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Relationship between intramammary infection and teat characteristics

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ABSTRACT

The relationship between teat characteristics and intramammary infection (IMI) was investigated in 111 cows. These cows were scored visually on teat shape, teat-end shape and teat pigmentation. Subsequently, foremilk quarter samples were collected weekly for 14 weeks from calving to assess bacterial presence and somatic cell count (SCC). Teat shape and teat-end shape were combined and termed teat type. The distribution of teat type was cylindrical-round (34%), funnel-round (21%), cylindrical-flat (16%) and bottle-round (9%). Approximately 44% of teats were fully pigmented (black/brown) while 25% of teats were pigmented over less than 20% of the surface area. The frequency of quarters that never became infected during the trial period was 78.4% and the mean SCC was 69,000 cells mL^{-1}. Among the infected quarters, the most frequently isolated pathogens were *Corynebacterium bovis* (45%), coagulase negative staphylococci (CNS) (43%) and *Streptococcus uberis* (6%). Analyses showed no associations between teat characteristics and quarters not becoming infected, or between teat characteristics and bacterial pathogens in infected quarters.

Keywords: intramammary infection; teat shape; teat-end shape; pigmentation; *Corynebacterium bovis;* CNS; SCC.

INTRODUCTION

Mastitis is a disease that can cause considerable economic loss to the dairy farmer and compromise the welfare of the cow. Physical barriers such as skin and mucosal membranes are considered the first line of defence against bacterial entry to the mammary gland. Research studies have considered breeding based on udder and teat morphology as a way to enhance the efforts to control mastitis. Teat shape and teat-end shape have both been candidates for this selection.

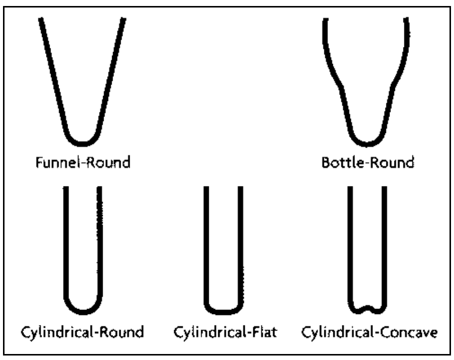
A review of previous studies suggests that funnel shaped teats had a lower frequency of mastitis than cylindrical ones (Seykora & McDaniel, 1985). The reasons suggested for lower mastitis in funnel shaped teats included decreased cup crawl and more complete milking out due to greater resistance to the teat being drawn into the cup (Seykora & McDaniel, 1985). However, Chrystal *et al.* (2001) studied the relationship between teat-end shape and somatic cell score (SCS) and did not find any significant associations. Seykora & McDaniel (1985) also suggested that lightly pigmented teats were more susceptible to harsh climatic environments, but no association was found between teat pigmentation and SCS. This study investigated the effects of teat characteristics on IMI and SCC in New Zealand crossbred dairy cows.

MATERIALS AND METHODS

Cows and teat scoring

One hundred and eleven cows were used in this study, and these were from three sire lines. Each teat was scored visually by one assessor at the end of the trial and before the afternoon milking. Overall teat shape was scored as being cylindrical, funnel, bottle or other, as described by Seykora & McDaniel (1985). Teat-end shape was also scored into discrete categories as round, pointed, flat, disc/plate or concave as described by Chrystal *et al.* (2001). Teat shape and teat-end shape were combined to define an overall teat type as represented in Figure 1. Each teat was also scored visually for percent of pigmentation (black/brown colouration). A teat was assigned to a pigmentation scale of one to five, one being the lowest and five being the highest level of pigmentation (20% range per category).

FIGURE 1: Summary of the most frequent teat types found in the study



Milk samples

Quarter foremilk samples were collected for bacteriological analysis according to the recommendations

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of the National Mastitis Council (1999), and somatic cell count (SCC) determination was performed on a CombiFoss 500 (Foss Electric, Denmark). Samples were collected weekly on the same day for 14 weeks post-calving from August to November 2002. On average, each quarter was sampled 11.4 times. No samples were collected from three blind quarters.

Statistical analysis

Statistical analysis was conducted using GenStat 6.2 (VSN International, Oxford, England). A quarter was defined as never infected if no pathogens were isolated in any of the weekly samples. The number of quarters that never became infected were analysed using generalised linear mixed models (GLMM) with teat shape, teat-end shape and pigmentation as fixed effects and cow as a random effect.

A quarter was considered infected when a pathogen was isolated on one or more occasions during the trial period. Mean values of infection status and SCS were calculated for each quarter and analysed using residual maximum likelihood analysis (REML) with teat shape, teat-end shape and pigmentation as fixed effects and cow as a random effect. The proportion of times that a quarter became infected was analysed after arcsin transformation. For statistical analysis, SCC was transformed to SCS [$SCS = \log_2\left(SCC/100\right) + 3$] (Dabdoub & Shook, 1984).

RESULTS

Teat scoring

A total of 439 teats were scored for the teat characteristics: teat shape, teat-end shape and pigmentation level (Table 2). Five quarters were not scored because either the quarter was blind or clinically swollen due to severe infection or physical damage. The most common teat shape was cylindrical (51%), followed by funnel (32.5%) and bottle (16%). Two teats did not belong to any of these categories. The most common teat-end was round (50%), followed by flat (20.5%). The remaining teat-end shapes had a frequency close to or less than 10%. The most common teat type was cylindrical-round (34%) followed by funnel-round (21%), cylindrical-flat (16%), bottle-round (9%) and cylindrical-concave (8%). Other combinations made up the remaining 12%.

Milk and bacteriological analysis

A total of 5032 samples were analysed for bacterial growth and SCC. There were 348 quarters (78.4%) that never became infected during the trial period. These quarters had a mean SCC of 69,000 cells mL^{-1} (max. 1.8 x 10^{6} cells mL^{-1}). Bacterial pathogens were isolated from 9.3% of samples. A mixed growth of bacteria was observed in only one sample. The type of bacteria isolated from the positive samples is shown in Table 1. In general, the number of quarters infected with *S. uberis* or CNS decreased as days in milk increased, while *C. bovis* cases increased as days in milk increased.

TABLE 1. Pathogens isolated from milk samples

Pathogen	*Cases*	*Frequency (%)*
Corynebacterium bovis	191	45.37
CNS spp.	180	42.76
Streptococcus uberis	27	6.41
Staphylococcus aureus	10	2.38
Streptococcus dysgalactiae	11	2.61
Escherichia coli	1	0.24
Actinomyces pyogenes	1	0.24
Total	421	100.00

Proportion analysis of teat traits

There were no significant differences in the proportion of uninfected quarters for the different teat characteristics (Table 2). Among the infected quarters there was no association between frequency of infection and teat shape, teat-end teat type or pigmentation. When the type of bacterial pathogen was considered, no associations were observed, except in the degree of pigmentation and frequency of *S. uberis* infection ($p<0.10$).

DISCUSSION

The frequencies of teat shapes were similar to those reported by Chrystal *et al.* (2001) who found that the frequency of round teat-ends was 57.5% and that of flat ends was 12.5%. In their study, the presence of round teat-ends increased as new generations arose, while that of flat remained relatively constant.

Teat morphology does not have a significant association with mastitis. Lodja *et al.* (1976) found no association between teat shape and incidence of sub-clinical mastitis, while Chrystal *et al.* (2001) reported that teat-end shape was not associated with SCS.

When quarters were scored for pigmentation, the 21-40% category was associated with a higher incidence of *S. uberis* infection ($p<0.10$). However, this result must be interpreted carefully because of the low frequency (7%) of quarters belonging to this category and the low incidence of *S. uberis* infection. Further research is therefore needed to determine the effect of pigmentation on susceptibility to mastitis pathogens.

This study did not find a significant difference between teat shape, teat-end shape, teat-type or pigmentation and susceptibility to IMI or association with SCS. There was no association between teat shape, teat-end shape, teat-type or pigmentation and susceptibility to infection by different bacterial pathogens. Some results may be inconclusive because of the low frequency of some teat characteristics in the cows and the low incidence of *S. uberis* infection. A study where the proportions of each trait are similar or where the study population is larger and where different milking conditions (e.g. liners, shells, vacuums, etc.) could

TABLE 2: Teat morphology and associations with infection and SCS

Teat Characteristic	*Never Infected Quarters*		*Infected Quarters*				
	Total (n)	Frequency (%) (SEM)	Frequency (%)	*C. bovis* (%)	CNS (%)	*S. uberis* (%)	SCS
Teat Shape		P = 0.492	P = 0.220 SED = 2.95	P = 0.128 SED = 1.98	P = 0.395 SED = 2.04	P = 0.887 SED = 0.55	P = 0.346 SED = 0.177
Cylindrical	223	78.35 ± 2.74	8.16	3.62	3.45	0.98	1.539
Funnel	143	80.28 ± 3.35	3.71	1.03	1.57	1.27	1.551
Bottle	71	70.09 ± 5.45	9.05	5.05	2.20	0.79	1.797
Teat-End Shape		P = 0.895	P = 0.943 SED = 4.47	P = 0.550 SED = 2.97	P = 0.649 SED = 3.06	P = 0.430 SED = 0.79	P = 0.472 SED = 0.265
Pointed	39	83.09 ± 5.83	7.35	1.47	2.09	1.91	1.703
Round	219	77.91 ± 2.83	8.01	3.92	2.93	0.73	1.632
Flat	90	76.92 ± 4.40	8.05	2.24	4.97	0.90	1.794
Disc/Plate	45	75.24 ± 6.53	7.50	5.37	1.52	0.29	1.693
Concave	46	75.27 ± 6.42	4.00	3.17	0.54	1.25	1.322
Pigmentation		P = 0.162	P = 0.258 SED = 3.93	P = 0.265 SED = 2.64	P = 0.304 SED = 2.73	**P = 0.084 SED = 0.76**	P = 0.582 SED = 0.236
0-20%	109	86.15 ± 3.29	6.57	2.48	1.61	0.66	1.497
21-40%	35	66.97 ± 8.20	7.17	0.11	4.32	2.88	1.887
41-60%	53	85.10 ± 4.89	2.26	2.40	0.36	0.12	1.607
61-80%	41	79.69 ± 6.47	9.07	6.54	1.69	0.85	1.607
81-100%	197	72.16 ± 3.21	9.78	4.86	4.05	0.57	1.545

be tested, would be important for elucidating the influence of teat characteristics and susceptibility to mastitis.

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REFERENCES

Chrystal, M.A.; Seykora, A.J.; Hansen, L.B.; Freeman, A.E.; Kelley, D.H.; Healey, M.H. 2001: Heritability of teat-end shape and the relationship of teat-end shape with somatic cell score for an experimental herd of cows. *Journal of Dairy Science 84*: 2549-2554.

Dabdoub, S.A.M.; Shook, G.E. 1984: Phenotypic relations among milk yield, somatic cell count, and clinical mastitis. *Journal of Dairy Science 67*: 163-4.

Lodja, L.; Stavikova, M.; Matouskova, O. 1976: The shape of the teat and teat end and the location of the teat canal orifice in relation to subclinical mastitis in cattle. *Acta Veterinaria Brno* 45: 181.

National Mastitis Council. 1999: Laboratory handbook on bovine mastitis. Madison, USA, National Mastitis Council.

Seykora, A.J.; McDaniel, B.T. 1985: Udder and teat morphology related to mastitis resistance: a review. *Journal of Dairy Science 68*: 2670-2683.