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Original Paper

The evaluation of the relationship of lactose to production and reproduction traits in different breeding conditions of the Slovak Spotted dairy cows

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The aim of this study was to evaluate lactose in relation to milk production and calving interval in dairy cows of Slovak Spotted cattle. A total of 92,730 lactations from 45,800 dairy cows evaluation from 2015 to 2019 were used for investigating lactose percentage (LP), milk yield (MY), lactose yield (LY), fat percentage (FP), proteins percentage (PP) and calving interval (CI). Data were analysed using the SAS version 9.4 and linear model with fixed effects: herd-years-season (HYS), sire (S), breeding type (BT), coding of milk (Cod-MY) and coding of calving interval (Cod-CI). In the dataset the average of LP was 4.77 ±0.20%, while the one of MY, LY, FP, PP and CI were 6,778.53 ±2,014.18 kg, 325.27 ±100.45 kg, 3.96 ±0.47%, 3.39 ±0.23% and 406.66 ±91.09 days. The correlation of LP with MY, LY, FP, PP and CI was equal to $r = 0.1712$, $r = 0.3157$, $r = 0.0546$, $r = 0.1852$ and $r = -0.0147$. These correlation coefficients were statistically highly significant $P < 0.0001$. Among all fixed effects in the analysis of variance of LP, the most relevant effect was observed for HYS ($P < .0001$).

Keywords: cattle, milk components, lactose, calving interval, correlation

1 Introduction

The lactose content makes up the highest percentage portion in milk and is not part of the creation of breeding programs for national breeds for milk production, as they state Sneddon et al. (2015) and Haile-Marian, Pryce (2017). In general, the lactose and other milk components in milk may be used indirect traits related to production, fertility in conjunction with health traits that are important for the economics of farming dairy cows as reported Miglior et al. (2007).

These traits are characterized by a low value of heredity and thus largely influenced by environmental traits, especially nutrition as they state in their publications Karcol et al. (2017), Juraček et al. (2020) and other authors. Costa et al. (2019) found that the lactose percentage has potential to asses health and thus the milk quality in Fleckvieh dairy cows.

The lactose in milk is affected by various factors such as genetics (Kasarda et al., 2015; Bujko et al., 2011, 2018 and others authors) and no-genetics (Boro et al., 2016; Bolacali and Öztürk, 2018; Juraček et al. (2020) and others authors).

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The relation between percentage of lactose and milk production indicators was the subject of the research of many authors, such as Ptak et al. (2012) and Sneddon et al. (2015).

The evaluation of production traits, reproduction traits and relation between each other in dairy cows shows authors in Slovakia (Bujko et al., 2019 and 2020; Kasarda et al., 2020), Czech (Stadnik et al., 2018) Austria (Costa et al., 2019), Poland (Satoła et al., 2017), Romania (Cziszter et al., 2017; Han and Bobiş, 2019), New Zealand (Sneddon et al., 2015) and other authors who have dealt with the similar areas of research.

In this work to presents results to evaluate of lactose percentage in relation to the milk production traits a calving interval in selected population of the Slovak Spotted dairy cows.

2 Material and methods

2.1 Data

Data for evaluation of relationship of lactose to milk components and reproduction traits in dairy cows of the Slovak Spotted cattle was provided from by the database of Breeding Services of the Slovak Republic from 2015 to 2019.

2.2 Coding of breeding type, milk yield and calving interval

Dairy cows were divided according to the Herd Book classification to subsequent breed-type groups: S_0 – purebred Slovak Spotted with the proportion of foreign breeds less than 12.5%; S_1 – cows with the genetic proportion of the Slovak Spotted from 75% to 87.4%; S_2 – cows with the genetic proportion of the Slovak Spotted from 50% to 74.9% (Slovak Simmental Breeders Association, 2020).

The population of dairy cows was divided into 3 groups according to the mean milk yield in kg (MY) and calving interval in days (CI):

1. lower than mean minus 1 *SD* – (M1, CI1),
2. from mean minus 1 *SD* to mean plus 1 *SD* – (M2, CI2),
3. higher than mean plus 1 *SD* – (M3, CI3).

2.3 Statistical analyses

For statistical processing of data using the Statistical Analysis System (SAS) version 9.4 (TS1M2), procedures MEANS, CORR and GLM (SAS, 2016). Correlation between lactose with milk components and CI were calculated as Pearson's correlations. Differences between estimated variables were tested at the levels of significance: + P <0.05, ++ P <0.01, +++P <0.001 or -P >0.05.

Linear model with fixed effects was used:

$$y_{ijklm} = \mu + HYS_i + S_j + PT_k + CM_l + CI_m + e_{ijklmn}$$

where:
μ – mean value; HYS_i – fixed effect of herd-years-season (1–6,434); S_j – fixed effect of sire (1–849); PT_k – fixed effect of breeding type (1–3); CM_l – fixed effect of coding of milk (1–3); CI_m – fixed effect of coding of calving interval (1–3); e_{ijklmn} – residual error

3 Results and discussion

The basic statistical parameters evaluated traits are presented in Table 1. The means of traits of milk production and calving interval in selected dairy cows of the Slovak Spotted cattle were similar to the national means for evaluation of milk production traits all dairy cows in Slovak Republic as shows the Results of Dairy Herd Milk Recording in Slovak Republic from years 2015 to 2019 (B.S. SR, S.E., 2020).

When evaluating traits of milk yields, we found that the mean of the standardized lactations of milk production during the examined period in 92,730 lactation records in 45,800 dairy cows were for the lactose yield 325.27 ±100.45 kg, 6,778.53 ±2,014.18 kg of milk yield (MY), 267.38 ±80.51 kg (3.96 ±0.47%) of fat yield (FY), 230.71 ±69.98 kgs (3.39 ±0.23%) of proteins yield (PY), 4.77 ±0.20% of lactose percentage (LP) and 406.66 ±91.09 days (CI), as shown

Table 2. The mean of milk production traits has similar tendency as results of Simmental dairy populations in Germany (7,904 kg milk, 331 kg of fat, 280 kg of protein),as shown by BRS (2020) or Austria (7,661 kg milk, 316 kg of fat, 263 kg of protein), as shown by ZAR (2020) and other country with breeding dairy cows Simmental cattle.

Table 1 Basic statistical parameters of milk production traits and CI in Slovak Spotted dairy cows

Traits	Statistical parameter				
	n*	mean ±standard deviation	coefficient of variation	mode	median
Lactose yield in kg (LY)	45,800	325.27 ±100.45	30.88	344.93	325.52
Milk yield in kg (MY)		6,778.53 ±2,014.18	29.71	6,663.0	6,780.0
Fat yield in kg (FY)		267.38 ±80.51	30.11	311.34	267.21
Proteins yield in kg (PY)		230.71 ±69.98	30.33	276.68	231.25
Fat in % (FP)		3.96 ±0.47	19.76	3.89	11.85
Proteins in % (PP)		3.39 ±0.23	6.88	3.39	3.39
Lactose in % (LP)		4.77 ±0.20	4.16	4.83	4.79
Calving interval in day (CI)		406.66 ±91.09	22.40	353.0	381.0

* – number of observation

Table 2 Correlation between LP, LY and other of milk production traits (MY, FP, PP and CI)

Traits	Milk (MY) (kg)	Fat (TY) (kg)	Proteins (PY) (kg)	Lactose (LY) (kg)	Fat (FP) (%)	Proteins (PP) (%)	Calving interval (CI) (day)
Lactose (LY) (kg)	0.8835+++	0.8094+++	0.9726+++	-	-0.1425+++	0.0311+++	-0.0132+++
Lactose (LP) (%)	0.2196+++	0.2191+++	0.3054+++	0.3157+++	0.0677+++	0.1729 +++	-0.0147+++

+++ P <0.001

Expressing the correlation among milk production characteristics and the lactose in milk, for example for lactose in kg with milk, fat, proteins in kg, lactose and calving interval, were found as follows r = 0.8835, r = 0.8094, r = 0.9726, r = 0.3157 and r = -0.0132. These correlation coefficients were statistically highly significant P <0.0001. The values of correlation dependence are comparable to the values they report Haile-Marian, Pryce (2017), Chegini et al. (2019), Hermiz and Hadad (2020) and others. Costa et al. (2019) shows correlation coefficients among LY with MY, FY, PY (r_g = 0.993, 0.879, 0.949).

Table 3 Factors affecting of lactose percentage (LP) in dairy cows of the Slovak Spotted cattle in different breeding condition

Resources of variability	Grades of freedom (DF)	Mean square	*F*-value	*R*-sguare
				lactose percentage
Herd-Years-Season (HYS)	6,794	0.163118	4.97+++	0.2057
Sire (S)	849	0.8045378	23.29+++	0.1266
Breeding Type (PT)	3	8.55550286	218.33+++	0.0032
Cod_milk (MY)	3	83.1600780	2,182.86+++	0.0309
Cod_calving interval (CI)	3	0.22559338	5.74	0.0001

coefficient of determination (R^2), +++ P <0.001

Based on the results of a linear model of the effect of all effects, we found the following value of the determination coefficient for the lactose percentage R^2 = 0.3150. These effects in the linear model were statistically highly significant (P <.0001). When analysed according to the effects of individual factors on lactose percentage, we found that effect of HYS (R^2 = 0.2057) than effect of sire (R^2 = 0.1266) as shows Table 3. These effects were statistically highly significant

(P <.0001). Our results were comparable to the results they of report Boro et al. (2016) and Hermiz and Hadad (2020). Alessio et al. (2016) states that lactose percentage of milk is infuenced by somatic cell count and parity and that it varies seasonally. They also state that it is not related to breed, milk yield, fat content or protein content.

4 Conclusions

The data shows that the percentage of lactose and the calving interval were low negatively correlated. However, in the linear model, the length of calving period (CI) showed no effect and a positive low to medium correlation with all milk traits. The analyses by effects on lactose percentage reviled higher effect of the HYS (R^2 = 0.2057), than effect of sire (R^2 = 0.1266) and these effects were highly statistically significant (P <.0001).

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