# GENETICS AND BREEDING

## Heritabilities of Teat End Shape and Teat Diameter and Their Relationships with Somatic Cell Score[1,2]

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### ABSTRACT

Teat end shapes were categorized for 1740 Holstein cows with 2261 lactations in nine herds. Frequencies of teat end shapes were pointed, 7%; pointed disk, 1%; round, 43%; round ring, 16%; round flat, 5%; round disk, 11%; flat, 6%; disk, 10%; and inverted, 0.8%. Teat diameters were measured 1.5 cm from the end of the teat. Teat end lesions were visually classified into four categories: no lesion, rough ring, very rough, and ulcerated, raw appearance. Repeatability estimates for teat end shape and teat diameter were 0.75 and 0.36, respectively. Heritability estimates of teat end shape for first, second, and all lactations combined were 0.53, 0.44, and 0.56, respectively. Teat diameter heritabilities were 0.23, 0.27, and 0.35, respectively. The genetic correlation between teat end shape and teat diameter was 0.64. Linear somatic cell scores (SCS) averaged across lactation and adjusted for days in milk and for month and age at calving were available for single lactations of 1506 cows. Least squares means of SCS for categorically scored teat end shapes were computed from a model that included herd date, parity, days in milk, lesion, and teat diameter. Teat end shape and teat end lesion did not significantly affect SCS. Wider teat diameters were associated with higher SCS. Predicted transmitting abilities for SCS and udder composite index scores were available for 113 sires that had five or more daughters with teat end scores. Predicted transmitting abilities for SCS were significantly associated with udder composite index but not with sire solutions for teat end shape.
(**Key words:** heritability, teat end shape, teat diameter, somatic cell score)

### INTRODUCTION

Mastitis is recognized as one of the most costly diseases afflicting dairy cows (3). The substantial cost of mastitis has been estimated in the literature (3, 14, 19). Mastitis is listed as the primary reason for disposal for 26.5% of dairy cows culled in the US (27). Growing concerns of consumers about antibiotic residues in milk from mastitis treatment are also a concern of the industry. Nearly all intramammary infections occur as a result of microorganisms passing through the teat canal (6). Logically, the characteristics of the teat end should influence the rate at which bacteria gains entry to the teat canal. Previous studies (16, 24) have tried to determine the role that the teat end plays in a genetic defense mechanism.

Genetic parameters of teat end shape have been the objective of previous research. Seykora and McDaniel (24) scored teat end shape for 898 lactating cows on a linear 50-point scale (1 = most pointed to 50 = most inverted). Heritability estimates were calculated from paternal half-sisters and daughter-dam regression. Estimates were 0.57 and 0.67, respectively. Repeatability of teat end shape was determined to be 0.76. Lojda et al. (15) visually classified 2407 teat ends from 1200 Bohemian Pied cows. Heritabilities calculated from paternal half-sisters and daughter-dam regression were 0.085 and 0.41, respectively. Lojda et al. (16) considered the latter score to be more accurate because the dams and daughters were kept, for the most part, in the same environment and thus concluded teat end shape to be highly heritable.

The relationship of teat end shape with mastitis has also been the focus of previous research. Ilgmann (11) examined the teat ends of 1000 cows and found clinical mastitis in 20% of cows with disk, funnel, or pocket-shaped teat ends, while clinical mastitis was found in only 9% of those cows with round teat ends. Natzke et al. (21) found that round teat ends had the lowest rate of new infections. Lojda et al. (16) found that plate-shaped to inverted funnel-shaped teat ends had higher frequencies of mastitis than did round teat ends. Seykora and McDaniel (24) found that cows with teat end shape scores of 35 would average 150,000 cells/ml higher in SCC than did cows with scores of 15. Hodgson and Murdock (9) determined SCC averages (cells per milliliter) for five different teat end shapes. The averages were 88,000 pointed, 118,000 round, 420,000 flat,

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377,000 disk, and 1,222,000 cone. These studies all showed that as teat end shape varied from pointed toward flat and inverted, SCC or mastitis incidence increased. Other studies (2, 7, 13, 20) have found no relationship between teat end shape and mastitis indicators.

Teat end lesions have been associated with increased incidence of mastitis. Johansson (12) found that plate-shaped teat ends predisposed cows to orifice eversion and, consequently, to mastitis. Seykora and McDaniel (24) scored teat end lesions on a linear scale (from 1 = smooth, well-closed orifice to 7 = raw, ulcerated appearance). They found teat end lesion score was positively associated with SCC ($P < 0.05$). Farnsworth (4), however, found no statistical differences in the prevalence of infection among normal teat ends with various hyperkeratotic lesions. Conversely, teat ends with erosions that were raw and ulcerated did show significantly higher prevalence of mastitis. The general consensus of Farnsworth and Sieber (5), Farnsworth (4), Sieber (25), and Sieber and Farnsworth (26) is that teat end lesions do not contribute to mastitis unless the lesions are severe (teat ends are raw or ulcerated).

The purpose of this study was to estimate the genetic parameters of teat end shape and teat diameter and to determine the relationship of teat end shape and teat diameter to SCS. Teat ends were also classified for lesions, and the relationship of teat end lesion with SCS was also assessed.

## MATERIALS AND METHODS

Data consisted of teat measurements and scores from 1740 Holstein cows with 2261 lactations taken during 15 visits to five commercial and four university herds in Minnesota and Wisconsin from July 1993 to June 1995. Recommended mastitis control programs were in effect in each of these herds, which had a weighted SCC average of 210,000 cells/ml. The major causes of mastitis in these herds tended to be environmental pathogens. All herds practiced pre- and postmilking teat dipping with a sanitizing solution. All cows were infused with a dry cow antibiotic preparation at the time of drying off. Over 85% of the cows in the study were milked in parlors with automatic take-offs. Visual scoring of teat ends and lesions and measurements of teat diameter were all similar to the methods used by Seykora and McDaniel (24) as shown in Figure 1. Teat ends were scored in nine categories (Table 1) and scored continuously on a linear 50-point scale. A score of 1 to 10 was considered pointed; 11 to 20, round; 21 to 30, flat; 31 to 40, disk; and 41 to 50, inverted or cone. Approximately 67% of the teat ends were categorized sufficiently by one of these primary categories. Four additional categories were created for teat ends that were not sufficiently described by one of the five primary categories. These categories were pointed disk (pointed teat end with disk-shaped orifices), round ring (round teat end with a prominent ring of tissue around the orifice), round flat (round teat end that was flat around the orifice), and round disk (round with disk-type orifice). Teat ends characterized by these latter four categories received a score on a continuous scale, which most closely described their overall shape. Teat diameter was measured 15 mm from the teat end. Lesions were visually classified on a linear 4-point scale (0 = lesion absence, 1 = rough ring, 2 = very rough ring, and 3 = ulcerated, raw appearance).

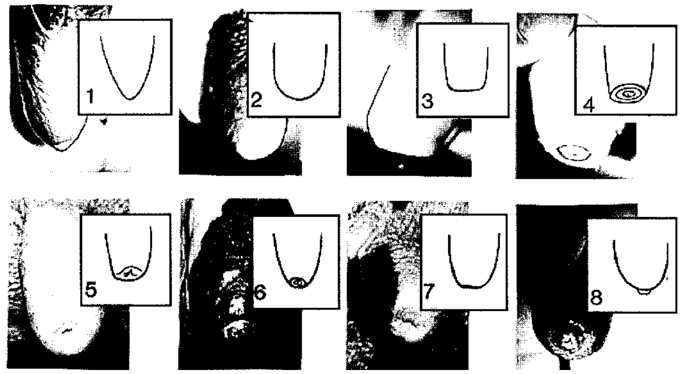


Figure 1. Teat end shapes: 1) pointed, 2) round, 3) flat, 4) disk, 5) inverted, 6) pointed disk, 7) round flat, and 8) round ring.

### Heritability Analysis

Heritability estimates were computed with an animal model using MTDFREML (28). Data included 1740 Holstein cows with 2261 lactations. Pedigrees were traced back three generations, if available. All cows had at least one ancestor in the pedigree file. Frequencies by lactation are listed in Table 2. Heritabilities and genetic correlations between teat end shape and teat diameter were calculated for first, second, and all lactations com-

TABLE 1. Frequency and percentages of categorically scored teat end shapes.

| Shape | Frequency | % |
|---|---|---|
| Pointed | 151 | 6.7 |
| Pointed disk | 28 | 1.2 |
| Round | 963 | 42.6 |
| Round ring | 361 | 16.0 |
| Round flat | 118 | 5.2 |
| Round disk | 249 | 11.0 |
| Flat | 138 | 6.1 |
| Disk | 235 | 10.4 |
| Inverted | 18 | 0.8 |
| Total | 2261 | 100.0 |