

Seasonal and Milking-to-Milking Variations in Cow Milk Fat, Protein and Somatic Cell Counts

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Abstract

The first objective of this study was to examine milking-to-milking variations in milk fat, protein and SCC (somatic cell count). The second objective of this study was to examine variations of milk components (fat, protein and SCC) over a period of six months (April-September 2010) at Agricultural Research Development Station Simnic. A total of 128 milk samples (64 morning milking and 64 evening milking ones) from milk bulk tank commingled from 90±4 Holstein cows, were collected and analyzed for fat, protein and SCC. Data suggested that milking period effects milk fat, making the fat percentage lower in the morning compared with the evening milking period, effect which was not similar in protein content. Seasonal differences in milk fat and protein were also investigated. The season of year had influenced SCC, fat and protein: SCC increased, while fat and protein decreased. The period of the day when milking took place and the season influenced fat, protein and SCC, but the composition of milk, as well as its hygienic quality, fell within the applicable standards for raw milk.

Keywords: evening milking, fat, morning milking, protein, somatic cell count

Introduction

The main factors of milk chemical composition variation are well known and have long been the subject of experimental research. This variation is linked to cows (days in milk, breed, health, completeness of milking) or the environment (season and feeding). Among the environmental factors, nutrition plays a predominant role especially the amount of diet supplied and the nature of the ratio.

It has been reported that protein percentage has less day-to-day than milking-to-milking variation, with protein percentage 0.09 points higher in the evening (Quist *et al.*, 2008). Fat percentage has more milking-to-milking variation than protein percentage, with fat percentage 0.32 points higher in the evening (Quist *et al.*, 2008).

The significantly higher fat content at 6-h compared with the 12-h milking interval during the first half of the milking is probably related to the way oxytocin provokes active transport of high-fat alveolar milk. Thus, the high-fat alveolar milk ejected at the end of the 12-h milking interval was not totally transferred along the mammary ducts before the milking ended (Lollivier *et al.*, 2002). Therefore, when the cows were milked 6-h later, this high-fat alveolar milk was readily available in the foremilk, as well as at the beginning of the milking. Weiss *et al.* (2002) also reported higher milk fat levels with decreasing milking interval.

Somatic cells are mostly cells of the immune system (80% in uninfected quarters, 99% in mastitic quarters). These somatic cells are part of the natural defense mechanism and include lymphocytes, macrophages, polymor-

phonuclear cells and some epithelial cells. Somatic cells are therefore a reflection of the inflammatory response to an intramammary infection or another trigger of the immune system. Somatic cell counts can indicate subclinical mastitis in herds or individuals. Infection status has the largest effect on SCC, even if the infection is on a short term. There is variation in SCC throughout milking, as well as diurnal variation from milking to milking. Diurnal variation consists of higher SCC in the evening than in the morning milkings, and the difference is assumed to be due to the interval between milkings.

The season affects milk component percentages and SCC, as Quist *et al.* (2008) also reported, as an inverse relationship between milk yield and component percentages, with summer milk production being higher, but percentages of fat and protein being reduced compared with the fall production and the one from winter months. Ng-Kwai-Hang *et al.* (1984) concluded that milk and component yield variations were dependent on environmental conditions.

The common seasonal trend in SCC involves peaking in the late summer and decreasing to a low during the winter months (Gavan *et al.*, 2009). Nevertheless, Ng-Kwai-Hang *et al.* (1984) found that SCC peaked during the winter months and was low in summer months, which was attributed to the cows being kept indoors in the winter and on pasture in the summer.

The main objective of this study was to describe the milking-to-milking variation of milk fat, protein percentages and SCC. Additional objectives were to investigate

the seasonal factors that affect milk fat, protein content and SCC.

Materials and methods

The present study was conducted during April 2010 to September 2010 at Agricultural Research and Development Station Simnic Craiova (Romania). Somatic cell count was estimated using SOMASCOPE milk test MK II (Delta instruments). Fat and protein were determined using Ultrasonic Milk Analyzers ECOMILK (EON Trading). Assays were made on 128 composite milk samples collected in sterile bottles directly from the bulk milk tank. The milk samples were collected twice per day, after each milking.

Descriptive statistics-consisting of the mean, standard deviation, were derived for milk fat, protein and SCC. SCC were transformed to the logarithm for analysis, to avoid bias of the mean by extremely high raw SCC. The variability of fat and protein was calculated by subtracting the lowest monthly average observed in the morning milking or evening milking from the highest monthly average.

Results and discussion

The milking period (morning vs. evening) considerable contributed to milk fat percentage variation.

Both mean fat and protein percentage peaked in the evening; however, fat increased from the morning milking to peak at the evening milking, whereas protein decreased from morning to evening. The mean fat content were spring morning 3.91 ± 0.23 , spring evening 4.08 ± 0.19 , summer morning 3.51 ± 0.31 , summer evening 3.93 ± 0.25 and protein content was spring morning 3.41 ± 0.05 , spring evening 3.45 ± 0.14 , summer morning 3.16 ± 0.11 , summer evening 3.25 ± 0.1 . The protein percentage had less variability than the fat percentage from milking to milking as shown in Tab. 1. The patterns of mean fat and protein percentage were consistent with those of Quist *et al.* (2008) and Verdi *et al.* (1987) who found that fat and protein percentages were higher in the evening milkings. Their results involved a herd milked also on a 12 hours interval. An increase in fat during the milking process has been reported in several studies (Lollivier *et al.*, 2002) probably as a result of releasing the high fat milk which was not ejected at the morning milking.

Ng-Kwai-Hang *et al.* (1984) found a difference of 0.65 for fat concentration between the morning milking and the evening milking and 0.26 respectively for protein content. Samples analysed in our study showed quite a small variability in milking-to-milking fat percentage, ranging from 0.06- 0.42. Milk protein proved less variable than the fat, with only 0.04-0.20 variation.

Milking-to-milking variation was not always consistent for milk fat, protein percentages and SCC. Milking

period measurements can peak or drop drastically for various reasons, and if one test per day is performed at one of these milkings, the results of that test day can misinform the producer. Although in-line daily measurements of fat and protein are not currently available from milking equipment, as it is a technology that is foreseeable in the future.

Regarding the season, the mean fat content coming from evening milking peaked in June (4.16%), but dropped to 3.66% in August, comparing with the morning milking which showed a constant decrease from 4.17 in April to 3.68 in September. Both fat and protein decreased slightly from 3.39 to 3.04 for fat, and 3.35 to 3.15, respectively for protein. These results oppose with those of Agabriel *et al.* (1993), where fat and protein were low in winter, but they increased after the return of the cows out to pasture. The steep rise in somatic cell counts in May is coincident with the cows being placed on pasture. Winters are long and cold, starting in November and continuing until late March. Internment of the cows in barns with approaching winter, confronts cows with new environmental stresses and bacterial challenges. Kennedy *et al.* (1982) noted that incidence mastitis is much higher during winter in areas where cows are indoors during the winter and on pasture in summer.

Spring grass or pasturing may have a specific transient and beneficial effect on milk protein. Seasonal increases in milk protein have been recorded for cows that were well fed during the winter (Agabriel *et al.*, 1993). The chemical composition of milk can be highly variable in concentration, fat and protein, which can vary independently, regardless of the factors that are difficult to control on the short term (calving period, type of feeding).

Average seasonal differences for fat and protein followed the expected seasonal trend with the highest value for fat 0.4 % in spring and for protein 0.14% in summer (Tab. 2). It has been found in the present study that the content of protein is rather constant throughout the seasons. This agrees with other studies that have shown that protein composition is influenced by feeding practices only to a small extent (Schopen *et al.*, 2009; Heck *et al.*, 2009; Coulon *et al.*, 1998; Ozrenk and Selcuk Inci, 2008).

In previous studies Lujerdean *et al.* (2007), Gavan *et al.* (2009) reported a lower fluctuation between the warm and the cold season for milk components.

The seasonal difference observed by Verdi *et al.* (1986) was 0.67% for fat and 0.3 to 0.5% for protein concentration.

Chandan *et al.* (2006) found a 10% variation for both fat and protein in milk with lowest levels in summer (July and August) and the highest levels in autumn (October and November).

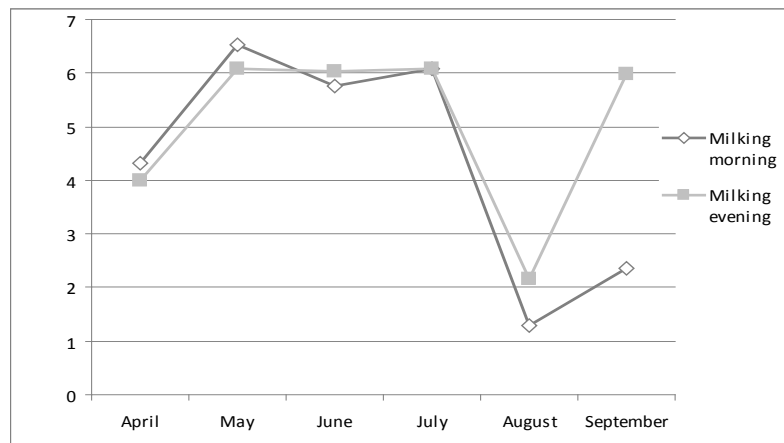
The mean fat and protein percentages were highest in morning and decreased in summer. In the evening, they continued to decline at a slower rate through spring and summer. The differences for fat from season to season were significant ($P < 0.01$), but were not significant ($P > 0.05$) in

Tab. 1. Milking-to-milking variations in fat and protein content

Month of lactation	Morning fat content		Evening fat content		Difference	P value	Morning protein content		Evening protein content		Difference	P value
	Mean%	±SD%	Mean%	±SD%			Mean%	±SD%	Mean%	±SD%		
April	4.17	±1.02	4.11	±0.24	+0.06	p>0.05	3.39	±0.06	3.35	±0.03	+0.04	NS
May	3.71	±0.21	3.99	±0.24	-0.28	p<0.05	3.46	±0.16	3.43	±0.15	+0.03	NS
June	3.87	±0.09	4.16	±0.18	-0.03	p<0.05	3.37	±0.11	3.28	±0.18	+0.09	p<0.05
Spring	3.91	0.44	4.08	±0.22	-0.17	p<0.05	3.40	±0.11	3.35	±0.12	+0.05	p<0.05
July	3.73	±0.64	4.15	±0.22	-0.42	p<0.01	3.15	±0.39	3.35	±0.23	-0.20	p<0.01
August	3.12	±1.14	3.66	±0.91	+0.54	p<0.01	3.04	±0.33	3.15	±0.24	-0.11	p<0.05
September	3.68	±0.21	4.00	±0.7	-0.32	p<0.05	3.29	±0.21	3.25	±0.24	+0.04	NS
Summer	3.51	0.66	3.93	±0.61	-0.42	p<0.01	3.16	0.31	3.21	±0.23	-0.05	p<0.05

Tab. 2. Seasonal variations of fat and protein content

	Spring				Summer				Difference fat		Difference protein	
	Fat%	±SD%	Protein%	±SD%	Fat%	±SD%	Protein%	±SD%	±	p value	±	p value
Morning	3.91	0.44	3.40	0.11	3.51	0.66	3.16	0.31	+0.4	p<0.01	+0.11	p<0.05
Evening	4.08	0.22	3.35	0.12	3.93	0.61	3.21	0.23	+0.15	p<0.05	+0.14	p<0.05

Fig. 1. The number of somatic cells ($\times 100\,000/\text{ml}$) in raw milk

the evening. Protein differences were relatively small and accounted for only 0.11 to 0.14 of total variation.

There was a steady decline in fat and mean protein content count from spring to summer. The lowest fat and protein percentage are in summer morning for both characters.

The SCC results (Fig. 1) illustrate that throughout the studied period, no consistent milking-to-milking variations were present; however, evening milkings had the highest value each day.

A programme of monitoring udder health was introduced in September because of the high SCC registered in the morning (599 000 cells/ml). The animals with subclinical mastitis were isolated for treatment. Subclinical mastitis was diagnosed by using California Mastitis test. As a result, SCC from morning milking was only about half the value from the evening milking (235 000 cells/ml comparing with 599 000 cells/ml). A recent study with 15 milking samples collected consecutively over 3 day re-

ported no consistent milking-to-milking variation and was always lower at the morning than the evening milking (Quist *et al.*, 2008). Producers should not rely on a single test day SCC when managing mastitis.

Somatic cell counts are particularly useful to follow individual quarters or cows over a season. Only quarters and cows with long term high cell counts are indicators of a chronic infection and require further management attention. Short term high counts are not necessarily a reason for concern since an apparent immediate cure occurred.

It is unlikely that the pattern of somatic cell counts in this study was a chance occurrence, as the seasonal pattern has been repeated in subsequent years (Gavan *et al.*, 2009). SCC demonstrated a seasonal trend, with higher SCC during the summer months than winter, data also observed by others authors. In Arizona, Nelson *et al.* (1967) found somatic cell counts highest from July to October and it began to decline after October. Bodoh *et al.* (1976) found seasonal patterns in Wisconsin inconsistent across

years with a maximum in July in one year and sustained high cell counts from August through December in another year. In France (Kennedy *et al.*, 1982), the highest somatic cell counts occurred between August and September, and in the Netherlands (Kennedy *et al.*, 1982), the highest cell counts was in November although testing was not through the winter. In our study SCC dropped dramatically in August from a mean value of 608 000 cells/ml to 128 000, and respectively 235 000 cells/ml. This change was obtained by monitoring subclinical mastitis using California Mastitis test.

Conclusions

Samples analysed in our study showed quite a small variability in milking-to-milking fat and protein content.

SCC fluctuation from milking-to-milking was not high, except for September evenings when SCC decline dramatically as a result of detecting animals with subclinical mastitis.

Further study is required to understand how season influence fat, protein and SCC, and the possibility to manipulate independently the mean concentrations of fat, protein and SCC.

Understanding the variability in milk fat, protein percentages and SCC is important when making management decisions and in milk-recording programs.

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