

First lactation milk production of cows of the Simmental breed reared in Bulgaria

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Abstract

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The present study involves 1946 cows of the Simmental breed population, which is relatively new in Bulgaria, formed at the beginning of the century. The cows included are reared in 44 farms under selection control and have lactated in the period 1999-2017. Simmental cows are characterised with high milk production under the conditions in our country. The average (LSM) milk yield of primiparous cows per 305-day lactation period is 5016 ± 70.81 kg, with fat content of the milk of $4.217 \pm 0.024\%$ and protein content of $3.398 \pm 0.013\%$, and per full lactation period (354.5 ± 8.68 milking days), the figures are respectively 5564 ± 128.0 kg, $4.253 \pm 0.024\%$ and $3.413 \pm 0.014\%$, respectively. The farm and the year of calving are proved to have an effect on all milk production indexes examined ($P < 0.001$). The average milk yield in the different farms varies from 4106 ± 176.9 to 7035 ± 130.4 kg, with more than 45% of the farms indicating average milk yield above 5000 kg. The calving season affects the variation ($P < 0.05$) in the normal and full lactation milk yield and does not affect the milk quality. Those cows which calved in the winter and spring have the highest milk, dairy butter and milk protein yield, and those which calved in the autumn – have the lowest.

Keywords: dairy cattle; Simmental; first lactation; milk production; milk quality

Introduction

The Simmental breed is one of the oldest and the second most widespread in the world numbering 40-60 million cattle, bred on 6 continents. The breed stretches back to the Middle Ages. The earliest records indicate that upon creation of the Simmental, the breeds crossed were a primitive indigenous Swiss one and the German large cattle. The name Simmental derives from the region where the cattle were originally bred – the “Simme Valley” located in “Bernese Oberland” region in Western Switzerland. The first herd book of the breed was registered in 1806, and the first breeders’ organisation was established in 1890 in Switzerland (HSB, 2018; SOR, 2018).

The Simmental is characterised by its high production incorporating combined meat and milk production, longevity,

adaptability, good maternal behaviour and pasture assimilation. The dual production and the continual use in mountainous and foothill conditions make the breed particularly appropriate for extensive systems of rearing (SGG, 2018).

The major purpose of the breed selection in Switzerland is achieving sustainable milk yield and high levels of protein content in milk, good meat quality and an appropriate Alpine conditions exterior (SWG, 2018), with the milk production being the leading factor in the breed selection index (ITM selection index) – with a relative share of 32% (SGS, 2017). The milk production relative share in the breed selection index in France is even higher – 45% (SMFR, 2017). Due to the different manner of use and rearing conditions, the Simmental milk yield varies greatly from one country to another. The average milk yield per first normal lactation in

Turkey is 3789±83.1 kg (Çilek and Tekin, 2005), the average milk yield in Serbia is 4084±72.75 kg (Budimir et al., 2011), 5766±154.2 kg in Austria (Shevhuzhev et al., 2017) and 6671±15.7 kg in Slovenia (Jeretina et al., 2013). In addition to its high milk yield, the Simmental has good meat qualities (Slosarz et al., 2000; Chládek et al., 2005; Aleksić et al., 2009, etc). For more than 30 years, the American Breeders' Organisation has been intensively working on the breed's improvement in entirely meat production direction (ASA, 2018; BFC, 2018).

The first Simmental cattle in Bulgaria (4 cows and 1 bull) were subject to targeted import in 1986 from the Hungarian "Bábolna" stud farm. Data indicates that there was an earlier import of bulls from Austria but their development was poor everywhere. At the same time, private farmers in the region of Kula and Belogradchik performed random crossing of the local grey cows with Simmentalized bulls from the Serbian Timok valley. Thus, "As a result of an extensive random crossing of the local grey cattle with Simmental and Simmentalized bulls of Yugoslavian and Swiss origin in the course of 50-60 years, a new breed which is constantly forming itself was created..." (Kadiyski et al., 1963). The new breed was recognized as Kula cattle in 1951. Bulgarian Simmental cattle, recognized in 1981, was created on the basis of the Kula cattle and a continuous crossing of local grey cattle with Simmental. However, following the liquidation of the cooperatives in the 1990 s, the Bulgarian Simmental cattle was practically extinguished (Nikolov et al., 2017) with only 114 cows being under selection control at present (EASR-AB, 2013). At the same time, the state initiates a new import of pure-bred Simmental heifers and bulls from Germany and Austria, product of a long selection in dairy and meat production. These animals and their descendants are central in the Simmental population currently controlled in our country (Nikolov et al., 2017). No studies have been carried out with reference to the new population, and the present work aims at ascertaining the levels milk production which is the major selection criterion index of the breed.

Materials and Methods

The present study involves 1946 first lactation cows, reared in 44 farms, which lactated in the period 1999-2017. The animals are under the selection control of "National Association for breeding of Montbeliard and Simmental Cattle in Bulgaria" which, in 2018, performs breeding activities with 2500 Simmental cows in 45 farms on the territory of the entire country. The milk production control is exercised following the validated methods of ICAR, and the milk quality indexes are specified in an independent dairy laboratory. The lactation period of the primiparous cows included in the study varies greatly – from 63 to 905 days. Therefore, lactation periods varying from 175 to 536 days are included upon calculation of the full lactation milk production parameters ($X=354\pm 2\sigma$). The standard lactation lasts from 240 to 305 days. The data are processed via Analysis of variance and the linear model has the following general layout:

$$Y_{ijkl} = \mu + YO_i + F_j + S_k + e_{ijkl},$$

where Y_{ijkl} is monitoring vector, μ is total average constant; YO , F , S are respectively fixed effects – year of first calving ($i=18$), farm ($j=44$) and season of calving ($k=4$); e_{ijkl} (l) – residual variation. The statistical processing is performed via SPSS 19.

Results and Discussion

The Simmental breed controlled population in Bulgaria has relatively high production levels (Table 1). The average milk yield per first standard lactation is 5016 kg, and per full 354.5-day lactation – 5478 kg. The lactation period is prolonged but full and normal lactation milk yield does not indicate any significant variations. Upon studying the production of the Simmental bull daughters, Jevtić-Vukmirović et al. (2012) have ascertained that the lactation period is within 268-392 days, and 2408-5222 kg of milk has been produced over the standard period of lactation.

Table 1. First lactation milk production indexes of cows of the Simmental breed, reared in Bulgaria

Indexes	Per full lactation, n = 1942					Per normal lactation (305 days), n = 1855				
	LSM	± SE	stdev	MIN	MAX	LSM	± SE	stdev	MIN	MAX
Lactation period, days	342,6	6,181	63,47	175	536	–	–	–	–	–
Milk yield, kg	5478	111,8	1278	1365	12867	5016	70,81	880,1	1421	9713
Fatty substances, %	4,234	0,025	0,261	2,4	5,3	4,217	0,024	0,255	3,160	5,340
Dairy butter, kg	231,3	4,726	52,57	41,74	503	210,3	2,781	33,46	63,94	364,2
Protein, %	3,403	3,403	0,141	2,0	4,3	3,398	0,013	0,142	2,260	4,540
Milk protein, kg	186,2	3,781	43,61	34,73	404	170,2	2,315	29,32	54,56	316,8

Along with the high milk yield, the population studied is characterized by high content of fats and protein in the milk with both of the indexes being higher in the full lactation milk. In conditions similar to those in our country, the Simmental has showed different production levels – in Romania the cows first normal lactation milk yield is averagely 4053 kg, with fat content 3.82% and protein 3.12% (Nistor et al., 2014); in Albania the normal lactation milk yield is 5400 kg with fat content 4.08% and protein 3.32% (Bicoku and Uruci, 2013); in Slovakia – 5676 kg with fat content 4.02% and protein 3.43% (Bujko et al., 2013). The average first lactation milk yield of the Simmental in Serbia is 4438 kg with fat content of 3.93% and dairy butter production of 171.1 kg (Nikšić et al., 2011). The authors advance the opinion that the production capacity of the primiparous cows can be considered satisfactory when having in mind the economic conditions- production system, import (third countries origin), the farm gate milk prices, subsidizing, etc.

The milk production of the cows of the Simmental breed is comparable to that of the other two combined breeds reared in our country. The lactation milk yield is 216 kg lower than that of the brown cattle (Krastanov et al., 2017), but the fat content is 0.34% higher and overall, 9.55 kg dairy butter more is produced from the Simmental. When compared to the normal lactation milk yield of the Montbeliard (Karamfilov and Nikolov, 2017), that of the Simmental is 438 kg lower, the fat content is 0.305% higher and, as a result, the latter's dairy butter quantity is only 2.1 kg lower. It needs to be pointed that unlike the Simmental, the Montbeliard and the Brown cattle are originally dairy meat breeds, and in the recent years in our country, the latter is directed in milk production through a continual assimilation with the extremely dairy American brown cattle. In 2017, a breeding program for recovery of the brown cattle combined type in Bulgaria has been endorsed (Nikolov, 2017).

Milk balanced chemical composition is of great importance for the production of cheese and products with a protected designation of origin (Bynum and Olson, 1982; Riddell-Lawrence and Hicks, 1989), and one of the main indexes in this respect is the fat to protein ratio. It is considered that the best fat-protein ratio in cheese production is between 1.15 and 1.20/1. When the abovementioned ratio is above 1.20, the fats impede the water separation from the cheese mass which in turn can lead to defects in the course of cheese maturation (COOPEX, 2015). The milk of the cows subject to our analysis has fat-protein ratio 1.24/1, which is suitable for cheese production. For example, the fat-protein ratio in the case of the Bulgarian Rhodope Cattle breed is 1.21-1.31 in the plain regions (Nikolov et al., 2011a,b), up to 1.331 in the mountainous areas (Nikolov

and Gadzhev, 2004), and in the separate lines from 1.33 to 1.69 (Gadzhev and Nikolov, 2008). However, during the first of the studies cited above (Nikolov et al., 2011a,b), the authors ascertained that the fat-protein ratio regarding the Bulgarian Black and White Cattle, reared under the same conditions, is quite low – 1.021/1.

Table 1 shows that the milk yield both per full and normal lactation greatly varies. The different type of feeding and rearing in the separate farms is one of the major factors for these variations. The farm is a particular variation source in all indexes studied (Table 2), and the average milk yield per normal lactation in individual farms is from 4106±176.9 to 7035±130.4 kg. The average lactation period is above 300 days with the exception of that shown in one farm where it is reported to have been 283±24.17 days; 38 farms are within 300-400 days range, and 5 farms have marked 400 milking days.

The influence of the farm on the animal production in our country is not surprising when taking into account the considerable differentiation of the farms in respect of material security, rearing conditions, feeding, zootechnical and veterinary service, etc. Different farms use different rearing systems during the seasons – stable-pasture or only stable, feeding also is not uniform. The lowest and the highest average standard milk yield of a primiparous cow mark a 40% difference.

Most of the farms subject to study (24), have an average milk yield from 4000 to 5000 kg, 18 have milk yield from 5000 to 6000, and only 2 farms have reported milk yield of over 6000 kg. The lowest average milk yield indicated is 3.89±0.078%, and the highest – 4.38±0.071%, with only 11% difference between the two end variants. Only two of the farms have shown milk yield below 4%. The protein content exhibits a similar dynamics.

The absolute difference between the latter property lowest and highest content is 5% (3.32±0.02% – 3.49±0.03%). Protein content of milk of above 3.4% was reported in 15 farms. Król et al. (2008) examine the milk production of the Simmental cows reared in Poland and ascertain that their milk is characterized by relatively high concentration of protein, including casein and whey protein. The authors have also established that the milk of the cows reared conventionally through grazing has significantly higher content of functional whey protein.

On the other hand, the cows fed under the TMR system (maize silage, hay, concentrated feed) produce milk with higher content of protein, casein and fats.

The average normal lactation dairy butter content in the individual farms is within the scope of 170 to 210 kg, and that of the milk protein – from 140 to 170 kg.

Table 2. Influence exercised by some factors on the first lactation milk production of cows of the Simmental breed, reared in Bulgaria

Indexes	F – criteria and degree of reliability		
	Farm	Year of calving	Season of calving
Per full lactation			
Lactation period, days	3,915***	5,196***	2,496*
Milk yield, kg	9,986***	7,517***	3,057*
Fatty substances, %	5,927***	4,515***	1,592
Dairy butter, kg	7,457***	7,320***	3,218*
Protein, %	2,361***	9,260***	1,291
Milk protein, kg	9,711***	9,044***	3,841**
Per normal lactation (305 days)			
Milk yield, kg	18,95***	9,596***	2,139*
Fatty substances, %	6,034***	5,399***	2,080
Diary butter, kg	14,69***	9,445***	1,404
Protein, %	2,451***	10,21***	0,313
Milk protein, kg	20,13***	11,43***	2,289*

*** $p < 0,001$; ** $p < 0,01$; * $p < 0,05$

In addition to the farm, other extremely influential non-genetic factors, to which great attention is paid in the milk cattle farming, are the year and season of calving (Farin et al., 1994; Schneider and Canadesi, 2000; Djurdjevic, 2001; Gadzhev and Nikolov, 2002; Kica et al., 2000; Pantelic et al., 2008; Strapák et al., 2010; Bujko et al., 2013, etc.). The year of calving is the second most important factor for the variation in the milk production of the primiparous Simmental cows reared in Bulgaria (Table 2). It has influence on all full and standard lactation indexes studied by us. Generally, there is no clear year trend (Fig. 1) but it can be seen that after 2012, the milk yield of the primiparous cows is higher when compared to that of those which calved in the preceding period.

The study carried out by us proved that the season of calving does not affect the variations in the qualitative composi-

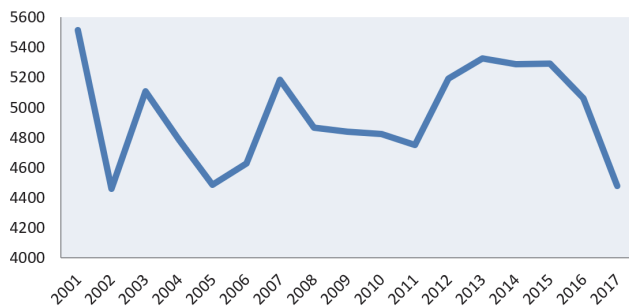


Fig. 1. Milk yield per standard first lactation of cows of the Simmental breed in different years

tion of the milk. It influences the lactation period ($p < 0,05$), the milk yield per full ($p < 0,05$) and normal ($p < 0,05$) lactation, the dairy butter per full lactation ($p < 0,05$) and the milk protein per full ($p < 0,01$) and normal lactation ($p < 0,05$).

The cows which calved in the winter and the spring have higher milk yield per normal lactation (Fig. 2.). In our country the winter feed is traditionally richer as silage and Lucerne hay of high quality are used. In the spring, the milk yield remains unchanged with the transition from winter to spring feed but during the summer and autumn it decreases. This is so due to the fact that the major part of Bulgarian pastures are natural which means they are not maintained or watered and the grass dries up and is therefore of poor nutritional value. Not only are the autumn and winter months more favourable for cows in terms of forage feed but they are also auspicious when it comes to temperature. On the other hand, the high temperatures and the intensive solar radiation during the summer have a strong negative effect on cattle behaviour (Zahariev et al., 2004; Zahariev and Nikolov, 2005; Nikolov et al., 2009), milk production (West, 2003; Brouček et al., 2009) and reproduction (García-Ispierto et al., 2006).

The higher milk yield of cows which calved in the autumn and winter has also been observed by Bekish (2008) for the Black-pied cattle in Belarus, Mostert et al. (2001) for Holstein and Jersey in South Africa, Gadzhev (2005) for Bulgarian Rhodope cattle. The latter explains the low milk yield of cows which calved in the summer with the fact that they have no access to sufficient complete feeding stuff during that season. This in turn leaves their needs unmet in the first two-three months which are of critical importance for the production of the cows (Todorov et al., 2011).

It is logical the fat content to increase in parallel with the decrease of the milk yield during the summer and spring

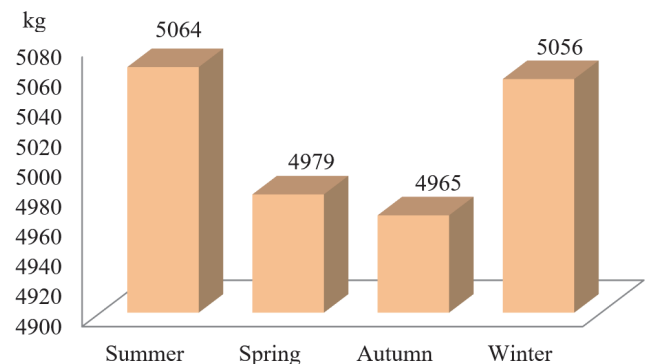


Fig. 2. Milk production per normal lactation period (305-day) of cows of the Simmental breed during different seasons

(Fig. 3). However, the difference with the values during the winter and spring is negligible. When it comes to protein content, dynamics can be barely noticed (Fig. 4) since the differences within the season are below 1%. Fat to protein ratio in milk remained within 1.24/1 during all four seasons.

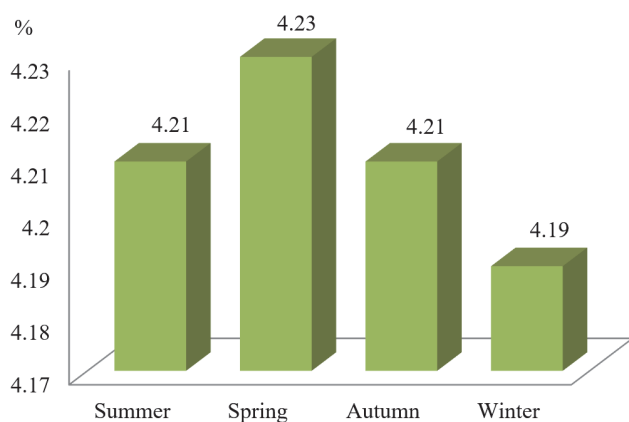


Fig. 3. Fatty substances content per normal lactation period (305-day) of cows of the Simmental breed during different seasons

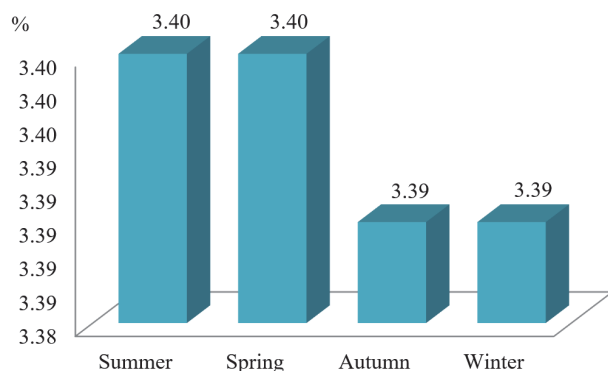


Fig. 4. Protein content per normal lactation period (305-day) of cows of the Simmental breed during different seasons

The results obtained prove once again that the Simmental is a breed with high adaptive ability and adaptive flexibility and can be successfully reared in our country despite the considerable differences in its creation and rearing conditions. It is known that in the Swiss Alps, where the breed was created, the extremely lush grassland is extensively used from early spring to early winter. So as to avoid the negative effect of the silage feed on the milk quality during the winter, the cows in most of the Swiss farms which produce typical local dairy products are exclusively fed with meadow hay from alpine pastures.

Conclusions

When taking into account the conditions in our country, it can be stated that the cows of the Simmental breed have a relatively high milk production per first lactation. The average (LS) milk yield per 305-day lactation is 5016 ± 70.81 kg, with fat content of the milk of $4.217 \pm 0.024\%$ and protein content of $3.398 \pm 0.013\%$, and per full lactation period (354.5 \pm 8.68 milking days) – respectively 5564 ± 128.0 kg, $4.253 \pm 0.024\%$ and $3.413 \pm 0.014\%$.

The respective farm and year of calving have an effect on all milk production indexes examined ($P < 0.001$). The average milk yield in the different farms varies from 4106 ± 176.9 to 7035 ± 130.4 kg, with more than 45% of the farms indicating average milk yield above 5000 kg. The calving season affects the variation ($P < 0.05$) in the normal and full lactation milk yield but does not affect the milk quality. Those cows which calved in the winter and spring have the highest milk yield, and those which calved in the autumn – the lowest.

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