

RESEARCH ARTICLE

(Open Access)**Evaluation Relation between Traits of Milk Production and Calving Interval in Breeding Herds of Slovak Simmental Dairy Cows**JOZEF BUJKO^{1*}, JURAJ CANDRÁK¹, PETER STRAPÁK², JÚLIUS ŽITNÝ¹, CYRIL HRNČÁR³¹Department of Genetic and Breeding Biology, Faculty of Agrobiolgy and Food Resources, Slovak Agricultural University in Nitra, A. Hlinku 2, 949 76 Nitra, Slovak Republic.²Department of Animal Husbandry, Faculty of Agrobiolgy and Food Resources, Slovak Agricultural University in Nitra, A. Hlinku 2, 949 76 Nitra, Slovak Republic.³Department of Poultry Science and Small Animal Husbandry, Faculty of Agrobiolgy and Food Resources, Slovak Agricultural University in Nitra, A. Hlinku 2, 949 76 Nitra, Slovak Republic.**Abstract**

Slovak Simmental cattle are a dual-purpose breed with a good milk and meat production, which belongs to the Simmental type of cattle. The aim this work was evaluated relation between traits of milk production and calving interval in breeding herds of Slovak Simmental dairy cows (S_0). Data were analysed using the Statistical Analysis System (SAS) version 9.3 (TS1M2) Enterprise Guide 5.1. and linear model with fixed effects of herd-year-season of calving (HYS), sire, number of lactation, and code of milk production by average of milk production. The average of milk production $5\ 866.4 \pm 2\ 066.6$ kg, average of fat production 233.5 ± 83.6 kg, average of protein production 200.4 ± 72.5 kg and average of lactose production 280.8 ± 98.2 kg, average of calving interval (CI) was 408.6 ± 83.9 days. The linear model to represent coefficient determination $R^2 = 0.2481$ % ($P < 0.001$) for calving interval with all fixed effects. The analyses by the effect was the highest effect of HYS of calving $R^2 = 0.1962$ %, than effect of sire $R^2 = 0.0417$ %. These effects were statistically high significant ($P < 0.001$). Correlation between milk, fat, protein, lactose in kg with calving interval ($r = 0.0130^*$, $r = 0.0214^{+++}$, $r = -0.0028^{+++}$, $r = 0.0115^{++}$) were statistically high significant. The results confirm the lower positive relation between traits of milk production (milk in kg, fat in kg, protein in kg and lactose in kg) and calving interval in breeding herds of Slovak Simmental dairy cows.

Keywords: Slovak Simmental cattle; breeding herds; dairy cows; traits of milk production; calving interval.**1. Introduction**

Milk production and reproductive performance are major factors with respect to overall efficiency and profitability of the dairy industry [3, 14]. Increase of production and improvement of the quality of milk, as well as fertility intensity, are main prerequisites of modern cattle production [4]. Slovak Simmental cattle are a dual-purpose breed with a good milk and meat production, which belongs to the Simmental type of cattle [6, 25].

For diversity valuation we can use pedigree analysis as presented by Hazuchova et al. [12], Kasarda et al. [13] and analysis following molecular-genetic information Miluchová et al. [15] and Gábor et al. [11].

Royal et al. [22] published that dairy selection objective have centred on milk production, with little attention being given to traits such as health and fertility.

Calving interval (CI) means interval between two subsequent calving's. Expected normal calving interval

is 365 days [20]. It is defined as the time from one calving to another. This traditional breeding system, with 12 months CI, is based on the idea that the production economy benefits from an early conception. Ball and Peters (2004) [2] reported that calving interval is a useful measure of fertility and in suckler herds is an important relationship between the length of calving season and profitability.

The analysis of calving interval and production traits in dairy cows introduce Bujko et al. [4, 5, 7 and 8], Dochi et al. [9], Evans et al. [10], Melendez and Pinedo [16], Panetto et al. [18], Ulutaş and Sezer [27].

The aim of this study was to find relation between traits of milk production and calving interval in select breeding herds of Slovak Simmental dairy cows (S_0).

2. Material and Methods**2.1. Data**

The material for evaluation traits in breeding herds of Slovak Simmental breed between 2010 and

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2015 were received from of Breeding Service of Slovak republic for period [26].

We observed subsequent results in dairy cows of 28 019 Slovak Simmental cattle: milk in kg (M), fat in kg (F), protein in kg (P) and lactose in kg (L) and calving interval (CI).

We divided dairy cows only breed-type S₀ - cows with genetic proportion of pure Slovak Simmental blood into 87.5 %.

2.2. Coding traits of milk production

To determine the effect of traits of milk production milk in kg (M), fat in kg (F), proteins in kg (P) and lactose in kg on calving interval -CI), the population was divided into 3 groups: **1** lower than $\bar{x} - 1s$ - (M1, F1, P1, L1); **2** from $\bar{x} - 1s$ to $\bar{x} + 1s$ - (M2, F2, P2, L2); **3** higher than $\bar{x} + 1s$ - (M3, F3, P3, L3).

2.3. Statistical analyses

The basic statistic analysis of milk production traits and calving interval was performed using the Statistical

Analysis System (SAS) version 9.3 (TS1M2) Enterprise Guide 5.1. [23]. For the actual computation a linear model with fixed effects was used:

$$y_{ijklm} = \mu + HYS_i + b_j + c_k + d_l + e_{ijklm},$$

where: μ = mean value, HYS_i = effect of herd, years and season of calving, b_j = father, c_k = number of lactation, d_l = cod of effect of M in kg, e_{ijklm} = residual error.

3. Results and Discussion

3.1. Traits of milk production

The basic traits of milk production in evaluated breeding herds of dairy Slovak Simmental cows are presented in Table 1. In the second lactations, the average production was $5\,901.2 \pm 2\,006.1$ kg of milk, 236.4 ± 81.4 kg of fat, 202.8 ± 70.7 kg of protein and 280.8 ± 98.2 of lactose. In other lactations, there was unstable tendency in traits of milk production.

Table 1 Statistical characteristic of milk production in dairy cows Slovak Simmental cattle (S₀)

Traits	Statistical parameter					
	n ¹	$\bar{x} \pm SD$ ²	CV ⁴	MIN ⁵	MAX ⁶	
2nd lactation	milk (kg)	23 017	$5\,901.2 \pm 2\,006.1$	34.0	1 500	13 435
	fat (kg)		236.4 ± 81.4	34.4	45.2	569.8
	protein (kg)		202.8 ± 70.7	34.9	42.5	480.8
	lactose (kg)		280.8 ± 98.2	35.0	51.4	658.4
3rd lactation	milk (kg)	16 481	$5\,964.0 \pm 2\,103.9$	35.3	1 501	16 400
	fat (kg)		237.4 ± 85.1	35.8	42.4	647.4
	protein (kg)		203.5 ± 73.7	36.2	41.2	584.2
	lactose (kg)		281.5 ± 102.4	36.4	55.9	765.3
4th lactation	milk (kg)	10 478	$5\,870.3 \pm 2\,115.2$	36.0	1 500	16 230
	fat (kg)		232.6 ± 85.7	36.9	43.9	703.5
	protein (kg)		199.5 ± 73.9	37.1	41.5	505.6
	lactose (kg)		275.4 ± 102.5	37.2	55.7	739.9
5th lactation	milk (kg)	5 868	$5\,667.9 \pm 2\,076.7$	36.6	1 503	13 819
	fat (kg)		223.4 ± 83.6	37.4	43.8	541.9
	protein (kg)		192.2 ± 72.5	37.7	41.6	476.5
	lactose (kg)		264.73 ± 100.15	37.8	56.9	646.1
6th lactation	milk (kg)	3 050	$5\,446.2 \pm 2\,050.4$	37.7	1 500	11 801
	fat (kg)		213.1 ± 81.4	38.2	45.11	510.5
	protein (kg)		184.4 ± 71.3	38.7	41.1	409.2
	lactose (kg)		253.6 ± 99.1	39.1	55.4	583.8

¹number of observations, ²average, ³standard deviation, ⁴coefficient of variation, ⁵minimum, ⁶maximum

The average length between first and second calving was 412.1 ± 88.2 days and between second and third calving it was 406.3 ± 81.9 days, between third and fourth and others calving it was 413.1 ± 113.5 days, as presented in Table 2. The average values of CI had unstable tendency analysed population. Our results point out higher values than those presented by Ulutaş and Sezer [27] and below values than results in population Simmental cattle Czech Republic, Austria

and Germany [6, 25]. Presented results are similar with results in all population of dairy cows in Slovakia [26].

3.2. Calving interval

The results of relationship between calving interval and traits of milk production by groups (M, F, P, L) showed, that the highest value of calving interval was in M₃ group (411.2 ± 82.9 days) and the lowest one

in M₂ group (406.9 ± 82.8 days). The similar tendency was in kgs of fat, in kgs of proteins, in kgs of lactose. These results are similar with conclusion of following authors [4, 5, 6, 8 and 14], who showed negative

tendency between reproduction traits and traits of milk production.

Table 2 Statistical characterization of mean calving interval between parity lactation in dairy cows Slovak Simmental cattle (S₀)

Traits		Statistical parameter				
		n ¹	$\bar{x} \pm SD^3$	CV ⁴	MEDIAN ⁵	MODUS ⁶
calving interval	1 st	23 017	412.1 ± 88.2	21.4	385	348
	2 nd	16 481	406.3 ± 81.9	20.2	383	344
	3 rd and others	19 396	406.3 ± 79.9	19.7	383	339

¹number of observations, ²average, ³standard deviation, ⁴coefficient of variation, ⁵median, ⁶modus,

3.3. Relationships between calving interval and traits of milk production

Table 3 Statistical characteristic of mean calving interval in groups in dairy cows Slovak Simmental cattle (S₀) according their milk performance

Traits	Code ¹	Statistical parameter				
		n ²	$\bar{x} \pm SD^4$	CV ⁵	MEDIAN ⁶	MODUS ⁷
calving interval	M ₁	7 765	410.6 ± 90.0	21.9	383	357
	M ₂	35 277	406.9 ± 82.8	20.4	383	353
	M ₃	15 852	411.2 ± 82.9	20.2	387	348
	F ₁	7 858	409.8 ± 88.8	21.7	383	357
	F ₂	36 848	406.5 ± 82.4	20.3	382	350
	F ₃	14 188	413.2 ± 84.6	20.5	388	348
	P ₁	7 735	411.7 ± 89.9	21.9	384	339
	P ₂	34 127	407.5 ± 83.5	20.5	383	350
	P ₃	17 032	409.4 ± 81.7	19.9	385	348
	L ₁	8 017	410.5 ± 89.4	21.8	383	357
	L ₂	35 281	406.9 ± 82.8	20.3	383	350
	L ₃	15 596	411.2 ± 83.3	20.3	386	348

¹code of milk production (M₁, M₂, M₃), fat production (F₁, F₂, F₃), protein production (P₁, P₂, P₃), lactose production (L₁, L₂, L₃), ²number of observations, ³average, ⁴standard deviation, ⁵coefficient of variation, ⁶median, ⁷modus,

Correlation between evaluated traits of milk production and calving interval were lower positive or negative and statistically high significant; correlation coefficients between kgs of milk, kgs of fat, kgs of proteins, kgs of lactose and calving interval were r= 0.0130, r= 0.0214, r= -0.0028, r= 0.0115 respectively (Table 4). These results are similar tendency with conclusions of these authors [6, 24 and 28], where report that the lower negative relation between reproduction and traits of milk production. Andersen-Ranberg et al. [1] showed the negative genetic correlation between female fertility and milk production. The selection for increasing milk yield results into genetic decline of female fertility. This correlation was negative and very low. These results

are similar with conclusions of Pryce et al. [21] and Royal et al. [22].

Table 5 shows the linear model to represent coefficients of determination on calving interval with all fixed effects R² = 0.2481 % (P<.0001). The most important factor was effect of herd-years-season (R² = 0.1962), than effect of sire (R² = 0.0417). These factors were significant (P<.0001). These results are similar with results [4, 5, 9, 10 and 14], where authors showed higher influence of effect HYS.

Table 6 shows the linear model to represent coefficients of determination on milk, fat, proteins and lactose in kg with all fixed effects R² = 0.4160 % for milk in kg, R² = 0.3942 % for fat in kg, R² = 0.4398 % for proteins in kg and R² = 0.4239 % for lactose in kg. The most important factor was effect of herd-years-season (R² =

0.3721 % for fat in kg to 0.4213 % for proteins in kg), than effect of sire ($R^2 = 0.1305$ % for fat in kg to 0.1485 % for lactose in kg). These factors were significant ($P < 0.0001$). These results are similar with results [6, 7,

9, 16 and 19], where authors showed higher influence of effect HYS.

Table 4 Relation between traits of milk production and calving interval

Traits	Milk in kg	Fat in kg	Fat in %	Proteins in kg	Proteins in %	Lactose in kg	Lactose in %
calving interval	0.0130 ⁻	0.0214 ⁺⁺⁺	0.0273 ⁺⁺⁺	-0.0028 ⁺⁺⁺	-0.0903 ⁺⁺⁺	0.0115 ⁺⁺	-0.0115 ⁺⁺

⁻ $P > 0.05$, ⁺ $P < 0.05$, ⁺⁺ $P < 0.01$, ⁺⁺⁺ $P < 0.001$

Table 5 Factors affecting calving interval in Slovak Simmental dairy cows (S_0)

Sources of variability	DF ¹	Mean Square	F Value	R-Square ²
				Calving interval
Herd-years-season (HYS)	4 932	16478.79	2.67	0.1962 ⁺⁺⁺
Sire	649	26622.51	3.91	0.0417 ⁺⁺⁺
Number of lactation	5	124222.34	17.68	0.0012 ⁺⁺⁺
Cod of milk production	2	120113.57	17.09	0.0006 ⁺⁺⁺

¹grades of freedom, ²coefficient of determination (R^2), ⁺⁺⁺ $P < 0.001$

Table 6 Factors affecting milk, fat, proteins and lactose in kg in Slovak Simmental dairy cows (S_0)

Sources of variability	DF ¹	Mean Square	F Value	R-Square ²			
				Milk	Fat	Proteins	Lactose
Herd-years-season (HYS)	4 932	20211565	7.34	0.3963 ⁺⁺⁺	0.3721 ⁺⁺⁺	0.4213 ⁺⁺⁺	0.4023 ⁺⁺⁺
Sire	649	7253477	2.63	0.1373 ⁺⁺⁺	0.1305 ⁺⁺⁺	0.1483 ⁺⁺⁺	0.1485 ⁺⁺⁺
Number of lactation	4	96961419	35.20	0.0038 ⁺⁺⁺	0.0056 ⁺⁺⁺	0.0048 ⁺⁺⁺	0.0054 ⁺⁺⁺

¹grades of freedom, ²coefficient of determination (R^2), ⁻ $P > 0.05$, ⁺ $P < 0.05$, ⁺⁺ $P < 0.01$, ⁺⁺⁺ $P < 0.001$.

4. Conclusions

The results confirm the lower positive or negative relation between traits of milk production (milk in kg, fat in kg, protein in kg and lactose in kg) and calving interval were $r = 0.0130$, $r = 0.0214$, $r = -0.0028$, $r = 0.0115$ in Slovak Simmental dairy cows (S_0). Than the results of relation between traits of milk production by groups (M, F, P, L) and calving interval showed, that the highest value of calving interval was in M_3 group and the lowest one in M_2 group. This tendency was in other groups (F, P and L). The linear model to represent coefficient determination $R^2 = 0.2481$ % ($P < 0.001$) for calving interval with all fixed effects. The most important factor affecting of calving interval was effect of HYS (herd-years-season) ($R^2 = 0.1962$), than effect

of sire ($R^2 = 0.0417$). These factors were significant ($P < 0.0001$).

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