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Effect of dry cow management on teat end bacterial contamination

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ABSTRACT

Two stock management practices were investigated for their effect on transfer of bacteria from the environment onto teat ends of dry dairy cows. Cows (n = 20) were required to walk or trot along races (1.2 km) deemed to be “clean” or “dirty”. Cows walked along “clean” or “dirty” races were similar in dirtiness of the udder, and bacterial loading of the teats. Cows that trotted along 'dirty' races showed a significant increase in degree of dirtiness of the teats and legs, and increased contamination of teats with coliform bacteria. Cows grazed for 24 hour periods using standard break-fencing systems, with (n = 20) or without (n = 20) the addition of back-fencing were assessed for the number and type of bacteria present on teat-ends. Cows that grazed paddocks with back-fencing had visually dirtier udders, but there was no difference in bacterial contamination of teats compared to those cows grazed without back-fencing. These studies suggest that the risk of bacterial contamination, and by extrapolation, risk of intra-mammary infection, may be mitigated by the speed with which cows are moved along races. However, grazing on muddy, soiled paddocks should not be discounted as a significant risk factor for mastitis.

Keywords: dry cow; *Streptococcus uberis*; mastitis; stock movement; fencing.

INTRODUCTION

Under pasture-based grazing systems typical of New Zealand, *Streptococcus uberis*, an “environmental” bacterium, is the predominant mastitis pathogen in the dry period and around calving (Pankey *et al.*, 1996; McDougall, 1998). Contamination of the dairy farm environment with *S. uberis* has been reported previously, with high contamination levels in races where cow traffic was frequent, and lower levels in areas where usage was minimal (Lopez-Benavides *et al.*, 2007). Seasonal variation in the levels of *S. uberis* contamination of the dairy farm environment (races and paddocks) have been observed with the highest levels occurring in winter (August) and the lowest in summer (January; Lopez-Benavides *et al.*, 2005). Pasture contamination with *S. uberis* following a period of grazing by dairy cows has also been observed (Lopez-Benavides *et al.*, 2007).

Incidence of intramammary infection is highly correlated with the number of mastitis causing pathogens on the teat-ends (Pankey, 1989). Experimental exposure trials have shown that cows exposed to mastitis-causing bacteria on teat-ends are at risk of developing intramammary infections (Boddie *et al.*, 2004; Galton, 2004).

Moving cows along races on dairy farms is an integral part of pastoral dairy farming. During lactation, cows are moved between paddocks and the farm dairy, usually twice a day. During the dry period, cows are moved regularly between paddocks to reach fresh grazing and moved through the dairy to facilitate weighing, feeding and other cow management practices. Walking or trotting may result in bacteria in the environment being thrown up onto the teats. Further, contamination of the hooves and legs with race material could result in direct contact with the udder when cows lie down. These actions provide potential mechanisms by which bacteria in the environment can be transferred onto the teat ends. During the dry-period, when feed demand is less than during lactation, longer paddock rotation lengths are used and cows are stocked at a higher density (Macdonald & Penno, 1998). Farmers are encouraged to use back-fencing to reduce the grazing of regrowth (Macdonald & Penno, 1998), and to limit exposure to previously grazed areas of the paddock, which will have become contaminated with environmental bacteria for example, coliform bacteria and streptococci species, (Hubble, 2007).

Given that *S. uberis* is known to colonise parts of a dairy farm environment and that contamination of teats can lead to the development of intra-mammary infection, two farm management practices were investigated for their ability to contaminate teat-ends of dry dairy cows. These were speed of movement of dry cows along farm races and use of back-fencing for grazing dry cows in winter.

MATERIALS AND METHODS

Experimental design

Between May and July 2007 (during the dry, non-lactating period), two studies were conducted at DairyNZ Lye Farm, Vaile Rd, Hamilton and utilised 60 pregnant, dairy cows (20 for the stock movement study, and 40 for the paddock grazing study). Experimental cows were returned to the main Lye Farm herd between each replicate.

Stock movement study

Speed of movement of cows along farm dairy races, and level of environmental contamination of the race material, were examined for their ability to contaminate clean teats. Cows were moved along races of approximately 0.6 km (1.2 km in total), which represents approximately half the distance of the furthest paddocks from the farm dairy. Races were 5 m wide and composed of a 400 mm base of compacted "rotten-rock" (poorly cemented silt stone), overlaid with 50 mm of compacted pit sand. Dirty races were defined as those receiving daily cow movement and were determined to be naturally contaminated with >5000 cfu (colony forming units) *S. uberis*/g wet weight race material. In comparison, clean races were defined as receiving cow traffic on not more than four days per week and *S. uberis* contamination in the race material of <500 cfu/g. Twenty cows were subjected to three treatments; "clean walk"; "dirty walk" and "dirty trot". A walk was defined as a similar pace to that used when returning cows to the paddock following milking and involving minimal driving, whilst a trot involved some driving so that the pace was faster than a walk, cow's heads were held higher and 50 - 100% of the group trotted over half the distance. Prior to each treatment, cow's hind teats were scrubbed with cotton wool swabs soaked in 70% alcohol. Cows were then subjected to a walking or trotting treatment and returned to the farm dairy where the udder and legs were visually assessed by a trained observer and allocated a cleanliness score (1 - 4) using the system of Schreiner and Ruegg (2002), with 1 being clear of all visual dirt and 4 being covered in dirt and faecal matter. Teats were assessed on a 1 - 3 scale. The hind teats were swabbed to determine the level of bacterial contamination (Lopez-Benavides *et al.*, 2006). At the end of all treatments, teats were sprayed with an iodine based teat spray (23 g/L available iodine) and cows returned to their paddock. The three treatments were replicated on three occasions between mid-June and early-July 2007 with treatment order varied on each of the three experimental days. Each walking or trotting episode lasted 10 - 20 minutes. Total rainfall during the seven days immediately preceding and including the day of each treatment replicate day was 16.2 mm, 4.6 mm and 68.6 mm respectively.

Paddock grazing study

To determine the relative contribution of the paddock environment to contamination of teat-ends in dry dairy cows, two grazing management systems were used. Conventional 24-hour break-fencing (CBF) provided an increasing area per cow as the cows moved through the paddock breaks (42 m^2/cow on Day 1 to 167 m^2/cow on Day 4). Break-fed, back-fencing (BFBF) maintained the cows at a constant stocking density, while limiting access to previously grazed parts of the paddock (42 m^2/cow throughout the experiment). On Day 1, all cows were brought to the farm dairy and their teats scrubbed with cotton wool swabs soaked in 70% alcohol. Cows were then split into two groups of 20, and allocated the first break. After 24 hours (Day 2), both groups were returned to the dairy, the cleanliness score of the udders, legs and teats was assessed and hind teats swabbed to determine the level of bacterial contamination. The CBF group was allocated a fresh break, with continued access to the previous day's paddock area, while the BFBF group was allocated a fresh break and had the previous day's paddock area back fenced to limit access. Fresh breaks were also allocated on Days 3 and 4, with back-fencing for the BFBF group. Cows in both groups had continual access to drinking water from troughs located in their grazing area. On the morning of Day 5, cows were brought to the farm dairy, the cleanliness score of the udders, legs and teats was assessed and teats swabbed. Treatments were replicated three times for 5-day periods between late-May and early-July 2007. Total rainfall during the 10-day periods immediately preceding and including the four days of the treatment periods, was 9.4 mm, 2.6 mm and 93.8 mm respectively.

Bacterial analysis

Farm race material: Samples of farm race material were collected and *S. uberis* levels measured using a selective *S. uberis* medium as described by Lopez-Benavides *et al.*, (2007). The *S. uberis* counts were expressed as colony forming units (cfu) per gram wet weight race material.

Teat end contamination: Cotton-tipped teat swabs collected during the studies were processed according to Lopez-Benavides *et al.*, (2006). All estimates of counts for *S. uberis* were made from selective *S. uberis* medium, total coliforms from McConkey Agar and total streptococci from Edwards Medium. Counts (cfu) were performed using 10-fold dilutions, followed by spread plating and counting and were expressed as cfu per swab.

Statistical analyses

All analyses were conducted using GenStat (Payne *et al.,* 2007). For the stock movement study, the bacterial counts and cleanliness scores were compared between treatments using ANOVA with treatment as the fixed effect and replicate, and treatment within replicate as the random effects. For the paddock study data, the difference in udder scores and cfu counts of the teats between Day 1 and on Day 5 (following four days of treatment) was compared using ANOVA with treatment as the fixed effect and replicate and treatment within replicate as the random effects. As some bacterial counts were zero, a value of 1 was added to all data prior to $\log_{10}$ transformation allow statistical analysis. Associations between the bacterial counts and cleanliness scores for each of the udder, teats and legs were investigated individually using regression analysis, pooling within treatment and within replicate. Analysis included replicate, treatment and their interaction as fixed effects and cleanliness score as an explanatory variable.

RESULTS

Those races classified as dirty were found to have an average 8,200 cfu *S. uberis*/g race material, while those classified as clean contained on average 420 cfu *S. uberis*/g race material.

After being trotted along dirty races, the legs and teats were both significantly dirtier (P = 0.021, P = 0.011 respectively) than those of cows who were walked along either clean or dirty races (Table 1). Trotting dairy cows along dirty races resulted in greater numbers (P = 0.011) of coliform bacteria (Table 1) on the teat ends. No difference in numbers of *S. uberis* was detected, although more total streptococci were recovered from teats of cows trotted along dirty races (P = 0.082).

TABLE 1: Average cleanliness scores of the udder, legs and teats (for udders and legs a 1 - 4 scale with 1 being clear of all visual dirt and 4 being covered in dirt and faecal matter, and for teats a 1 - 3 scale) and average bacterial contamination of the right and left back teats ($\log_{10}$ colony forming units; cfu) and in cows following movement along clean or dirty races (1.2 km) while walking or trotting. SED = standard error of the difference.

	Race condition and movement speed			SED	P
	Clean/Walk	Dirty/Trot	Dirty/Walk		
Cleanliness score					
Udder	1.80	2.29	2.00	0.181	0.125
Legs	2.55	3.08	2.66	0.114	0.021
Teats	1.21	1.95	1.39	0.130	0.011
Teat swabs - $\log_{10}$ (cfu/swab)					
S. uberis	1.31	1.94	1.60	0.37	0.343
Total streptococci	2.27	3.20	2.16	0.36	0.082
Total coliforms	2.23	3.33	2.50	0.20	0.011

For the paddock grazing study, the change in cleanliness scores of the legs and teats over the course of the experiment was not different between the BFBF and CBF treatments. However, cows on the BFBF treatment showed a greater increase in dirtiness of their udders compared to cows on the CBF treatment (P = 0.035) (Table 2). There was no difference in bacterial contamination on teat ends of dairy cows between the initial assessment, and the fourth day of treatment (Table 2) regardless of whether cows were grazed in paddocks with conventional break-fencing (CBF) or when back-fencing was applied (BFBF).

For both studies, a significant (P <0.05) and positive relationship was found between the bacterial count of different pathogens and the cleanliness score of each of the udder, teats and legs.

TABLE 2: Average cleanliness scores of the udder, legs and teats (for udders and legs a 1 - 4 scale with 1 being clear of all visual dirt and 4 being covered in dirt and faecal matter, and for teats a 1 - 3 scale) and average bacterial contamination of the right and left back teats ($\log_{10}$ colony forming units; cfu) and of cows on Day 2 and average difference between Day 2 and following three days of grazing in paddocks with conventional break fencing (CBF) occurring every 24 hours, or break fencing with backfencing (BFBF) to limit access to previously grazed areas of pasture. SED = standard error of the difference.

	Day 2	Difference between Day 2 and 5			P
	Average	BFBF	CBF	SED	Treatment effect
Cleanliness score					
Udder	2.10	0.23	0.08	0.03	0.035
Legs	2.62	0.10	-0.03	0.10	0.319
Teats	1.76	0.12	0.00	0.07	0.250
Teat swabs - $\log_{10}$ cfu/swab					
S. uberis	2.30	-0.02	-0.22	0.28	0.547
Total streptococci	3.74	0.03	-0.12	0.28	0.649
Total coliform	3.43	-0.24	-0.15	0.08	0.375

DISCUSSION

Teat-end contamination with bacteria is clearly linked to the development of mastitis in dairy cows (Pankey, 1989; Boddie *et al.*, 2004; Lopez-Benavides *et al.*, 2006). These data suggest that the speed of movement of a dairy cow along a dirty farm race was more important than the cleanliness of the race material, in terms of influencing the degree of contamination of the teat-ends. The temptation to drive cows faster along races exists on farms but raises a number of animal welfare concerns. Increased herding pressure leads to an increased risk of lameness (Chesterton, 2006). Our study shows that increasing the herding pressure is also likely to result in a higher bacterial loading on teat-ends which increases the risk of mastitis. Strategies that reduce herding pressure, such as allowing cows to walk freely, or controlling mob movement from the front of the herd during times when cows are tempted to trot could minimize this risk.

Bacterial contamination of paddocks with *S. uberis* was only observed in the 24 hours following grazing or spreading of effluent, except during winter when it was detectable in the soil for up to two weeks following grazing (Lopez-Benavides *et al.*, 2007). Cows exposed to muddy paddocks, especially during winter are likely to have an increased level of teat contamination and a higher risk of intra-mammary infection. Limiting exposure to this soiled environment should reduce the risk of contamination, but in the current study no difference in the cleanliness score of the legs or teats was detected between the two treatments. Furthermore, teat swabs showed no detectable difference in the bacterial loading of the teat ends. Simple visual appraisals of the paddocks carried out throughout the experiment suggested no obvious difference in the degree of pugging or soiling of the paddock breaks between the two treatments. A more extreme treatment, such as cows kept overnight on races that are highly contaminated with bacteria, could result in more significant contamination of teat-ends. This practice has been used by dairy farmers in very wet weather and is worthy of further investigation.

Schreiner and Ruegg (2003) observed a relationship between cleanliness of cows and the rate of sub-clinical mastitis, with cows with dirty udders having an increased risk of developing intra-mammary infection caused by major pathogens. The stock movement and paddock grazing studies further support this finding as there was a significant and positive relationship between bacteria recovered from teat-swabs and the cleanliness of the udder, teats and legs.

Teat end contamination levels observed in the paddock grazing study were similar to those reported by Lopez-Benavides *et al*, (2006) for cows grazing during the dry period. Cows in the paddock grazing study tended to have more bacterial contamination of the teat ends compared with cows in the stock movement study, although cleanliness scores aeared to be similar between studies. This was expected since cows were subjected to the paddock environment for up to four days compared with cows in the stock movement study, which were exposed to the treatment environment for a maximum of 20 minutes. Teats of cows on the stock movement study were also scrubbed between treatments thereby reducing bacterial contamination. Long periods of exposure to a soiled environment are likely to increase bacterial loading of teat-ends. Therefore exposing cows to soiled paddocks for long periods should not be discounted as a risk factor for the development of mastitis.

The results of these studies suggest that teat-end contamination would be reduced by minimizing herding pressure, especially along dirty races, but that the use of back-fencing would not have a significant impact on teat end contamination, at least in a relatively dry winter.

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