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

M. A. A. Al-Hered, Saadi S. Khalaf*, J. E. Alkass,** and K. H. Juma**

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

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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:

\[ Y_{ijklmnop} = \mu + P_i + M_j + S_k + T_l + C_m + B_n + L_o + \varepsilon_{ijklmnop} \]

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, n th body condition, and o th level of milk production, \( \mu \) is the overall mean, \( P_i \) is the effect of parity (1, 2, 3, 4), \( M_j \) is the effect of month of calving (September, October, November), \( S_k \) is the effect of shape of udder (round, dish, pendulous), \( T_l \) is the effect of texture of udder (spongy, semi-spongy, non-spongy), \( C_m \) is the effect of CMT score (0, 1, 2, 3), \( B_n \) is the effect of body condition (2, 2.5, 3, 3.5), and \( L_o \) is the effect of level of milk production (high, medium, low), \( \varepsilon_{ijklmnop} \) is a random error which is assumed to be normally distributed with zero mean and \( \delta^2 \).

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 60.46 cm and decreased thereafter to 59.92 cm.

**Factors Affecting the Circumference of the Udder**

The overall mean of the Circumference of the Udder (CU) was 109.69 cm (Table 1) and was similar to that reported by Issa (1979) on Friesian cows in Iraq, and greater than that pertinent to Friesian cows (75.96 cm) 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 110.84 cm.

**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 (Smothies *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>
<thead>
<tr>
<th>Table 1. Least-squares means ± S.E. of factors affecting udder dimensions (cm).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No.</strong></td>
</tr>
<tr>
<td>Overall mean μ</td>
</tr>
<tr>
<td>Month of calving</td>
</tr>
<tr>
<td>September</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>November</td>
</tr>
</tbody>
</table>
Table 2. Analysis of variance for factors affecting udder dimensions of lactating Holstein cows.

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

CMT = California Mastitis Test
*p<0.05, ** p<0.01

REFERENCES


<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trait 1</td>
<td>109.69</td>
<td>62.13</td>
</tr>
<tr>
<td>Trait 2</td>
<td>111.24</td>
<td>61.35</td>
</tr>
<tr>
<td>Trait 3</td>
<td>119.0</td>
<td>61.76</td>
</tr>
<tr>
<td>Trait 4</td>
<td>58.65</td>
<td>56.49</td>
</tr>
</tbody>
</table>

(P < 0.01) indicates statistical significance at the 0.01 level.