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MILKING FLOW CHARACTERISTICS, UDDER AND TEAT DIMENSIONS AND THEIR RELATIONSHIP WITH MILK YIELD OF FRIESIAN COWS RAISED IN EGYPT

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SUMMARY

The rates of milk flow, times for milking and udder and teats conformation characteristics (pre- and postmilking) were measured at 30-60 and at 60-90 days post partum during evening milkings for 102 Friesian cows raised in Sakha Experimental station through 1995. Milk yield per milking during the successive single minutes of milking was recorded by using stop-watch and milkmeter. The averages of milk yield per milking, peak rate of milk flow, time to peak rate of milk flow, average rate of milk flow, time of machine milking, percentage of milk produced in the first 2 minutes, first minute milk yield, first two minutes milk yield and first three minutes milk yield, stripping time and stripping yield were 5.78 kg, 2.3 kg/minute, 1.9 minute, 1.6 kg/minute, 3.3 minute, 72.5%, 2.1 kg, 3.7 kg, 4.6 kg, 32.26 second and 0.487 kg, respectively. Means of milk yield per 90 day of lactation was1020 kg. Means of pre-milking udder dimensions were 51.66, 6.30, 32.02, 71.7 and 57.69 cm for udder height, udder-hock difference, udder depth, udder diagonal and perimeter, respectively, while post-milking of the same traits with the same order were 54.74, 9.56, 28.34, 65.26 and 61.08 cm, respectively. Means of pre-milking teat dimensions were 2.44, 2.38, 5.80 and 5.25 cm for fore teat diameter, rear teat diameter, fore teat length and rear teat length, respectively, while post-milking means for the same traits were 1.99, 1.90, 4.91 and 4.42 cm, respectively. The distance between pre-milking teats of the same side or of fore or of rear teats averaged 9.72, 17.89 and 9.95 cm, respectively, while means of the same traits in the same order post-milking were 8.11, 14.88 and 8.12 cm, respectively.

Least-squares ANOVA indicated that season-parity and cow affected significantly most milking flow characteristics. Spring season would probably be the best favourable season to optimize most milking flow traits in Friesian cows. Traits related to udder size (i.e. udder height, udder-hock distance, udder depth, udder diagonal and perimeter) were significantly ($P<0.001$) influenced by season-parity and cow effects. The traits related to teat morphology (teat diameter, teat length) were significantly ($P<0.05$, $P<0.01$) influenced by effects of season-parity and cow. The distance between teats of the same side and distance between fore teats were also affected significantly ($P<0.001$) by effects of season-parity and cow. With advance of parity, the udder and teat increase in dimention, as did milk yield. Most of the traits increased as parity increased from first parity to the third and later parities. Spring season was the favorable season for all udder and teat dimensions.

Residual correlations (from a model including season-parity combination and cow) among most milking flow characteristics were positive and highly significant. Positive correlation (P<0.01) between milk yield per milking and most of milk flow characteristics indicate that high-producing Friesian cows tended to have faster rates of milk flow with a longer milking time than low-producing cows. Lactation milk yield was correlated negatively with udder height (-0.186). The diagonal and perimeter of the udder are highly significantly (P<0.01) correlated with 90-day milk yield (0.401), whereas there was weak correlation between 90-day milk yield and either of teat length or diameter. Correlations among udder and teat traits with one exception (distance between teats), were highly significant. Lengths and diameters of fore and rear teats were closely associated.

Ketwords: Friesian cows, milk yield, milking flow, udder and teat dimensions

INTRODUCTION

Characteristics of milk flow and time of milking for dairy cows are economically important to the dairy producers, since dairying has a large requirement for labor which accounts for 75 to 82% of the cost of milking (Appleman and Micke, 1973). Genetic improvement in these traits is slow in the case of insufficient information. Rate of milk flow influences the amount of labor needed. Measures of milk flow are mentioned to have a sufficient economic importance to be included as criteria for selecting breeding animals (Smith *et al.*, 1974). Characterstics of peak rate of milk flow and total milking time are most frequently suggested (Touchberry and Markos, 1970; Tomaszewski *et al.* 1975). Blake *et al.* (1978) found negative correlations between rate of milk flow and labor inputs. Sandvik (1957) and Touchberry *et al.* (1970) obtained positive correlations between milking flow characteristics (peak flow rate, average flow rate and machine time) and milk yield per milking.

Physical characteristics of the udder and teats were related to economically important traits in dairy cows. Shape and attachments of the udder and size, shape and placement of the teats are generally considered as important characters for dairy cows. Shanks and Spaher (1982) indicated that distance between teats tends to increase and udder height tends to decrease with a greater yield of milk. Results of Thomas *et al.* (1984), Seykora and McDaniel (1986) and Monardes *et al.* (1990) indicated that various udder characteristics (low udders, wide teats, large teats) are associated with increased mastitis. These characteristics may be important because they increase the chance of injury and exposure to pathogens. Seykora and McDaniel (1986) and VanRaden *et al.* (1990) reported that udder and teat morphology is very heritable and repeatable and could serve as a marker trait for selection to reduce mastitis in dairy cattle. Most breeders try to improve these characters by selection. Geneticists and dairy producers have expressed their concern over possible detrimental correlated responses to intensive selection for milk yield, including changes of udder conformation. Shanks and Spahr (1982) concluded that selection for increased daily milk yield may be expected to result in higher udders during first lactation.

The purposes of this study were: (1) to examine the importance of season, parity and cow effects as sources of variation in milking flow traits and different morphological traits of the mamary gland, (2) to detect the associations among milking flow characteristics and milk yield per milking, and (3) to detect the associations among udder and teat traits and milk yield.

MATERIAL AND METHODS

This study was carried out on 102 lactating cows of the Friesian herd raised in Sakha Experimental farm in the northern part of Delta through 1995. Cows were housed in sheds under the loose system. From December first till the end of May, animals were fed on a ration of concentrate mixture in addition to green Berseem (*Trifolium alexandrinum*) and rice straw, while they were fed on clover hay from June to November. Cows calved during the period : September-November, March-May and June-August were considered as autumn, spring and summer calvers, respectively. Cows were machine milked twice daily in a herringbone parlor. Milk yield of both morning and evening milkings were recorded. During the second post-partum 30 days and for each evening milking, data on rate of milk flow, time of machine milking and yield per milking during the successive single minutes of milking were collected after applying the last teat cup till stripping and during the stripping by the aid of stop watch and milkmeter. The same measurements were taken for the second time on the same animal after one month (i.e. at 60-90 day post-partum).

Data on rate of milk flow during the successive minutes of milking till stripping comprised peak rate of milk flow (PRMF; kg/minute), i.e. maximum yield milked during a single minute of machine time; time to peak rate of milk flow in minutes (TPRMF); time of machine milking till stripping (MMT; minute/milking); average rate of milk flow up to stripping (ARMF; kg/minute), i.e. cumulative milk yield up to stripping divided by cumulative time till stripping; milk yield produced during the first (M1), two (M2), three (M3) minutes of milking; milk produced in the first two minutes expressed as a percentage from milk yield produced till stripping (M2%); machine time needed for stripping (STRT); stripping milk yield (SMY); milk yield per milking (YPM).

Physical udder and teat measurements pre- and post- milking were collected. Two udder heights were measured as the distance from the ground to the lowest point of the udder floor (UH), and as the distance from the ground to the lowest point of the udder floor minus the distance from the ground to the point of the hock (UHD). Hock height was recorded in this second measure, since it is often used by breeders as a reference point when evaluating udder height. Udder depth (UD) and diagonal (DI) were also measured. Perimeter of the udder floor (PUF) was obtained by summing the sides of the trapezoid formed by the teat imprints. Measures of teat dimensions were taken on front (F) and rear (R) teats of right side of the udder. Length of fore teat (FTL) and rear teat (RTL) were defined as the distance from the base on the udder to the tip of the teat. Diameter of fore (FTD) and rear teats (RTD) were measured with a vernier caliper at the midpoint of the teat. Distances between the following pairs of teats: front teats (DF), rear teats (DR) and between front and rear teat (DFR) were obtained before and after milking. All pre-milking and post-milking changes in distances between teats were obtained by subtraction. The same measurements were taken for the second time on the same animal after one month (*i.e.* at 60-90 day post-partum). Acumulated daily milk yield till the day of measurements was recorded (AMY).

Due to complete confounding between cow and both of season of calving (spring, summer and autumn) and parity (1, 2 and ≥ 3), the last two factors were treated as a combination. Data of different traits were analysed fitting a model includes the effects of season-parity combination as a fixed effect and cow within season-parity and error term as random effects. Residual correlations among milking traits across records of the cow (adjusted for all effects included in the model) were calculated from least-squares ANOVA using Harvey (1990).

RESULTS AND DISCUSSION

Means and variations

Means and standard deviations for milking flow characteristics, milk yield (per milking and 90-day) and udder and teat dimensions are tabulated in Table (1). Means of yield per milking (YPM), peak rate of milk flow (PRMF) and average rate of milk flow (ARMF) were 5.78 kg, 2.3 kg/minute and 1.6 kg/minute, respectively. Average rate of milk flow was lower than those reported by Touchberry *et al.* (1970), White *et al.* (1975), Miller *et al.* (1976), Blake *et al.* (1978) and Petersen *et al.* (1986). This may be due to low milk yield of Friesian cows raised in Egypt compared with the high yield produced by cows of foreign breeds (Holstein and Friesian breeds).

The averages of time to peak rate of milk flow (TPRMF) and time of machine milking till stripping (MMT) were 1.9 minutes and 3.3 minutes, respectively. Touchberry *et al.* (1970) and White *et al.* (1975) reported nearly similar results. However, these averages are less than those obtained by Tomaszewski *et al.* (1975) and Miller *et al.* (1976). This contradiction may be due to using different sources of data and also due to breed differences. Rogers and Spincer (1991) in Holstein cows showed that yield per milking was a principal determinant of machine time (14.4 kg and 6.19 minute, respectively).

Means of milk produced in the first one (M1), first two (M2), first three (M3) minutes and M2% were 2.1, 3.7, 4.6 kg and 72.5%, respectively. The means of machine time needed for stripping (STRT) and stripping milking yield (SMY) were 32.26 seconds and 0.487 kg, respectively. These values are less than those obtained by Petersen *et al.* (1986).

Accumulated milk yield (AMY) avraged 1020 kg. Means of pre-milking traits determined the udder size were 51.66 cm for udder height, 6.30 cm for udder-hock difference, 32.02 cm for udder depth, 71.70 cm for diagonal and 57.69 cm for perimeter of the udder. The corresponding post-milking estimates of the same traits, respectively were 54.74, 9.56, 28.34, 65.26, and 51.08 cm. The averages of pre-milking teat dimensions were 2.44 and 2.38 cm for fore and rear diameter, 5.80 and 5.25 cm for fore and teat lengths, while the corresponding averages for post-milking traits, respectively were 1.99, 1.90, 4.91 and 4.42 cm. Means of pre-milking distances between teats were 9.72, 17.89 and 9.95 cm for DFR, DF and DR, respectively, while the corresponding means for post-milking distances were 8.11, 14.88 and 8.12 cm, respectively (Table 1). These udder dimensions are in agreement with El-Barbary and Ahmed (1979) working on Friesian cows and their crosses with native cows in Egypt, while they are lower than those reported by White and Vinson (1975) and Rogers and Spencert (1991) with Holstein cows.

Diameters of fore teats were slightly wider (0.06 cm) than rear teats and were on average slightly more longer (0.55 cm) than rear teats (Table 1). These results are in agreement with that found by Higgins *et al.* (1980). The distance between fore teats was 17.89 cm and usually larger than that for the rear teats (9.95cm). After milking, the distances between fore and rear teats of the same side decreased by about about 19.9%, while they decreased by about 22.5% between rear teats. Average distances between teats before and after milking were lower than those of White and Vinson (1975), Weinberg *et al.* (1980) and Seykora and McDaniel (1986) with Holstein cows.

For milking characteristics except STRT and SMY, percentages of phenotypic variation (PV%) were moderate or high and ranged from 21.2 to 35.2% (Table 1). In agreement with the present findings, Tomazewski *et al.* (1975) found that PV% ranged from 25.0 to 37.0% for PRMF, ARMF, MMT, M2%, M1 and M2. PV% for STRT and SMY were smaller than those for milking flow characteristics (9.8 and 13.0%). The high PV% estimates indicate that there was short-term environmental variation in these traits. Pre-milking UHD is more variable (29.3%) than other pre-milking traits, while UH is less variable (4.1%). The same trend was observed for post-milking traits (Table 1). The percentages of variability for pre-milking DFR were larger than those for pre-milking DF and DR. In agreement, Miller *et al.* (1995) with Holstein cows found that coefficients of variation for pre-milking DR were larger (30-32%) than those for DDFR and DF (20%) .

Season-parity effect

PRMF, ARMF, MMT, M1, M2, M3, STRT, SMY and YPM linearly increased with advance of parity, while TPRMF and M2% linearly decreased (Table 2). Rogers and Spincer (1991) working on Holstein cows reported that milk yield and time per milking increased with lactation number. Peak rate of milk flow increased with the increase of lactation number (Petersen *et al.,* 1986). Blake *et al.* (1978) found that older cows received more time for machine milking and stripping than young cows.

Spring is the most favorable season for PRMF, TPRMF, ARMF, MMT, M1, M2, M3 and YPM which had large means compared with the other two seasons of summer and autumn (Table 2). This favourableness in spring may be due to that there is a carryover effect of preceeding winter season which had favorable climatic and nutrtional conditions.

The evolution of the morphological traits of the udder and teat from the first to the third and later parities is shown in Table 2. With advance of parities, the udder and teat increased in dimension, as did milk yield exact and as described by Fernands *et al.* (1995). Udder height and udder-hock difference decreased with the advance of parity (i.e. udder became too near to ground and bacame adjacent to hock with the increase of parity). Least-squares means of AMY and udder dimensions (depth, diagonal and perimeter) increased with advance of parity. Teat dimensions (diameter and length) increased from first parity to third and later ones. In Iraq, Al-Hakim *et al.* (1986) working on Karadi cows (native cows) found that udder and teat measurements attained their maximum values at second lactation. Also, Tomar (1974) working on Hariana cows, reported that udder measurements increased with

Table 1. Means and their standard deviation (SD) and percentages of variability (PV%) of milking flow characteristics, udder and teat traits in Friesian cows raised in Egypt.

Trait	Mean	SD	PV%
PRMF (kg/minute)	2.3	.71	22.9
TPRMF (minute)	1.9	.63	27.1
MMT(min/milking)	3.3	.84	25.6
ARMF (kg/minute)	1.60	.41	22.0
M1(kg)	2.1	.77	29.9
M2 (kg)	3.7	1.13	25.4
M3 (kg)	4.6	1.98	35.2
M2 (%)	72.5	15.29	21.2
STRT (second)	32.26	6.47	9.8
SMY (kg)	.487	.148	13.0
YPM (kg/milking)	5.78	1.92	26.7
AMY (kg/60 or 90d)	1020	356	28.9
Premilking traits			
UH (cm)	51.66	5.99	4.1
UHD (cm)	6.30	4.57	29.3
UD (cm)	32.02	4.93	6.2
DI (cm)	71.70	13.49	5.3
PUF (cm)	57.69	7.18	6.7
FTD (cm)	2.44	0.60	12.8
RTD (cm)	2.38	0.56	14.5
FTL (cm)	5.80	1.38	8.2
RTL (cm)	5.25	1.20	9.6
DFR (cm)	9.72	2.29	11.9
DF (cm)	17.89	4.49	7.0
DR (cm)	9.95	2.57	8.6
Postmilking traits			
UH (cm)	54.74	6.17	4.3
UHD (cm)	9.56	5.26	25.0
UD (cm)	28.34	4.64	6.4
DI (cm)	65.26	13.40	5.5
PUF (cm)	51.08	6.46	5.9
FTD (cm)	1.99	0.50	12.6
RTD (cm)	1.90	0.43	11.9
FTL (cm)	4.91	1.26	9.5
RTL (cm)	4.42	1.05	10.3
DFR (cm)	8.11	1.95	11.6
DF (cm)	14.88	3.96	8.4
DR (cm)	8.12	2.23	10.8

Table 2. Least-squares means ± (SE) of milking flow characteristics, udder and teat traits according to season-parity subclasses+

Trait	Season of claving								
	Spring			Summer			Autumn		
	1st parity (38)	2nd parity (34)	3rd parity (38)	1st parity (18)	2nd parity (14)	3rd parity (28)	1st parity (14)	2nd parity (8)	3rd parity (12)
PRMF (kg/minute)	2.2	2.5	2.6	1.9	2.0	2.3	1.8	2.3	2.4
	(.13)	(.13)	(.13)	(.18)	(.21)	(.15)	(.21)	(.28)	(.23)
TPRMF (minute)	2.2	2.1	1.9	2.0	2.0	1.5	2.0	1.8	1.0
	(.09)	(.10)	(.09)	(.14)	(.16)	(.11)	(.16)	(.21)	(.17)
MMT(min/milking)	3.1	3.3	3.8	3.0	3.0	3.2	3.0	3.0	3.0
	(.13)	(.14)	(.13)	(.19)	(.22)	(.15)	(.22)	(.29)	(.24)
ARMF (kg/minute)	1.5	1.7	1.8	1.3	1.3	1.6	1.2	1.5	1.7
	(.06)	(.07)	(.06)	(.09)	(.11)	(.07)	(.11)	(.14)	(.11)
M1(kg)	1.9	2.1	2.4	1.7	1.7	2.1	1.6	2.0	2.1
	(.13)	(.14)	(.13)	(.19)	(.22)	(.15)	(.22)	(.29)	(.24)
M2 (kg)	3.5	4.2	4.2	3.1	3.1	3.7	2.9	3.6	3.6
	(.19)	(.20)	(.19)	(.27)	(.31)	(.22)	(.31)	(.41)	(.33)
M3 (kg)	4.2	5.3	5.6	3.3	3.6	4.5	3.5	4.3	5.2
	(.33)	(.35)	(.33)	(.48)	(.55)	(.39)	(.55)	(.73)	(.59)
M2% (%)	73.6	72.9	65.5	77.8	75.9	72.3	78.5	76.8	69.3
	(2.4)	(2.6)	(2.4)	(3.6)	(4.1)	(2.9	(4.1)	(5.4)	(4.4)
STRT (second)	27.7	29.0	38.7	28.0	31.2	36.4	26.5	30.0	39.1
	(.90).	(.95)	(.90)	(1.31)	(1.49)	(1.05)	(1.49)	(1.97)	(1.61)
SMY (kg)	.400	.426	.668	.366	.421	567	.335	437	.633
	(.019)	(.020)	(.019)	(.027)	(.031)	(.022)	(.031)	(.041)	(.033)
YPM (kg/milking)	5.3	6.3	7.4	4.4	4.5	5.8	4.2	5.0	5.9
	(.29)	(.30)	(.29)	(.42)	(.47)	(.33)	(.47)	(.63)	(.51)
AMY	924	1060	1323	792	798	1104	713	976	1045
	(52)	(55)	(53)	(76)	(87)	(61)	(87)	(115)	(94)
Premilking traits									
UH	56.9	52.9	46.6	56.0	50.9	50.7	51.5	48.6	47.5
	(1.08)	(1.15	(1.08)	(1.58)	(1.79)	(1.26)	(1.79)	(2.37)	(1.93)
UHD	10.52	7.47	4.10	10.07	4.55	4.53	6.07	2.37	1.83
	(.801)	(.847)	(.801)	(1.16)	(1.32)	(.933)	(1.32)	(1.75)	(1.43)
UD	30.4	32.0	36.7	29.4	31.0	33.0	27.1	30.5	31.4
	(.93)	(.98)	(.93)	(1.35)	(1.53)	(1.08)	(1.53)	(2.03)	(1.65)
DI	64.5	68.6	83.1	63.2	76.7	80.7	62.1	68.5	65.8
	(2.52)	(2.67)	(2.52)	(3.66)	(4.16)	(2.94)	(4.16)	(5.50)	(4.49)
PUF	57.1	58.3	63.9	53.9	54.0	58.5	51.2	54.0	55.6
	(1.32)	(1.40)	(1.32)	(1.93)	(2.18)	(1.54)	(2.18)	(2.89)	(2.36)
FTD	2.30	2.36	2.79	2.37	2.41	2.47	2.10	2.29	2.62
	(.127)	(.134)	(.127)	(.185)	(.210)	(.148)	(.210)	(.278)	(.226)

Table 2. Cont.

Trait	Season of calving								
	Spring			Summer			Autumn		
	1st parity (38)	2nd parity (34)	3rd parity (38)	1st parity (18)	2nd parity (14)	3rd parity (28)	1st parity (14)	2nd parity (8)	3rd parity (12)
RTD	2.14	2.25	2.80	2.25	2.31	2.39	2.28	2.46	2.50
	(.111)	(.117)	(.111)	(.161)	(.183)	(.129)	(.183)	(.242)	(.197)
FTL	5.65	6.06	6.65	4.82	5.13	5.60	5.64	5.66	5.81
	(.296)	(.313)	(.296)	(.430)	(.488)	(.345)	(.488)	(.646)	(.527)
RTL	4.78	5.35	6.18	4.66	4.89	5.26	4.89	4.91	5.68
	(.246)	(.260)	(.246)	(.357)	(.405)	(.286)	(.405)	(.536)	(.438)
DFR	9.44	9.30	12.06	8.96	9.00	9.64	8.60	9.00	9.08
	(.433)	(.458)	(.433)	(.630)	(.714)	(.505)	(.714)	(.945)	(.772)
DF	17.4	19.6	21.6	14.8	16.7	19.4	13.9	14.5	14.0
	(.85)	(.90)	(.85)	(1.23)	(1.40)	(.99)	(1.40)	(1.85)	(1.51)
DR	9.69	10.18	11.07	9.16	9.78	11.0	8.78	9.00	8.75
	(.569)	(.602)	(.569)	(.828)	(.938)	(.663)	(.938)	(1.24)	(1.01)
Postmilking traits									
UH	60.6	55.9	49.5	59.2	53.5	53.3	54.5	51.8	51.1
	(1.08)	(1.15)	(1.08)	(1.58)	(1.79)	(1.26)	(1.79)	(2.37)	(1.93)
UHD	14.18	10.44	7.92	13.21	7.88	7.00	9.00	5.37	5.33
	(.970)	(1.03)	(.970)	(1.41)	(1.60)	(1.13)	(1.60)	(2.11)	(1.73)
UD	26.1	28.3	32.9	26.0	27.5	28.9	24.8	27.3	28.5
	(.88)	(.93)	(.88)	(1.28)	(1.45)	(1.03)	(1.45)	(1.92)	(1.57)
DI	56.7	61.6	76.9	56.8	69.9	74.8	57.9	60.6	62.5
	(2.46)	(2.60)	(2.46)	(3.58)	(4.06)	(2.87)	(4.06)	(5.37)	(4.39)
PUF	50.0	51.4	56.5	47.9	48.3	52.8	44.7	47.6	49.5
	(1.22)	(1.29)	(1.22)	(1.78)	(2.02)	(1.42)	(2.02)	(2.67)	(2.18)
FTD	1.88	1.96	2.28	1.92	1.93	2.04	1.70	1.80	2.08
	(.107)	(.113)	(.107)	(.155)	(.176)	(.124)	(.176)	(.233)	(.190)
RTD	1.74	1.82	2.24	1.74	1.85	1.95	174	1.79	2.00
	(.085)	(.09)	(.085)	(.124)	(.141)	(.099)	(.141)	(.187)	(.152)
FTL	4.78	5.13	5.66	3.85	4.25	4.80	4.85	4.88	5.00
	(.267)	(.282)	(.267)	(.388)	(.440)	(.311)	(.440)	(.582)	(.475)
RTL	4.02	4.48	5.22	3.88	4.07	4.39	4.16	4.25	5.00
	(.213)	(.226)	(.213)	(.310)	(.352)	(.249)	(.352)	(.466)	(.380)
DFR	7.69	7.85	10.23	7.23	7.44	8.39	7.10	7.62	7.70
	(.359)	(.38)	(.359)	(.522)	(.592)	(.419)	(.592)	(.783)	(.640)
DF	15.1	16.9	18.1	11.8	13.0	15.4	11.1	11.5	12.2
	(.71)	(.75)	(.71)	(1.04)	(1.18)	(.83)	(1.18)	(1.56)	(1.27)
DR	7.75	7.30	9.32	7.36	7.83	8.75	7.17	7.41	7.56
	(.486)	(.514)	(.486)	(.707)	(.801)	(567)	(.801)	(1.06)	(.866)

+ = Number of animals used is given in parentheses.

the advance of cow's age. The same trend was also found by Seykora *et al.* (1986). Petersen *et al.* (1985) found that udders of later lactations averaged less distance from the ground. Sykora and McDdaniel (1986) reported that lengths and diameters of teats increased by about 10% from first to fourth lactations and distances between teats increased by about 40-50% from the first to the fifth lactation. For pre- and post-milking, spring season is the most favourable season for UH, UD, PUF, FTD, RTD, FTL, RTL, DFR, DF and DR. These traits had larger means comparing to the other two seasons of summer and autumn (Table 2). This favourableness in spring season may be due to that there is a carryover effect of preceeding winter season which had favourable climatic and nutritional conditions.

The effect of season-parity had oftenly significant ($P<0.001$) influence on all milk flow characteristics except M2% (Table 3). Sandvik (1957) reported that age of cow was identified as a significant source of variation for peak rate of milk flow and machine time. Smith *et al.* (1974) reported that month of calving had insignificant effect on peak time, peak flow, time to peak flow, machine time, stripping time and stripping yield. Blake *et al.*, (1978) with Holstein cows showed that there is a significant effect of lactation number on machine time, but there was no significant effect on stripping time and average flow and peak flow. Rogers and Spencer (1991) reported that milk yield and milking time increased ($P<0.01$) with the advance of lactation number.

For all traits of teat and udder dimensions, season-parity differences were significant ($P<0.05$, $P<0.01$, $P<0.001$) except for FTD and DR in pre- and post-milking (Table 3). Petersen *et al.* (1985) found that parities accounted for significant ($P<0.01$) portions of variation of udder height and pre-milking and post-milking perimeter.

The cow contributed significantly ($P<0.05$, $P<0.01$ and $P<0.001$) to the most of the traits of milk flow (Table 3). Also, cow was the most important factor contributing significantly ($P<0.001$) to the variability of all udder and teat traits (Table 3).

The decrease in pre- to post-milking udder and teat dimensions was similar among parities (Table 4). Udder height (UH) decreased largerly more in second and in third and later parities (64.6 to 93.4%) than in first parity (36%). The decrease in other traits was comparable among all parities and averaged 5.8 to 6.3% for UH, from 7.2 to 13.8% for udder depth, diagonal and perimeter; from 23.5 to 28.6% for teat diameter, from 16.9 to 19.6% for teat length, from 17.0 to 22.6% for distance between fore and rear teats of the same side, from 20.4 to 22.7% for distance between fore teats and from 20.3 to 28.5 for distance between rear teats. However, the decrease in distance between rear teats during milking was greater than during the other two distances. The greater collapse in the distance between rear teats is probably because rear quarters, although constrained anatomically by their location to be closer together than front quarters, possess more secretary tissues and ductal area and produce more milk than front quarters (Miller *et al.*, 1995). Petersen *et al.* (1985) reported that differences between least-squares means for second parity and those for third and later parities were not as large as those for first parity. Most changes in means and variations of the udder dimensions occurred between the first and the second lactation. Al-Hakim *et al.* (1986) working on Karadi cows in Iraq found that teat lengths and diameters and distance between teats attained their maximum values at second lactation.

Table 3. F-ratios and ANOVA for milking flow characteristics, udder and teat traits in Friesian cows raised in Egypt.

Trait	Source of variation		
	Season-parity (df=8)	Cow within season-parity (df=93)	Error (df=102)
PRMF	2.768**	2.344***	.277
TPRMF	6.272***	1.409*	.265
MMT	4401***	.756	.716
ARMF	4.521***	1.382*	.124
M1	2.605**	1.754**	.395
M2	3.667***	1.552**	.886
M3	3.795***	1.626**	2.623
M2%	1.903	.910	236.8
STRT	18.377**	3.107***	10.074
SMY	26.217***	3.020***	.004
YPM	8.200***	1.344	2.384
AMY	8.400***	1.205	87089
Premilking traits			
UH	7.379***	10.048***	4.480
UHD	8.255***	6.715***	3.637
UD	5.619***	8.378***	3.936
DI	6.677***	16.718***	14.500
PE	5.073***	4.482***	14.966
FTD	1.581	6.335***	.0976
RTD	2.639**	3.923***	.1197
FTL	2.020*	14.946***	.2235
RTL	2.937***	9.130***	.2525
DRR	4.706***	5.343***	1.339
DF	6.217***	17.583***	1.570
DR	1.251	16.868***	.7316
Postmilking traits			
UH	8.255***	8.012***	5.632
UHD	6.012***	6.243***	5.730
UD	5.366***	8.998***	3.309
DI	7.371***	18.042***	12.824
PE	4.904***	6.285***	9.103
FTD	1.591	6.981***	.0625
RTD	2.946***	5.506***	.0508
FTL	2.215*	12.362***	.2195
RTL	2.960***	8.409***	.2067
DRR	5.818***	5.512***	.8922
DF	7.820***	12.442***	1.570
DR	1.394	11.773***	.7647

*= P≤ 0.05, **=P≤.01, ***=P≤.001

Table 4. Percentage of change in udder and teat traits due to milking according to parity in Friesian cows raised in Egypt.

Trait	Parity		
	1	2	≥3
UH	6.0	5.8	6.3
UHD	36.4	64.6	93.4
UD	13.0	12.5	12.0
DI	10.7	11.3	7.2
PUF	13.8	12.9	12.1
FTD	23.5	23.7	23.5
RTD	27.6	28.6	24.3
FTL	19.6	18.3	16.9
RTL	18.9	18.2	17.2
DFR	22.6	19.1	17.0
DF	21.3	22.7	20.4
DR	24.0	28.5	20.3

Correlations among milking characteristics, udder teat and milk yileld traits

Residual correlations between milking flow characteristics (Table 5) show that there were strong positive relationships (P<0.01) between PRMF and both ARMF, M1, M2 and M3 (0.727, 0.740, 0.818 and 0.526). Petersen *et al.* (1986) found that the correlation between peak flow and average flow was positive and near to unity. Highly negative correlation (P<0.01) was observed between MMT and M2% (-0.693). PRMF and ARMF are relatively highly positively correlated (P<0.01) with YPM (r= 0.525 and 0.586, respectively). MMT increased (P<0.01) as YPM increased (r=0.654). Touchberry and Markos (1970) and Thomas *et al.* (1993) obtained similar results. Highly positive correlations (P<0.01) were also observed (Table 5) between M1, M2 and M3 and YPM (r= 0.459, 0.599 and 0.705, respectively). STRT and SMY had positive correlations with YPM, which indicate that highly producing cow (e.g. more milk produced per milking) takes more time and gives more milk in stripping than low-producing cow. The same conclusion was reported by Petersen *et al.* (1986). Correlations of all milking flow characteristics with milk yield per milking (YPM) were positive except M2%, i.e. high-producing cows tended to have faster rates of flow with a larger milking time than low-producing cows.

A strong positive correlation (P<0.01) was found between STRT and SMY (0.620). Correlations of STRT and SMY with M2% (Table 5) were negative and small (r=-0.036 and -0.178, respectivley), i.e. more milk produced in the first two minutes, as a percent, indicating that low stripping milk will be gained in a long time. Also, M2% had a negative correlation (P<0.01) with M3 (r=-0.397). Correlations of STRT and SMY with TPRMF were nearly uncorrelated whereas those with MMT and TPRMF were positive (Table 5). These results indicate that time to peak rate of milk flow was delayed for cow that produced more milk, as a percent, in the first two minutes.

Residual correlations between pre- and post-milking udder and teat traits along with milk yield per milking are shown in Table 6.

Table 5. Residual correlations among milking flow characteristics in Friesian cows raised in Egypt.

	TPRMF	MMT	ARMF	M1	M2	M3	M2%	STRT	SMY	YPM
PRMF	.000	-.025	.727**	.740**	.818**	.526**	.144*	-.025	.078	.525**
TPRMF		.529**	-.126	.068	.051	.439**	-506**	.003	.000	.373**
MMT			-.167*	.069	.068	.443**	-693**	.051	.132	.654**
ARMF				.522**	.710**	.415**	.039	-.039	.124	.586**
M1					.775**	.534**	.200**	.063	.077	.459**
M2						.534**	.291**	.000	.110	.599**
M3							-397**	.050	.190**	.705**
M2%								-.036	-.178*	-515**
STRT									.620**	.017
SMY										.259**

*=P≤0.05, **=≤0.01

A significant negative correlations (P<0.05, P<0.01) were found between YPM and premilking udder dimensions (UH, UHD,DI and PUF). The estimates ranged from -0.282 to -0.225. These results suggested that high producing cows tended to have larger udders which suspended closer to the ground than those of low producing cows (i.e.. Udder that was lower . and closer to the floor produced more milk yield). Rogers and Spencer (1991) found that the correlation between udder height and milk yield per milking ranged from -0.25 to -0.23. In contrary, AMY had a highly significant (P<0.01) positive correlations with all udder dimensions where estimates ranged from 0.223 to 0.483 (Table 6). Petersen *et al.* (1985) reported that correlations of milk production and premilking udder dimensions were from 0.2 to 0.3, whereas those of milk production and postmilking dimensions tended to be slightly smaller. Udder height had negative phenotypic correlation with mature equivalent milk (Petersen *et al.*, 1985). Unexpected significant (P<0.05, P<0.01) negative correlations were found between YPM and teat dimentions (FTD, FTL and RTL) where estimates ranged from -0.204 to -0.157, while a positive significant correlation was observed between AMY and all teat dimentions (r=0.265 to 0.349). In Egypt, El-Barbary and Ahmed (1979) on Friesians and their crosses with native cows reported highly significant correlation between teat diameter and milk yield (70-day and total milk yield) where estimates ranged from 0.32 to 0.83. Also, the present results were in agreement with findings of Rogers and Spencer (1991) since correlations ranged from 0.24 to 0.33. The correlations between teat length and AMY were significantly (P<0.01) positive and ranged from 0.265 to 0.268 for pre-milking teat length (Table 6). Longer teat seems to be associated with an increase in milk yield. The same conclusion was reported by Al-Barbary and Ahmed (1979), Seykora and McDaniel (1986) and Rogers and Spencer (1991). In Egypt, the former authors working on Friesians and their crosses with native cows, found that teat length had significant correlation (0.16 to 0.22) with 70-day milk yield. The longer teats may be not preferred since this might be associated with an increase in mastitis, which could be caused by machine incompatibilities (Seykora and McDaniel, 1986).

Table 6. Residual correlations among udder and teat traits in Friesian cows raised in Egypt.

	Pre-milking traits													
	YPM	AMY	UH	UHD	UD	DI	PE	FTD	RTD	FTL	RTL	DFR	DF	DR
AMY	-560**													
Premilkinf traits														
UH	-265**	.398**												
UHD	-225**	.381**	.518**											
UD	-.106	.333**	.282**	.106										
DI	-198**	.223**	.265**	.081	.237**									
PUF	-282**	.483**	.371**	.236**	.301**	.429**								
FTD	-204**	.349**	.232**	.198**	.207**	.415**	.423**							
RTD	-.134	.328**	.133	.159*	.072	.174*	.265**	.329**						
FTL	-192**	.268**	.157**	.119	.161*	.194**	.295**	.056	.081					
RTL	-.157*	.265**	.103	.084	.142*	.144*	.184**	.129	.153*	.201**				
DFR	-.019	-.083	-.034	-.091	-.033	.018	-.048	.010	-.006	-373**	-.181*			
DF	-.080	.214**	.146*	.100	.073	.100	.223**	.142*	-.041	.077	.058	.208**		
DR	-.087	.055	.093	.127	-.030	-.084	.135	-.047	-.047	.103	.114	.064	.283**	
Postmilking traits														
UH	-169**	.344**	.881**	.441**	.314**	.223**	.314**	.217**	.186**	.082	.125	-.059	.085	.053
UHD	-.134	.273**	.374**	.751**	.099	-.005	.135	.158*	.207**	-.004	.122	-.057	.045	.110
UD	.193**	-.097	.072	-.017	.566**	.058	-.069	-.038	-.123	-.131	.016	-.009	-.063	-.026
DI	-.030	-.111	.016	-.057	.031	.604**	.028	.030	-.038	.088	-.122	-.001	-.107	-.139*
PUF	-.065	.232**	.250**	.086	.358**	.189**	.574**	.316**	.157*	.284**	.011	.027	.047	.093
FTD	-.153*	.201**	.143*	.093	.058	.327**	.244**	.821**	.144*	.017	.060	.061	.194**	.076
RTD	-230**	.252**	.101	.166*	.149*	.204**	.165*	.191**	.491**	-.020	.177*	.028	-.041	-.002
FTL	-.117	.131	.126	.045	.021	.018	.085	.004	.030	.641**	.117	-311**	.038	-.044
RTL	-.096	.084	-.060	-.080	-.010	-.130	-.144*	-199**	-.030	.160*	.711**	-186**	-.129	.114
DFR	.052	-.107	-.013	-.010	-.069	.002	-.103	.043	-.066	-215**	-.038	.614**	.181*	.053
DF	.116	-.035	.152*	-.021	.021	.178*	.179*	.115	-.034	.110	.019	.112	.519**	.212**
DR	-.054	-.022	.051	.057	.011	-.021	.051	.125	.061	.119	.039	.012	.101	.486**

*=P≤0.05, **=≤0.01

Insignificant negative correlations between YPM and pre-milking teat distances were found (Table 6). A reverse trend was reported by Rogers and Spencer (1991) which stated that milk production had highly significant positive correlations (P<0.01) with pre-milking and post-milking teat distances where estimates ranged from 0.30 to 0.56.

Udder height had highly significant (P<0.01) positive correlations with other udder dimensions (r=0.265 to 0.518). The correlation of udder height with udder height minus hock height was highly significant (Table 6). These correlations indicate that high producing cows tend to have lower udders than low producing ones. The relationships between udder height minus hock height and production traits appear to be slightly lower than those between udder height and production traits. Most changes of udder dimensions following milk removal had positive phenotypic correlations. Udder height had significant (P<0.05, P<0.01) positive relationships with fore teat dimentions (r= 0.157 to 0.232), Table 6. For Holsteins, Higgins *et al.*, (1980) reported strong negative relationship between udder height and teat length (-0.24 to -0.21) and between udder height and teat diameter (-0.47 to -0.40). FTD had a highly significant (P<0.01) positive correlations with all udder dimensions (r=0.198 to 0.423). Also, teat dimensions except RTD had positive relationship with UD, DI and PUF (r= 0.142 to 0.423).

The relationship between udder height and pre-milking distance between teats were small and non-significant (Table 6). In contrary, Petersen *et al.* (1985) working on Holsteins found, that correlations between udder height and distance between teats before and after milking were negative and high (-0.55 to -0.33), whereas those of udder height with pre-milking minus post-milking differences in distances between teats were near to zero.

Positive correlations were observed between teat diameter and teat length (Table 6). This means that long teats were wider. Higgins *et al.* (1980) on Holsteins found that teat diameter had a significant positive correlations with teat length (r=0.45 to 0.54). The relationships among pre- and post-milking traits were strong and highly significant which ranged from 0.566 to 0.881 for udder dimensions, from 0.491 to 0.821 for teat dimentions and from 0.486 to 0.614 for distances between teats (Table 6). Petersen *et al.* (1985) stated that phenotypic correlations among udder measures (udder height, distance between teats) before or after milking were usually greater than 0.60. Petersen *et al.* (1985) found that phenotypic correlations between pre-milking and post-milking udder dimensions usually ranged from 0.45 to 0.85.

The distances between teats were highly positively correlated (Table 6). Also, lengths and diameters of fore and rear teats were closely associated. Diameter of fore teats were linked with udder heights (UH and UHD) and the reverse was true for rear teat, while the the rear teat diameter was phenotypically correlated with its length. Phenotypic correlations among distances between teats before or after milking were usually greater than 0.207 which were lower than those reported by Seykora *et al.* (1981).

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صفات تدفق اللبن، صفات الضرع والحلمات وعلاقتهم بمحصول اللبن فى أبقار الفريزيان المرباه تحت الظروف المصرية

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تم قياس معدل تدفق اللبن أثناء عملية الحليب ووقت الحليب اللازم خلال الفترة من ٣٠-٦٠ يوم ومن ٦٠-٩٠ يوم بعد الولادة لعدد ١٠٢ بقرة حلابة فى محطة التجارب بسخا فى عام ١٩٩٥. سجلت قرانتين لكل حيوان خلال نفس موسم الحليب وذلك أثناء الحلبة المسائية. سجلت كمية اللبن المنتجة فى كل دقيقة أثناء عملية الحليب وذلك بإستخدام ساعة إيقاف وجهاز ميلكيميتر. كذلك أخذت مقاييس الضرع والحلمات قبل وبعد الحليب وكانت أهم النتائج المتحصل عليها هى:

كانت متوسطات محصول اللبن فى الحلية، أقصى معدل لتدفق اللبن، الوقت اللازم لأقصى تدفق، متوسط معدل تدفق اللبن، الوقت اللازم لعملية الحليب، نسبة اللبن المنتج فى أول دقيقتين، كمية اللبن فى أول دقيقة، كمية اللبن فى أول دقيقتين، كمية اللبن فى أول ثلاث دقائق، الوقت اللازم لعملية التقطير وكمية اللبن المنتجة أثناء عملية التقطير هى على التوالى ٥,٧٨ كجم، ٢,٣كجم/دقيقة، ١,٩ دقيقة، ١,٦ كجم/دقيقة، ٣,٣ دقيقة، ٧٢,٥٪، ٢,١ كجم، ٣,٧ كجم، ٦,٤ كجم، ٢٦,٣٢ ثانية , ٠,٤٨٧ كجم. كما أظهرت النتائج أن كلا من موسم الحليب-ترتيب الولادة وكذلك البقرة يؤثران تأثيرا معنويا فى معظم الصفات الخاصة بتدفق اللبن. وكان موسم الربيع أفضل تلك المواسم فى أبقار الفريزيان المرباه تحت الظروف المصرية.

كانت متوسطات كمية اللبن فى ٩٠ يوم هى ١٠٢٠ كجم. كما كانت متوسطات صفات الضرع قبل الحليب هى على التوالى ٥١,٦٦، ٦,٣٠، ٣٢,٠٢، ٧١,٧، ٥٧,٦٩ سم لصفات إرتفاع الضرع، المسافة بين الضرع والعرقوب، عمق الضرع، قطر الضرع وكذلك محيط الضرع، بينما كانت تلك المتوسطات لنفس الصفات بعد عملية الحليب على التوالى هى ٥٤,٧٤، ٩,٥٦، ٢٨,٣٤، ٦٥,٢٦، ٦١,٠٨ سم.

كانت المتوسطات لمقاييس الحلمات قبل الحليب هى على التوالى ٢,٤٤، ٢,٣٨، ٥,٨٠، ٥,٢٥ سم لصفات قطر الحلمتين الأمامية والخلفية وطول الحلمتين الأمامية والخلفية , بينما كانت تلك المتوسطات لنفس الصفات بعد عملية الحليب هى ١,٩٩، ١,٩٠، ٤,٩١، ٤,٤٢ سم. أما بالنسبة للمسافة بين الحلمات فكانت المتوسطات قبل الحليب هى ٩,٧٢ سم للمسافة بين الحلمتين الأمامية والخلفية، ١٧,٨٩ سم للمسافة بين الحلمتين الأماميتين، ٩,٩٥ سم للمسافة بين الحلمتين الخلفيتين, بينما كانت تلك المتوسطات لنفس الصفات بعد الحليب هى ٨,١١، ١٤,٨٨، ٨,١٢ سم.

أظهرت النتائج أن تأثير كلا من موسم الحليب-ترتيب الولادة والبقرة كان عالى المعنوية على معظم الصفات المتعلقة بحجم الضرع (إرتفاع الضرع، المسافة بين الضرع والعرقوب، عمق الضرع، قطر الضرع ومحيط الضرع). أوضحت النتائج أيضا أن تأثير كلا من موسم الحليب-ترتيب الولادة والبقرة كان معنويا (P<0.05, P<0.01, P<0.001) على مقاييس الحلمات (القطر - الطول)، أما بالنسبة للمسافة بين الحلمات (الأمامية-الخلفية، الأماميتن والخلفيتين) فكان لموسم الحليب-ترتيب الولادة والبقرة تأثيرا عالى المعنوية على تلك الصفات. إزدادت معظم صفات الضرع والحلمات مع تقدم رقم الولادة من الموسم الأول إلى الموسم الثالث والواسم المتأخرة.كما يعتبر موسم الربيع من أفضل المواسم بالنسبة لجميع الصفاتز

كانت معاملات الإرتباط (بعد التصحيح للعوامل الموجودة فى النموذج الإحصائى) بين جميع صفات تدفق اللبن موجبة وعالية المعنوية. إيجابية ومعنوية تلك المعاملات بين محصول اللبن فى الحلبة وجميع صفات تدفق اللبن يشير إلى أن الأبقار الفريزيان عالية الإنتاج تكون سريعة فى معدلات تدفق اللبن مع زيادة فى وقت عملية الحليب بالمقارنة بتلك الأبقار منخفضة الإنتاج.

كانت قيم معـاملات الإرتبـاط سـالبة وعاليـة المعنويـة ((P<0.01) بيـن كميـة اللبـن فـى الحلبـة وجميـع صفات الضرع قبل الحليب ما عدا عمق الضرع حيث تراوحت القيم بين -٠,٢٨٢ إلى -٠,١٩٨ , وعلى العكس من ذلك كانت تلك القيم موجبة وعالية المعنوية بين كمية اللبن فـى ٩٠ يوم وجميـع صفات الضرع حبث تراوحت القيم بين ٠,٢٢٣ إلى ٠,٤٨٣.

أظهرت النتائج أن قيم معاملات الإرتباط بين كميـة اللبـن فـى الحلبـة وجيـع صفـات الحلمـات (القطـر - الطول) سالبة ومعنوية (P<0.05, P<0.01) حيث تراوحت القيم بين -٠,١٥٧ إلى -٠,٢٠٤ , بينما كانت تلك المعاملات موجبة القيم وعالية المعنويـة بيـن كميـة اللبـن فـى ٩٠ يـوم وتلـك الصفـات حيث تراوحت القيم بين ٠,٢٦٥ إلى ٠,٣٤٩. أما بالنسبة للمسافة بين الحلمات فقـد ظهـر أن هنـاك علاقـة عكسية ضعيفة وغير معنوية مع كمية اللبن فى الحلبة بينما كانت قوية وموجبة مع كمية اللبن فى ٩٠ يوم.

كانت معاملات الإرتباط بين كلا من كمية اللبن فى الحلبة وكميـة اللبـن فـى ٩٠ يـوم مـع جميـع صفـات الضرع والحلمات والمسافة بين الحلمات بعد الحليب أقل من مثيلاتها قبل الحليب وغير ثابتة الإتجاه.

أظهر مقياس إرتفاع الضرع علاقة قوية وموجبة مع جميع الصفات الأخرى للضرع حيث تراوحت القيم بين ٠,٢٦٥ - ٠,٥١٨ ، كما أن لمحيط الضرع نفس العلاقة فى القوة والإتجـاه مـع بـاقى مقـاييس الضـرع حيث تراوحت قيـم معـاملات الإرتبـاط بيـن ٠,٢٣٦ - ٠,٤٢٩. وكذلـك مـع جميـع صفـات الحلمـات حيث تراوحت القيم بين ٠,١٨٤ - ٠,٤٢٣. كما كانت قيم معاملات الإرتباط بيـن قطـر الضـرع وجميـع صفـات الحلمات موجبة ومعنوية حيث تراوحت القيم بين ٠,١٤٤ - ٠,٤١٥.

كانت معاملات الإرتباط بين لنفس صفات الضرع والحلمات قبل وبعد الحليب قويـة وعاليـة المعنويـة حيث تراوحت القيم من ٠,٥٦٦ إلى ٠,٨٨١ بين صفـات الضـرع قبـل وبعد الحليـب، ومـن ٠,٤٩١ إلى ٠,٨٢١ بين صفات الحلمات قبل وبعد الحليب ومن ٠,٤٨٦ إلى ٠,٦١٤ بين صفـات المسـافة بيـن الحلمـات قبل وبعد الحليب.