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Effect of Different Premilking Manual Teat-Cleaning Methods on Bacterial Spores in Milk

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ABSTRACT

Different teat-cleaning methods were evaluated to determine their effect on the presence of spores from anaerobic bacterial spore-formers in the milk. Artificial contamination was used to achieve uniform contamination of teats to reduce the number of cows and samples needed in the experiments and still obtain adequate power to detect differences among tested methods. Teats were contaminated experimentally with a large amount of *Clostridium tyrobutyricum* spores in a manure–water slurry. Various types of dry and moistened towels and different combinations of methods using soap or 2 types of towels, together with cleaning times of 10 or 20 s, were compared in 2 Latin square-designed experiments with 7 cows, 7 treatments, and 4 replications in each experiment. In comparison with control (no cleaning and no forestripping), cleaning teats with dry paper towels for 10 s reduced concentration of spores in milk by 45 to 50%. A 50 to 74% reduction was achieved using different types of moist towels for 10 s. Methods using 2 towels, soap, or a longer cleaning time reduced bacterial contamination by 85 to 91%. The most effective methods in reducing milk spore content (96% reduction) were use of a moist washable towel with or without soap followed by drying with a dry paper towel, for a total time of 20 s per cow. One of the best cleaning methods was studied in an additional experiment to determine the effect of different teat contamination mixtures. The Latin square-designed experiment with 8 cows, 8 treatments, and 2 replications showed that cleaning was independent of the tested contamination matrix (manure, soil, or sawdust), type of spores (*Cl. tyrobutyricum* and *Bacillus cereus*), or degree of contamination (manure or extra manure).

Key words: premilking teat cleaning, *Clostridium tyrobutyricum* spore, *Bacillus cereus* spore, milk quality

INTRODUCTION

Bacterial spore contamination of milk can cause processing problems for the dairy industry because spores can survive pasteurization. Presence of *Bacillus cereus* is a limiting factor for the shelf life of pasteurized milk (Griffiths, 1992) and a potential food poisoning agent (Granum and Lund, 1997). It is a spore-forming bacterium commonly found in soil and is most frequently found in milk during the grazing season when the risk of teat contamination with the soil is greatest (Slaghuis et al., 1997; Christiansson et al., 1999). In addition, spore-forming bacteria of the *Clostridium* species cause late blowing in some types of cheese (Stadhouders et al., 1985). The major source of the clostridia found in the milk is feeding silage, especially in the poor-quality portions of the silage (Stadhouders and Spoelstra, 1990). Spores can then be found in feces of animals consuming the silage, and manure contamination on the teats results in the spores being transferred to the milk (Stadhouders and Jørgensen, 1990; Herlin and Christiansson, 1993).

Worldwide, several different premilking manual cleaning methods are practiced, but comparative information about their effect on milk quality is scarce. Previous systematic investigations generally considered the effect of cleaning on bacterial contamination. Cleaning teats reduced milk bacterial counts more than when no cleaning was done, and wet cleaning was better than dry cleaning (Galton et al., 1982, 1986; Pankey, 1989). Washing teats with water directly from a hose should be followed by careful drying of the teats (Galton et al., 1984). Use of different sanitizers or disinfectants in teat preparations improved cleaning better than cleaning with water from a hose followed by drying with a paper towel (Adkinson et al., 1991; Ingwa et al., 1992), or using a dry or wet towel, but was not more effective than using a wet towel followed by drying with a paper towel (Galton et al., 1986). Using a disinfectant entails a risk of adding residues to milk (Galton et al., 1984; Rasmussen et al., 1991).

Few investigations of the effect of teat cleaning on the presence of spores in the milk have been conducted. McKinnon et al. (1983) found that the total bacterial

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Table 1. Description of cleaning methods using different commercially available teat-cleaning paper towels, a washable cotton towel, and a synthetic towel (Experiment 1)

Treatment	Description of towel[1,2]	Size of towel, cm
1A (control)	No cleaning of udder and teats, no forestripping	—
1B	Dry paper towel a, smooth surface	25.5 × 33
1C	Dry thin paper towel b, rough surface	25 × 28
1D	Moist thin paper towel c, premoistened with 10% isopropanol	25 × 29
1E	Moist paper towel d, premoistened with <0.5% ethanol and 1.5 to 3.0% alkyl benzene sulfonate	23 × 28
1F	Moist washable cotton towel, dipped in water and firmly wrung	35 × 36
1G	Moist washable towel of synthetic fiber, dipped in water and firmly wrung	36 × 51

[1]Four kinds of paper towels (a, b, c, and d) were used.

[2]Cleaning time was fixed to 10 s.

contamination and aerobic spore counts in milk decreased when teats were washed and dried before milking in comparison with no cleaning or washing without drying. Washing teats with hypochlorite before drying did not further affect the aerobic spore counts in milk. Rasmussen et al. (1991) showed that cleaning teats with a dry paper towel produced fewer bacterial and anaerobic spore counts in milk than no cleaning. Longer cleaning time together with use of a wet paper towel, followed by drying with a paper towel, was even more effective. Long cleaning time and more active scrubbing of the teat ending with a moist cotton towel further decreased bacterial counts in milk. Their results indicated that the physical structure of the towel and the physical action were important. Similarly, Stadhouders and Jørgensen (1990) concluded that the more intensive the cleaning and drying of the teats, the smaller the concentration of clostridial spores in the milk.

The objectives of this study were to 1) compare effectiveness of using different methods for premilking manual teat cleaning under controlled conditions with teats experimentally contaminated with spores of *Clostridium tyrobutyricum*, and 2) evaluate the efficiency of the best cleaning methods according to the type of spores, matrix (contamination carrier), and degree of contamination by using different matrices mixed with spores of *Cl. tyrobutyricum* or *B. cereus* or both.

MATERIALS AND METHODS

Animals and Treatments

In each of 3 different experiments, the teats of 7 or 8 Swedish Friesian cows producing 17 to 35 kg of milk daily were experimentally contaminated with spores of *Cl. tyrobutyricum* or *B. cereus* mixed with different matrices and various premilking cleaning methods were tested. Cows were housed in tie stalls on rubber mats bedded with sawdust. All cows in each experiment were fed similar rations (including the same batch of silage) and were fed at least 30 min before milking.

Experiment 1. Effect of using 4 commercially available teat-cleaning paper towels (a, b, c and d; Table 1) and towels of cotton or synthetic fiber was studied. In this experiment, cleaning time was fixed at 10 s. Teats were contaminated before milking with a sterilized manure–water slurry containing *Cl. tyrobutyricum* spores. Treatments for Experiment 1 are listed in Table 1.

Experiment 2. Effect of teat-cleaning time in combination with different teat-cleaning methods was studied. Teats were contaminated before milking with a sterilized manure–water slurry containing *Cl. tyrobutyricum* spores. Treatments for Experiment 2 are shown in Table 2.

Experiment 3. Cleaning efficiency as affected by the contamination matrix, type of spores, and degree of contamination was studied. Influence of the matrix was studied by using manure, soil, or sawdust contaminated with the most common bacterial spores for each matrix (manure: *Cl. tyrobutyricum*; soil and sawdust: *B. cereus*). Influence of degree of contamination was studied by using 2 contamination mixtures having different concentrations of manure (manure and extra manure). Influence of type of spores (*B. cereus* and *Cl. tyrobutyricum*) was studied by using 2 contamination mixtures (manure and soil) containing both types of spores. Teats were purposely contaminated before milking with 4 different combinations of contamination sources and spores, 1 per cow. Cleaning method 2F described in Table 2 and a control was used for all contamination mixtures. Treatments for Experiment 3 are shown in Table 3.

Experimental Design

In Experiment 1 and 2, each of 7 cows was assigned to 1 of 7 different cleaning methods (Tables 1 and 2, respectively) at 7 milking occasions in a Latin square design. In each experiment, 4 replications (2 milkers and morning vs. evening milking) were conducted for a total of 28 milking occasions. Each experiment was carried out for 2 wk. In Experiment 3, each of 8 cows at 8 milking occasions was assigned to 1 of 4 different combinations of contamination mixtures, and with or without teat cleaning before milking, in a Latin square