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Research Article

Effect of the Degree of Udder Contamination in Dairy Cows on the Somatic Cell Count in Milk

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ABSTRACT

The study includes a total of 310 Black-and-white cows from 9 herds throughout the period from November 2010 till January 2011. The farms used two rearing technologies (free and tied) and were of different capacity. To assess the degree of udder contamination a 4-grade system has been used. The rearing technology and the farm capacity had a reliable effect on somatic cells count (SCC) in milk. In tied rearing higher SCC have been recorded than in free rearing, a lesser relative share of cows with clean udders (hygiene score -1) and a greater one of cows with contaminated udders (hygiene score 3 and 4). The greatest was the relative share of cows with contaminated udders (hygiene score 3 and 4) and the least clean were the cows in farms with tied rearing and capacity from 50 to 100 cows. Cows with score 1 (clean udder) had the smallest somatic cell count – $172.4x10^3$/ml, which was related to low risk of mastitis diseases. The ones with score 3 and 4 had somatic cell count over $400x10^3$/ml. The availability of more than 20% of cows with udder hygiene score 3 and 4 was an indicator for increased risk of mastitis in the herd and obtaining low quality milk. Somatic cell count in milk depended largely on the maintenance of bedding and the farm hygiene rather than the farm capacity and the rearing technology.

Key Words: Udder hygiene score, somatic cells, dairy cows, free rearing, tied rearing

ÖZET

SÜT SIĞIRLARINDA MEME KONTAMİNASYON DERECESİNİN SÜTTEKİ SOMATİK HÜCRE SAYISI ÜZERİNE ETKİSİ

Çalışma, Kasım 2010'dan Ocak 2011'e kadar olan süre zarfında 9 sürüde bulunan 310 adet siyah alaca ineği kapsamıştır. Çiftlikler farklı kapasitelerde bulunan iki yetiştiricilik sistemini (serbest gezinmeli ve bağlamalı sistem) içermektedir. Meme kirlenme derecesini değerlendirmek için 4-dereceli sistem kullanılmıştır. Sütte somatik hücre sayımının (SHS) yetiştiricilik sistemi ve çiftlik kapasitesi üzerinde güvenilir sonuçları olduğu bulunmuştur. Temiz memelerden (hijyen skoru-1) daha az, kontamine memelerden (hijyen skoru-3 ve 4) ise daha yüksek olmak üzere, bağlamalı sistemde bulunan hayvanların sütlerinde serbest gezinmeli sistemden daha yüksek oranda SHS bulunmuştur.

Kontamine memelere (hijyen skoru-3 ve 4) sahip ineklerin daha fazla olduğu ve temiz memelere sahip ineklerin ise en az sayıda olduğu bağlamalı sistemde çiftlik kapasitesi 50 ile 100 arasında değişmektedir. Hijyen skoru-1 olan (temiz meme) ineklerde somatik hücre sayısı en düşük bulunmuş – 172,4x10^3/ml ve mastitis hastalığı ile ilgili riskin düşük olduğu belirlenmiştir. Hijyen skoru-3 ve 4olanlarda somatik hücre sayısı 400x10^3/ml'nin üzerinde bulunmuştur. Hijyen skoru 3 ve 4 olan memelere sahip olan ineklerin %20'den fazla oranda bulunması, sürü içinde mastitis riskini arttırdığı ve düşük kaliteli sütün oluşumuna neden olduğu belirlenmiştir. Sütte somatik hücre sayısının çiftlik kapasitesi ve yetiştiricilik sisteminden ziyade büyük oranda altlık ve çiftlik hijyenine bağlı olduğu saptanmıştır.

Anahtar Kelimeler: Meme hijyen skoru, somatik hücre, süt sığırları, serbest gezinmeli sistem, bağlamalı sistem

Introduction

Somatic cell count is a factor that has an effect on the quality of milk obtained from dairy cattle farms. Moreover, the high somatic cell count is a reliable indicator of udder mastitis infections (Ruegg, 2006; Tongel and Broucek, 2010). Mastitis is one of the main productive diseases in dairy cows. It results in reduction of milk yield (Rajala-Schultz et al., 1999), increases prevention and treatment costs (Kaneene and Scott-Hurd, 1990) and can seriously influence the cull of animals (Grohn et al., 2005). Crucial for the prevention of mastitis diseases is the maintenance of good udder hygiene. The maintenance of good hygiene in the environment of animals and of the animals themselves corresponds to lower somatic cell count in milk (Barkema et al., 1998; Reneau et al., 2003). Regardless of the improvements in many spheres of the milk industry, the opportunity for maintaining clean cows and reducing the accumulation of bacteria on the teat tips has improved very little. The increase of herd size, poor barn solutions, rare cleaning of aisles and removal of manure, the pressure over producers to increase productivity of milking parlours and the changes in the availability and use of various bedding materials hinder the achievement of a significant success in that sphere.

Recently various systems for assessment of the degree of udder contamination and its relation to the somatic cell count in milk and subclinical mastitis has had ever wider application (Ruegg, 2006; Schreiner and Ruegg, 2003).

Several systems for hygiene assessment have been developed (Cook, 2002; Reneau et al., 2003; Schreiner and Ruegg, 2003) and some of these have been used as indicators for quality and improvement of poor hygiene resulting in udder health problems.

The objective of the study is to find out whether there is some relationship between rearing technology, farm capacity and udder contamination score to somatic cell count in milk obtained in cattle farms.

Materials and Methods

The study has been carried out with a total of 310 Black-and-white cows from 9 herds throughout the period from November 2010 till January 2011. Cattle farms have varied capacity from 20 to 200 animals. Due to the great number of animals in large farms from 100 to 200 cows, 25% of lactating cows have been studied, on farms with capacity from 50 to 100 – 50% of the lactating cows selected ad hoc and on farms with less than 50 cows – all lactating cows Table 1.

Farms have been numbered with numbers from 1 to 9 due to promised confidentiality to owners.

Rearing technology has been presented in the study in two classes: 1 – free and 2 – tied rearing. Free rearing is applied in farms of greater capacity – 3 altogether, in the other 6 tied rearing are applied. Free rearing in all farms is in closed buildings, with individual boxes for rest with rubber beddings. No straw for bedding is provided. Cleaning is done by delta-scraper equipment with automatic operation at every 2 hours. Milking is in a milking parlour.

In tied rearing in all farms beds are 1.90 m long and straw is used for bedding. Manure is removed by a chain-plate conveyor. Milking is on the spot with a central milk line.

To assess the degree of udder contamination a 4-score system of assessment has been used developed by Ruegg (2006), in which 1 is the score of clean udder; 2 – slightly contaminated udder (from 2 to 10% contaminated surface); 3 – medium contaminated udder (10 to 30% contaminated surface) and 4 – heavily contaminated udder (over 30% of contaminated surface). The assessment of udder contamination has been done on a monthly basis immediately before preparing cows for milking.

To record the effect of the percentage of cows with udder hygiene score 3 and 4 herds have been grouped in the following classes: 1 - up to 20%, 2 - from 21 to 30%; 3 - from 31 to 40% and 4 - above 40% of cows with scores 3 and 4.

Table 1. Allocation of farms according to capacity, technology and share of cows included in the study.
Tablo 1. Çiftliklerin kapasitesine, sistemine ve çalışmaya dahil edilen ineklerin payına göre dağılımı.

Farm	Number of lactating cows	Percentage of assessed cows	Number of cows assesses per visit	Rearing technology	Capacity
Farm 1	178		45		
Farm 2	142	25	36	Free	Over 100 cows
Farm 3	110		28		
Farm 4	80		40		
Farm 5	74	50	37		From 50 to 100 cows
Farm 6	58		29		
Farm 7	41		41	Tied	
Farm 8	33	100	33		Up to 50 cows
Farm 9	21		21		

Table 2. Descriptive statistics for average hygiene score and somatic cell count in milk by herds.
Tablo 2. Her bir sürü için ortalama hijyen skoru ve somatik hücre sayısına ait tanımlayıcı istatistikler.

Herd	Number n	Hygiene score Mean ± SE	SCC 10^3/ml Mean ± SE
Herd 1	135	1.87 ± 0.08 ^{ac}	278.7 ± 10.1 ^{ac}
Herd 2	108	2.17 ± 0.10 ^{abc}	311.1 ± 13.7 ^{ab}
Herd 3	78	2.51 ± 0.12 ^{b}	349.6 ± 17.3 ^{b}
Herd 4	120	2.03 ± 0.09 ^{c}	308.1 ± 11.6 ^{ac}
Herd 5	111	2.59 ± 0.09 ^{b}	365.7 ± 13.6 ^{b}
Herd 6	87	2.41 ± 0.12 ^{b}	352.6 ± 16.5 ^{b}
Herd 7	123	2.30 ± 0.09 ^{b}	328.5 ± 11.8 ^{b}
Herd 8	99	1.67 ± 0.07 ^{a}	258.5 ± 9.6 ^{c}
Herd 9	63	2.44 ± 0.12 ^{b}	373.3 ± 17.2 ^{b}

$^{a, b, c}$: Differences are statistically significant at P <0.001 if average values have no common letter.

The somatic cell count in milk has been determined by a portable Ekomilk Scan device on the spot in farms and milk test samples (20 ml) have been taken immediately from each animal during milking.

The results have been processed through StatSoft 1984-2000 Inc (Copyright 1990-1995 Microsoft Corp.).

For assessment of the effect of factors the following model has been used:

$$Y_{ijklm} = \mu + F_i + T_j + M_k + HS_l\,(PHS_l) + e_{ijkl}$$

Where:

Y_{ijkl} is the dependable variable (SCC); μ is the population mean; F_i is the effect of the herd, T_j is the effect of the rearing technology, M_k is the month of reporting; HS_l is the effect of udder hygiene score; or (PHS_l) the percentage

of cows with hygiene score 3 and 4 and e_{ijkl} is the random residual effect.

To assess the studied factors two models have been used presented in Table 3.

The data have been analyzed by using the LSMLMW computer program by Harvey (1987). Through variation analysis (ANOVA) for each model the least square mean (LSM) and least square estimates (LSE) have been obtained by classes of fixed factors, comprising the sum total of squares calculated as a deviation from the mean value of the trait obtained for the model.

Results

A statistically significant difference has been reported both in average hygiene scores and somatic cell count in herds (Table 2). The lowest is the udder hygiene score and the somatic cell count of herds 1 and 8, respectively 1.87 and 1.67 points and 278.7 and $258.5x10^3$/ml. The highest is SCC of herd 9 – $373.3x10^3$/ml. The differences in the two parameters in most herds are statistically significant.

A study has been made about the effect of controlled factors on somatic cell count in milk (Table 3). In the statistical models the associated factor technology and farm capacity has been included and in tied rearing there are two classes of varied capacity – from 50 to 100 cows and under 50 cows. When applying the I-st model reliable effect of all controlled factors has been reported (in $P<0.01$ and $P<0.001$). When applying the second model in which the factor percentage of cows with hygiene scores 3 and 4 has been included, it is the only one that has reliable effect. That means that basic factor for higher SCC in milk is the presence of cows with contaminated udder – hygiene scores 3 and 4.

Table 3. Analysis of the variance for effect of the controlled factors on SCC in milk.
Tablo 3. İncelenen faktörlerin sütteki somatik hücre sayısı üzerine etkisine ait varyans analizi.

Variation sources	Degree of freedom (n – 1)	Somatic cell count in milk			
		First Model		Second Model	
		F	P	F	P
Total for the model	924	2203.00	***	8.57	***
μu – yμ	1	1470.70	***	7.59	**
Capacity*technology	2	8.38	**	1.97	-
Month of reporting	2	10.49	***	2.96	-
Hygiene score	3	5767.42	***	-	
Percentage of cows with hygiene score 3 and 4	3	-		17.16	***

Table 4. LS means and scores about the effect of the percentage of cows with udder hygiene score 3 and 4.
Tablo 4. Meme hijyen skoru 3 ve 4 olan ineklerin yüzdesinin en küçük kareler ortalaması üzerine etkisi.

Indicator Percentage of cows with udder hygiene score 3 and 4	LS estimate	LS mean ± SE
Average for the model	-	302.2 ± 5.38
Up to 20%	-51.7	250.6 ± 14.60
From 21 to 30%	-9.3	292.9 ± 8.33
From 31 to 40%	+16.7	318.9 ± 14.08
Over 41%	+44.2	346.4 ± 7.31

In farms with tied rearing a slightly higher somatic cell count has been reported compared to free rearing (Figure 1). The highest is SCC on farms with tied rearing and capacity from 50 to 100 cows – $346.7x10^3$/ml, and the lowest - in free rearing.

On farms with both methods of rearing there is difference in the relative share of cows with different udder hygiene scores (Figure 2). The greatest is the relative share of cows with score 1 (clean udder) in free rearing - 36.5%, followed by tied rearing with capacity up to 50

cows - 31.9%. In tied rearing with capacity from 50 to 100 cows the highest percentage of cows with contaminated udder has been reported - 3 and 4, respectively 26.4 and 17.6%, or a total of 44%.

A reliable difference has been found in the reported somatic cell count in individual milk samples in cows with different milk hygiene score (Figure 3). Cows with score 1 – clean udder have the lowest SCC – 172.4x10^3/ml, and the ones with score 4 have SCC 572.8x10^3/ml.

In model second on Table 3 a reliable effect of the percentage (in classes) of cows with udder hygiene score 3 and 4 on SCC has been reported. As a result of the above model the LS-estimates and means have been presented according to percentage of cows with scores 3 and 4 for udder hygiene (Table 4). Only in herds with up to 20% cows with contaminated udder - scores 3 and 4, low SCC of 250.6x10^3/ml has been reported. In the other herds with over 20% of cows with similar scores SCC increases gradually and the highest is that with over 41% of cows with scores 3 and 4.

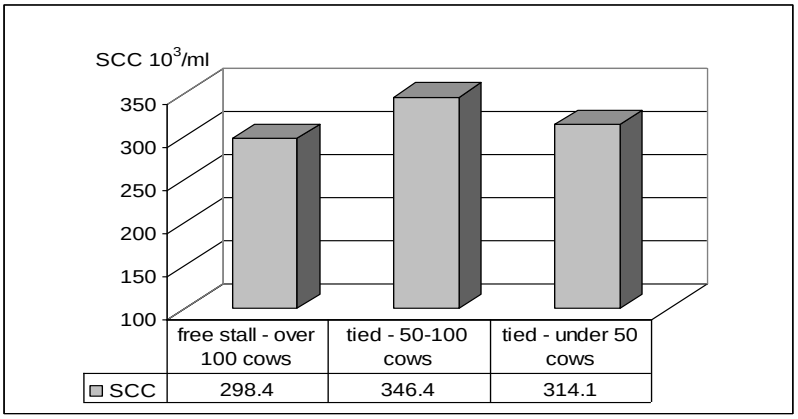

Figure 1. LS Means SCC depending on the technology and farm capacity.
Şekil 1. Teknoloji ve çiftlik kapasitesine göre somatik hücre sayısına ait en küçük kareler ortalamaları.

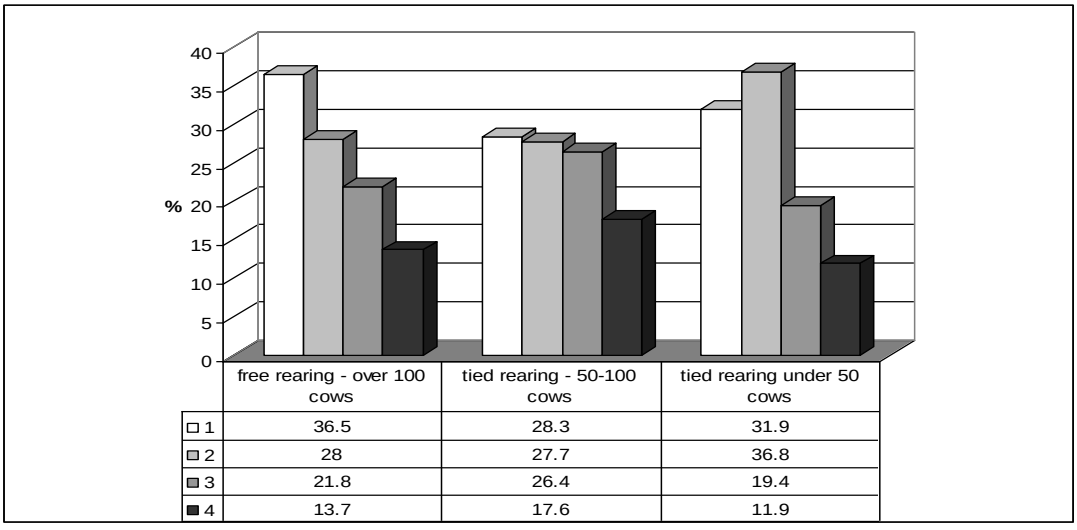

Figure 2. Relative share of the cows by hygienic score depending on technology and farm capacity.
Şekil 2. Teknoloji ve çiftlik kapasitesine bağlı olarak hijyenik skorlara göre inek dağılımları.

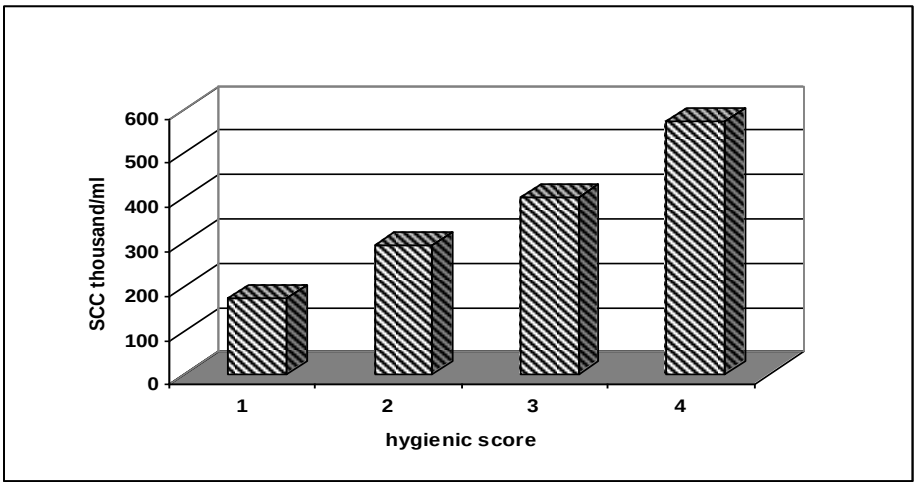

Figure 3. LS Means for the SCC depending on the udder hygiene score.
Şekil 3. Meme hijyeni skorlarına göre somatik hücre sayısına ait en küçük kareler ortalamaları.

Discussion

The monitoring includes the winter season only when cows stay longer in the barn in both methods of rearing. That stay especially in tied rearing is related to greater contamination of the bedding with feces and urine and requires more frequent cleaning and change of the bedding. Also the use of straw as bedding is a prerequisite for a greater number of microorganisms on the teats and udder of cows which is related to greater number of mastitis (Bey et al., 2002).

Schreiner and Ruegg (2003) use a system for assessment of udder hygiene to document the degree of pollution in 1250 cows from 8 herds. Authors find out that cows reared tied have a cleaner lower part of the legs and respectively slight transfer of manure though them onto the udder. Basically udder contamination is directly from beds contaminated with manure. The upper part of legs and loins in tied rearing are dirties than in free rearing, which is a consequence of the fact that they spend about 22 hours a day on the bed.

The reporting of more clean cows in free rearing compared to tied rearing and respectively, lower SCC is due to the fact that scraper devices for manure cleaning are automatically operated at every 2 hours and manure aisles are pretty clean in these farms.

On the other hand, of both farms with the lowest udder hygiene scores and the lowest SCC number, one (Farm 1) is with free rearing and the other one (Farm 8) is with tied. That shows that one of the main factors is the human factor - maintaining good hygiene in the buildings and of the animals reared. A similar conclusion has been made by Barkema et al. (1998). They find out that in 31% of herds with SCC above $250x10^3$/ml milking parlours have poor hygiene, in buildings for rearing of animals there is more manure kept and cubicles are cleaned more rarely.

In recent years new technologies of rearing and production enter more and more dairy cattle breeding. With them most processes are mechanized and automated, which necessitates the use of more qualified labour. That results in more efficient production and higher requirements on behalf of owners regarding hygiene and production of higher quality milk related to it.

The differences between the two groups of farms with tied rearing are due mainly to the fact that farms with capacity of up to 50 cows are family-owned and the animals are cared for by the owner and his family members. In farms with tied rearing and capacity from 50 to 100 cows owners use hired labour who are usually with low qualification. These workers are

occupied entirely with all production processes in which hygiene of buildings and animals has less priority.

A number of authors point out a certain relationship between udder contamination score and somatic cell count in the milk of the respective animals. The lower the udder contamination score (cleaners udder), the lower the somatic cell count in milk (Rajala-Schultz et al., 1999; Ruegg, 2006; Tongel and Broucek, 2010). Apart from being a prerequisite for mastitis infections to occur, dirty udders reduce the efficiency of milking, both in milking on the spot and in milking parlour. More time is needed for cleaning the udder and in milking on the spot more water comes onto the beds, which is a prerequisite for udder contamination when animals lie down. Due to these reasons udder hygiene score has to be applied regularly on dairy farms as an indicator of quality control (Ruegg, 2004).

The results of our study show reliable increase of SCC in cows with higher udder hygiene scores. Only in cows with score 1 SCC is within the limit of up to $200x10^3$/ml ($172.4x10^3$/ml). Somatic cell count can indicate likely infection within the udder, and SCC of $200x10^3$/ml is generally regarded as being suggestive of bacterial infection, with sensitivity at this threshold between 74.5% and 83.4% (Schepers et al., 1997). The increase of SCC above these values is a signal for available subclinical mastitis (Barkema et al., 1998). With risk values, around and above $400x10^3$/ml are the cows with scores 3 and 4, respectively 400, 41 and $572.8x10^3$/ml.

Schreiner and Ruegg (2003) point out that cows with udder hygiene score 3 and 4 are predisposed 1.5 times more to infections that those with scores 1 and 2.

The results obtained by us reveal that when more that 20% of cows with udder hygiene score 3 and 4 appear in the herd, the average SCC is above $250x10^3$/ml, which means there is a risk of mastitis. Moreover, the increase of the percentage of cows with contaminated udders results in obtaining milk with lower quality parameters at purchase and losses increase not only milk yield reduction, but also from increase of costs for treatment and decrease of income from non-marketed products or products marketed at lower price.

Similar results are given by other authors as well. Schreiner and Ruegg (2003) when studying 58 herds point out that in 19% of udders with scores 3 and 4 there is an increased risk of infection.

Conclusion

The rearing technology and the farm capacity have a reliable effect on SCC in milk. In tied rearing higher SCC is reported than in free rearing, as well as lower relative share of cows with clean udders (hygiene score -1) and greater of cows with contaminated udders (hygiene score 3 and 4). The greatest is the relative share of cows with contaminated udders (hygiene score 3 and 4) and the smallest is the number of clean cows in farms with tied rearing and capacity from 50 to 100 cows.

Cows with score 1 (clean udder) have the lowest SCC – $172.4x10^3$/ml, which is related to low risk of mastitis diseases. The ones with score 3 and 4 have SCC over $400x10^3$/ml.

The presence of more than 20% of cows with udder hygiene score 3 and 4 is an indicator for increased risk of mastitis in the herd and obtaining low quality milk.

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