Original scientific paper

The impact of breeding region and lactation on milk yield traits in the of Simmental cattle population of the Republic of Serbia

Dragan Stanojevic[1], Radica Djedovic[1], Vladan Bogdanovic[1], Krstina Zeljic Stojiljkovic[1], Nikolija Gligovic[1], Ivan Mitrovic[1], Marina Lazarevć[2], Ljiljana Samolovac[2]

[1] *University of Belgrade, Agricultural Faculty, Zootechnical Institute, Belgrade, Republic of Serbia*

[2]*Insitute for Animal Husbandry, Belgrade, Republic of Serbia*

Corresponding author: Dragan Stanojevic, stanojevic@agrif.bg.ac.rs

Abstract

The objective of this research was to study phenotypic expression and factors that can affect milk yield traits in the population of Simmental cattle breed in the Republic of Serbia. The research was conducted on a set of data that included records on the production and origin of Simmental breed cows displayed both in regional and municipal exhibitions in the territory of the Republic of Serbia in the period from 2004 to 2017. A final data set included records on production and origin of 1176 Simmental breed cows. The animals were raised in the area covering 9 regions of the Republic of Serbia. The research included most important milk yield traits in standard lactation: milk yield, milk fat content, milk fat yield, yield of 4% fat-corrected milk (4%FCM). An average milk yield in studied population accounted for 5.520±919 kg, milk fat content 3.94±0.11%, milk fat yield 218±38 kg, while the yield of 4% fat-corrected milk accounted for 5.474±933 kg. It was determined that region, age and lactation had a very high statistically significant effect on studied traits while the age of cows had no statistical effect.

Key words: milk traits, Simmental breed, breeding region

Introduction

In the Republic of Serbia milk production represents the most important branch of livestock production and it takes place in quite different zootechnical conditions. Milk production is affected by a number of factors which can be divided into genetic and non-genetic ones.

When it comes to breeds which the animals that produce milk belong to Simmental and Holstein Friesian breeds are predominant ones. Simmental breed originated from Switzerland but over time it spread throughout a whole world being known as "Fleckvieh" in Germany and Austria, "Pie Rouge", "Montbeliard" and "Abondance" varieties of this breed in France and "Pezzata Rossa" in Italy. It was created by an intensive selection in pure breed. Apart from that, ameliorative cross breeding with dairy breeds was conducted particularly with Red Holstein breed. Simmental breed is also the most numerous cattle breed in the Republic of Serbia participating with 80 % in total number of cattle (Skalicki et al., 2007).

In Serbia Simmental breed was first imported in the 19th century. The animals were imported from Hungary, Czechoslovakia, Switzerland, Austria and Germany. Development of this breed in Serbia was significantly contributed by an artificial insemination. Two centeres for artificial insemination developed, one in 1952 in Krnjaca and the other in 1957 in Velika Plana. The population of Simmental cattle in Serbia is predominantly created by melting crosses of indigenous breeds of cattle using Simmental bulls or their semen in the second half of the 20th century.

Simmental cattle is mostly raised in central Serbia as a breed of dual production capabilities. Simmental dairy production in our country falls behind an average world dairy production primarily due to bad nutrition and management. According to the 2019 breeding programme (Main breeding program in cattle breeding - Simmental breed. Institute of Animal Husbandry - Zemun, Belgrade, 2019 for Simmental breed an average milk production in standard lactation should reach 6500 kg milk with 4.10% milk fat and 3.60% protein.

Milk yield in Simmental breed in different countries varies depending on quality of a breeding stock, selection programme and breeding conditions. Milk yield in Simmental breed that is mostly imported from Germany and Austria and raised in Serbia is 6000-7000 kg with 4.1% milk fat and 3.6% protein. Some breeding stocks of Simmental breed produce milk yield over 8000 kg. Niksić et al. (2011) report that milk yield ranges between 4400-5500 kg depending on a breeding stock. An average milk yield in Simmental breed of Serbia accounts for 4810 kg milk with 3.9% milk fat and 3.2% protein.

Pantelic et al. (2020) reported that average milk yield in first-calf heifers in 2019 accounted for 4692 kg milk with 3.98% milk fat and 3.18% protein. The yield of milk fat and protein was 187.27 kg and 149.64 kg respectively. The average milk production in Germany in 2016 accounted for 7568 kg with 4.19% milk fat and 3.52% protein (https://www.milcherzeugerverband-bayern.de/) and was significantly higher compared to the production determined in our population of Simmental cattle by above mentioned authors. In

Bulgaria the average milk production of Simmental cows for period from 1999 to 2017 was 5.016±70.81 kg with 4.217±0.024% milk fat in lactation lasting 305 days. In addition, it was determined that farm and year of calving had a significant effect on studied traits (Karamfilov et al., 2019).

Milk yield in dairy cattle of Austria from 1950 to 2010 increased from 3000 kg to 6850 kg. In 2012 milk production accounted for 7000 kg milk (Gruber and Stegfellner, 2015). Petrovic et al. (2009) determined that quantitative traits of milk yield in first-calf heifers were under a strong effect of a breeding region and showed a highly significant deviation from a general average ($P<0.01$). In addition, significant deviation on the yield of milk and milk fat was caused by a year of calving. Pantelic et al. (2021) in their study which included 2589 first-calf heifers of Simmental breed raised on the farms of individual livestock producers in the region of Central Serbia determined that milk yield traits showed a high variability depending on breeding region in which the animals were raised. The aim of the study was to examine the influence of the region of rearing and lactation on the milk yield characteristics of Simmental cows in Republic of Serbia.

Material and Methods

The trial was conducted on a data set that included records on production and origin of cows of Simmental breed exhibited in regional and municipal exhibitions in the territory of the Republic of Serbia in the period from 2004 to 2017. A final set of data contained records on production and origin of 1176 cows of Simmental breed. The animals were raised in the area of 9 regions of the Republic of Serbia. Displayed animals were born in the period from 1992 to 2015 and were exhibited in the age from 2 to 13 years, that is, from 1st to 10th lactation. Production results of animals were taken from the exhibition catalogue and represented production records from herd book and were obtained in a regular procedure of control of productivity.

The research included most important milk yield traits in standard lactation such as follows:

- Milk yield (MY) (kg),
- Milk fat content (MFC) (%),
- Milk fat yield (MFY) (kg),
- Yield of 4% fat-corrected milk (4%FCM) (kg) calculated by formulas:

4%FCM= 0.4M + 15F where is: M- milk quantity (kg); F- milk fat quantity (kg).

In research the effect of the region and the year of exhibition was studied along with the age of cows in the time of the exhibition and the lactation in which the cows were exhibited for

mentioned milk yield traits in standard lactation. The animals were displayed in the exhibitions in 9 regions: 1- Podunavski, 2- Rasinski, 3- Branicevski, 4- Kolubarski, 5- Jablanicki, 6- Beogradski, 7- Nisavski, 8- Sumadijski and 9- Borski. However due to a relatively small number of animals that were exhibited after the third lactation (140 cows), they were classified into a category of cows exhibited in their fourth or higher lactation.

The average values and variability of studied traits were calculated within PROC MEANS procedure of SAS programme package (version 9.4). The effect of factors on analyzed traits of milk yield was investigated within PROC GLM procedure of SAS programme package while an applied fixed model had a following form:

$Y_{ijkl} = \mu + R_i + G_j + S_k + L_l + e_{ijkl}$, where

Y_{ijkl} – is a phenotypic expression of milk yield traits,

μ- population average,

R_i-fixed effect of the region of exhibition (i=1-9),

G_j-fixed effect of the j year of exhibition (j=2004-2017),

S_k-fixed effect of the k age in the moment of exhibiting expressed in years (k=1-14),

L_l- fixed effect of the l lactation (l=1-4),

e_{ijkl}-random error.

Within the PROC GLM procedure of SAS programme package the values of the least square means (LSM) were calculated as well.

Results and Discussion

Phenotypic expression and variability of studied milk yield traits are shown in Table 1.

Table 1. Mean values and variability of milk yield traits

Trait	N	$\bar{x}$	σ^2	σ	Min	Max	Cv (%)
Milk yield (kg)	1176	5520	844039	919	3660	9750	17.00
Milk fat content (%)	1176	3.94	0.01	0.11	3.47	4.40	2,.73
Milk fat yield (kg)	1176	218	1438	38	137	374	17.00
Yield of 4% fat corrected milk	1176	5474	871295	933	3523	9167	17.00

On the basis of the records it can be seen in Table 1 that the average milk yield in studied population was 5.520±919 kg, milk fat content 3.94±0.11%, milk fat yield 218±38 kg while the yield of 4% fat-corrected milk was 5.474±933 kg.

Medic et al. (2006), as well as Niksic et al. (2011), determined lower mean milk yield for about 1000 kg while the content of milk fat in their research was lower by 0.04%. Genetic

improvement in production capabilities achieved in cows had caused mean values obtained in this research to be far higher than in the research of Medic et al. (2006). This difference in mean production occurred because conducted their research in wider population of cows while our research included only the cows that participated in the exhibitions, i.e. the highest quality cows of the population. Similar values were found in their research Cziszter et al. (2017) in population of Fleckvieh cow in Romania.

The effect of the region of holding exhibition, years of the exhibition, age of animal and lactation on the yield of milk and content of milk fat were analyzed in the research. Table 2 shows the significance of factors included in the analysis.

Table 2. Values of F-test for studied factors

Trait	Region	Year of exhibition	Age	Lactation	R^2
	df1=8	df1=6	df1=10	df1=3	
Milk yield	<0.01**	<0.01**	0.7322 ns	<0.01**	0.22
Milk fat content	<0.01**	<0.01**	0.0799 ns	<0.01 **	0.16
Milk fat yield	<0.01**	<0.01**	0.6892 ns	<0.001 **	0.23
4% fat corrected milk	<0.01**	<0.01**	0.7123 ns	<0.01 **	0.23

**- high statistically significant effect, ns- no statistically significant effect

Table 3 shows the least square means (LSM) for studied traits according to the region of holding exhibition. In Table 3 we can see that region, age and lactation had a very high statistically significant effect on studied traits, while the age of cows had no statistically significant effect. Determination of model ranged from 0.16 for the milk fat content in standard lactation to 0.23 for 4% FCM.

Table 3. LSM values for studied traits according to the region of holding exhibition

	Region								
Trait	Podunavski	Rasinski	Branicevski	Kolubarski	Jablanicki	Beogradski	Nisavski	Sumadijski	Borski
MY (kg)	5814	5982	5802	5098	5434	5946	4452	5804	5586
MFC (%)	3.96	3.97	3.93	3.98	3.93	3.97	3.92	4.03	3.82
MFY (kg)	231	237	228	203	214	236	176	233	214
4%FCM(kg)	5784	5949	5738	5082	5377	5923	4416	5823	5443

MY – milk yield, MFC- milk fat content, MFY- milk fat yield, 4%FCM- yield of 4% fat corrected milk

The highest milk yield as of 5.982 kg was recorded in Rasinski district while the lowest one as of 4.452 kg was recorded in Nisavski district. Milk fat content varied in considerably smaller limits in relation to milk yield where Sumadijski district stands out with highest milk fat content as of 4.03%, while the lowest content of milk fat was recorded in Borski district.

Maximum milk fat yield and 4% fat-corrected milk were recorded in Rasinski district being 237 kg of milk fat and 5.949 kg of 4% fat-corrected milk while the lowest yield was recorded in Nisavski district where it accounted for 176 kg milk fat and 4.416 kg 4% fat-corrected milk.

Differences obtained in milk yeild, milk fat content, milk fat yield and 4% milk fat-corrected milk are the consequence of different conditions of raising which dominate in these districts but also of the application of different semen during artificial insemination, therefore, the impact of different sires on production of their daughters**.**

The same conclusion was reached also by Petrovic et al. (2009) in their research. They determined that milk yield, besides region, is affected by the year of calving as well. Similar research was conducted by Pantelic et al. (2021) who obtained the same conclusion.

Table 4. LSM values for studied traits according to lactation

	Group of lactation			
Trait	1	2	3	4
MY (kg)	5052	5553	5703	5877
MFC (%)	3.92	3.94	3.96	3.97
MFY (kg)	198	219	226	233
4% FCM(kg)	4990	5505	5668	5852

MY – milk yield, MFC- milk fat content, MFY- milk fat yield, 4%FCM- yield of 4% fat corrected milk

Table 6 shows LSM values for studied traits according to lactation. The highest milk yield was realized by the cows in group 4, i.e. by the cows that realized 4 and more lactations their production being 5.877 kg while the lowest milk yield was realized by the first-calf heifers as of 5.052 kg. Milk fat content had the same trend of rise being the lowest in the cows in the first group i.e. first-calf heifers as of 3.92%, while the highest one was obtained by the cows in group 4 as of 3.97%. The highest increase regarding milk yield occurred between the first and the second lactation while later on this increase gradually declined. The yield of milk fat and 4% fat-corrected milk was lowest in the first-calf heifers and accounted for 198 kg milk fat and 4990 kg 4% fat-corrected milk. The highest mean values of these parameters were recorded in the cows in the group 4 being 233 kg milk fat and 5852 kg 4% fat-corrected milk. Gruber and Stegfellner (2015) in their research concluded the same. They confirmed that the number of lactations has a significant effect on milk yield and that the highest leap in milk production occurs between the first and the second lactation while later on the increase gradually declines. They also reported that the content of milk fat did not change significantly but that the milk yield increased due to the increase of the milk quantity which is the case here as well.

Conclusion

The research conducted confirmed that there are high statistically significant differences in expressing the analyzed traits of milk yield between the regions in which the animals were raised. This difference between the regions with the highest and with the lowest production amounted to even 1530 kg. Such a difference indicates a large heterogeneity of breeding conditions and practices as an applied technology of production. Lactation and year of the exhibition also highly statistically affected variability of analyzed milk yield traits. In the next period it will be necessary to work on optimizing all zootechnical conditions on dairy farms in order to create more favorable conditions for milk production and achieve the results obtained by the cows in other populations of Simmental cattle breed.

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