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RESEARCH ARTICLE

The Relationships Among Some Udder Traits and Somatic Cell Count in Holstein-Friesian Cows [1]

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Summary

This study was carried out to investigate the relationships between somatic cell count (SCC) and some udder traits in 129 head Holstein-Friesian cows (1st and 5th month of lactation) raised at 3 dairy farm in Kamislar Village in Bozdogan county of Aydin province, Turkey. Farms were visited monthly between July 2011 and June 2012, and about 1108 milk samples and different udder measures were taken in 50±20 days, 90±20 days, 130±20 days of lactation of each cow studied. Mean log_{10}SCC were calculated as 4.9±0.003 (87.923). The overall results showed that dairy farms and month of year groups had a significant effect on log_{10}SCC ($P<0.01$). Positive correlations among fore teats perimeter and log_{10}SCC (0.11) in farm A and among and log_{10}SCC distance between fore teats (0.12) and distance between rear teats (0.10) in farm B, were found at the level of $P<0.01$, respectively. The correlation between rear teats perimeter and log_{10}SCC (-0.12) was found to be negative and statistically significant in farm C ($P<0.01$). Consequently, udder traits relevant to minimization or elevation of SCC should be carefully evaluated in selection studies.

Keywords: *Holstein-Friesian, Cow, Somatic Cell Count, Udder Traits*

Siyah Alaca İneklerdeki Somatik Hücre Sayısı ile Bazı Meme Özellikleri Arasındaki İlişkiler

Özet

Bu araştırma, Aydın ili Bozdoğan ilçesi Kamışlar Köyü'ndeki 3 süt sığırcılığı işletmesinde yetiştirilen 129 baş Siyah Alaca ineğin (laktasyonun 1. ve 5. ayları arasında) somatik hücre sayısı ile bazı meme özellikleri arasindaki ilişkileri incelemek amacıyla yapılmıştır. İşletmelere Temmuz 2011 ve Haziran 2012 tarihler arasında, ayda bir gidilerek laktasyonun 50±20 gün, 90±20 gün, 130±20. günlerinde yaklaşık 1108 adet süt örneği ile farklı meme ölçüleri alınmıştır. Ortalama log_{10}SHS 4.9 ± 0.003 (87.923) olarak hesaplanmış, log_{10}SHS üzerine işletme ve ayın istatistiki olarak önemli bir etkisi olduğu tespit edilmiştir ($P<0.01$). A işletmesinde ön meme başı çapı ile log_{10}SHS arasındaki (0.11) ve B işletmesinde log_{10}SHS ile ön meme başları arası mesafe (0.12) ve arka meme başları arası mesafe (0.10) arasındaki korelasyonlar $P<0.01$ düzeyinde bulunmuştur. C işletmesinde log_{10}SHS ile arka meme başı çevresi (-0.12) arasındaki korelasyon negatif ve istatistik bakımdan önemli çıkmıştır ($P<0.01$). Çalışmada, SHS'nı azaltan ya da arttıran meme özelliklerinin seleksiyon çalışmalarında dikkatlice değerlendirilmesi sonucuna varılmıştır.

Anahtar sözcükler: *Siyah-Alaca, İnek, Somatik hücre sayısı, Meme özellikleri*

INTRODUCTION

Milk yield improvement has been well known as the main purpose of most dairy breeders, besides it has also well been documented that single-trait selection for milk production may prone cattle to decreased immunity (resistance against disease) and reproduction efficiency [1-3]. Udder diseases, predominantly mastitis as one of the most frequent and economical cow disease, may possess increasing costs on milk producers [3-6] and finally lead to obligatory culling [7].

Reported heritability for clinical mastitis is very low in general and may vary from 0.02 [2] to 0.05 [8]. As for this, correlated traits may be used for indirect selection for improvement of mastitis resistance, majorly somatic cell score (SCC - log-transformed somatic cell count), besides within some selected conformation traits [3]. In a previous study genetic correlations of the same traits among different lactations were found positive (moderate to high), suggesting that SCC and clinical mastitis may be considered

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as the same traits for different lactations. In addition genetic correlations of clinical mastitis and SCC varied from 0.37 to 0.68 [7], with the average correlation close to 0.70 [2,9], for the first and third lactations, respectively, showing that clinical mastitis and SCC present different features of udder health [5]. The heritability of SCC is also low, varying from 0.06 [10] to 0.13 [11].

Cell numbers involved in milk are closely related to inflammation and udder health. SCC in raw and heat-treated milk from a healthy mammary gland according to EU Directive (Health and Hygiene Directive 92/46/EEC), is lower than 400.000 cells/ml, SCC in milk and milk products is lower than 500.000 cells/ml [12].

Somatic cell count, a useful predictor of intramammary infection involving leucocytes [13], is totally accepted as for the standard measurement of milk quality worldwide. Therefore SCC is readily available in almost dairy farmer at least monthly [14]. Widely distributed data are now available worldwide on large population of cows regarding factors influencing SCC in milk. A variety of reviews or relevant studies have addressed issues regarding SCC, their variety and probable use for detecting the quality of milk [14-26]. An elevated SCC in milk has a negative influence on the quality [21,27-31]. Subclinical mastitis has always been recognized as a result of low milk production, changes related to milk consistency (density), diminished probability of adequate milk processing, lowered protein and higher risk for milk hygiene [13]. Similar confounding were reported by [32] indicating a positive relation among SCC and milk yield for the first lactation, and a negative relation for the processing lactations. Clinical mastitis is more likely to be included in a breeding in contrast to SCC, whereas moderate to strong genetic correlations between clinical mastitis and SCC may suggest that selecting diminished SCC may improve mastitis resistance [33].

The relationships between different udder traits, milk yield and SCC were investigated by one researcher. The genetic correlations among udder height, rear udder height, cleft depth, udder levelness and SCC were found -0.41, -0.44, 0.20 and 0.21, respectively [34].

Some authors investigated the farm effects on SCC [35-40]. Many others reported that the effects of stage of lactation, month and parity on SCC were considered [5,14,29,31,37,39,41-49].

The objective of this study was to investigate the relationship between some udder traits and SCC in Holstein-Friesian cows raised at selected dairy farms in Bozdogan county, Aydin province.

MATERIAL and METHODS

The survey was conducted with 129 head Holstein-Friesian cows were determined at 1st-5th months of lactation and managed at 3 dairy farms in Kamislar Village in Bozdogan county of Aydin province, Turkey. The general features of the dairy farms are shown in the *Table 1*. Farms were visited monthly from July 2011 to June 2012 and were collected about 1108 milk samples and different udder and teat of each cows were measured into 3 lactation stage (50±20 days, 90±20 days, 130±20 days of lactation). In this study, cows were separated 4 parity groups. The cows having the fourth and larger lactation numbers were included in Parity 4.

Collection of Milk Samples

The milk samples from each cow were withdrawn from each teat into tubes among both the morning and evening milking samples. Morning milking was stored in a cooler box and then was immediately transferred to the laboratory for analyzing on the same day. Evening milk samples were kept in a refrigerator and analyzed the next day immediately. The milk samples were treated according to the directions given previously [50] and Standard Methods for the Examination of Dairy Products [51]. SCC in the samples was determined by direct microscopic SCC method [52]. Milk samples were spread on 2 microscope slide areas, with 5×20 mm^2 in size. Slides were arranged

Table 1. *General features of the dairy farms*
Tablo 1. *Süt sığırı işletmelerinin özellikleri*

General Features	**Farm A**	**Farm B**	**Farm C**
N cows (N=129)	51	42	36
Barn type	Open Concrete-dirt surface Free stall	Open Concrete-dirt surface Free stall	Open Concrete-dirt surface Free stall
Animal sill	Using/Hay sill	Using/Hay sill	Using/Hay sill
Milking system	Milking parlor (1x10)	Milking parlor (1x9)	Milking parlor (2x5)
Milking machine cleaning	Rightly	Rightly	Rightly
Pre-milking/post-milking udder cleaning and disinfection	Water- Disinfection Using	Water- Disinfection Using	Disinfection Using
Feeding	During milking Roughage + Mixed feed	During milking Roughage + Mixed feed	During milking Roughage + Mixed feed
Touring Area	In barn	In barn	In barn

according to Direct Microscopic Somatic Cell Count (DMSCC) and kept at 37°C in an incubator. Then, milk samples on slides were painted in the manner of the technique of a dye solution involving methylene blue. The dye solution was prepared with combined of 0.6 g of certified methylene blue chloride to 54 mL of 96% ethyl alcohol, 40 mL of tolien and 6 mL glacial acetic acid. The counting was fulfilled in 20 fields under a 100x immersion objective in each slide and averages were calculated. The multiplication of the microscope factor with this average values was corresponded to SCC in per mL of milk [53].

Udder and Teat Measurement

The distance from fore and rear teats to the floor (DFTF and DRTF, respectively) and vertical length of fore and rear teats (FTL and RTL, respectively), the distance between fore, rear and side teats (FTD, RTD and STD, respectively) and the fore and rear teat perimeter (FTP and RTP, respectively) were measured by using a ruler. The fore and rear teat diameter (FTDM and RTDM, respectively) was measured at the mid-point of each teat by the help of calipers. All measures were performed after and before morning and evening milking.

The SCC values were transformed to $\log_{10}$ for normality and homogeneity of variances in the SCC data. The statistical analyses were performed using least squares method in the General Linear Model (GLM) procedure of Minitab package program [54]. The means were compared by Duncan's multiple range test [55]. The statistical model used for the analysis is as follows:

$$Y_{ijklm}=m+s_i+a_j+p_k+lp_l+e_{iklm}$$

Where; y_{ijklm}: i. farm, j. month, k. parity, l. lactation period, m. cow's logarithmic SCC, μ : population mean, s_i : i. farm's effect (i: 1, 2, 3), a_j : j. month's effect (j: 1, 2,…,12), p_k: k. parity's effect (k: 1, 2, 3, 4), lp_l : l. lactation period's effect (1: 50±20 days, 2: 90±20 days, 3: 130±20 days), e_{ijklm}: residual random error.

In this study, the correlation coefficients were calculated between udder measures and $\log_{10}$SCC. To compute correlations between $\log_{10}$SCC and udder measures, Pearson's correlation analysis were used. Other statistical analysis was performed using SPSS statistical packet program [56].

RESULTS

Basic Statistics

The mean values of 305-day milk yield were ranged from 4142 to 4557 kg in farm A, from 3930 to 4847 kg in farm B and from 4344 to 5100 kg in farm C. According to analyses, differences between lactations were non-significant in each farm (P>0.05).

The mean values of udder traits were changed between 1.98 cm and 1.87 cm for FTDM, 1.82 cm and 1.86 cm for RTDM, 5.86 cm and 6.30 cm in for FTL, 5.24 cm and 5.51 cm for RTL, 8.04 cm and 8.10 cm for FTP, 7.96 cm and 8.15 cm for RTP, 14.71 cm and 15.62 cm for FTD, 7.78 cm and 7.84 cm for RTD, 12.26 cm and 12.75 cm for STD, 52.80 cm and 53.91 cm for DFTF, 53.45 cm and 53.95 cm for DRTF in farm A.

The mean values of udder traits were changed between 2.13 cm and 1.93 cm for FTDM, 1.92 cm and 1.90 cm for RTDM, 5.91 cm and 6.43 cm for FTL, 5.31 cm and 5.79 cm for RTL, 8.12 cm and 7.83 cm for FTP, 8.04 cm and 8.28 cm for RTP, 15.30 cm and 15.42 cm for FTD, 8.69 cm and 8.80 cm for RTD, 12.04 cm and 12.34 cm for STD, 52.23 cm and 50.99 cm for DFTF, 51.74 cm and 51.65 cm for DRTF in farm B.

The mean values of udder traits were 1.88 cm and 1.81 cm for FTDM, 1.79 cm and 1.81 cm for RTDM, 5.63 cm and 6.13 cm for FTL, 5.07 cm and 5.67 cm for RTL, 8.06 cm and 7.24 cm for FTP, 7.80 cm and 7.10 cm for RTP, 13.98 cm and 13.45 cm for FTD, 7.66 cm and 7.40 cm for RTD, 11.72 cm and 11.78 cm for STD, 52.86 cm and 54.23 cm for DFTF, 53.94 cm and 55.66 cm for DRTF in farm C.

The least square means and standard error of means of $\log_{10}$SCC are shown in *Table 2*.

The results were shown that $\log_{10}$SCC was reached the highest value in July and August and also was reached the lowest values between April and June. The values of $\log_{10}$SCC were decreased from parity 1th to 3rd and were increased to parity 4.

The differences between farms were found statistically significant for $\log_{10}$SCC (P<0.01) and the analysis revealed that the effects of months were also statistically significant for $\log_{10}$SCC (P<0.01). The differences between parity and lactation periods were found statistically non-significant for $\log_{10}$SCC (P>0.05).

Correlations Between SCC and Udder Traits

The correlations between $\log_{10}$SCC and udder measures are presented in *Table 3*. The correlation among $\log_{10}$SCC and udder traits generally tended to negatively and was only found positive and statistically significant correlation between $\log_{10}$SCC and FTDM (0.11) in farm A (P<0.05). The correlations among $\log_{10}$SCC-FTD (0.12) and $\log_{10}$SCC-RTD (0.10) were found positively and statistically significant (P<0.01). The correlations between $\log_{10}$SCC and udder measures were also found negatively and the highest correlation values was determined to -0.12 ($\log_{10}$SCC-RTP) and statistically significant in farm C (P<0.01).

DISCUSSION

In the given circumstances (twice a day milking), SCC<100.000 cell/mL in milks were obtained from udder

Table 2. *The least square means and standard error of means of log_{10}SCC (cell/ml)*

Tablo 2. *log_{10}SHS'nın en küçük kareler ortalamaları ve standart hataları (hücre/ml)*

Factors	N	X±Sx	
		log_{10}SCC	Re-transformation SCC
Farm		**	
A	448	4.90^{b}±0.003	80.687
B	360	5.09^{a}±0.007	123.956
C	300	4.94^{b}±0.004	87.923
Months		**	
1 (January)	142	4.96^{c}±0.070	92.083
2 (February)	140	4.94^{c}±0.060	88.919
3 (March)	136	4.94^{c}±0.005	87.673
4 (April)	106	4.92^{c}±0.002	83.999
5 (May)	66	4.92^{c}±0.060	84.123
6 (June)	62	4.92^{c}±0.004	84.661
7 (July)	46	5.16^{a}±0.033	146.812
8 (August)	46	5.06^{b}±0.030	115.401
9 (September)	60	4.99^{bc}±0.019	99.052
10 (October)	82	5.00^{bc}±0.016	100.582
11 (November)	104	5.01^{bc}±0.014	103.137
12 (December)	118	4.94^{c}±0.005	87.909
Parity		N.S	
1	354	5.00±0.005	93.854
2	328	4.99±0.007	99.583
3	172	4.94±0.006	88.876
4	254	4.96±0.006	91.853
Lactation period		N.S	
1 (50 ± 20)	518	5.00±0.005	100.257
2 (90 ± 20)	386	4.95±0.004	90.783
3 (130 ± 20)	204	4.93±0.003	85.930
The overall mean	**1108**	**4.94±0.003**	**87.923**

N.S: *Non-significant, * (P<0.05), ** (P<0.01),* ***a,b,c:*** *Means with different superscripts in each line are different*

Table 3. *The correlations between log_{10}SCC and udder traits in farms*

Tablo 3. *İşletmelerde meme özellikleri ile log_{10}SHS arasındaki korelasyonlar*

Traits	Farms		
	A	B	C
FTDM	0.11*	0.03	-0.08
RTDM	-0.04	-0.02	-0.01
FTL	-0.08	-0.05	-0.03
RTL	-0.04	-0.05	-0.07
FTP	-0.04	-0.01	-0.11
RTP	-0.06	-0.30	-0.12*
FTD	-0.01	0.12**	-0.07
RTD	-0.04	0.10*	0.02
STD	-0.05	0.09	-0.01
DFTF	-0.04	-0.04	-0.01
DRTF	-0.01	0.22	0.09

** (P<0.05), ** (P<0.01),* ***FTDM:*** *Fore teat diameter,* ***RTDM:*** *Rear teat diameter,* ***FTL:*** *Fore teat length,* ***RTL:*** *Rear teat length,* ***FTP:*** *Fore teat perimeter,* ***RTP:*** *Rear teat perimeter,* ***FTD:*** *Fore teat distance,* ***RTD:*** *Rear teat distance,* ***STD:*** *Side teat distance,* ***DFTF:*** *Distance from fore teat to floor,* ***DRTF:*** *Distance from rear teat to floor*

lobes that healthy and uninfected was reported [57]. In this study, SCC was determined as 4.94±0.003 (87.923) cell/mL. The vales of mean SCC (4.94±0.003 (87.923) in milk was lower than threshold value (500.000 cell/mL) that was acknowledged according to EU Directive. The mean values of SCC were found lower from findings of some researchers [29,36,37,45,46] and were found higher from findings of some researchers [47]. These circumstances is an indicator of conform to criteria of milk quality in farms in this study.

In the present study, the effect of farm on SCC was determined statistically significant (P<0.01). This result was found similar to findings of some other authors [33,35,36,38,39] and was showing differences with findings of some authors [37,44,46]. Also, the effects of month on SCC was determined statistically significant (P<0.01). The SCC values was found higher in summer months than winter months and the results of environmental temperature and hormonal mechanism of cows were reported from some researchers [29,36,40]. In this study, the effect of measuring month on SCC was found statistically significant (P<0.01), the highest value of SCC was determined on July-August and the lowest value of SCC on April, May and June. This result was found similar with findings of some researchers [36,38,48] and was found different from some authors [47]. The primary cause of differences in results may be heat stress from calving cow in summer season.

When analyzed to variations of SCC in accordance with parity, the highest value of SCC was determined in first parity and was found similar to values in other parity. The effect of parity on SCC was found statistically non-significant (P>0.05). This result was similar with findings of some researchers [46] and was found different from findings of some other authors [5,36,42,45,47].

In the present study, the effect of lactation stage on SCC was found statistically non-significant (P>0.05), while the effect of lactation stage on SCC was found statistically significant by some researchers [5,13,29,30,41-47].

In the present study, the positive correlation between SCC and FTP was found statistically significant in Farm A (P<0.01). The correlations SCC–FTD and SCC-RTD were found positive and statistically significant in Farm B (P<0.01) (respectively 0.12 and 0.10). The correlation between SCC and RTP was found negative and significant (P<0.01). These results were found similar with findings of some researchers [9,47]. Finally, correlations between SCC and

other udder traits were found statistically non-significant (P>0.05), especially relationships between SCC and FTL were found similar with findings of some researchers [58].

The results from this study indicate that some important findings about the correlations between SCC and some udder traits were obtained in farms. The values of mean SCC (4.94±0.003 (87.923) cell/mL) in milk was lower than threshold value (500.000 cell/mL) that was acknowledged according to EU Directive. The dairy cows are approved to physiologically for SCC in farms. In the sense of udder healthy optimum management programs should be carried to seasonal. Hereby, udder traits relevant to minimization or elevation of SCC should be carefully evaluated in selection studies.

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