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Some Factors Related to Height and Circumference of Udders Among Lactating Holstein Cows[1]

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ABSTRACT

The effects of some factors on Height (HU) and Circumference (CU) of udders were investigated in 201 lactating Holstein cows using the GLM (General Linear Model) method. The overall means of HU and CU were 62.13 and 109.69 cm, respectively.

The effects of month of calving, daily milk yield, California Mastitis Test score, and body condition on HU and CU were not significant. Parity affected HU and CU significantly ($p<0.01$); with advancing age HU decreased while CU increased. Shape of udder affected HU ($p<0.01$) and CU ($p<0.05$). HU of dish, round and pendulous shaped udders were 59.48, 61.85 and 58.37 cm, in the same order. The corresponding CU were 116.87, 112.08 and 117.76 cm. HU and CU were affected by the texture of the udder ($p<0.05$). HU of spongy, semi-spongy and non-spongy udders was 61.35, 59.69 and 58.65 cm, respectively. The corresponding CU were 111.24, 116.49 and 119.00 cm.

The heritabilities of HU and CU were 0.20 and 0.04, respectively. The genetic and phenotypic correlation coefficients between HU and CU were –0.68 and –0.52, respectively.

KEYWORDS: Udder dimensions, genetic correlation, heritability, Holstein.

INTRODUCTION

Previous work has indicated that various udder characteristics (low udders, wide teats, large teats and flat teat ends) are associated with increased mastitis (Rogers and Hargrove, 1991 and Rogers *et al*., 1991) These characteristics may be important because they increase the chance of injury and exposure to pathogens from the cow's environment.

The present work attempted to investigate some of the factors associated with the height of udder and its circumference in lactating Holstein cows. Such information will assist in the formulation of mastitis control programmes.

MATERIALS AND METHODS

At the Al-Nasr Dairy Cattle Station, United Company for Animal Resources Ltd. the effects of some factors on height and circumference of udder were investigated in 201 lactating Holstein cows.

At the station, cows are kept in open barns and milked three times daily (03:00, 11:30 and 19:00h) in a fully computerized milking parlor. Feeding varies with years and with seasons depending on feeds available. Cows are dried off gradually when their daily milk yield is less than 5kg. Cows are vaccinated against prevailing diseases, and sprayed regularly to eradicate ecto-parasites. The California Mastitis Test (CMT) is performed before each milking.

Body condition of each cow was scored using the ESCA (East Scotland Agricultural College) method which depends on the thickness of fat layer on the loin and tail attachment (Petrus and Grenhalgh, 1987). As body condition improves, its score increases from 1.5 to 4.0. Udders were palpated and their textures were categorized as spongy, semi-spongy and non-spongy. The height of udder was measured as the perpendicular

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distance between the floor of the udder and the platform. The circumference of the udder was measured horizontally by a measuring tape at the level of the udder's front attachment.

The data were analysed statistically by the GLM (General Linear Model) method within the SAS (2001) programme and as in the following mixed model:

$$Y_{ijklmnop} = \mu + Pi + Mj + Sk + Tl + Cm + Bn + Lo + e_{ijklmnop}$$

where,

$Y_{ijklmnop}$ is the trait belonging to the pth cow, of the ith parity, jth calving month, kth udder shape, lth texture of udder, mth CMT score, nth body condition, and oth level of milk production, μ is the overall mean, Pi is the effect of parity (1, 2, 3, 4), Mj is the effect of month of calving (September, October, November), Sk is the effect of shape of udder (round, dish, pendulous), Tl is the effect of texture of udder (spongy, semi-spongy, non-spongy), Cm is the effect of CMT score (0, 1, 2, 3), Bn is the effect of body condition (2, 2.5, 3, 3.5), and Lo is the effect of level of milk production (high, medium, low), $e_{ijklmnop}$ is a random error which is assumed to be normally distributed with zero mean and $\delta^2 e$.

Genetic and phenotypic Variance-Covariance (VCV) matrices were estimated by the Restricted Maximum Likelihood (REML) method (Patterson and Thompson, 1971), with the account of the fixed effects. The matrices for each studied trait were tested for positive, and the non-positive matrices were "bent" or modified to be positive (Hays and Hill, 1981).

RESULTS AND DISCUSSION

Least-squares means ± S.E. and the analysis of variance for factors affecting Height of Udder (HU) and its Circumference (CU) are presented in Tables (1 and 2).

Factors Affecting Height of Udder

The overall mean of the Height of Udder (HU) was 62.13cm, and was similar to that among Friesian cows in Iraq (Issa, 1979), Egypt (El-Barbary *et al*., 1984) and Sweden (Ral *et al*., 1990).

Month of calving had no significant effect on HU, though a slight decrease in HU was recorded among cows calving during November (59.33cm). This can be attributed to increased milk yield during November resulting from improved climatic conditions and abundance of roughages.

Height of udder decreased steadily from 62.85cm in the 1st lactation to 57.49cm in the 4th lactation ($p<0.01$). Parity was also reported by Pawlina (1989) to affect HU. The decrease in HU due to parity in the current study can be related to increased milk yield associated with advancing age. Hence, Johansson and Rendel (1972) stated that cows mature between 6-8 years of age during which milk yield is at its highest.

The effect of daily milk yield on HU lacked significance. Yet, with increasing daily milk yield HU decreased. Such a non-significant effect confirms the findings of Burnside *et al*. (1963) and Bakken (1981).

The effect of shape of udder on HU was highly significant ($p<0.01$); heights among cows with round, dish and pendulous shaped udders were 61.85, 59.48 and 58.37cm, respectively.

Spongy udders had significantly ($p<0.05$) the greatest height (61.35cm). This may be attributed to non-spongy udders having greater contents of connective and adipose tissues than spongy udders.

HU was not affected significantly by the intensity of infection with mastitis and this could be attributed to the limited number of observations included in the current study. However, the relation between HU and CMT score showed no distinct trend; maximum UH (60.85cm) was among healthy cows (CMT – 0) followed by CMT – 3 (60.39cm), CMT – 1 (59.80cm) and CMT – 2 (58.55cm) in descending order. Such findings are in agreement with those reported by White and Vinson (1975), Rogers and Hargrove (1991) and Amin and Gere (2000). Significant negative correlations between HU and infection of udder were found also by Young *et al*. (1960) and Bakken (1981).

Body condition asserted no significant effect on HU

which steadily increased with increasing body condition score from 59.36 to 60.46cm and decreased thereafter to 59.92cm.

Factors Affecting the Circumference of the Udder

The overall mean of the Circumference of the Udder (CU) was 109.69cm (Table 1) and was similar to that reported by Issa (1979) on Friesian cows in Iraq, and greater than that pertinent to Friesian cows (75.96cm) in Egypt (El-Barbary *et al*., 1984).

Although the effect of month of calving on CU was not significant, CU was highest (117.79 cm) among cows calving during November, and lowest among their contemporaries calving during October. This can be attributed to increased milk yield during November resulting from moderate climatic conditions and abundance of roughages.

Circumference of udder increased steadily and significantly ($p< 0.01$) from 107.2 cm in first lactation cows to 122.3 cm in the 4th lactation. Such increase can be related to growth of the udder and increased milk yield associated with advancing age (Johansson and Rendel, 1972). Parity was also reported to have significant effects on CU by Shanks and Spahr (1982), El-Barbary *et al*. (1984) and Brzuski *et al.* (1992).

Although the effect of level of milk yield on CU was not significant, CU tended to increase with increasing daily milk yield. A non-significant effect as such confirms the findings of Burnside *et al.* (1963) and Bakken (1981).

Circumference of the udder varied from 117.76 cm among cows with pendulous udders followed by those with flat (116.87 cm) and round (112.08 cm) shaped udders in descending order ($p<0.05$). The increase in CU among cows with pendulous udders is due to irregularities of its shape and particularly of the rear (hind) quarters (Johansson and Rendel, 1972).

Udder texture was significantly ($p<0.05$) associated with CU. The circumference varied between 111.24 cm among cows with spongy udders, and 119.0 cm among those with non-spongy udders. This can be attributed to non-spongy udders having greater contents of connective and adipose tissues than spongy udders.

Intensity of infection with mastitis had no significant effect on CU. However, the largest CU (121.41 cm) was associated with high intensity infection (CMT – 2), while the smallest CU (112.10 cm) was pertinent to healthy cows (CMT – 0). An increase in CU as such can be related to increased intra-mammary pressure associated with infection.

Body condition effect on CU was not significant; CU decreased steadily with increasing body condition score, namely from 118.34 to 110..84cm.

Genetic Parameters

The heritabilities of HU and CU were 0.20 and 0.04, respectively. Such estimates are lower than those reported by other workers whose heritabilities for HU ranged between 0.23 and 0.59 (Smothers *et al*., 1993; Fuerest-Waltl *et al.,* 1998; and Amin and Gere, 2000) and for CU was 0.54 (Kabanov, 1981). The low heritability estimates obtained in the current study denote to the low genetic variance in the two traits, and can be attributed to the limited number of observations encountered.

The genetic and phenotypic correlation coefficients between HU and CU were negative and highly significant ($p<0.01$), being -.0.68 and –0.52, respectively.

Table 1. Least-squares means ± S.E . of factors affecting udder dimensions (cm).

		Least- squares Mean ± S.E.	Least-squares Mean ± S.E.
	No.	**Height of udder**	**Circumference of udder**
Overall mean μ	201	62.13	109.69
Month of calving			
September	91	60.31±1.17a	115.76±3.39a
October	79	60.07±1.01a	113.16±2.93a
November	31	59.33±1.74a	117.79±5.03a

Parity			
1	65	62.85±1.08a	107.22±3.13b
2	56	59.94±1.12b	116.32±3.29a
3	52	59.33±1.08bc	116.43±3.11a
4	28	57.49±1.25c	122.31±3.62a
Daily milk yield			
< 10 kg	27	60.32 ±1.17a	114.36±3.38a
11 15 kg	55	60.19±1.11a	115.91±3.23a
> 15 kg	119	59.19± 0.98a	116.45±2.85a
Shape of udder			
Dish	87	59.48±1.01b	116.87±2.98ab
Round	77	61.85±1.09a	112.08±3.15b
Pendulous	37	58.37±1.10b	117.76±3.19a
Texture of udder			
Spongy	122	61.35±0.95a	111.24±2.75b
Semi-spongy	23	59.69±1.05ab	116.49±3.05ab
Not spongy	56	58.65±1.54b	119.00±4.48a
CMT score			
0	167	60.85±0.73a	112.10±2.13a
1	20	59.80±1.14a	116.01±3.32a
2	9	58.55±1.65a	121.41±4.79a
3	5	60.39±2.29a	112.74±6.62a
Body condition			
2	33	59.36±1.19a	118.34±3.45a
2.5	50	59.85±0.95a	117.28±2.74a
3	100	60.46±1.06a	115.82±3.07a
3.5	18	59.92±1.44a	110.84±4.16a

Like letters following means denote no significant difference between them, otherwise they differ significantly ($p<0.01$).

Table 2. Analysis of variance for factors affecting udder dimensions of lactating Holstein cows.

Source of Variation	d.f.	M.S. Height of Udder	M.S. Circumference of Udder
Month of calving	2	3.32	257.25
Parity	3	159.41**	1247.39**
Daily milk yield	2	21.33	41.04
Shape of udder	2	153.77**	507.47*
Texture of udder	2	68.60*	639.15*
CMT score	3	18.32	286.83
Body condition	3	7.27	223.46
Error	183	22.03	184.55

CMT = California Mastitis Test

*$p<0.05$, ** $p<0.01$

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بعض العوامل ذات العلاقة بارتفاع ومحيط الضرع لدى ابقار الهولستاين الحلوب

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ملخـص

في دراسة على 201 بقرة هولستاين حلوب بلغ المتوسط العام لارتفاع ومحيط الضرع 62.13 و 109.69 سم والمكافئ الوراثي لهما 0.20 و 0.04 ومعامل الارتباط الوراثي والمظهري بينهما –0.68 ($P < 0.01$) و-0.52 ($P < 0.01$) على التوالي. ولم يكن لشهر الولادة وانتاج الحليب اليومي وتقدير اختبار كاليفورنيا لالتهاب الضرع وحالة الجسم تأثير معنوي في ارتفاع الضرع ومحيطه، في حين كان تأثير تسلسل الولادة فيهما معنوياً ($P < 0.01$) حيث انخفض الارتفاع وازداد المحيط مع تقدم العمر. كان لشكل الضرع تأثير معنوي في ارتفاعه ($P < 0.01$) ومحيطه ($P < 0.05$) حيث تميز الضرع الصحي والمستدير والمتدلي بارتفاع 59.48 و 61.85 و58.37 سم وبمحيط 116.87 و 112.08و117.76 سم على التوالي، كما تأثر ارتفاع الضرع ومحيطه بنسجة الضرع ($P < 0.05$) حيث بلغا على التوالي 61.35 و111.24سم لدى الضرع الاسفنجي و59.69 و116.49 سم لدى الضرع شبه الاسفنجي و58.65 و119.0سم لدى الضرع غير الاسفنجي.

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