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Milk Yield, Somatic Cell Count, and Udder Measurements in Holstein Cows at Different Lactation Number and Months

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ABSTRACT

The aim of this study was to investigate the effect of lactation number and months on milk yield, somatic cell count (SCC) and udder measurements in Holstein cows. In the study, 30 first lactation and 49 second lactation, totally 79 Holstein cows housing in a farm located in Nigde province (Turkey) were used. Somatic cell count and udder measurements were determined at each visit of the farm per months, while lactation milk yield of each animal was calculated using Test Interval Method. It was observed that the effect of lactation number on lactation milk yield (P<0.01) and SCC (P<0.05) was increased significantly. The effect of lactation number on udder measurements was significant (P<0.01) except front teat length (FTD). Influence of lactation months on milk yield and SCC was increased and statistically significant (P<0.01). The effect of lactation months on distance between front teats (DFT), distance between rear teats (DRT), front teat diameter (FTD), rear teat diameter (RTD) was significant (P<0.01). A negative correlation was found between SCC and milk yield, front teat clearance from ground (FTC) and rear teat clearance from ground (RTC). On the other hand, a positive correlation was also evident between RTD and distance between front and rear teats. Furthermore, there were positive correlation between milk yield and DFT, DFR, DRT, and FTD, whereas a negative correlation was observed between milk yield and FTC. In conclusion, cows in second lactation showed importantly increased milk yield and SCC as compared to cows in first lactation, whereas FTC and RTC decreased and other udder measurements increased.

Key words: Holstein cow, lactation, milk yield, somatic cell count, udder measurement

ABSTRAK

Tujuan penelitian ini adalah untuk menguji pengaruh angka dan bulan laktasi terhadap produksi susu, *somatic cell count* (SCC), dan ukuran ambing pada sapi Holstein. Sebanyak 30 ekor sapi Holstein laktasi pertama dan 49 ekor laktasi kedua digunakan pada penelitian ini, sehingga total 79 ekor dikandangkan di peternakan yang terletak di Propinsi Nigde, Turki. SCC dan ukuran ambing diukur pada setiap kunjungan ke peternakan setiap bulan, sedangkan produksi susu tiap ternak dihitung menggunakan *Test Interval Method*. Pengaruh angka laktasi terhadap produksi susu (P<0,01) dan SCC (P<0,05) secara nyata meningkat. Angka laktasi berpengaruh sangat nyata (P<0,01) terhadap ukuran ambing, kecuali terhadap panjang ujung puting (FTD). Bulan laktasi berpengaruh nyata (P<0,05) meningkatkan produksi susu dan SCC. Bulan laktasi juga berpengaruh nyata (P<0,05) terhadap jarak antar ujung puting (DFT), jarak antar pangkal puting (DRT), diameter ujung puting (FTD), dan diameter pangkal puting (RTD). Korelasi negatif terjadi antara SCC dan produksi susu, serta antara jarak ujung puting dengan tanah (FTC) dan jarak pangkal puting dengan tanah (RTC). Namun demikian, terdapat korelasi positif antara RTD dan jarak antar ujung dan pangkal puting. Selain itu, korelasi positif juga terjadi antara produksi susu dan DFT, DFR, DRT, dan FTD, namun korelasi negatif ditemukan antara produksi susu dan FTC. Dapat disimpulkan bahwa sapi pada laktasi kedua menunjukkan peningkatan produksi susu dan SCC jika dibandingkan dengan pada laktasi pertama, selain itu FTC dan RTC menurun serta ukuran ambing meningkat.

Kata kunci: sapi Holstein, Laktasi, produksi susu, somatic cell count, ukuran ambing

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INTRODUCTION

Milk yield is one of the most important factors for sustainability of dairy cattle breeding. Milk yield are affected by many phenotypic and genotypic factors. For instance, breed, age, lactation number and period, properties of teat and udder of cow, management and animal nutrition strategies of farm effect the milk yield and also quality (Koç, 2006).

There are many reports which indicate either the importance of lactation number on milk yield per lactation (Uğur *et al.,* 2006; Koçak *et al.,* 2008; Şahin & Ulutaş, 2010) or insignificance of lactation number (Sehar & Özbeyaz, 2005; Koçak *et al.,* 2007). Similarly, Koçak *et al.* (2007) reported the importance of calving season on lactation milk yield, while others stated the presence of ineffectiveness of calving season on both 305 days milk yield and lactation milk yield (Pelister *et al.,* 2000; Bilgiç & Alıç 2005; Bakır *et al.,* 2009).

It was reported that lactation number and months had effect on somatic cell count (SCC) in cows and the highest SCC obtains at the second (Kiiman, 1998) and the third lactatiting cows (Eyduran *et al.,* 2005). Environmental factors such as heat stress may also increase SCC (Eyduran *et al.,* 2005; Göncü 2000).

The structural properties of teat and udder are widely used as indirect selection criteria for the resistance against mastitis and lower SCC (Kul *et al.,* 2006). A negative correlation between SCC and udder clearance from the ground were reported (Rupp & Boichard, 1999).

To our knowledge, only a limited number of studies have focused the detailed relationships among lactation number, udder measurements and SCC in Turkey. Therefore, in this study, the effect of lactation number and months on milk yield, SCC and udder measurements in Holstein cows was investigated.

MATERIALS AND METHODS

Animals

In the study, 30 first lactation and 49 second lactation, totally 79 Holstein cows housing in a farm located in Nigde Province (Turkey) were used. Somatic cell count and udder measurements were determined at each visit of the farm per months throughout 10 mo during June 2009-March 2010. Daily milk yield was obtained from computer assisted milking system program.

Feeding Management

Cows were grouped according to lactation period and fed by total mix ration (TMR) having different feed ingredients (Table 1).

Table 1. Total Mix Ration (TMR) and calculated nutrient content for lactating cows

Feed ingredients	TMR		
	Fresh (1 month)	Peak yield (2-5 month)	Late lactation (6-10 month)
Alfalfa hay (kg/cow)	6	5	5
Corn silage (kg/cow)	10	17	12
Wheat straw (kg/cow)	-	-	2.5
Concentrated feed: Forage	43:57	40:60	46:54
Calculated nutrient content			
Crude protein (%)	17.0	17.3	16.0
ADF (%)	19.8	19.1	24.2
NDF (%)	32.3	33.1	40.5
NEl (kcal/kg)	2968	2932	2661

Note: ADF= Acid detergent fibre, NDF= Neutral detergent fibre, NEI= Net energy intake.

Collecting of Milk Samples and Somatic Cell Count

Cows were milked three times per day. Individual milk samples were collected monthly at the second milking throughout lactation by special sample collecting cup mounted to automatic milking system and transferred into 50 mL sterile plastic tubes. Somatic cell count of milk samples were measured by DeLaval Cell Counter (DeLaval Int. AB, Tumba, Sweden).

Udder Measurements

Front teat length (FTL), rear teat length (RTL), front teat diameter (FTD), rear teat diameter (RTD), distance between front teats (DFT), distance between rear teats (DRT), front teat clearance from ground (FTC), rear teat clearance from ground (RTC) and distance between front and rear teats (DFR) were measured before milking by measuring stick and flexible tape as previously reported by Kul *et al*. (2006); Kuczaj (2000).

Calculation of Lactation Milk Yield

Lactation milk yield of each animal was calculated by using the Test Interval Method (TIM) that was a reference method by ICAR (ICAR, 2014). The formula to calculate milk yield and duration of lactation (day), daily average milk yield, as shown below.

$$\text{Milk Yield} = (A-1)k_1 + a/2[k_1 + k_n + 2(k2 + k3 + ... + k_n - 1)]$$

$$DL = n*a - (a/2 - A),$$

$$DAMY = \sum ki/n,$$

In these formulas, k_1: first control milk yield, k_n: last control milk yield, DL: duration of lactation (day), A: time between parturition and first control, DAMY: daily average milk yield, k_i: control total milk yield, n: control number, a: milk control interval.

Statistical Analysis

The verifying of homogeneity of data were analysed by Kolmogorov-Smirnov test. Logarithmic transformation was used due to abnormal homogeneity of SCC values. Untransformed data were used for average and standard error values, while transformed data were used to determine the significance. First degree auto regressive was used for covariance structure. The correlation between SCC and udder measurement values were analysed by Pearson correlation test. The effects of lac-

tation number and months on the milk yield, SCC and udder measurements were determined by least squares analysis of variance. The differences between the means of the sub-groups were tested by Duncan test. The results were given in standard least squares means (LSM) and standard error means (SEM). Statistical analysis was performed by SAS program (SAS, 2009).

The model used to analyse the effect of lactation number and months on milk yield, SCC and udder measurements was;

yijk = μ+ Ai + Bj + eijk where;

for milk yield and SCC, udder measurement characteristics, y= traits, μ= overall mean, A_i= lactation number where i= 1 and 2, B_j= lactation mounts where j= June to March, and e_{ijk} was the random residual.

RESULTS AND DISCUSSION

Lactation milk yield and lactation period of experimental cows are presented in Table 2. Accordingly, lactation number affected lactation milk yield (P<0.05), whereas it did not affect length of lactation (P>0.05) (Table 2).

Udder measurements of the first and the second lactating cows were detected as follows; FTL, 6.07 and 6.04 cm; RTL, 4.84 and 4.93 cm; FTD, 2.56 and 2.67 cm; RTD, 2.51 and 2.63 cm; DFT, 16.47 and 17.99 cm; DRT, 9.34 and 10.40 cm; FTC, 55.42 and 49.71 cm; RTC, 57.14 and 50.08 cm; DFR, 13.15 and 15.37 cm, respectively.

The effects of lactation number and months on milk yield, SCC and udder measurements are given in Table 4. It was found that lactation number increased daily milk yield (P<0.01) and SCC (P<0.05). The averages of daily milk yield and SCC in the first and second lactating cows were 26.85 kg/d and 29.92 kg/d and 241 x10^3 mL/cell and 306 x10^3 mL/cell, respectively. Lactation number did not significantly affect FTL (P>0.05), on the other hand it significantly (P<0.01) affected other udder measurements (Table 4).

It was seen that the effect of lactation months on daily milk yield and SCC was increased significantly (P<0.01). The highest milk yield was observed during the second month of lactation (34.73 kg/d). The average SCC was ≤ 200 x10^3 mL/cell during the second, fourth and ninth month of lactation, whereas it was 200-399 x10^3 mL/cell during other months of lactation. It was determined that lactation numbers had significant (P<0.01) effect on FTD, RTD, DFT and DRT (Table 4). It can be said that especially FTD and RTD is related to change of SCC.

There was a negative correlation between SCC and milk yield (P<0.01), FTC (P<0.05) and RTC (P<0.05), while a positive correlation was found in RTD (P<0.01) and DFR (P<0.05). Moreover, a positive correlation was evident milk yield between DFT, DFR, DRT and FTD (P<0.01), whereas FTC showed a negative and significant (P<0.01) correlation (Table 3).

The average lactation milk yield (8577.64 kg) obtained in this study was higher than those in other studies which were reported 6273.0 kg by Erdem *et al.* (2007), 6400.3 kg by Sehar & Özbeyaz (2005), 7704.3 kg by Koçak *et al.* (2007) in different rations, ingredients and nutrient compositions. Higher milk yield may be due to the genetic capacity of the cows, breeding and nutrition condition of farm or three times milking per day. In this study, the duration of lactation (292.9 d) was similar to results (297 d) reported by Sehar & Özbeyaz (2005) but lower than those reported by Erdem *et al.* (2007) (308.5 d), and Koçak *et al.* (2007) (325.6 d).

It was found that the effect of lactation number on daily milk yield (P<0.01) and lactation milk yield (P<0.05) was significant, whereas the lactation number did not show any significant effect on duration of lactation (P>0.05). The studies indicating the maintenance

Table 2. Milk yield and lactation length in Holstein cow

Variation source	Lactation milk yield (kg)	Lactation length (day)
Lactation number	*	NS
1	7982.83±378.21	289.93±5.48
2	9172.45±290.96	295.88±4.22
Average	8577.64±238.59	292.90±3.46

Note: *= P<0.05; NS= not significant.

Table 3. Correlation between udder measurements, milk yield and somatic cell count (SCC) in Holstein cows

Traits		1	2	3	4	5	6	7	8	9	10	11
SCC log	(1)	1	-0.251**	-0.017	-0.102*	0.024	-0.105*	-0.067	0.098*	0.021	0.043	0.129**
MY	(2)		1	0.042	-0.144**	-0.02	-0.051	0.296**	0.382**	0.107**	0.183**	0.069
FTL	(3)			1	-0.091*	0.562**	-0.019	0.175**	-0.021	0.149**	0.141**	0.061
FTC	(4)				1	-0.02	0.860**	-0.215**	-0.352**	-0.268**	-0.158**	-0.098*
RTL	(5)					1	-0.141**	0.209**	-0.123**	0.219**	0.101*	0.155**
RTC	(6)						1	-0.278**	-0.273**	-0.347**	-0.120**	-0.145**
DFT	(7)							1	0.340**	0.420**	0.108**	0.133**
DFR	(8)								1	0.110**	0.213**	0.164**
DRT	(9)									1	0.127**	0.156**
FTD	(10)										1	0.563**
RTD	(11)											1

Note: MY= Milk yield;FTL= Front teat length; FTC= Front teat clearance from ground; RTL= Rear teat length; RTC= Rear teat clearance from ground; DFT= Distance between front teat; DRT= Distance between rear teat; FTD= Front teat diameter; DFR= Distance between front and rear teats; RTD= Rear teat diameter; NS= not significant. *= P<0 05, **= P<0.01.

Table 4. Milk yield, somatic cell count (SCC), and udder measurements at different lactation number and months

	n	Milk yield (kg/d)	SCC ($x10^3$ cell/mL)	FTL (cm)	FTC (cm)	RTL (cm)	RTC (cm)	DFT (cm)	DFR (cm)	DRT (cm)	FTD (cm)	RTD (cm)
LN		**	*	NS	**	**	**	**	**	**	**	**
1	30	26.85±0.44	241.24±41	6.07±0.1	55.42±0.3^{a}	4.84±0.1^{b}	57.14±0.3^{a}	16.47±0.2^{b}	13.15±0.2^{b}	9.34±0.2^{b}	2.56±0.02^{b}	2.51±0.02
2	49	29.92±0.34	305.95±33	6.04±0.1	49.71±0.3^{b}	4.93±0.1^{a}	50.08±0.3^{b}	17.99±0.2^{a}	15.37±0.1^{a}	10.40±0.2^{a}	2.67±0.02^{a}	2.63±0.01
LM		**	**	NS	NS	NS	NS	**	NS	**	**	**
June	66	33.06±0.83^{ab}	280.69±78^{abcd}	5.86±0.1	52.06±0.6	4.91±0.1	52.12±0.6	18.49±0.4^{a}	14.71±0.3	11.03±0.4^{a}	2.70±0.04^{a}	2.63±0.04^{b}
July	55	34.73±0.83^{a}	184.20±84^{bcd}	6.22±0.1	52.77±0.6	5.12±0.1	53.09±0.7	18.69±0.5^{a}	14.35±0.3	10.75±0.4^{ab}	2.69±0.04^{a}	2.78±0.04^{a}
August	65	30.94±0.83^{bc}	227.97±80^{cd}	6.03±0.1	51.68±0.6	4.74±0.1	53.06±0.6	17.83±0.4^{ab}	14.65±0.3	10.39±0.4^{ab}	2.64±0.04^{ab}	2.66±0.04^{b}
September	79	31.73±0.84^{bc}	161.82±81^{d}	6.13±0.2	52.30±0.6	4.92±0.1	53.56±0.7	17.77±0.5^{ab}	14.63±0.3	10.52±0.4^{ab}	2.67±0.04^{a}	2.69±0.04^{ab}
October	79	29.71±0.84^{cd}	268.17±71^{abcd}	6.02±0.1	52.50±0.6	4.77±0.1	54.18±0.6	17.62±0.4^{ab}	14.37±0.3	9.86±0.3^{cd}	2.70±0.04^{a}	2.65±0.04^{b}
November	78	27.49±0.83^{d}	309.47±75^{ab}	6.29±0.1	53.19±0.6	4.96±0.1	55.34±0.6	17.67±0.4^{ab}	14.46±0.3	9.47±0.4^{cd}	2.66±0.04^{ab}	2.57±0.03^{bc}
December	63	24.48±0.84^{e}	365.96±80^{ab}	6.14±0.1	52.70±0.6	4.99±0.1	53.76±0.7	16.88±0.5^{bc}	14.16±0.3	9.53±0.4^{cd}	2.55±0.04^{bc}	2.49±0.03^{cd}
January	49	24.15±0.87^{e}	356.14±87^{ab}	5.82±0.2	52.98±0.7	4.86±0.1	53.50±0.7	15.78±0.5^{c}	14.02±0.4	10.05±0.4^{ab}	2.51±0.04^{c}	2.43±0.03^{ef}
February	48	24.69±0.92^{e}	182.33±94^{abc}	6.06±0.2	52.93±0.7	4.79±0.1	53.87±0.7	15.70±0.5^{c}	13.70±0.4	8.65±0.4^{d}	2.55±0.04^{bc}	2.45±0.04^{ef}
March	45	22.88±1.00^{e}	399.22±93^{a}	5.98±0.2	52.60±0.7	4.79±0.1	53.62±0.8	15.90±0.5^{c}	13.56±0.4	8.47±0.4^{d}	2.49±0.04^{c}	2.36±0.04^{f}
Average		28.39±0.28	273.60±27	6.05±0.1	52.57±0.2	4.89±0.0	53.60±0.2	17.23±0.2	14.26±0.1	9.87±0.1	2.62±0.01	2.57±0.01

Note: FTL= Front teat length; FTC= front teat clearance from ground; RTL= rear teat length; RTC= rear teat clearance from ground; DFT= distance between front teat; DRT= distance between rear teat; FTD= front teat diameter; DFR= distance between front and rear teats; RTD= rear teat diameter; LN= lactation number; LM= lactation month; NS= not significant; a, b, c, d, e, f= differences between different letters in the same column is significant. * = P<0 05; ** = P<0.01.

of positive effect of lactation number on milk yield from the first lactation to the third lactation or fourth even fifth lactation (Khattab & Ashmawy 1988) were consistent with the results of present study. Gürses & Bayraktar (2012) reported that the comparative sort of lactation number was 2>1>3>4>5>6+ according to 305 d milk yield. Khattab & Ashmawy (1988) stated that when lactation number and age increased, body weight, feed intake and milk secretion capacity of udder increased.

The effect of lactation number on SCC was found to be significant in this study (P<0.05). Similar results were reported in other studies (Koç & Kızılkaya 2009; Eyduran *et al.*, 2005; Eyduran, 2002; Göncü, 2000). It was determined that the effect of lactation number was not significant only for FTL and significant for other udder measurements (P<0.01), whereas FTC and RTC decreased and other udder measurements increased in the second lactating cows. It is suggested that the increment of milk yield in the second lactating cows may be associated with changes in udder measurements. Özbeyaz *et al.* (1998) reported that udder clearance from ground tended to decrease, when lactation number increased.

The effect of lactation months on daily milk yield was found to be significant (P<0.01). It was determined that milk yield was high during the first and the second months of lactation, and it tended to decrease during 3-6 mo of lactation and clearly decreased 7-10 mo of lactation. The effect of lactation months on SCC was significant (P<0.01). The average SCC during the second (July), fourth (September) and ninth (February) months was ≤200 $x10^3$ cell/mL, while it was 200-399 $x10^3$ cell/mL during other months of lactation. The last month of lactation showed the highest SCC. Koç & Kızılkaya (2009) and Ural (2013) reported that the effect of months of lactation was significant on SCC (P<0.01). Differences in SCC across lactation months can be explained the occurrence of rainfall and hours of sunshine which affect contamination of the teat ends by the mastitis causing organisms. Also, Göncü (2000) and Eyduran (2002) indicated that the season was an important factor affecting the SCC. Eyduran *et al.* (2005) reported that average SCC in August was two folds higher than average SCC in December and heat stress during summer season affected SCC. In the present study, it was seen that lactation months were effective in increasing SCC rather than season. The discrepancies in this study may be related to climate of the region or the reflection of reducing dilution effect following decreasing milk yield after the third month of lactation. It was determined that the effect of lactation months was significant on DFT, DRT, FTD and RTD (P<0.01), while it was not significant in other udder measurements. Moreover, it was seen that DFT, DRT, FTD and RTD decreased in the upcoming months of lactation. It may be suggested that this changes occurs parallel to reducing milk yield.

In the present study, SCC showed a negative correlation with FTC and RTC (P<0.05), while RTD (P<0.01) and DFR (P<0.05) had positive correlation (Table 3). The negative correlation between udder clearance from ground and SCC was reported in other studies (Rupp & Boichard, 1999). Kul *et al.* (2006) reported that structural properties of udder were indirect selection criteria for resistance to mastitis and low SCC level. It was found that a negative correlation was evident between SCC and milk yield (P<0.01). Juozaitiene *et al.* (2006) reported the similar negative relation between SCC and milk yield. In this study, a positive correlation between milk yield and DFT, DRT, FTD, DFR was evident (P<0.01), whereas milk yield showed a negative correlation with FTC (P<0.01). It is suggested that the increment in milk yield may be closely associated with physiological development of udder.

CONCLUSION

There was a negative correlation between SCC and some udder measurements like FTL, FTC, RTC, and DFR. It is suggested that the use of SCC and same udder measurements as a selection criteria for the genetic selection of dairy cows to improve the milk yield.

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