

Relationships Between Milk Yield and Udder Measurements in Brown Swiss Cows*

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Abstract: The effects of udder and teat measurements on milk yield in Brown Swiss Cows were studied. The differences among the means for front and rear teat length, front and rear teat diameter, front and rear udder height, distance between front teats and mammary type scores in different lactation numbers were statistically significant ($P < 0.001$). Front and rear teat length, and front and rear udder height after milking were higher than before milking. Front and rear teat diameter, distance between front teats, distance between rear teats and distance between front and rear teats after milking were lower than before milking. Furthermore, 305-day milk yield and milk yield per milking were significantly positively correlated with distance between front and rear teats and mammary type scores before milking ($P < 0.001$).

The mean values before milking for front and rear teat length, front and rear teat diameter, front and rear teat udder height, distance between front teats, distance between rear teats, distance between front and rear teats and mammary type scores at general lactation were 59.45 and 49.72 mm, 22.14 and 21.53 mm, 47.96 and 47.59 cm, 12.29 cm, 7.76 cm, 9.58 cm and 23.65, respectively. In conclusion, teat and udder measurements and mammary type scores significantly affected milk yield.

Key Words: Brown Swiss cow, milk yield, udder and teat measurement

İsviçre Esmeri İneklerde Meme Ölçüleri ve Süt Verimi Arasındaki İlişkiler

Özet: Çalışma İsviçre Esmeri ineklerde meme ve meme başı ölçüleri ve bu ölçülerin süt verimi ile ilişkilerini belirlemek amacıyla gerçekleştirilmiştir. Laktasyon sayılarına göre sağım öncesi ve sonrası, ön ve arka meme başı uzunluğu, ön ve arka meme başı çapı, ön ve arka meme yüksekliği, ön meme başları arası mesafe ortalamaları ile meme puantajına ait ortalamalar arasında yüksek derecede önemli farklılıklar belirlenmiştir ($P < 0,001$). Ön ve arka meme başı uzunluğu ile ön ve arka meme yüksekliği, sağım sonrası sağım öncesi ölçülerine göre daha yüksek, ön ve arka meme başı çapı, ön, arka ve ön ve arka meme başları arası mesafe ise sağım sonrası, sağım öncesine göre daha düşük ölçülmüştür. Sağım öncesi, 305 günlük süt verimi ve her sağımdaki süt verimi ile ön ve arka meme başları arası mesafe ortalamaları ve meme puanı arasında önemli pozitif korelasyonlar bulunmuştur ($P < 0,001$).

Sağım öncesi, ön ve arka meme başı uzunluğu, ön ve arka meme başı çapı, ön ve arka meme yüksekliği, ön, arka ve ön ve arka meme başları arası mesafe ile meme puantajına ait laktasyon genel ortalamaları sırasıyla 59,45 ve 49,72 mm, 22,14 ve 21,53 mm, 47,96 ve 47,59 cm, 12,29 cm, 7,76 cm, 9,58 cm ve 23,65 olarak hesaplanmıştır. Sonuç olarak, meme ve meme başı ölçüleri ve meme puantajının süt verimini önemli düzeyde etkilediği belirlenmiştir.

Anahtar Sözcükler: İsviçre Esmeri, süt verimi, meme ve meme başı ölçüleri

* This study was carried out in Bahri Dağdaş International Agricultural Research Institute.

Introduction

Mammary properties are directly involved in economic production in dairy cows. Both morphologic and physiological mammary properties affect milk yield.

The aim of most selection in milk cows is to increase milk yield. Therefore the udder plays the most important role in dairy cows. It is also important for the udder to connect to the body strongly, and deeper and larger udders with lobes in balance are demanded. Thin and soft skin on the udder make the milk characteristics of a cow better. Udder and teat measurements show variation between breeds and individuals in the same herd according to age and lactation stages.

Different levels of coefficient correlation between udder-teat measurements and milk yield have been reported. Phenotypic correlation coefficients were found between 0.11 and 0.30 for 305-day milk yield with teat length and diameter (1,2).

The 305-day milk yield was reported to be negatively correlated with udder height (3-5). However, 305-day milk yield was positively correlated with distance of front, rear and front-rear teats (5-8). Mammary type scores with 305-day milk yield were also positively correlated (5-9).

This study was carried out to determine the udder and teat measurements, mammary type scores and inter-relationship between these measurements and milk yield in Brown Swiss cows at the Bahri Dağdaş International Agricultural Research Institute.

Materials and Methods

Milk yield was determined monthly. Measurements of the udder and teat were obtained in the morning just before and after milking. Mammary type scores, udder and teat measurements were obtained from each cow 5 times, in months 2, 4, 6, 8 and 10 of lactation. Months of lactation were grouped as 1, 2, 3, 4 and 5.

Teat length, the distance between the teats and udder height were measured with a measuring tape. Teat diameter was measured with callipers before and after morning milking.

Milk yield groups were divided into 3 groups according to 305-day milk yield: milk yield <3000 kg was group 1, milk yield between 3001 and 4000 kg was group 2 and milk yield >4001 kg was group 3.

The mammary system was evaluated out of 30 points, consisting of mammary structure 10 points, front half 6 points, rear half 7 points, teat 5 points and mammary vein 2 points (10). Data were obtained from 94 Brown Swiss cows.

The data were analyzed by the following general linear model:

$$Y_{ijkl} = \mu + a_i + b_j + c_k + e_{ijkl}$$

Y_{ijkl} is the observation of measurement (front and rear teat length, front and rear teat diameter, front and rear udder height, distance between front, rear and front and rear teats and mammary type scores to investigate a cow),

μ is the overall mean,

a_i is the effect of lactation number (i: 1, 2, 3, 4, 5, 6+);

b_j is the effect of lactation stage (j: 1, 2, 3, 4 and 5);

c_k is the effect of milk yield groups (k: 1, 2 and 3);

e_{ijkl} is the random error.

In addition, one-way ANOVA was used to determine the statistical significance of lactation days, and actual and 305-day milk yield according to lactation number. Comparisons between the groups were made by Duncan's test. The phenotypic correlations between milk yield per milking and 305-day milk yield with different teat measurements and mammary type scores were determined by SPSS.

Results

Means and standard errors for actual milk yield and 305-day milk yield and lactation time are presented in Table 1, according to lactation days. The means of actual milk yield, 305-day milk yield and lactation days were 3062 kg, 2968 kg and 275.3 days, respectively. Effects of lactation number on actual milk yield and 305-day milk yield were statistically significant ($P < 0.05$).

Means with the standard errors for front and rear teat length and diameter are given in Table 2. According to the analyses, lactation number and milk yield group had a significant effect on front and rear teat length before and after milking ($P < 0.001$). Lactation stage significantly affected rear teat length ($P < 0.05-0.01$). Lactation numbers had a significant effect on front and rear teat diameter before and after milking ($P < 0.001$).

Table 1. Means and standard errors for actual milk yield and 305-day milk yield and lactation days according to lactation number.

Lactation number	n	Actual milk yield, kg	Lactation days, day	305-day milk yield, kg
		$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$
Mean	94	3062 140.6	275.3 9.5	2968 88.3
1	18	3554 ± 306.9 ^a	305.8 ± 19.0	3208 ± 215.5 ^a
2	21	3005 ± 334.9 ^{ab}	279.1 ± 22.1	2821 ± 170.4 ^{ab}
3	15	2810 ± 269.7 ^{ab}	243.6 ± 20.7	3195 ± 203.1 ^a
4	13	3283 ± 245.4 ^{ab}	286.2 ± 22.9	3178 ± 165.3 ^a
5	10	3484 ± 596.0 ^a	291.2 ± 35.9	3162 ± 349.7 ^a
6+	17	2415 ± 304.5 ^b	248.5 ± 23.0	2421 ± 187.1 ^b
Probability		*	NS	*

a, b: Means with different superscripts within column indicate significantly different value ($P < 0.05$).
NS: Non significant ($P > 0.05$), *: $P < 0.05$

Table 2. Means with the standard errors of front and rear teat length and diameter.

	n	Front teat length, mm		Rear teat length, mm		Front teat diameter, mm		Rear teat diameter, mm	
		Before milking	After milking	Before milking	After milking	Before milking	After milking	Before milking	After milking
Mean	94	59.45 ± 0.64	65.33 ± 0.62	49.72 ± 0.55	55.95 ± 0.58	22.14 ± 0.18	20.47 ± 0.18	21.53 ± 0.21	20.01 ± 0.13
Lactation number		***	***	***	***	***	***	***	***
1	18	57.18 ± 1.26 ^{bc}	60.64 ± 1.22 ^c	47.85 ± 1.09 ^{bc}	52.91 ± 1.13 ^c	20.59 ± 0.36 ^d	19.20 ± 0.35 ^{bc}	20.54 ± 0.42 ^d	19.10 ± 0.26 ^c
2	21	53.06 ± 1.26 ^c	58.35 ± 1.22 ^c	44.42 ± 1.09 ^c	50.27 ± 1.13 ^c	20.27 ± 0.35 ^d	18.98 ± 0.35 ^c	20.32 ± 0.41 ^d	18.94 ± 0.26 ^c
3	15	58.70 ± 1.46 ^{ab}	65.16 ± 1.40 ^b	49.32 ± 1.26 ^{ab}	56.13 ± 1.30 ^b	21.56 ± 0.41 ^c	19.81 ± 0.40 ^{bc}	20.78 ± 0.48 ^{cd}	19.44 ± 0.30 ^{bc}
4	13	67.54 ± 1.55 ^a	71.71 ± 1.50 ^a	54.63 ± 1.34 ^a	59.97 ± 1.39 ^a	24.61 ± 0.44 ^a	21.65 ± 0.43 ^a	23.84 ± 0.51 ^a	21.21 ± 0.32 ^a
5	10	59.03 ± 1.67 ^{ab}	66.62 ± 1.62 ^b	49.76 ± 1.44 ^{ab}	57.80 ± 1.50 ^b	22.76 ± 0.47 ^{bc}	20.74 ± 0.46 ^b	21.73 ± 0.55 ^{bc}	20.01 ± 0.35 ^b
6+	17	61.20 ± 1.50 ^{ab}	69.49 ± 1.40 ^a	52.32 ± 1.29 ^{ab}	58.63 ± 1.30 ^{ab}	23.02 ± 0.42 ^b	22.43 ± 0.40 ^a	21.96 ± 0.49 ^{ab}	21.38 ± 0.30 ^a
Lactation stage		NS	NS	**	*	NS	NS	NS	NS
1	94	57.35 ± 1.16	63.57 ± 1.12	46.16 ± 1.00 ^b	53.00 ± 1.04 ^b	22.66 ± 0.33	20.91 ± 0.32	21.88 ± 0.38	20.18 ± 0.24
2	91	57.97 ± 1.17	63.98 ± 1.14	48.95 ± 1.01 ^{ab}	55.24 ± 1.06 ^{ab}	21.99 ± 0.33	20.35 ± 0.32	21.42 ± 0.39	19.64 ± 0.24
3	80	59.74 ± 1.23	64.15 ± 1.19	50.28 ± 1.06 ^a	55.69 ± 1.11 ^{ab}	22.20 ± 0.35	20.08 ± 0.34	21.62 ± 0.41	19.90 ± 0.26
4	69	60.32 ± 1.31	66.71 ± 1.27	50.67 ± 1.13 ^a	56.79 ± 1.18 ^{ab}	21.85 ± 0.37	20.31 ± 0.36	21.40 ± 0.43	19.83 ± 0.27
5	42	61.88 ± 1.66	68.23 ± 1.61	52.53 ± 1.43 ^a	59.04 ± 1.49 ^a	21.99 ± 0.47	20.71 ± 0.46	21.32 ± 0.55	20.52 ± 0.34
Milk yield groups		***	***	***	***	NS	**	**	*
1	54	63.90 ± 0.87 ^a	68.52 ± 0.83 ^a	54.47 ± 0.75 ^a	60.22 ± 0.77 ^a	22.28 ± 0.24	20.92 ± 0.24 ^a	21.97 ± 0.29 ^a	20.15 ± 0.18 ^a
2	28	55.14 ± 1.05 ^c	62.27 ± 0.99 ^c	46.56 ± 0.91 ^b	53.47 ± 0.92 ^b	21.54 ± 0.30	19.75 ± 0.28 ^b	20.64 ± 0.35 ^b	19.49 ± 0.21 ^b
3	12	59.32 ± 1.42 ^b	65.19 ± 1.38 ^b	48.12 ± 1.23 ^b	54.17 ± 1.28 ^b	22.60 ± 0.40	20.74 ± 0.39 ^a	21.98 ± 0.47 ^a	20.40 ± 0.30 ^a

a-d: Means with different superscripts within column indicate significantly different value ($P < 0.05$).
NS: Non significant ($P > 0.05$), *: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$

Means for front and rear udder height are presented in Table 3. Effects of lactation number on front and rear udder height were significant before and after milking ($P < 0.001$).

As presented in Table 4 the effects of lactation number on distances between front and rear teats were significant before and after milking ($P < 0.01-0.001$). According to milk yield group, distances between front

teats and between rear teats before milking were significant ($P < 0.01$). However, lactation stage had a significant effect only on distances between rear teats before and after milking ($P < 0.05$). Effects of lactation number and milk yield group on distances between front and rear teats were significant ($P < 0.01-0.001$) before and after milking (Table 4). However, lactation stage did not have a significant effect on distances between front and rear teats before and after milking ($P > 0.05$).

Table 3. Means with the standard errors of front and rear udder height.

	n	Front udder height, cm		Rear udder height, cm	
		Before milking	After milking	Before milking	After milking
Mean	94	47.96 ± 0.23	48.90 ± 0.30	47.59 ± 0.31	48.47 ± 0.32
Lactation number		***	***	***	***
1	18	53.25 ± 0.44 ^a	54.25 ± 0.59 ^a	53.72 ± 0.62 ^a	54.60 ± 0.63 ^a
2	21	52.61 ± 0.44 ^a	53.79 ± 0.59 ^a	51.38 ± 0.62 ^b	53.61 ± 0.64 ^a
3	15	49.16 ± 0.51 ^b	50.74 ± 0.68 ^b	49.11 ± 0.71 ^c	49.87 ± 0.73 ^b
4	13	44.09 ± 0.55 ^c	45.39 ± 0.73 ^c	44.00 ± 0.76 ^d	44.86 ± 0.78 ^c
5	10	43.70 ± 0.59 ^c	44.55 ± 0.79 ^c	42.82 ± 0.82 ^d	43.85 ± 0.84 ^c
6+	17	44.95 ± 0.53 ^c	44.70 ± 0.68 ^c	44.53 ± 0.73 ^d	44.01 ± 0.73 ^c
Lactation stage		NS	*	NS	NS
1	94	47.96 ± 0.41	49.56 ± 0.54 ^a	47.10 ± 0.57	49.01 ± 0.58
2	91	48.58 ± 0.41	49.25 ± 0.55 ^{ab}	48.41 ± 0.57	48.97 ± 0.59
3	80	48.38 ± 0.43	49.54 ± 0.58 ^a	47.60 ± 0.60	49.18 ± 0.62
4	69	47.22 ± 0.46	47.36 ± 0.62 ^b	47.17 ± 0.64	47.79 ± 0.66
5	42	47.67 ± 0.58	48.81 ± 0.78 ^{ab}	47.73 ± 0.81	47.38 ± 0.84
Milk yield groups		*	*	NS	NS
1	54	48.72 ± 0.31 ^a	49.46 ± 0.40 ^a	47.80 ± 0.42	48.92 ± 0.43
2	28	47.89 ± 0.37 ^{ab}	49.31 ± 0.48 ^a	47.75 ± 0.51	48.43 ± 0.52
3	12	47.27 ± 0.50 ^b	47.94 ± 0.67 ^b	47.23 ± 0.70	48.03 ± 0.72

a-d: Means with different superscripts within column indicate significantly different value (P < 0.05).
 NS: Non significant (P > 0.05), *: P < 0.05, **: P < 0.01, ***: P < 0.001

Table 4. Means with the standard errors of distances between teats with mammary type scores.

	n	Distances between front teats, cm		Distances between rear teats, cm		Distance between front and rear teats, cm		Mammary type scores
		Before milking	After milking	Before milking	After milking	Before milking	After milking	
Mean	94	12.29 ± 0.18	9.18 ± 0.16	7.76 ± 0.13	5.27 ± 0.11	9.58 ± 0.21	7.37 ± 0.16	23.65 ± 0.11
Lactation number		***	***	**	***	**	**	***
1	18	10.55 ± 0.36 ^b	7.21 ± 0.32 ^c	6.87 ± 0.25 ^c	4.13 ± 0.21 ^c	8.35 ± 0.42 ^b	6.22 ± 0.32 ^b	22.63 ± 0.23 ^b
2	21	12.55 ± 0.36 ^a	9.44 ± 0.32 ^b	7.59 ± 0.25 ^{bc}	4.91 ± 0.21 ^b	9.35 ± 0.42 ^{ab}	7.69 ± 0.32 ^a	22.48 ± 0.23 ^b
3	15	12.34 ± 0.42 ^a	8.93 ± 0.37 ^b	7.59 ± 0.29 ^{bc}	5.21 ± 0.24 ^b	9.84 ± 0.49 ^{ab}	7.64 ± 0.37 ^a	23.28 ± 0.26 ^b
4	13	12.13 ± 0.45 ^a	9.05 ± 0.39 ^b	7.91 ± 0.31 ^b	5.15 ± 0.26 ^b	9.72 ± 0.52 ^{ab}	7.58 ± 0.39 ^a	24.75 ± 0.28 ^a
5	10	13.11 ± 0.48 ^a	10.56 ± 0.42 ^a	8.04 ± 0.34 ^b	5.97 ± 0.28 ^a	9.22 ± 0.56 ^{ab}	7.14 ± 0.42 ^{ab}	24.43 ± 0.30 ^a
6+	17	13.04 ± 0.43 ^a	9.91 ± 0.37 ^{ab}	8.54 ± 0.30 ^a	6.29 ± 0.24 ^a	10.98 ± 0.50 ^a	7.97 ± 0.36 ^a	24.32 ± 0.27 ^a
Lactation stage		NS	NS	*	*	NS	NS	**
1	94	12.97 ± 0.33	9.66 ± 0.29	8.45 ± 0.23 ^a	5.67 ± 0.19 ^a	9.94 ± 0.39	7.57 ± 0.29	24.42 ± 0.21 ^a
2	91	12.39 ± 0.34	9.38 ± 0.23	7.95 ± 0.24 ^{ab}	5.54 ± 0.20 ^{ab}	10.08 ± 0.39	7.61 ± 0.30	23.67 ± 0.21 ^b
3	80	12.15 ± 0.35	8.86 ± 0.31	7.51 ± 0.25 ^b	4.94 ± 0.21 ^b	9.46 ± 0.41	7.08 ± 0.31	23.57 ± 0.22 ^b
4	69	12.25 ± 0.38	9.42 ± 0.33	7.56 ± 0.26 ^b	5.18 ± 0.22 ^{ab}	9.34 ± 0.44	7.41 ± 0.33	23.47 ± 0.24 ^b
5	42	11.67 ± 0.48	8.59 ± 0.42	7.30 ± 0.33 ^b	5.04 ± 0.28 ^b	9.07 ± 0.55	7.20 ± 0.42	23.12 ± 0.30 ^b
Milk yield groups		**	NS	**	NS	***	***	***
1	54	11.47 ± 0.25 ^b	8.97 ± 0.22	7.19 ± 0.18 ^b	5.08 ± 0.14	8.20 ± 0.29 ^b	6.60 ± 0.22 ^b	22.29 ± 0.16 ^c
2	28	12.43 ± 0.41 ^a	9.54 ± 0.26	7.59 ± 0.21 ^b	5.21 ± 0.17	9.78 ± 0.35 ^{ab}	7.11 ± 0.26 ^b	23.87 ± 0.19 ^b
3	12	12.95 ± 0.30 ^a	9.04 ± 0.36	8.49 ± 0.29 ^a	5.54 ± 0.24	10.75 ± 0.47 ^a	8.40 ± 0.36 ^a	24.79 ± 0.25 ^a

a-c: Means with different superscripts within column indicate significantly different value (P < 0.05).
 NS: Non significant (P > 0.05), *: P < 0.05, **: P < 0.01, ***: P < 0.001

Effects of lactation number, lactation stage and milk yield group on mammary type scores were significant ($P < 0.01-0.001$). Mean mammary type score was 23.65 (Table 4).

Phenotypic correlations between 305-day milk yield and milk yield per milking with different teat measurements and mammary type scores are presented in Table 5.

Discussion

Front and rear teat length tends to be increased before and after milking with advancing lactation stage. Greater front and rear teat lengths were found in the first milk yield group than in the second and third. Similar findings were reported by Schaeffer et al. (11) and Rogers and Spencer (12). Our findings were greater than those reported by several researcher (3,13-15), but the findings were lower for teat length than those reported previously (8,16). As found in this study, Singh and Gupta (17) stated that in Karan Swiss cows front teat length was greater than rear teat length. In addition, the findings were similar to those in reports of increased front and rear teat length with advancing age and lactation number by Özbeyaz et al. (5) and Rasmussen et al. (14). The results found in this study are also supported by those of other studies on lactation stage (5,18).

Front and rear teat diameters before milking were higher than those after milking. Teat diameter tended to be increased before and after milking with advancing lactation number. Similar results have been reported by several researchers (3,19). The results in this study were higher than those reported by Öztürk and Alpan (13) but lower than those reported by Özbeyaz et al. (5), Şekerden et al. (8) and Rogers and Spencer (12).

Front and rear udder heights tend to be decreased with advancing lactation number and front and rear udder height before milking was lower than that after. According to milk yield groups, front and rear udder height was lowest in the 3rd milk yield group. The present results are supported by the observations made by Bayraktar (4) and Özbeyaz et al. (5), namely that udder height decreased with increasing age and lactation number. Our findings for front udder height were also similar to those reported by several researchers (12,16). On the other hand, front udder height was lower than that reported by Lin et al. (3). Rear udder height was similar to that reported by Rogers and Spencer (12), and higher than that reported by Özbeyaz et al. (5), Şekerden and Erdem (7) and Şekerden et al. (8).

Distances between front teats and between rear teats tended to be increased before and after milking with advancing lactation number. The distances were wider before milking than after milking. On the other hand, the distances decreased before milking with advancing

Table 5. Phenotypic correlations between 305-day milk yield and milk yield per milking with different teat measurements and mammary type scores.

Properties	Before milking		After milking	
	Milk yield per milking	305-day milk yield	Milk yield per milking	305-day milk yield
Front teat length (mm)	-0.112*	-0.129*	-0.112*	-0.094
Rear teat length (mm)	-0.186**	-0.211**	-0.206**	-0.113*
Front teat diameter (mm)	0.139*	0.004	-0.057	-0.050
Rear teat diameter (mm)	0.072	-0.054	-0.068	-0.015
Front udder height (cm)	-0.161**	-0.170**	-0.058	-0.018
Rear udder height (cm)	-0.125*	-0.058	-0.059	-0.026
Distance between front teats (cm)	0.268***	0.115*	0.090	0.127*
Distance between rear teats (cm)	0.232***	0.100	0.088	0.046
Distance between front and rear teats (cm)	0.192***	0.216***	0.161**	0.049
Mammary type scores	0.516***	0.472***		

*: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$

lactation stage. The highest distances according to milk yield groups were in the 3rd milk yield group, and the lowest were in the 1st milk yield group before milking. These results were similar to those found by several researchers (16,19) for Brown Swiss cows. The findings were higher than those reported by Öztürk and Alpan (13). In contrast, these results were lower than those reported by Özbeyaz et al. (5).

Distances between front and rear teats tended to be increased with advancing lactation number. Before milking distances were higher than those after. According to milk yield group, the distances before and after milking were higher in the 3rd milk yield group. These results were similar to those reported by Alaçam et al. (19), and lower than those reported by Özbeyaz et al. (5).

Mammary type scores tended to be increased with advancing lactation number. Mammary type scores decreased with advancing lactation stage. Mammary type scores in the 1st, 2nd and 3rd milk yield groups were 22.29, 23.87 and 24.79, respectively. These findings were similar to those reported by Özbeyaz et al. (5) and Şeker et al. (15), and higher than those reported by Öztürk and Alpan (13).

There were negative correlations between milk yield per milking and 305-day milk yield with front and rear teats length both before and after milking. Mammary type scores correlated significantly with milk yield per milking and 305-day milk yield ($P < 0.001$). These findings were similar to those reported by several

researchers (4,5,9). Front and rear udder height was negatively phenotypically correlated with milk yield per milking and 305-day milk yield both before and after milking (Table 5). Before milking there were significant correlations between front and rear udder height and 305-day milk yield ($P < 0.05-0.01$). The findings were similar to those reported by several researchers (3,6,8).

Distances between front teats, between rear teats and between front and rear teats were positively correlated with milk yield per milking and 305-day milk yield both before and after milking (Table 5). Before and after milking a significantly positive correlation was observed between distances between front and rear teats and milk yield per milking ($P < 0.01-0.001$). In addition, milk yield per milking and distances between front teats and between rear teats were significantly correlated before milking ($P < 0.001$). Similar results have been reported by several researchers (4-8).

Consequently, it was determined that teat length, udder height, distances between front teats, between rear teats and between front and rear teats and mammary type scores significantly affected milk yield. In addition, 305-day milk yield decreased with increasing rear teat length. Milk yield increased with decreasing udder height and increasing distances between teats. Cows with high mammary type scores had high milk yield. Because of the high positive correlation between milk yield and mammary type scores, and distances between teats, these traits might be used as selection criteria in order to increase milk yield.

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