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THE CHANGES OF MILK PRODUCTIVITY AND QUALITY OF LATVIAN LOCAL BREED DAIRY COWS

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Abstract

Dairy cow milk productivity can be affected by series of factors that could be influenced by environment or cows' physiological condition. One of the best factors for characterization of the rearing conditions and cow potential is the age at first calving (AFC) and the live weight at the beginning of first lactation. The aim of our study was to determine the effect of AFC and live weight at first lactation on the local breed cow milk productivity, composition and quality. In the study were included 25 Latvian Brown (LBGR) and 25 Latvian Blue (LZ) breed cows in the genetic resource conservation program and analysed in VPP AgroBioRes project. Cows were located in different regions of Latvia and in different farms (in average 2.8 cows per farm). Cows were distributed in 4 groups depending on their AFC and live weight in the beginning of first lactation.. The average milk productivity in first lactation the highest were in year 2017 for LBGR breed cows (5250.1 kg), in the same time LZ breed cows characterized with 5164.5 kg milk. The AFC not only significantly ($p<0.05$) impacted the milk productivity, but also showed effect on analysed cow lifespan as LBGR breed cows in the group with AFC >30 months did not live past third lactation. The significantly higher LBGR cow milk productivity in the third lactation were in cow group with live weight at first lactation 451 – 500 kg, but in LZ breed group - >550 kg (accordingly 5342.5±231.35 and 5493.0±522.69 kg milk).

Keywords: milk composition, somatic cell count, milk yield.
JEL Codes: Q00, Q01, Q10.

Introduction

The farm modernization and increased world demand for dairy production farmers usually prefer specialized dairy breed (usually Holstein Black and White (HBW) breed) cows. Although HBW cows are highly productive, they have not built the resistance to different local environmental conditions (Gorlov et al., 2016). On the other hand the native breed cows are bred in the region for hundreds of years and are more resistant to negative environmental effects, they characterizes with stronger health, better longevity and higher milk composition indicators (Adamczyk et al., 2017). Despite the positive aspects of local breed cows, their lower milk yield is one of main factors that determines the number of native breed cows in farms of European Union states. With that in consideration there is a need to emphasize the positive traits of local breed cows and therefore maintain the dairy breed biodiversity.

The different aspects of cow milk productivity and quality can be affected by a series of different physiological and environmental factors. One of the factors that unites a parts of both groups is age at first calving that depends on the heifer rearing conditions in farm and also the physiological potential of each individual animal (Brickell et al., 2009). The live weight in the beginning of first lactation and the age at first calving are one of main factors that show significant impact on the milk productivity and composition in the first and later lactations (De Haas et al., 2007; Sartori et al., 2018). As the age of first calving usually is linked to the live weight of heifer before the start of breeding, later in cows' life it shows similar relationships with the milk productivity and also milk quality (Dobos et al., 2001; Handcock et al., 2018).

In Latvia there are 2 dairy cow native breeds – Latvian Blue (LZ) and Latvian Brown (LBGR). Cows are located mainly in small farms (1–5 cows per farm), with the exception of Latvia University of Life Sciences and Technologies (LLU) research and study farm "Vecauce" where are located 30 LBGR cows.

The inclusion in the national dairy cow genetic resource conservation program is determined by different conditions for each of the breeds. In LBGR breed genetic resources are included dairy cows with known predecessors for at least four generations, with at least 60% LBGR breed blood (with the condition that the rest are the related breeds – Danish Red and Angeln) and with the minimal productivity requirements (4000 kg milk per lactation with milk fat content at least 4.2% and milk protein content – at least 3.2%). In LZ breed genetic resource conservation program are included cows with the distinctive blue coat colour, the LZ blood >50% with the condition that there could be part of Lithuanian Grey breed blood.

The aim of our study was to determine the effect of age at first calving and live weight at the beginning of first lactation on the local breed cow milk productivity, composition and quality.

Materials and methods

In study were included data about 25 Latvian Brown (LBGR) and 25 Latvian Blue (LZ) breed cows included in native breed conservation program and also in the Latvian VPP AgroBioRes 3 LIVESTOCK project for the milk protein gene analysis. All cows were located in different farms (in average 2.8 cows per farm) and had different feeding and housing conditions. In analysed farms cows were grazed in summer period, but in winter they were permanently kept in the barn.

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From "Latvian Agricultural Data Centre" data base were collected data about standard lactation milk productivity (milk yield, kg) and composition (fat and protein content, %) traits as well as somatic cell count (thousands in 1 mL^{-1} milk) in first and subsequent lactations. The live weight in the 1st and 3rd lactations and data about the age at first calving.

Data were collected from all concluded lactations in the timespan from year 2006-2017. The number of concluded lactations and average cow age in each year is given in figure 1.

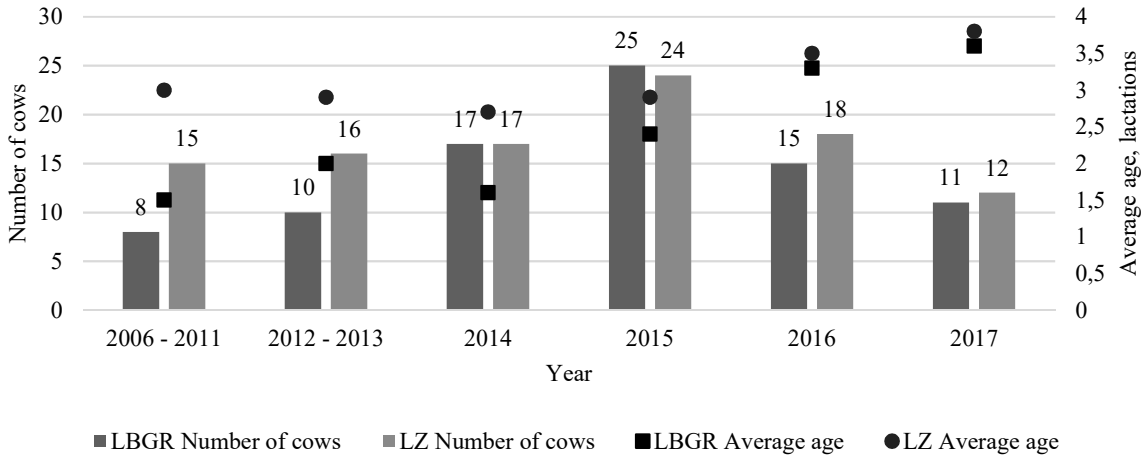

Figure 1. The number of closed lactations and average cow age in different time periods

For study purposes cows were distributed in 4 groups depending on their age at first calving (AFC). In the analysed cow groups LBGR breed cows characterized with earlier AFC – majority (18 cows) first time calved younger than 27 months old, but in LZ breed group there was an opposite tendency – 18 cows first time calved after the age of 28 months. (Table 2).

Table 1. The number of cows in the different groups of age at first calving

Age at first calving (AFC), months	Average AFC	Breed		Total
		LBGR	LZ	
<25	23.7±0.49	9	3	12
26-27	26.4±0.14	9	4	13
28-30	29.3±0.19	5	9	14
>30	34.0±0.99	2	9	11
Total	×	25	25	50

To determine the effect of live weight on cow productivity and milk quality, cows were distributed in 4 groups depending on their live weight in the beginning of first lactation. (Fig. 2) The live weight of dairy cows is evaluated 2 times per life – at the beginning of first and third lactation (with the body conformation trait linear evaluation for milk recording purposes. In LBGR breed group the largest amount of dairy cows were in the first live weight group (<450 kg), but majority of LZ breed cows characterized with live weight >501 kg.

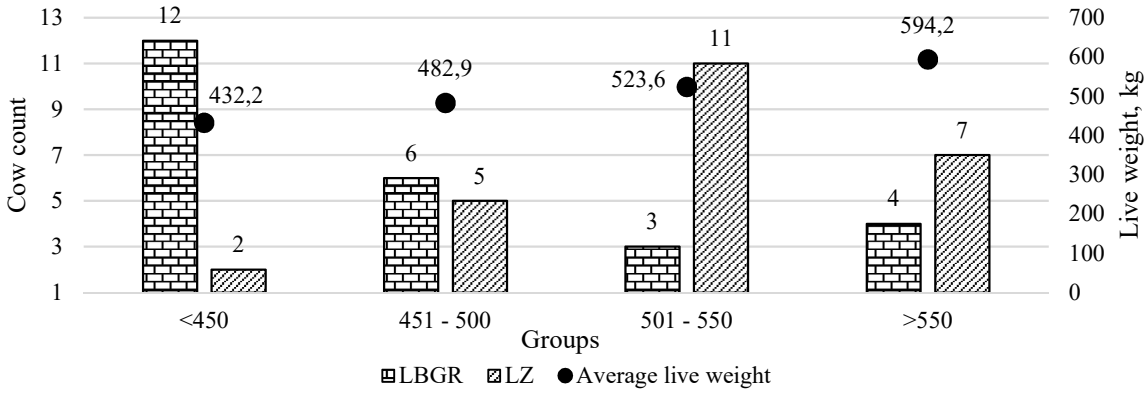

Figure 2. The average number of cows in different first lactation live weight groups

Data in tables are represented as mean value ± standard error and the impact of live weight in 1st lactation and AFC on cow milk productivity and quality was determined by analysis of variance. Pairwise comparisons between cow groups were conducted by using *Bonferroni* test. The significant differences ($p<0.05$) in the tables

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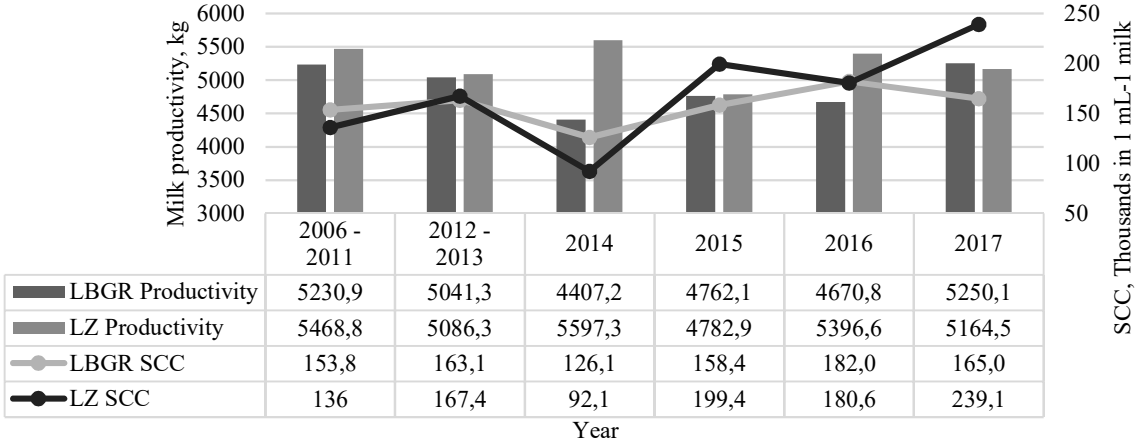
were marked with superscripted letters of alphabet (^{A,B,C,} etc.). The mathematical processing of data was performed with IBM SPSS 20.0 program package.

Results

The local cows usually characterizes with significantly lower milk productivity and poorer milk quality than specialized dairy breed cows, and they also has poorer milk quality, but their milk composition traits (especially milk protein content) are much more higher (Kuczynska et al., 2012).

The highest milk yield in the first lactation from Latvian Brown (LBGR) breed cows were obtained in year 2017 (5250.1 kg), but in Latvian Blue (LZ) breed group – in year 2014 (5597.3 kg). Although the milk quality is appropriate for the requirements of high quality milk, the somatic cell count (SCC) of LBGR cows in timespan form year 2006 to 2017 varies from average 126.1–182.0 thousands in 1mL^{-1} milk, but in LZ breed group in the same time it varied from 92.1 up to 239.1 thousands in 1 mL^{-1} milk. (Fig.3.)



	2006 - 2011	2012 - 2013	2014	2015	2016	2017
LBGR Productivity	5230,9	5041,3	4407,2	4762,1	4670,8	5250,1
LZ Productivity	5468,8	5086,3	5597,3	4782,9	5396,6	5164,5
LBGR SCC	153,8	163,1	126,1	158,4	182,0	165,0
LZ SCC	136	167,4	92,1	199,4	180,6	239,1

Figure 3. Average first lactation milk productivity and quality in different time periods (LB – Latvian Brown, LZ – Latvian Blue, SCC – Somatic cell count)

In the meantime the milk composition n improved with the each year for both LBGR and LZ breed cows. In year 2017 LBGR cows had not only the highest milk yield, but also their milk protein and milk fat content was significantly ($p<0.05$) higher than it was in LZ cow milk (accordingly 4.79% and 4.22%). The milk protein in the first lactation in recent years although not significantly, but higher was in LBGR cow milk (accordingly 3.45% and 3.39%) (Fig.4).

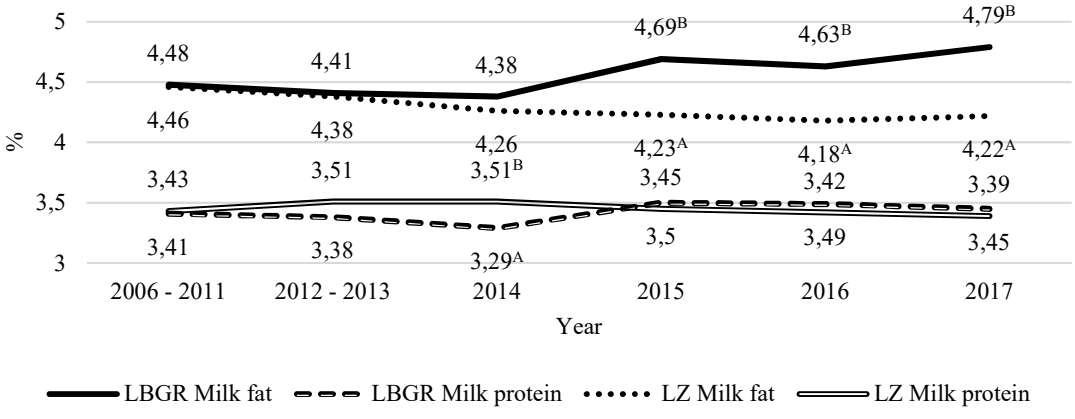


Figure 4. The composition of LB and LZ cow milk in different time periods

Age at first calving (AFC) had significant impact ($p<0.05$) not only on the milk productivity in first and later lactations, but also affects the most important milk composition traits. The highest milk productivity in first lactation for LBGR breed cows were in the group with AFC <27 months (4332.0–4406.8 kg milk) and this positive tendency remained up until third lactation. In Lithuanian study of their local breed cows (Šerniene and Kabasisnsiene, 2015) were observed similar tendency that milk productivity significantly increased for cows with AFC >26 months. In LZ cow breed group the highest milk productivity in first and subsequent lactations were obtained in group with AFC 25–30 months.

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The milk composition traits within different AFC groups showed significant differences not only in between the groups, but also between lactations. The milk fat content in the first lactation the highest were in the LBGR cow group with AFC >30 months (4.82±0.18%), but in the third lactation the highest milk fat content were in cow group with AFC <25 months (5.15±0.51%). In the LZ breed group milk fat content showed similar tendencies. As milk protein is one of most stable milk composition trait, the AFC showed small impact on it in the first and third lactation. Especially in the LBGR breed group there was no significant differences in between the groups, but in LZ breed group significantly higher milk protein content in first and third lactation had cows with AFC 25–26 months (3.75± 0.25%). The tendency to increase milk fat and protein content with the increase of AFC is observed in Romanian studies of local Black and White cows (Cismaş et al., 2012).

Table 2. The milk productivity in first and third lactation of LBGR and LZ breed cows depending on the age at first calving

	MY		MF		MP	
AFC	LBGR	LZ	LBGR	LZ	LBGR	LZ
			First lactation			
<25	4083.8± 186.70^{A}	4279.0± 1009.22^{A}	4.56± 0.17^{A}	4.33± 0.33^{A}	3.33± 0.16	3.67± 0.34^{A}
25-26	4139.8± 338.21^{AC}	5006.3± 215.11^{B}	4.44± 0.18^{A}	4.00± 0.11^{B}	3.22± 0.14	3.75± 0.25^{A}
27-30	4406.8± 631.37^{B}	5530.6± 395.17^{C}	4.20± 0.21^{B}	4.44± 0.18^{A}	3.20± 0.18	3.11± 0.11^{B}
>30	4332.0± 228.32^{BC}	4610.4± 283.77^{AB}	4.82± 0.19^{C}	4.44± 0.17^{A}	3.36± 0.23	3.22± 0.15^{B}
			Third lactation			
<25	5282.0± 692.00^{A}	5635.0± 400.17^{A}	5.15± 0.51^{A}	3.99± 0.12^{A}	3.52± 0.23	3.33± 0.35^{A}
25-26	5105.2± 453.39A^{B}	5261.8± 179.02^{B}	4.60± 0.24^{B}	4.50± 0.29^{B}	3.40± 0.25	3.75± 0.25^{B}
27-30	5027.2± 521.38^{B}	5854.0± 834.55^{A}	4.92± 0.14^{C}	4.33± 0.14^{AB}	3.49± 0.28	3.22± 0.08^{A}
>30	-	5259.5± 258.07^{B}	-	4.50± 0.29^{B}	-	3.49± 0.29^{AB}

AFC – Age at first calving, months; MY – milk yield, kg; MF – milk fat content, %; MP – milk protein content, %; LBGR – Latvian Brown; LZ – Latvian Blue.
^{ABC} – traits with different superscripted alphabet letters has significant differences ($p<0.05$).

The quality of milk often are one of main factors that affects not only dairy cow profitability, but also longevity (Cielava et al., 2017). Red breed group cows, with the increase of their age, often characterizes with poor udder quality that results with increased SCC in milk and later culling. In the 4th AFC group (>30 months) there was not any LBGR breed cows, because they were culled from herds before the finish of third lactation.

The highest SCC were observed in the third lactation LBGR breed cows (192.0 thousands in 1mL^{-1} milk) that first time calved at the age of 25-26 months. In comparison LZ breed cows had significantly lower SCC in first lactation almost in every AFC group and the tendency remains up until the third lactation.

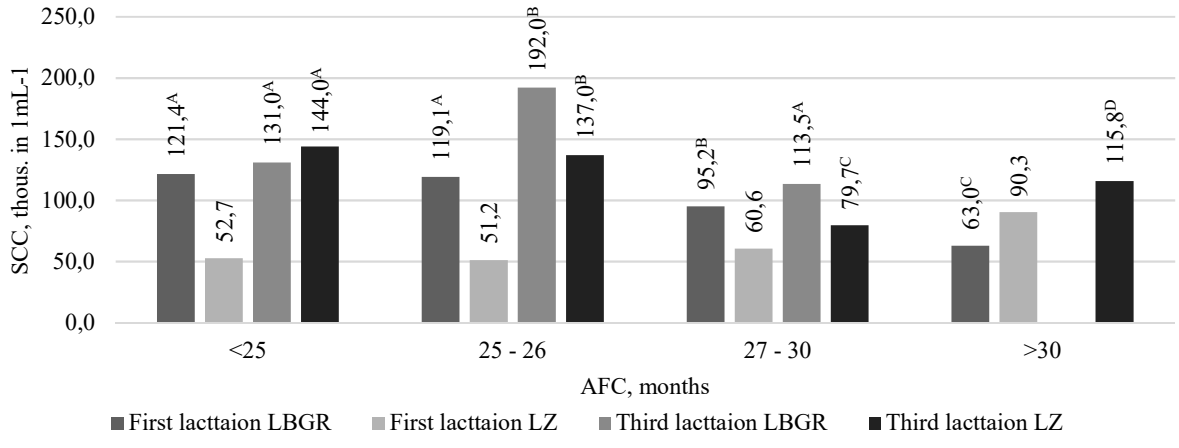

Figure 5. LBGR and LZ cow milk quality depending on age at first calving

The live weight in the beginning of the first lactation is one of most representative data about the physiological condition of dairy cow. As local breed cows often are smaller in their stature (130-135 cm), they have lower live weight than specialized dairy breeds. As we distributed cows into 4 groups, depending on their live weight, there was a tendency that in LBGR breed the highest milk productivity level was obtained from cows with live weight in the beginning of first lactation - 451 to 550 kg (accordingly 4620.0±202.93 and 4596.3±165.76 kg milk) and the tendency remained in the third lactation (accordingly 5342.5±231.35 and 5207.0±801.40 kg milk). But in LZ breed group the tendency was not as distinct as in LBGR. The significantly higher milk productivity in first lactation in LZ breed group was for cows with live weight in the beginning of first lactation 451-500 kg

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(5304.2±75.72 kg milk), but in the third lactation the best results showed cows with the highest live weight (>551 kg). In first lactation the highest milk fat and protein content in both LBGR and LZ breed groups were in the third cows group with live weight 501-550 kg, the same tendency remained in the third lactation.

For LBGR the milk protein content significantly highest were observed in the first and fourth group (accordingly <450 kg and >551 kg) with the same tendency in the third lactation, but in the LZ breed group The highest milk protein content were observed in cow milk with live weight at the beginning of first lactation 451-500 kg (accordingly 3.60±0.23% and 3.74±0.11%).

Table 3. The milk productivity in first and third lactation of LBGR and LZ breed cows depending on live weight in the beginning of first lactation

LW	MY		MF		MP	
	LBGR	LZ	LBGR	LZ	LBGR	LZ
First lactation						
<450	3869.7±219.77^{A}	4256.5±1068.51^{A}	4.50±0.15^{A}	3.99±0.23^{A}	3.33±0.14^{A}	3.03±0.18^{A}
451-500	4620.0±202.93^{B}	5304.2±75.72^{B}	4.33±0.21^{B}	4.40±0.25^{A}	3.17± 0.17^{B}	3.60±0.23^{B}
501-550	4596.3±165.76^{B}	4866.1±347.71^{C}	4.67±0.33^{C}	4.45±0.16^{A}	3.01±0.17^{C}	3.18±0.12^{C}
>551	4191.3±847.05^{A}	5081.4±526.82^{BC}	4.49±0.29^{A}	4.29±0.18^{B}	3.37±0.29^{A}	3.43±0.29^{D}
Third lactation						
<450	4951.6±291.93^{A}	4565.0±335.28^{A}	4.73±0.14^{A}	4.03±0.34	3.64±0.15^{A}	3.12±0.12^{A}
451-500	5342.5±231.35^{B}	5137.4±356.27^{B}	4.25±0.25^{B}	3.99±0.15	3.25±0.23^{B}	3.74±0.11^{B}
501-550	5207.0±801.40^{B}	4966.7±230.60^{AB}	4.99±0.05^{C}	4.29±0.18	3.67±0.28^{A}	3.29±0.19^{C}
>551	4913.5±359.50^{A}	5493.0±522.69^{C}	4.75±0.12^{A}	4.14±0.14	3.42±0.07^{AB}	3.43±0.20^{D}

LW – live weight in first lactation, kg; MY – milk yield, kg; MF – milk fat content, %; MP – milk protein content, %; LBGR – Latvian Brown; LZ – Latvian Blue.
^{ABCD} – traits with different superscripted alphabet letters has significant differences ($p<0.05$).

The milk quality of cows with different live weight in first lactation showed predictable tendencies. Significantly lower SCC in both breed groups and all live weight classes were in the first lactation cow milk, but with the increase of cow age, the SCC in milk significantly increased. The largest amount of SCC were in third lactation LBGR cow milk (278.5 thousands in 1 mL^{-1} milk) with live weight in first lactation >551 kg, but the lowest were obtained from first lactation in the same live weight group (36.3 thousands in 1 mL^{-1} milk).

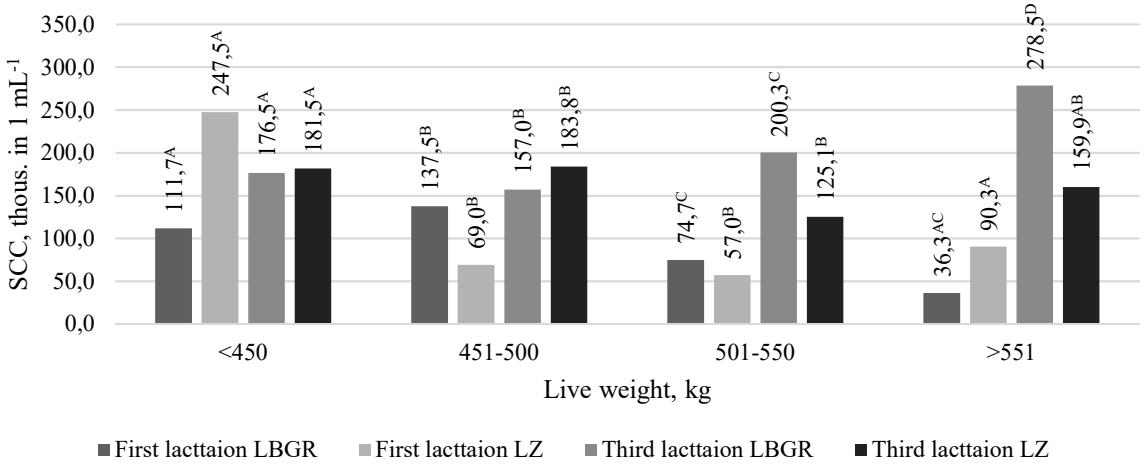

Figure 6. LBGR and LZ cow milk quality depending on the live weight at the beginning of first lactation

The overall tendency is that the largest amount of SCC were obtained from the cows with the lowest (<450 kg) and with the highest (>551 kg) live weight. The optimal LBGR and LZ local breed live weight for the lowest SCC in first and subsequent lactations is 451–550 kg.

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Conclusions

The use of local breed cows in modern dairy farming could be beneficial for farmer because of their high milk fat and protein content. The age at first calving and the live weight in the first lactation can serve as important indicators of the rearing conditions and cow physiological condition indicators in farm. In our study the optimal age at first calving and live weight for the maximal possible milk productivity were <25 months and 451–550 kg in LBGR breed group and 27–30 months and >551 kg in LZ breed group.

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