to studying the influence of somatic cells count (SCC) in the milk of cows during the first lactation on their lifetime productivity, age and reasons for culling.

The study of SCC content is important, since the connection of this indicator with udder disease is quite high [8-9]. SCC is one of the indicators that determine the quality of milk and, accordingly, the price when it is sold to processing enterprises. At the same time, treatment of dairy cows is quite expensive and lengthy. In industrial herds, preventative measures and selection methods are used, for example, the selection of animals that are less susceptible to mastitis and the early culling of those predisposed to it.

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2 Material and methods

The purpose of our work was to study the volume of lifetime milk yield, age and reasons for the retirement of cows in connection with the average content of somatic cells in milk during the first lactation. The study was conducted at a breeding plant for breeding Ayrshire cattle in the Republic of Karelia, Russian Federation.

We recorded a total of 1052 cows that calved for the first time in 2016–2018. During the study period, milk yield per cow was 8037–8719 kg of milk with a fat content of 3.91-4.22% and milk protein – 3.18-3.27%.

An analysis was performed in a monitoring mode for 5 years based on the data of 2911 lactations.

Calculation of milk yield for life and for 305 days of lactation, percentage of fat and protein, determination of the reason and age of culling was carried out according to zootechnical reporting documents and the breeding plant database. Somatic cells count (SCC) in milk was determined in a specialized laboratory using infrared spectrometry at least 5 times during lactation.

3 Results

Table 1 shows the productivity indicators of cows for completed lactation over time.

The average milk yield for 305 days of completed lactation in first-calf heifers was 7328 kg with a fat content of 3.95% and protein content of 3.28%. With age, milk yield and fat content increased in the examined cows. By the 3rd lactation and beyond, milk yield increased by 1890 kg, the percentage of milk fat content increased by 0.18% ($P<0.001$). The protein content was at a fairly high level (3.24–3.28%), although it decreased slightly with age.

The average content of somatic cells in cows' milk was low - 130.1 thousand/ml. There is an opinion that a SCC of up to 200 thousand/mL corresponds to a healthy udder [10-14]. At the same time, there is an increase in the SCC indicator with age from 104.6 to 217.8 thousand/ml on average per lactation. The repeatability of SCC between the 1st and 2nd lactations is +0.121 ($P<0.01$), between the 2nd and 3rd – +0.391 ($P<0.001$).

Table 1. Changes in productivity and SCC of cows with age.

Age of cows, lactations	Indicators				
	Number of cows	Milk yield for 305 days of lactation, kg	Fat, %	Protein, %	SCC, thousand/mL
1	991	7328	3.95	3.28	104.6
2	741	8566***	4.03***	3.27	143.4**
3 and older	1119	9218***	4.13***	3.24	217.8***
Average	2851	8359	4.04	3.26	130.1

**P<0.01; ***P<0.001

Based on the average SSC content (thousand/ml) during the 1st lactation, all cows were divided into 4 groups: less than 100, 100–299, 300–499 and 500 or more (Table 2). A tendency was established for the average age of productive longevity to decrease from 2.74 lactations in the 1st group to 2.32 in the 4th group. Lifetime milk yield decreased from 27.1 to 24.2 thousand kg of milk, respectively.

Groups with SCC from 100 to 499 thousand/ml were at an intermediate position both by age of use (2.66-2.68 lactation) and by the volume of lifetime milk yield (25.8-26.0 thousand kg). The level of SCC had no effect on the average daily milk yield.

A weak negative relationship was established between SCC in the 1st lactation and lifetime milk yield (–0.066; P<0.05), as well as between SCC and productive longevity (–0.071; P<0.05).

Table 2. Font The influence of SCC level in the 1st lactation on the duration of productive life and milk yield of cows.

Gradations by SCC of cows in the 1st lactation, thousand/ml	Number of cows	Age of last lactation	Lifetime number of milking days	Milk yield	
				lifetime yield, thousand kg	yield per 1 day of lactation, kg
Less than 100	808	2.74	1007	27.1	26.1
100–299	179	2.66	974	25.8	25.9
300–499	27	2.68	977	26.0	25.9
500 and more	38	2.32	897	24.2	25.9
Average	1052	2.71	996	26.7	26.0

During the entire study period, 94.4% of cows were culled. Of these, 6.0% - during the 1st lactation, 25.3% after its completion. 45.2% of cows reached full-age lactation and were culled at the end of the 3rd lactation and older.

There is a tendency for cows to be culled earlier with an increase in SCC (Table 3). Thus, in the group with SCC less than 100 thousand/ml, 5.5% of cows were culled during the 1st lactation, and 25.2% of cows were culled at the end of the 1st lactation. Culling at the age of 3 lactations and older was 45.7%. In the following gradations according to the SCC, culling at an early age increased slightly – to 6.4–7.7% and 26.9%, respectively. Among the culled cows in the group with SCC 500 thousand/ml or more, the proportion of first-calf heifers was the highest - 45.9%, including 13.5% with unfinished lactation. This is significantly higher than in group 1 (P<0.05). In groups with SCC of 300 thousand/ml or more at the end of the 3rd lactation and older, 34.6–35.2% were culled versus 45.7–47.4% in groups with SCC less than 300 thousand/ml. It is known that the highest milk yield is obtained from cows in full-age lactation (3rd and older). In our study, it was the cows whose average SCC content was less than 300 thousand/ml in the first lactation that reached the age of highest productivity. At higher values of SCC, maximum culling was observed in the 1st–2nd lactation.

Table 3. The influence of SCC level in the 1st lactation on age structure of cows' culling.

Age of culling, lactation	Total		Gradations by SCC content, thousand/ml							
	head	%	less than 100		100–299		300–499		500 and more	
Total cows	993	100	757	100	173	100	26	100	37	100
including:										
1st unfinished	60	6.0	42	5.5	11	6.4	2	7.7	5	13.5
1st	251	25.3	191	25.2	41	23.7	7	26.9	12	32.4
2nd	233	23.5	179	23.6	39	22.5	8	30.8	7	18.9
3-rd and older	449	45.2	345	45.7	82	47.4	9	34.6	13	35.2

The main reasons for culling were diseases of the limbs, reproductive system and udder. They account for 32.7, 32.4 and 20.7%, respectively. They are significantly inferior to metabolic disorders (5.4%) and diseases of the gastrointestinal tract (3.9%). Only 1.0% of cows was culled due to low productivity.

A study of the distribution of the main reasons for the culling of cows, taking into account the gradations by SCC, showed that with an average content of SCC up to 500 thousand/ml, diseases of the limbs and gynecological diseases are the most common (32.6–

42.3% and 26.6–34.2%, respectively). Udder diseases account for 19.6–23.7%; they take the 3rd place in terms of prevalence (Figure 1).

Culling due to mastitis exceeded other reasons in the group of cows with SCC of 500 thousand/ml or more (29.7% versus 24.3 and 27.0%). According to a number of authors [1, 15], it is precisely the excess of SCC of 500 thousand/ml that indicates udder disease.

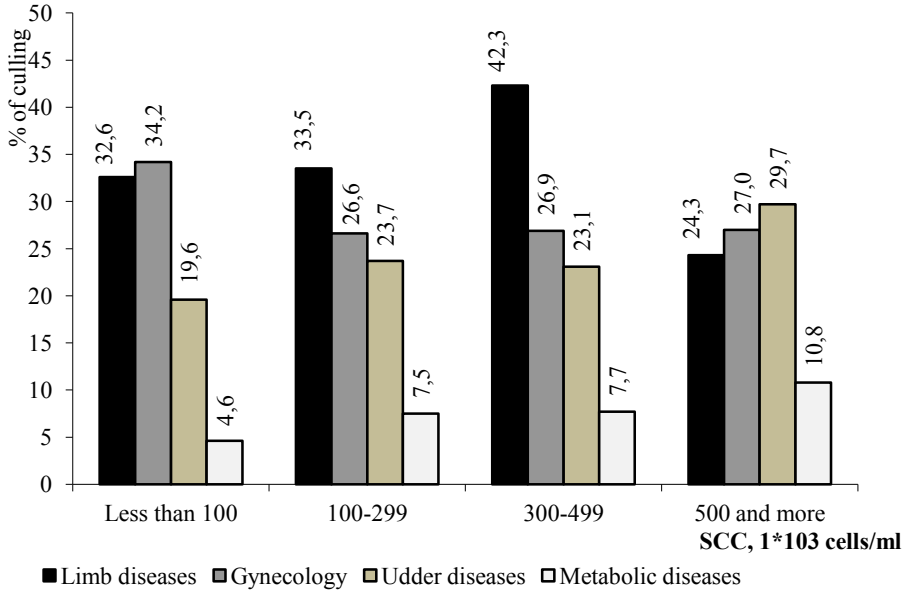

Fig. 1. The influence of SCC level in the 1st lactation on the main reasons for culling cows.

We also analysed the age and reasons for culling of cows depending on the recorded cases of increased SCC content during lactation. The studied livestock was divided into groups. The 1st group included cows in which all milk samples during the 1st lactation had low SCC (less than 200 thousand/ml). These are cows with healthy udders. If at least one sample during lactation contained 200 thousand/ml cells or more, the cows were assigned to group 2. It is possible that subclinical mastitis was observed in this case. Registration of increased SCC did not affect the age of culling of cows. It was 30.9 and 32.8% among first-calf heifers, at the end of the 2nd lactation 22.8–25.4%, 3rd lactation and older – 46.3 and 41.8%, respectively.

Due to udder diseases, only 18.8% of cows from group 1 and 26.6% from group 2 were culled ($P<0.01$). During the 1st lactation and upon its completion, mastitis was indicated as the reason for culling in 8.2 and 15% of cows of the 1st and 2nd groups, respectively. This trend continued in the future. At the age of 2 lactations – 17.5 and 22.6%. Among the cows culled at the end of the 3rd lactation and later due to mastitis, 26.5% had a healthy udder at an early age, and 38.2% had increased SCC ($P<0.05$).

The frequency of registration of an increased number of SCC (1 time or more) did not have a noticeable impact on the decision to cull.

4 Discussion

Our study established a decrease in the age of productive longevity of cows with high SCC (500 thousand/ml or more on average for the 1st lactation) by 0.42–0.36 lactations compared to cows with lower SCC.

With an increase in SCC, there was a tendency for cows to be culled earlier. For example, in the group with SCC less than 100 thousand/ml, 30.7% of cows were culled during the 1st lactation and at its end, including 5.5% with unfinished lactation. Among the culled cows with SCC of 500 thousand/ml or more, the proportion of first-calf heifers was the highest - 45.9%, including 13.5% with unfinished lactation ($P<0.05$). The highest milk yield is obtained from cows in full-age lactations. In our study, cows whose average SCC was less than 300 thousand/ml in the 1st lactation reached the age of highest productivity (3rd and older).

Increasing of SCC is the most widely used and effective method for detecting intramammary infection of dairy cows. There is an opinion that SCC in healthy mammary glands is less than 100 thousand [14] or less than 200 thousand/ml [10, 11, 13]. An increase in SCC indicates an udder disease. If SCC at the beginning of lactation exceeds 200–400 thousand/ml, it increases the risk of culling throughout the entire lactation [3, 9, 16, 17]. Culling is higher in animals with an average somatic cells level in lactation of more than 700 thousand/ml [15].

The most common diseases are limb diseases and gynecological diseases (32.6–42.3% and 26.6–34.2%, respectively) in cows with an average milk cell content of up to 500 thousand/ml. Udder diseases amounted to 19.6–23.7%. Culling due to mastitis exceeded other reasons in the group of cows with SCC of 500 thousand/ml or more (29.7% versus 24.3 and 27.0%).

The authors of the previous studies noted diseases of the limbs, udder, metabolic and digestive disorders, and fertility problems as the main reasons for culling [2]. It was revealed that mastitis is closely connected with a reduction in productive life and a decrease in reproductive capacity [10, 14].

When comparing cows with a healthy udder and cows of the same age with recorded cases of increased SCC (above 200 thousand/ml) during the 1st lactation, no differences were found by age of culling. The analysis of the reasons for culling showed that only 18.8% of cows from the 1st group and 26.6% from the 2nd group were culled due to udder diseases ($P<0.01$). The influence of the udder health of first-calf heifers on the incidence of mastitis and culling was evident in subsequent lactations. Among the cows culled at the end of the 3rd lactation and later due to mastitis, 26.5% had a healthy udder at an early age, and 38.2% had an increased SCC ($P<0.05$).

It is considered that a high (more than 400 thousand/ml) SCC in the current lactation may be a risk factor for culling due to the occurrence of intramammary infection after calving [12, 16], metabolic disorders, and gynecological diseases.

5 Conclusion

As a result, our study established that the state of udder health in the first lactation, expressed in the average content of somatic cells in milk, influences the subsequent use of cows. Prevention of mammary gland diseases in the early stages of lactation contributes to a longer productive life of cows and the realization of their potential.

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