J. Food and Dairy Sci., Mansoura Univ., Vol. 2 (8): 469 - 480, 2011

EFFECT OF PARITY SEASON AND STAGE OF LACTATION ON SOMATIC CELL COUNT MILK YIELD AND QUALITY OF FRIESIAN COWS

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ABSTRACT

The objective of this study was to evaluate the effect of some factors on somatic cell count (SCC) in milk, milk yield (MY) and milk compassion, as well as he relationship between SCC, MY and milk quality of Friesian cows. A total of 1250 test-day were studied for 145 dairy Friesian cows during the consecutive period from March 2009 to April 2010 were collected. All Friesian cows ranged between 400 and 600 kg live body weight, 3 -13 years of age and 1- 8 parities. Cows of the experimental period were fed concentrate feed mixture (CFM), berseem hay, rice straw and corn silage (summer ration) and CFM, fresh berseem and rice straw (winter ration). Throughout the experimental period, cows were machine milked and daily milk yield was individually recorded. Milk composition was determined. Milk samples for SCC determination were collected monthly of calving to the end of lactation. Results revealed that SCC significantly (P<0.05) decreased in second and third- parities and higher in four and fifth parities. Milk yield was significantly (P<0.05) higher in second parity, and decreased in other parities**.** The SCC was significantly higher in summer, moderate in spring and lower in winter and autumn seasons. Milk yield was significantly higher in winter, moderate in autumn and decreased in summer and spring seasons. Milk protein and lactose were significantly higher (P<0.01) in summer and lower in winter season. The SCC, milk protein and lactose increased in summer ration, but MY decreased significantly (P<0.05) in summer ration. Somatic cell count increased significantly (P<0.01) at first 30 days of lactation (469×10^3 /ml) (early lactation), highly significantly (P<0.001) in the end of lactation (597×10^3 /ml), and deceased after 90 and 180 days of lactation. Milk yield was significantly (P<0.05) decreased by increasing SCC**.** Protein content was significantly (P<0.05) larger in milk (2.42 to 2.81), when SCC increased (200×10^3)to 1000×10^3 cell/ml milk. An Increase in SCC during the late of lactation was accompanied with decrease in MY, fat, lactose percentages and milk quality.

Keywords: Friesian, somatic cell count, milk yield, stage of lactation, season and parity

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INTRODUCTION

The total somatic cell count (SCC) of milk can vary because of a number of external factors. Bovine mastitis, or inflammation of the mammary gland is the most important cause in elevating milk SCC, and stage of lactation, season, MY and number of lactations are all also known to influence milk SCC (Kennedy *et al*., 1982, Brolund, 1985, Verdi, and Barbano 1991 and Harmon 1994). Elevated milk SCC is associated with altered protein distribution, decreased casein and lactose levels (Mitchell, *et al*., 1986 and Munro, *et al*., 1984).

Seasonal patterns can also be found in individual cow SCC (ICSCC), with generally the highest ICSCC in July and August (Bodoh *et al*., 1976;

Salsberg *et al*., 1984). Green *et al*. (2006) suggested that part of the seasonal variation of bulk milk SCC (BMSCC) was caused by the larger proportion of cows with prolonged high ICSCC in the summer. Herds with a seasonal calving pattern in the southern hemisphere; for example, in New Zealand, had the highest BMSCC around the calving period in the winter months (July to September). The lowest BMSCC in these herds occurred in September to October, shortly after the calving period, and BMSCC then slowly increased again toward the end of the season in April to May (Clements *et al*., 2005).

Seasonal effects have also been reported for the incidence rate of clinical mastitis (IRCM), with the highest IRCM for streptococci and coliforms in the summer months of June to August in confined US dairy herds (Erskine *et al*., 1988; Hogan *et al*., 1989; Makovec and Ruegg, 2003). Because the epidemiology of each pathogen is unique, the effect on BMSCC and IRCM and its relationship to climatic and environmental factors might be different. Summer humidity and temperature increase coliform counts in bedding material, resulting in an increased coliform IRCM (Smith *et al*., 1985; Erskine *et al*., 1988). Zadoks *et al*. (2005), the proportion of fecal samples containing *Strep. uberis* was larger during the summer grazing season than during winter**.**

The SCC is an indicator of the intensity of the cellular immune defense, and it represents a marker of the sanitary state of the udder. During the course of intramammary infection, leucocytes migrate from the blood towards the mammary gland leading to increase SCC in the milk. SCC represents a valuable tool for the prevalence assessment and screening mastitis. A common accepted SCC values had not been established (Gonzalez-Rodriguez *et al,* 1995 and Gonzalo *et al,* 1994 and 2002).

Improving milk production remains a challenge for tropical and developing countries. Several studies have been done on zebu cattle with the ambition of increasing milk production by improved feeding and management (Coulibaly and Nialibouli, 1998; Bonfoh *et al*., 2005; Sidibé-Anago *et al*., 2006). An important management tool in dairy production is milk recording based on knowledge about the relative day-to-day variation in MY and composition.

The objective of this study was to evaluate the effects of parity, season and stage of lactation on SCC in milk, MY and milk compassion, as well as the relationship between SCC, MY and milk quality of Friesian cows.

MATERIALS AND METHODS

A total number of 1250 test-day were studied for 135 dairy Friesian cows during the consecutive period from March 2009 to April 2010 collected from Sakha Animal Production Research Station belonging to Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture. All cows ranged between 400 and 600 kg live body weight, 3 -13 years of age and 1- 8 parities.

Animals were housed in semi open sheds and fed traditional summer ration consisted of concentrate feed mixture, berseem hay, rice straw and corn silage and traditional winter ration consisted of concentrate feed mixture, fresh berseem and rice straw. Cows were fed to cover the recommended requirements according to NRC (2001) for dairy Friesian cows. Cows were fed in group feeding assigned according to live body weight, milk yield and reproductive status. Concentrate feed mixture and rice straw was offered two times daily, while fresh berseem, berseem hay or corn silage was offered once daily. Water was available for animals all the day round.

Cows were machine milked twice daily at 6:00 and 17:00 h. Daily milk yield (morning and evening) was individually recorded for the months of lactation. Milk samples were monthly collected to determine milk composition using Milko-Scan (Model 133B).

After bacteriological plating, SCC were determined for each milk sample with a Fossomatic 90 (A/S N Foss Electric, Hillerød, Denmark) between 24 and 48 h postcollection by the previously described method (Gonzalo *et al*., 1993).

The obtained data were statistically analyzed using SAS (1990). The significant differences among treatment groups were tested using Duncan's Multiple Range Test (Duncan, 1955). The statistical model was

$Y_{ij} = U + A_i + e_{ij}$.

Where:

Y_{ij} = Observed traits

U = Overall mean

A_i = Experimental

e_{ij} = Random error

RESULTS AND DISCUSSION

Data in Table (1) showe that SCC significantly (P<0.05) decreased in second and third- parities and was higher in four and fifth parities. Milk yield was significantly (P<0.05) higher in second parity and decreased in other parities. However, milk composition (MC) was not significant.

Table (1): Least squares means (±SE) of SCC, MY and M.C. by parity.

Item	Parities				
	1	2	3	4	≥5
SCC ×10³ /ml	397±24^{b}	296±24^{c}	367±27^{bc}	412±27^{ab}	471±18^{a}
MY (kg)	12.33±0.3^{b}	13.92±0.2^{a}	12.65±0.3^{b}	12.61±0.3^{b}	12.55±0.2^{b}
M.C.					
Fat %	4.52±0.37	3.85±0.36	3.46±0.42	3.55±0.41	3.41±0.28
Protein %	2.50±0.2	2.62±0.2	2.49±0.3	2.54±0.2	2.55±0.2
Lactose %	4.19±0.02	4.21±0.02	4.17±0.02	4.22±0.02	4.18±0.02

[a and b]: Means within the same row with different superscripts are significantly different (P<0.05).

The SCC increases with the age and number of lactation in infected milk herds. Monardes, (1994) and Gaafar *et al*, (2010) showed that SCC increased significantly (P<0.05) with the progress number of lactation or parity. The SCC level considered normal under 200000 cells/ml of milk, although it may be less in the first lactation. Generally, SCC increases with the age and number of lactation of infected cows. The SCC in udder, which is not contaminated, does not seem to vary with the age (Monardes, 1984). However, MY was significantly (P<0.05) increased in second parity and decreased during third to fifen- parities. The present results came in agreement with the findings of Millogo, *et al*. (2009), who found that high SCC was linked to lower MY. It is a well known fact that increased SCC is correlated to decreased milk yield (Harmon, 1994).

Parity has been identified as a risk indicator for clinical mastitis in several observational studies (Schutz *et al*., 1990; Weller *et al*., 1992; Laevens *et al*., 1997; Barkema *et al*., 1998; Pryce *et al*., 1999). All these studies reported that the incidence of clinical mastitis increased with increasing parity.

Generally, SCC increases with increased parity, whereas MY decreased with increased parity.

Data in Table (2) illustrate the effect of season on SCC, MY and M.C.It could be seen that SCC was significantly higher in the significantly summer, moderate in spring and lower in winter and autumn. However, MY was significantly higher in winter, moderate in autumn and decreased in summer and spring season.

Table (2): Least squares means (±SE) of SCC, MY and milk composition by season.

Item	Seasons			
	Winter	Spring	Summer	Autumn
SCC $\times 10^3$ /ml	346 ± 17.1^c	439 ± 24.4^b	593 ± 28.8^a	357 ± 18.3^c
MY (kg)	15.2 ± 0.29^a	12.1 ± 0.25^c	11.17 ± 0.17^c	13.5 ± 0.19^b
Milk composition:				
Fat %	3.99±0.27	3.64±0.38	3.80±0.44	3.46±0.23
Protein %	2.45 ± 0.02^c	2.55 ± 0.02^b	2.92 ± 0.03^a	2.49 ± 0.02^c
Lactose %	4.06 ± 0.01^c	4.06 ± 0.01^c	4.43 ± 0.02^a	4.27 ± 0.02^b

[a and b]: Means within the same row with different superscripts are significantly different (P<0.05).

The obtained results agree with Bodoh *et al*., (1976) and Paape *et al*., (1973), who found that season has been found to affect SCC, with counts generally is being the lowest in winter and highest in summer (Bodoh *et al*., 1976 and Paape *et al*., 1973). Waage *et al*. (1998) indicated that a decrease in BMSCC was associated with an increased risk for clinical mastitis in heifers. Heifers calving in late spring or summer are at a higher risk for developing clinical mastitis than heifers calving during cool weather months (Waage *et al*., 1998).The status of infection is determined and influenced by the level of the lactation. All the animals which were free from infection have elevated SCC immediately after giving partum; so, a fast decrease is observed after birth in non-infected animals or quarters (Monardes, 1994 and Harmon and Reneau, 1993). Mrode and Swanson (1996) showed a negative relationship between milk production and SCC in later parities due partly to culling in the first parity on the basis of mastitis and milk production

Milk protein and lactose were significantly (P<0.01) higher in summer and lower in winter. However, increased SCC was due to increased milk protein, and lactose in summer season (Table 2). The results agree with Millogo, *et al*. (2009), who found that the relative day-to-day variation in protein and lactose contents was larger when SCC increased.

Nutrition significantly affected (P<0.05) on SCC, MY and protein contents Table (3). The SCC, milk protein and lactose increased in summer ration, but, milk yield decreased significantly (P<0.05) in summer ration.

Improving milk production remains a challenge for tropical and developing countries. Several studies have been done on zebu cattle with the ambition of increasing milk production by improved feeding and management (Coulibaly and Nialibouli, 1998; Bonfoh *et al*., 2005; Sidibé-Anago *et al*., 2006). An important management tool in dairy production is milk recording based on knowledge about the relative day-to-day variation in MY and composition.

Table (3): Least squares means (±SE) of SCC, MY and M.C. by nutrition.

Item	Nutrition	
	Summer ration	Winter ration
SCC $\times 10^3$ /ml	425.1 ±15.7[a]	376.5 ±14.2[b]
MY (kg)	11.84±0.14[b]	13.97 ±0.16[a]
Milk composition:		
Fat %	3.56±0.24	3.87±0.22
Protein %	2.61±0.01[a]	2.45±0.01[b]
Lactose %	4.31±0.01[a]	4.10±0.01[b]

[a and b]: Means within the same row with different superscripts are significantly different (P<0.05).

Somatic cell count increased significantly (P<0.01) on first 30 day of lactation (469$\times 10^3$ /ml) (early lactation), and highly significantly (P<0.001) in the end of lactation (597$\times 10^3$ /ml)(270 day of lactation), but, decreased on 90 and 180 days of lactation (326 and 373 $\times 10^3$ /ml), respectively, (Table 4).

These results suggest that after controlling for infection status, an increase in SCC at the end of lactation may signify the onset of the initial processes of involution (Kari and Newman, 2008). The SCC is usually elevated at the time of calving and then decreases at a rapid rate, particularly during the first 2 wk of lactation (Dohoo, 1984). Somatic cell count tended to decrease with the progress of lactation up to the peak period (2nd month), and increased significantly (P<0.05) thenafter with the progress month of lactation (Gaafar *et al*,. 2010).

The total SCC of milk can vary because of a number of external factors. Bovine mastitis, or inflammation of the mammary gland, is the most important cause of elevated milk SCC, and stage of lactation, season, MY and number of lactations are all also known to influence milk SCC (Kennedy *et al*., 1982, Brolund, 1985, Verdi, and Barbano 1991 and Harmon 1994). Elevated milk SCC is associated with altered protein distribution, decreased casein and lactose levels (Mitchell, *et al*., 1986 and Munro, *et al*., 1984). These results are in accordance with those obtained by Ceron-Munoz *et al*. (2002), who found that SCC decreased in the second month of lactation and increased thenafter up to the ninth month of lactation. Farghaly (2002) showed that stage of lactation affected significantly milk SCC, since milk SCC were the highest shortly after calving, dropped to a minimum between 40 and 80 days postpartum and then steadily increased until the end of lactation

Milk yield was significantly higher in 90 days of lactation (17.1 kg), moderate in early lactation (first 30 days) and 180 days of lactation (12.8 and 14.2 kg, respectively) and decreased in 270 days of lactation (9.5 kg, the end of lactation) Table 4.

Table (4): Least squares means (±SE) of SCC, MY and M.C. by stage of lactation

Item	Stage of lactation			
	30 day	90 day	180 day	270 day
SCC $\times 10^3$ /ml	469±27.4^b	326±19.6^c	373± 23.3^c	597±28.8^a
MY (kg)	12.8±0.18^c	17.1±0.23^a	14.2±0.27^b	9.5±0.16^d
Milk composition:				
Fat %	3.78±0.29	3.54±0.28	3.60±0.32	3.86±0.27
Protein %	2.60±0.04^{bc}	2.51± 0.03^c	2.62±0.03^b	2.89±0.03^a
Lactose %	4.11±0.01^b	4.39±0.01^a	4.33±0.02^a	4.07±0.02^b

$^{a\ and\ b}$: Means within the same row with different superscripts are significantly different (P<0.05).

Milk protein significantly (P<0.05) decreased in 90 days of lactation and increased in 270 days of lactation. However, lactose was higher in 90 and 180 days of lactation, compared with the first and end of lactation (Table 4).

Stage of lactation also influences the risk on occurrence of clinical mastitis, which even differed among heifers and multiparous cows (Barkema *et al*., 1998). High SCC in early lactation is most likely caused by the presence of minor pathogens, whereas high SCC of cows being more than 90 days in milk is primarily caused by *C. bovis*. The prevalence of major pathogens in quarters with ≥100,000 cells/ml decreased in the course of lactation (De Haas, 2003).

Results in Table (5) show the effect of SCC on MY and M.C. It could be found that milk yield was significantly (P<0.05) decreased by increased SCC**.**

Table (5): Least squares means (±SE) of MY and milk composition by SCC.

SCC$\times 10^3$	Milk compassion			
	MY	Fat	Protein	Lactose
<200	15.22±0.14^a	3.85±0.22	2.42±0.01^c	4.24±0.01^a
200-399	13.39±0.25^b	3.64±0.38	2.64±0.02^b	4.19±0.02^{ab}
400-1000	12.33±0.28^c	3.53±0.42	2.57±0.03^b	4.17±0.02^b
>1000	11.04±0.29^c	3.49±0.45	2.81±0.03^a	4.01±0.03^c

$^{a\ and\ b}$: Means within the same row with different superscripts are significantly different (P<0.05).

The results come in agreement agreement with the Millogo, *et al*. (2009) and Juozaitiene *et al*. (2006), who reported lower milk production in cows with high SCC. The two fold increase in SCC above 50,000 cells/ml resulted in a milk yield loss of 0.4 kg/day in primiparous cows and 0.6 kg/day in multiparous cow. The increased SCC indicates the mammary gland inflammation, which are not treated results in the decrease of MY and its quality, and consequently in the economic losses for a farmer (Gardzina *et al.*, 2000; Malinowski, 2001). Roger and Peter (1995) indicated that a herd with a SCC of about 200,000/ml will have minimal losses in MY, but for every increase in SCC of 100,000/ml, there will be a reduction of 2.5% in MY. Gaafar *et al*, (2010) showed that milk yield decreased significantly ($P<0.05$) with increasing SCC in milk.

Protein percentage was significantly ($P<0.05$) larger in milk (2.42 to 2.81), when SCC increased 200,000 to 1,000,000 cell/ml milk, the results were similar to that of Millogo, *et al*. (2009), who found that the relative day-to-day variation in protein content was larger (15%) when SCC increased.

Fat and lactose content were lower in milk with higher SCC. The results agree with the Dang and Anand (2007) and Berglund *et al*. (2007), who reported lower lactose content in connection with higher SCC which was also observed by Millogo, *et al*. (2009). The relative day-to-day variation in MY and milk composition for machine-milked dairy cows has been estimated to be about 6-8% for yield, 5-8% for fat content, 1.5 – 2% for protein content and just above 1% for lactose (Sjaunja, 1986). According to the same author, the variation can be explained by the stage of lactation, parity, health, season and milking interval.

The relative day-to-day variation of SCC was 7.8% with SCC (Log10)= 5.13 as on average. SCC differs in the different milk fractions. Milk yield, milk fat content and lactose content were higher in samples with SCC <200,000 cells/ml, compared to samples with SCC > 200,000 cells/ml (Millogo, *et al*., 2009) In contrast, milk protein content was lower. The samples with SCC <200,000 cells/ml also showed smaller variations of fraction, the lowest concentration in the first alveolar fraction (Millogo, *et al*. 2009); SCC levels are also higher during removal of the alveolar milk towards the end of milking (Sarikaya and Bruckmaier, 2006). Hutton *et al*. (1990) found that to determine mastitis control strategies that were more likely associated with herds with good to excellent (herd average sec <283,000 cells/ml) as compared with herds with fair to poor control of mastitis (herd geometric average sec >283,000 cells/ml). The level of mastitis infection in a dairy herd can have a significant impact on herd profitability. Losses due to mastitis include decrease in milk production, increase in treatment costs, discarded milk, premature culling, death, decreased genetic potential, decreased reproductive performance, load rejection due to violation of SCC or antibiotic residues and loss of milk quality premiums (Fetrow, 2000, Oliver *et al*., 2000 and Ruegg, and Reinemann 2002).

Somatic cell counts are accepted as the international standard measurement of milk quality and, for this reason, are rapidly being made available in developing countries where they have not previously been utilized.

CONCLUSION

From the current study it could be concluded that that increasing SCC in milk decreased MY and composition and resulted in poor quality of Friesian cows. Somatic cell count in milk was effected by season, parity and stage of lactation.

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تـأثير عدد الـولادات، الموسـم ومرحلـة الحليـب علـي عدد الخلايـا الجسـدية وإنتـاج وجودة اللبن للأبقار الفريزيان

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تهدف هذه الدراسة إلى معرفة تأثير عدد الولادات، الموسم ومرحلة الحليب علي عدد الخلايا الجسدية وإنتاج وتركيب اللبن وكذلك علاقة عدد الخلايا الجسدية بإنتاج وجودة اللبن في أبقار الفريزيان. استخدم في هذه الدراسة ١٢٥٠ اختبار يومي لعدد ١٣٥ بقرة فريزيان خلال عام من مارس ٢٠٠٩ حتى أبريل ٢٠١٠. الأبقار يتراوح أوزانها من٤٠٠ إلي ٦٠٠ كجم وعدد ولادات من ١-٨ ولادة. غذيت الأبقار في الفترة التجريبية علي علف مركز ودريس برسيم وسيلاج أذرة وقش أرز (عليقه صيفية) وعلف مركز وبرسيم وقش أرز (عليقه شتوية). و وكان يتم حلب الأبقار حلب آلي وتسجيل اللبن لكل بقرة يوميا. وتم أخذ عينات اللبن مرة كل شهر لتقدير عدد الخلايا الجسدية ومكونات اللبن.

ويمكن تلخيص النتائج المتحصل عليها فيما يلي:

- انخفض عدد الخلايا الجسدية انخفاض معنوي ($P<0.05$) خلال موسم الولادة الثاني والثالث وازداد بعد ذلك بزيادة عدد الولادات. أما إنتاج اللبن فقد زاد زيادة معنوية ($P<0.05$) في الموسم الثاني وانخفض في باقي المواسم.
- زادت عدد الخلايا الجسدية زيادة معنوية في فصل الصيف وانخفضت في فصلي الشتاء والخريف بينما كانت متوسطة في فصل الربيع. أما إنتاج اللبن فقد ارتفع في الشتاء وانخفض في الصيف. كما ارتفع معنويا ($P<0.01$) كل من البروتين واللاكتوز في الصيف وانخفضا في الشتاء.
- أدت العليقه الصيفية إلي زيادة عدد الخلايا الجسدية وبروتين ولاكتوز اللبن بينما انخفض معنويا ($P<0.05$) إنتاج اللبن.
- زاد عدد الخلايا الجسدية زيادة معنوية ($P<0.001$) خلال الشهر الأول من الحليب ٤٦٩×١٠^٣ /مل وفي نهاية الحليب ٥٩٧×١٠^٣ /مل بينما انخفضت أثناء اليوم ٩٠ و١٨٠ من مرحلة الحليب. بينما انخفض إنتاج اللبن بزيادة عدد الخلايا الجسدية.
- ارتفع بروتين البن من ٢,٤٢ إلي ٢,٨١ عندما زاد عدد الخلايا الجسدية في اللبن من ٢٠٠×١٠^٣ إلي ١٠٠٠×١٠^٣ /مل لبن.
- أدت زيادة عدد الخلايا الجسدية في اللبن إلي انخفاض إنتاج البن ومكونات اللبن من الدهن واللاكتوز وكذلك انخفاض جودة اللبن.

قام بتحكيم البحث

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