Effects of Premilking Udder Hygiene on Environmental Bacterial Contamination, Chemical Residue, and Sediment in Milk

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Background

Premilking hygiene is an essential component of effective milking programs. Methods of premilking hygiene for udder preparation and stimulation vary among dairymen because of mechanization, personal preference and working routine. Regardless of premilking procedures, udder preparation should reduce the number of mastitis pathogens on the teat prior to milking, and reduce the bacterial count in milk (8). Work has indicated that the transfer of bacteria can occur among cows when common clothes or towels (even immersed in disinfectant between cows) are used for a series of cows. Bacterial populations in milk increase by wetting the udder surface above the teat with subsequent inadequate cleaning and drying, thereby allowing water laden with bacteria to drain into the teatcups during milking. In general, washing udder surfaces may allow transfer of contaminated water into the mouthpiece of the liner during milking thus having little or no positive value in the control of the disease (1, 2, 13, 14, 15, 17, 22). Inadequate cleaning and drying of teats increase bacterial populations in milk and on teat skin (8). Such environmental bacterial contamination of milk can affect milk quality and possibly udder health.

Work has shown that the combination of disinfectant and mechanical effects of manipulation (water hose, chlorine solution – 600 ppm, hand or bucket, chlorine solution – 600 ppm, cloth) removes transcient contamination from the teats but indicates ineffectiveness in the prevention and removal of the colonization of *Staphylococcus aureus* (21). The use of a teat washer that combines chemical (iodophor solution—100 to 200 ppm available iodine) and mechanical (solution swirled around teat under pressure) effects reduce the bacterial contamination of teat surfaces, especially *Staphylococcus aureus* and *E. coli* (14).

Reports on the effects of udder wash sanitizers on premilking hygiene of udders and teats are conflicting. Some have shown that sanitizers may be of benefit in lowering bacterial populations on teat skin and in milk, and in reducing the rate of infections (10, 18) whereas other work shows marginal benefit, if any (7, 19, 21, 26). Effects may depend on the extent and type of environmental bacterial contamination of teats, type and concentration of sanitizer, and method of application.

Postmilking teat disinfectants have bacteriostatic properties that are desired in reducing bacterial population on the teats (20, 24). If postmilking teat dips are used as premilking teat disinfectants, then chemical residues in the milk, especially iodine, are of concern. The increase in iodine concentration in milk has been attributed to supplemental iodine in dairy rations (9), iodophor sanitizers and teat dips (3, 4, 6, 9, 11, 12, 16, 25), and animal medications (3, 5). A study indicated that an iodophor teat dip increases iodine in milk by 8.8 μg per 100 ml. Primary mode for the increased iodine in milk appears to be due to absorption through the skin, rather than by contamination from the teat surface (9).

Experiments

The objective of our work was to determine the effects of various udder preparations and disinfectants (udder wash sanitizers and postmilking teat dip used as a premilking disinfectant dip) on reducing bacterial populations, sediment and chemical residue in milk.

Experiments 1 and 2

Two experiments were conducted to determine effects of various udder preparations on environmental bacterial contamination of milk. In Experiment 1, preparations dealt with cleaning and drying both udder and teats, or teats only. In Experiment 2, preparations dealt with teats only with the addition of a 1% iodophor postmilking teat dip used as a premilking disinfectant dip. Effects of an iodophor udder wash sanitizer and drying with paper towels were studied in both experiments. The preparations are listed in Tables 1 and 2. Water hose, wet towel and dry towel were applied for 15 seconds (s) during cleaning, and drying with paper towels lasted 10s. Forestripping occurred prior to all preparations. Machines were attached immediately after termination of preparation. Premilking disinfectant dip was applied to the teats with immediate manual drying with paper towel or with a delay of 15s with no drying, or with no delay and no drying, and immediate machine attachment.

Cows free of intramammary infection were used based on negative composite milk samples. This procedure insured that bacteria present in the milk were from the environment. Standard plate count (SPC) plus counts for coliforms and

TABLE 1. Experiment 1. Standard plate count.

Statistical grouping	Preparations	Standard plate count
		—Bacteria per ml— X
a	1) None	17,073
	2) Water hose, udder	19,496
	3) Water hose, sanitizer, udder	15,398
b	4) Dry towel, teat	10,654
c	5) Water hose, sanitizer, drying, udder	5,547
	6) Water hose, teat	5,974
	7) Water hose, sanitizer, teat	5,632
	8) Water hose, drying, teat	4,139
	9) Wet towel, teat	5,033
	10) Wet towel, sanitizer, teat	6,547
	11) Wet towel, drying, teat	3,690
	12) Wet towel, sanitizer, drying, teat	3,763
d	13) Water hose, sanitizer, drying, teat	2,116

a b, c, d Statistical groupings - Preparations within each grouping are not different (P >.05).
SE ± 2,497

TABLE 2. Experiment 2. Standard plate count.

Statistical grouping	Preparations	Standard plate count
		—Bacteria per ml— X
a	1) None	6,380
	2) Water hose, teat	6,130
	3) Water hose, sanitizer, teat	6,196
	4) Dry towel, teat	6,117
b	5) Water hose, drying, teat	3,927
	6) Wet towel, teat	4,695
	7) Wet towel, sanitizer, teat	4,467
	8) Disinfectant dip, teat	4,203
	9) Disinfectant dip, delay, teat	3,802
c	10) Water hose, sanitizer, drying, teat	3,259
	11) Wet towel, drying, teat	2,337
	12) Wet towel, sanitizer, drying, teat	2,045
	13) Disinfectant dip, drying, teat	2,938

a, b, c Statistical groupings - preparations within each grouping are not different (P >.05).
SE ± 911

staphylococcus species were determined. Cows were housed in free stalls concreted and bedded with sawdust.

Experiment 3

Effects of various preparations on teat skin microflora were determined. The preparations are listed in Table 3. Experimental design was similar to Experiment 1. Right front and left rear teats of each animal were rinsed prior to preparation, left front and right rear teats were rinsed after preparation (before machine attachment) and all teats were rinsed after machine removal.

TABLE 3. Experiment 3. Standard plate count for teat rinses.

Preparations	Before udder preparation		Before machine attachment		After machine removal	
	Bacteria per ml (SPC)					
	x	SE	x	SF	x	SF
No preparation	231,462[a]	40,908	146,500[a]	29,139	4,535[a]	509
Dry towel, teat	210,937[a]	40,908	140,742[b]	29,139	3,661[a]	509
Wet towel, teat	200,318[a]	40,908	81,962[c]	29,139	3,309[a]	509
Wet towel, sanitizer, teat	146,170[a]	40,908	88,593[c]	29,139	1,079[a]	509
Wet towel, drying teat	109,687[a]	40,908	34,045[d]	29,139	1,030[a]	509
Wet towel, sentizer drying, teat	183,143[a]	40,908	22,049[d]	29,139	1,094[a]	509
Disinfectant dip, drying teat	132,950[a]	40,908	21,659[d]	29,139	3,886[a]	509

[1]Preparations are grouped according to statistical grouping for teat rinses before machine attachment.
a, b, c Means with same letter in same column are not different (P >.05)

Experiment 4

Effects of various udder preparation on sediment in milk were determined. The preparations are listed in Table 4. Experimental design was similar to Experiments 1 and 2. Sediment scores were determined for individual cow composite milk collected from weigh jars.

TABLE 4. Experiment 4. Milk sediment.

Statistical grouping	Preparations	Sediment
		—µg/1— x
a	1) None	2.4
	2) Disinfectant dip, teat	2.3
b	3) Dry towel 10s, teat	1.6
	4) Water hose 5s, teat	1.6
	5) Water hose 10s, teat	1.9
	6) Water hose 20s, teat	1.7
c	7) Dry towel 20s, teat	1.3
	8) Disinfectant dip, drying 10s, teat	1.4
	9) Disinfectant dip, drying 20s, teat	1.4
d	10) Wet towel 10s, teat	1.2
	11) Wet towel 20s, teat	1.0
	12) Wet towel 10s, drying 10s, teat	.95
	13) Wet towel 20s, drying 10s, teat	1.1

a, b, c, d Statistical groupings - Preparations within each grouping are not different (P >.05).
SE ± .12.

Experiment 5 and 6

Experiment 5 was conducted to determine the effects of a 1% iodophor postmilking teat dip used as a premilking disinfectant dip on iodine residue in milk. Preparations are listed in Table 5. Experiment 6 was conducted to determine effects of different iodine concentration (.5; 1.0%) of iodophor teat disinfectants on iodine residue in milk. Preparations are listed in Table 6. For both experiments,

TABLE 5. Experiment 5. Mean iodine in milk (μg/100 ml) for different premilking treatments.

	Control period	Treatment period	Difference[d]
	μg per 100 ml		
	x	x	x
No premilking disinfectant No postmilking disinfectant	22.63	28.56	5.93[a]
Premilking disinfectant dip, drying, teat	21.10	32.88	11.78[a]
Premilking disinfectant dip, drying,postmilking disinfectant, dip, teat	26.56	48.51	21.95[b]
Premilking disinfectant dip, teat	22.48	106.70	84.22[c]

a, b, c Means with different superscripts differ (P < .01).
d Standard error of mean ± 3.4.

TABLE 6. Experiment 6. Mean iodine in milk (μg/100 ml) for different premilking treatments.

	Control period	Treatment period	Difference[d]
	μg per 100 ml		
	x	x	x
Premilking disinfectant dip, drying, postmilking disinfectant dip, teat (.5%)	41.32	48.17	6.85[ab]
Postmilking disinfectant dip, teat (.5% iodine)	38.42	43.07	3.65[a]
Premilking disinfectant dip, drying, postmilking disinfectant dip, teat (1% iodine)	36.22	51.26	15.08[bc]
Postmilking disinfectant dip, teat (1% iodine)	38.79	47.82	9.03[b]

a, b, c Means with different superscripts differ (P < .01).
d Standard error of mean ± 2.5.

individual paper towels were used for drying (one per udder). Teats were dipped at a standard length of 2 cm. Machines were attached immediately after application of treatment. During an adjustment period of two weeks, all cows were fed the same ration.

Results and Discussion

Experiment 1

The SPC is in Table 1. For SPC, preparations 1, 2 and 3 within statistical grouping (a) had the highest counts indicating inadequate cleaning of udder and teats. These counts indicated that forestripping alone and the wetting of the udder and teat surfaces with no drying were insufficient in the removal of water laden with bacteria. Sanitizer was of no significant benefit. Statistical grouping (b) included dry towel, teat. Some benefit was achieved from the physical action of the paper towel on the teats. Preparations 5, 6, 7, 8, 9, 10, 11 and 12 of statistical grouping (c) further reduced bacterial counts. These reduced counts may be attributed primarily to restricting water application to teats only, cleaning benefit by physical action against the teat surfaces by hands and paper towels and by drying of teats. Sanitizer was of no benefit when used with wet towels. Preparation 13 had the lowest SPC which indicates that the physical force of the water from the hose with hand action plus the benefit of sanitizer with subsequent drying were of additive and maximum benefit. Data for coliforms and staphylococcus species indicated similar trends as SPC.

Experiment 2

Since data in Experiment 1 indicated that udder surfaces should not be wetted and udder wash sanitizer was of little or no benefit, this experiment was designed to further test preparations dealing with cleaning and drying of teats only and use of postmilking teat dips as a premilking teat disinfectant. Bacterial counts are in Table 2. For SPC, preparations 1, 2, 3, and 4 within statistical grouping (a) had the highest bacterial counts. Inadequate cleaning occurred during forestripping for no preparation as in Experiment 1. Preparations 2 and 3 had similar SPC which may be attributed to amount of water usage and no subsequent drying. There was no benefit of the physical action of dry towel in cleaning like there was in Experiment 1. Preparations 4, 5, 6, 7, 8, and 9 in statistical grouping (b) involved wet towel as minimum usage of water with no drying and with and without sanitizer. Water hose preparation included drying which indicates drying is important in removing the excessive water used with the hose compared to the wet towel. Use of premilking disinfectant dip with no drying and with delay had similar results. Statistical grouping (c) consisted of preparations involving water hose, wet towel, and premilking disinfectant dip. All of these preparations involved drying with paper towels. Like in Experiment 1, sanitizer was of benefit when used with the water hose with subsequent drying. Coliforms and staphylococcus species followed similar trends as SPC.

Experiment 3

Means for teat rinses before udder preparation, before machine attachment and after machine removal are in Table 3. Treatments for before udder preparation and after machine removal did not differ; however, treatments before machine attachment did differ. Treatments are statistically grouped in Table 3 by SPC for before machine attachment. Bacteria on teats before machine attachment indicated that preparation 1 (none) had the highest count, since only forestripping occurred. Dry towel, teat was in the second highest statistical grouping (b) for SPC. Statistical grouping (c) had lower counts which indicate that preparations with wet towel, with or without sanitizer reduced the bacterial

population by cleaning with water and hand action. Statistical grouping (d) involved preparations of drying of teats after the use of wet towel with and without sanitizer, or use of premilking disinfectant dip. Drying was important after teats were cleaned with water or disinfectant. Treatment effects were not statistically different for counts of teat rinses after machine removal. Milking machine action and duration were sufficient to remove bacteria from teat surfaces to similar population levels.

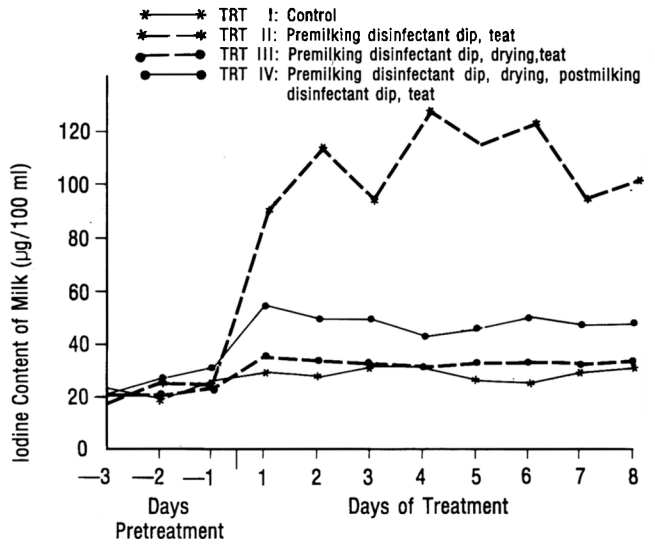
Experiment 4

Sediment values are in Table 4. Preparations within statistical grouping (a) had the highest sediment, suggesting inadequate cleaning of teats. These preparations involved no manual cleaning and drying of teats. Preparations 3, 4, 5, and 6 within statistical grouping (b) further reduced the sediment which may be attributed to the physical force of the water and hand manipulation of the teat for the preparations involving the water hose. Duration of cleaning with the water hose within 5 to 20s had no significant effect. Dry towel 10s, teat, consisted of sufficient physical manipulation of the teats to lower the sediment compared to preparations without any physical manipulation. Within statistical grouping (c), dry towel 20s, teat, further reduced the sediment compared to dry towel 10s, teat, suggesting duration of application for dry towel is important. Within (c), preparations 8 and 9 consisted of premilking disinfectant dip, plus drying for 10 and 20s. Wetting of the teats with the disinfectant with immediate drying was adequate to remove sediment. Lowest values for sediment were achieved for preparations 10, 11, 12, and 13 within statistical grouping (d). These preparations involved the use of wet towel for 10 and 20s with and without manual drying. These data indicate that the combination of the wetness and physical manipulation of the teats with wet towels was adequate in removing sediment without subsequent drying.

Experiment 5

Effects of udder preparations consisting of a 1% iodophor teat dip used as a premilking disinfectant dip on iodine residue in milk are presented in Table 5 and Figure 1. No significant difference ($P>.05$) exists between premilking disinfectant dip, drying, teat versus treatment of no premilking disinfectant and no postmilking disinfectant (control), suggesting drying of teats with individual dry paper towels for 10s removes a sufficient amount of iodine from the teats. The addition of postmilking disinfectant dip to premilking disinfectant dip, drying significantly increased iodine residue in milk by 16 μg per 100 ml compared to control and an increase of 10.2 μg per 100 ml beyond the iodine residue of premilking disinfectant dip, drying, teat. Premilking disinfectant, teat, with no drying significantly increased the iodine residue in milk by 78.3 μg per 100 ml compared to control and 62.5 μg per 100 ml compared to premilking disinfectant dip, drying, teat. This drastic increase of iodine in milk indicates the importance of cleaning and drying the teats with dry paper towels after the use of premilking iodophor disinfectant dip.

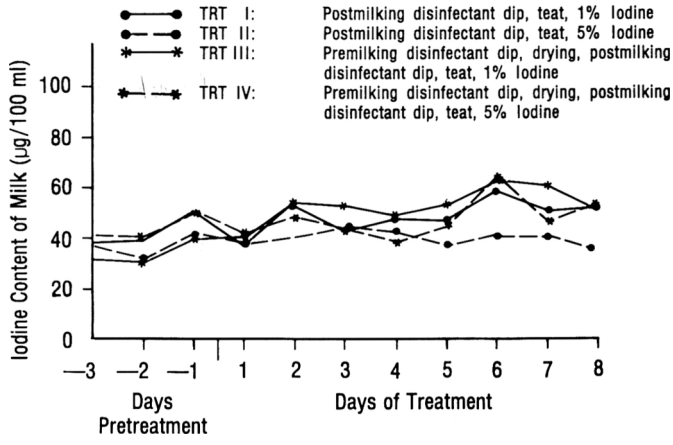
FIGURE 1. Effects of premilking iodophor disinfectant dip on milk iodine.



Experiment 6

Effects of udder preparations consisting of .5 and 1.0% iodophor teat dips used as a premilking disinfectant dip or iodine residue in milk are presented in Table 6 and Figure 2. No difference exists between the treatments with .5% iodine. The addition of premilking disinfectant dip to postmilking teat dipping did increase the iodine residue by 3.2 μg per 100 ml but not significantly. The drying of teats for 10s after premilking disinfectant dip with paper towels was sufficient for removal of the dip. The combination of premilking disinfectant dip and postmilking teat dip with .5% iodine was not different from the treatment of postmilking teat dip, teat, with 1% iodine dip. The additive effect of premilking disinfectant dip plus postmilking teat dip, both with 1% iodine, resulted in greater iodine residue in milk compared to other treatments. This would indicate that the combination

FIGURE 2. Effects of various concentrations of iodine in premilking iodophor disinfectant dip on milk iodine.



of iodine residue on the teats from premilking disinfectant dip, even after drying, plus the absorption of iodine through the skin from postmilking teat dip contributed to the significantly higher residue. Data indicate that .5% iodine dip contributes less iodine residue in milk compared to 1% iodine dip.

Summary

From these experiments, the following can be concluded: 1) udder surfaces should be dry but not necessarily clean at machine attachment; 2) udder wash sanitizer was of no benefit except when used with water hose; 3) only teats should be cleaned; 4) cleaning must be by the use of water or dipping with an effective postmilking teat disinfectant; 5) thorough drying of teats with paper towels is essential; 6) manual drying of teats with paper towels after premilking disinfectant dipping of teats is needed to reduce iodine residue in milk; 7) iodine residue in milk varies according to concentration of iodine in the premilking disinfectant dip and in postmilking teat dip; and 8) teats need to be clean and dry prior to machine attachment to achieve low sediment in milk. Most effective preparations require cleaning of teats followed by drying with cleaning action either by (a) water hose and hand manipulation, or (b) wet, individual paper towels and hand action, or (c) disinfectant dip followed by thorough wiping not only to ensure drying but to manipulate teat surface for cleaning and removal of disinfectant residue.

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