



Factors affecting daily milk yield, fat and protein percentage, and somatic cell count in primiparous Holstein cows

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ABSTRACT

The objective of this study was to determine effective factors on the variation of daily milk yield (DMY), fat (F%) and protein percentage (P%), and somatic cell count (SCC) in Holstein cows. A total of 278 primiparous cows were examined by four parameters in four calving seasons (CS), three years and six test days (TD) post-calving. While SCC and fat values were affected by CS ($P < 0.05$), no significant difference was found among DMY and P% by CS. Both year and TD were not effective on SCC, but significant differences ($P < 0.05$) were determined among DMY, F% and P% by two factors. Correlation of P% with SCC and F% was estimated to be positive ($P < 0.01$; $r = 0.168$ and $r = 0.457$, respectively), and correlation of DMY with fat and protein was determined as negative ($P < 0.01$; $r = -0.363$ and $r = -0.335$, respectively). The study confirmed that multiple milk parameter factors are highly important to obtain more quality and quantity milk from primiparous dairy cows.

Key words: Cow, Environmental factor, Milk composition, Somatic cell count.

INTRODUCTION

Today, optimizing environmental conditions may be seen as most important step to increase financial efficiency in dairy farms. At this point, determination of somatic cell count (SCC) and chemical composition of milk are precisely advised to dairy owners (Memiši *et al.*, 2011).

SCC has been assumed as a reliable reflector for determining milk quality or any disorders in the production cycles in an early time (Atasever *et al.*, 2011). An increased SCC in the first lactation is of importance because it has been associated with an increased risk of culling, raised SCC as well as reduced milk production later in that lactation (Green *et al.*, 2008). In this context, using test day SCC values in addition to fat and protein percentage are commonly used as reliable parameters to detect productive abnormalities in herds. Besides, there is a lack of information about the effects of environmental factors on these parameters especially in the first lactating dairy cows.

The objective of the present investigation was to determine the variation in milk composition parameters caused by some effective factors in primiparous Holstein cows.

MATERIALS AND METHODS

Animal selection and milk analyses: The research was conducted in the experimental farm of Czech University of

Life Sciences, Prague, Czech Republic. Milk yield, composition and SCC records of 278 primiparous Holstein cows were used as the study material. Selected cows were milked two times in a day with machine and maintained under similar conditions in the farm. The cows were loose housed in a cubicle straw-bedded barn and fed a total mixed ration consisting of maize silage, alfalfa silage, straw, grass hay, alfalfa hay, concentrates, brewery draff, bakery waste and mineral supplements. The ingredient composition of the diet corresponded to the current daily milk yield of individual cows and feeding rations were completely balanced for energy, protein, fat, mineral and vitamin content. Feeding rations consisted of same components throughout the entire experimental period.

In SCC analysis, infrared spectroscopic method was used for measuring the values. Also, all samples were analyzed for fat and protein by the Milkoscan 133B (Foss-Electric, Denmark).

Statistical analysis: Due to high variation among SCC value, SCC data were transformed to \log_{10} for normality and homogeneity of variances. To evaluate both parameters by season of calving (CS), four groups were formed: 1= January, February, March; 2= April, May, June; 3= July, August, September; 4= October, November, and December. After calving, all cows were assessed for SCC, variation in DMY,

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Abbreviations: **DMY:** Daily milk yield, **F:** Fat, **P:** Protein, **SCC:** Somatic cell count, **CS:** Calving season, **TD:** Test day milk yield.

fat and protein percentages throughout 6 months for observing the changes according to test days. To evaluate effect of year, records were analyzed by 3 subgroups between 2009 and 2011.

The two parameters were examined by analysis of variance (ANOVA) and means were compared by Tukey test. The linear model was as follows:

$$y_{ijkl} = \mu + a_i + b_j + c_k + e_{ijkl}$$

y_{ijkl} is the observation value,

μ is the overall mean,

a_i is effect of season of calving ($i = 1, 2, 3$ and 4),

b_j is effect of year ($j = 1, 2, 3$),

c_k is effect of test day (TD) ($k = 1, 2, \dots, 6$), and

e_{ijkl} is random error.

To determine the relationships of SCC with other components, Pearson's correlation coefficients were estimated. All statistical analyses were applied by SPSS 17.0 for Windows at the 0.05 significance level.

RESULTS AND DISCUSSION

The study revealed that the mean number of somatic cells count (SCC) was 295652 cells/ml. This value could be assessed to be acceptable for human consumption due to lower than the limit of SCC (400×10^3 cells/ml) by EU directives (Directive 92/ 46ECC Council, 1992).

Table 1 contains data on logSCC, DMY, fat and protein percentage proportions. As seen that effect of CS on logSCC was statistically significant ($P < 0.05$), and means of summer and autumn CS groups were different from each

other. Highest mean (5.19 ± 0.52) was calculated in winter CS and the lowest mean (5.11 ± 0.52) was determined in spring CS group. While this finding was in agreement with the results of Yoon *et al.* (2004), it was in contrast to the findings of Tancin (2013). Actually, seasonal variation in SCC values in different studies could be assumed as an expected case due to climatic and regional differences where the investigations had been conducted.

No statistically significant difference was obtained in DMY values by CS groups (Table 1). Mean dMY value of the study was calculated to be 27.64 ± 3.76 kg and this level was higher than report of Erdem *et al.* (2010), but lower than the results of Rehák *et al.* (2012) who conducted a study in the same region. However, due to the fact that this value was obtained from first calving cows, it might be regarded as favorable. Similarly, Rehák *et al.* (2012) reported that primiparous cows of Holstein breeds exhibited lower milk yields in the first 30 weeks of lactation than greater-parity cows.

In the study, mean fat ratio was calculated to be $3.89 \pm 0.39\%$ and the mean of autumn CS was different from the mean of spring and summer CS groups, statistically ($P < 0.05$). Actually, estimated mean fat ratio of the present study might be assumed in acceptable thresholds. Also, the lower fat ratio in autumn CS group might be explained with effect of fresh-green fodders on milk composition after hot season.

While the mean for P% was calculated as 3.20 ± 0.20 , this value was not corresponded to F% results. Actually, the reason of the variation in P or F values by season is not clear

TABLE 1: Milk parameters (mean \pm SD) by effective factors

Factor		logSCC		dMY (kg)		Fat (%)		Protein (%)
CS	n	*	n	NS	n	*	n	NS
1	68	5.19 ± 0.52^{ab}	68	27.11 ± 3.41	68	3.86 ± 0.42^{ab}	68	3.19 ± 0.18
2	79	5.11 ± 0.52^{ab}	79	27.63 ± 3.51	79	3.96 ± 0.39^a	79	3.23 ± 0.18
3	57	5.14 ± 0.50^a	57	28.31 ± 3.40	57	4.02 ± 0.40^a	57	3.21 ± 0.21
4	73	5.17 ± 0.49^{ab}	74	27.63 ± 4.49	74	3.74 ± 0.33^b	74	3.18 ± 0.21
Overall	277	5.15 ± 0.51	278	27.64 ± 3.76	278	3.89 ± 0.39	278	3.20 ± 0.20
Year								
1	51	5.22 ± 0.47	52	26.33 ± 3.48^a	52	4.01 ± 0.44^a	52	3.28 ± 0.17^a
2	153	5.15 ± 0.53	153	27.73 ± 3.39^{ab}	153	3.89 ± 0.39^{ab}	153	3.18 ± 0.18^b
3	73	5.12 ± 0.48	73	28.39 ± 4.42^b	73	3.79 ± 0.35^b	73	3.19 ± 0.24^b
Overall	277	5.15 ± 0.51	278	27.64 ± 3.76	278	3.89 ± 0.39	278	3.20 ± 0.20
TD								
1	275	5.05 ± 0.61	278	26.73 ± 4.84^a	278	4.01 ± 0.66^{ab}	278	3.13 ± 0.28^{ab}
2	277	4.93 ± 0.59	278	29.36 ± 4.88^c	278	3.77 ± 0.59^c	278	3.07 ± 0.23^a
3	277	4.91 ± 0.61	278	28.64 ± 4.39^{bc}	278	3.81 ± 0.56^{bc}	278	3.15 ± 0.25^b
4	277	4.95 ± 0.60	278	27.75 ± 5.54^{ab}	278	3.89 ± 0.60^{abc}	278	3.23 ± 0.26^c
5	276	4.91 ± 0.59	278	27.41 ± 4.59^a	278	3.92 ± 0.65^{abc}	278	3.30 ± 0.33^{cd}
6	277	4.91 ± 0.51	278	26.86 ± 4.64^a	278	3.94 ± 0.60^{ab}	278	3.33 ± 0.24^d
Overall	1659	4.94 ± 0.59	1668	27.79 ± 4.91	1668	3.89 ± 0.62	1668	3.20 ± 0.28

Different superscript letters in the same column indicate statistically significant differences ($P < 0.05$)

CS: calving season 1: winter, 2: spring, 3: summer, 4: autumn; Year 1: 2009, 2: 2010, 3: 2011; TD: test day

*: $P < 0.05$

Bertocchi *et al.* (2014). These variations could correspond to level of negative energy balance during the first period of lactation (Ducháček *et al.*, 2014). The results of this study points out that CS is not effective on protein percentage in primiparous Holstein cows and this finding is consistent with Stádník and Louda (1999).

According to year evaluation, no significant difference was found among CS groups. However, means were tended to drop with advancing year. As parallel with this finding, dMY means elevated with later years. While overall mean was estimated to be 27.64 ± 3.76 kg in the investigation, means of 2009 and 2011 were statistically different ($P < 0.05$). The results obtained in this study revealed that milk yield of the investigated farm reached better threshold with advancing time viz., fat percentage proportion increased simultaneously with consolidation of protein percentage content in milk. This fact corresponds with compensation of negative energy balance (Stádník *et al.*, 2013).

The effect of year on fat percentage was found statistically significant ($P < 0.05$), (Table 1). The fat percentage tended to decrease with advancing year. The fact that a drop in fat percentage related to increased milk yield is an expected case (Pantelic *et al.*, 2008) as a result of breeding schemes used in dairy breeds (Stádník *et al.*, 2013).

Protein percentage in 2009 was highest (3.28 ± 0.17) and this value was different from other year group means ($P < 0.05$). Similar to fat percentage, a reduction could be observed in protein percentage in the study (Table 1). Results clearly indicate that elevated milk production according to years reflected as a drop in milk fat and protein percentage in the investigated farm. Therefore, we can recommend focusing on selection of the most suitable sires used in observed farm for heifers insemination in the future.

In TD evaluation, no significant difference was obtained among logSCC means (Table 1). Tanèin (2013) informed that the periods after calving and the end of lactation are generally considered as critical for udder health. Obtained highest mean in the first TD group (5.05 ± 0.61) might be assumed as an argument for the reached result.

Of the different production traits, dMY mean was lowest in first TD and highest in second TD (Table 1). A

general concept that, Holstein cows reach to peak milk yield approximately in six weeks post-calving (Rehák *et al.*, 2012). Besides, gradually decline could be seen in dMY means related to lactational persistency in evaluated cows. Similarly as mentioned already, selection of sires used for heifers mating should be more precise and effective (Šafus *et al.*, 2005).

In spite of highest fat percentage obtained in first TD, a linear impairment was attractive (Table 1). Besides, the lowest fat percentage of second TD group supports the earlier result on calculated highest dMY in this period. In agreement with this result, lowest protein ratio was determined in the second TD. The decline in fat and protein percentage in the peak milk production period (TD 2) could be explained with the antagonist relationship between milk yield and dry matter ratio of milk as well as by negative energy balance during post-partum period (Ducháček *et al.*, 2013).

Estimated correlation coefficients are presented in Table 2. Negative correlation between logSCC and dMY reflects inverse effect of SCC on milk production level and it can be assumed as unsurprised result. On the other hand, logSCC significantly correlated with protein percentage ($r = 0.168$, $P < 0.01$). This clearly indicates using possibilities of some protein fractions for detecting milk quality similar to SCC. Besides, estimated negatively significant ($P < 0.01$) correlations of dMY with F% and P% could be assessed as inevitable, however generally accepted result. Also, determined positively significant ($P < 0.01$) correlation between fat and protein percentage points out that both

TABLE 2: Correlation coefficients between milk components

Component	dMY	Fat	Protein
logSCC	-0.52	0.13	0.168**
dMY		-0.363**	-0.335**
Fat			0.457**

** : $P < 0.01$

parameters should be regarded for monitoring milk quality in dairy operations.

Results showed that SCC and some milk fractions were under significant effect of regarded factors. That's why, eliminating effective environmental factors is highly crucial to obtain more quality and quantity milk from first lactating cows. Also, assessing multiple milk parameters are suggested to dairy owners in animal selection for subsequent generations.

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