Dairy Split Session II

Mastitis Prevention and Control

Dr. Walter Guterbock, *presiding*

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

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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 used, udder preparation should minimize the number of mastitis pathogens on teats prior to milking, and minimize bacterial counts in milk (1). Bacterial populations in milk increase by wetting the udder surface above the teats with subsequent inadequate cleaning and drying, thereby allowing water laden with bacteria to drain into the teatcups during milking. 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 (2,3,4,5,6,7,8,9). Also, inadequate cleaning and drying of teats increase bacterial populations in milk and on teat skin (1). The transfer of bacteria can occur among cows when common clothes or towels (even immersed in disinfectant between cows) are used for cleaning teats for a series of cows. Thus, environmental bacterial contamination of milk and teats can affect milk quality and possibly udder health.

Effects of udder wash sanitizers on premilking hygiene of udders and teats are conflicting. Some work has shown that sanitizers may be of benefit for lowering bacterial populations on teat skin and in milk, and for reducing the rate of infections (10,11), whereas other work shows marginal benefit, if any (12,13,14,15). Even with higher concentration of sanitizers, desired germicidal action is difficult to achieve during the short udder preparation time. Also, higher concentrations may cause irritation to milkers' hands, and cows' teats. Effects may depend on the extent and type of organic matter and environmental bacterial contamination of teats, type and concentration of sanitizer, contact time, and method of application. The combination of disinfectant and mechanical action (water hose, chlorine solution - 600 ppm; hand or bucket, chlorine solution - 600 ppm, cloth) removes transient contamination from teats but ineffective in the prevention and removal of the colonization of *Staphylococcus aureus* (14). 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) actions reduce the bacterial contamination of teat surfaces, especially *Staphylococcus aureus* and *Escherichia coli* (5).

Postmilking teat disinfectants have bacteriostatic properties that are desired in reducing bacterial population on the teats (16, 17, 18). If postmilking teat dips are used as premilking teat disinfectants, then chemical residues in milk, especially iodine, are of concern. The increase in iodine concentration in milk has been attributed to supplemental iodine in dairy rations (19), iodophor sanitizers and teat dips (19,20,21,22,23,24,25,26), and animal medications (20, 27). 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 (19).

Objective

The objective of our work was to determine the effects of various udder preparation and disinfectants (udder wash sanitizer and postmilking teat dips used as premilking disinfectants dip) on reducing bacterial populations, sediment, and iodine residue in milk.

Experiments

Experiments 1 and 2

Two experiments were conducted to determine effects of

various udder preparations on environmental bacterial contamination of milk. In Experiment 1, preparation 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 (25 ppm) and drying with paper towels were studied in both experiments. The preparations are 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 selected as determined by culturing composite milk samples on esculin blood agar. This procedure ensured that bacteria in the milk were from the environment. Standard plate count (SPC) plus counts for coliforms psychrotrophic bacteria and Streptococcus and Staphylococcus species were determined. Cows within each treatment were milked with the same milking units, and milk was collected in the same weigh jars to prevent contamination of milk among treatments. Cows were housed in free stalls concreted and bedded with sawdust.

Experiment 3

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

Experiment 4

This experiment was conducted to determine effects of different premilking disinfectant dips on bacterial counts in milk. Teat dips used (2% dodecyl-benzene-sulfonic acid (DDBSA) dip; 1% iodophor dip; and 5.25% sodium hypochlorite dip) were formulated for postmilking teat dipping. Preparations are in Table 4. Experimental design was similar to Experiment 1.

Experiment 5

Since data from earlier experiments indicated the importance of drying teats with dry paper towels, this experiment was designed to determine the effects of three types of towels on bacterial counts on teats. Towels were single-fold towel, Nibroc® Kowtowl®[1], and Sani-Prep®[1] towel. Preparations are in Table 5. Experimental design was similar to Experiment 3.

Experiment 6

Since milk quality is affected by sediment, possible effects of premilking preparations were determined. Preparations are in Table 6. Experimental design was similar to Experiment 1. Sediment scores were determined for individual cow composite milk collected from weigh jars.

Experiments 7 and 8

Experiment 7 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 7. Experiment 8 was conducted to determine effects of different iodine concentrations (.5; 1.0%) of iodophor teat disinfectants on iodine residue in milk. Preparations are in Table 8. For both experiments, individual paper towels were used for drying (one per udder). Teats were dipped at a standard length of one inch. Machines were attached immediately after application of treatment. During an adjustment period of two weeks and during the experiment, all cows were fed the same ration.

Experient 9

A field study involving commercial dairy herds was conducted to determine effects of iodophor premilking teat dipping (using postmilking iodophor teat disinfectants) on iodine residue in milk among herds. Iodophor teat dips of .1% and 1.0% concentrations were used. Preparations are in Table 9. Eighty cows in each of five herds were assigned to the four preparations for a total of 100 cows per preparation. Preparations were applied by the dairymen. Individual paper towels (one per cow) were used in drying. Machines were attached immediately after application of preparation. Iodine residue in the milk was determined for individual cow composite milk collected from weigh jars. During an adjustment period of two weeks prior to the experiment and during the experiment, all cows were fed the same ration. No iodophor udder wash sanitizer and postmilking teat dips were used except for experimental preparations.

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 plus wetting of the

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[1] *Mention of commercial products is made to aid in defining experimental conditions and does not imply the endorsement of these products to exclusion of other products that may be suitable.*

Nibroc® Kowtowl®, James River, Towel Div., 650 Main St., Berlin, NH 03570.

Sani-Prep®, Scott Paper Company, Scott Plaza II, Philadelphia, PA 19113.

udder and teat surfaces with no drying were insufficient in removal of water laden with bacteria. Sanitizer was of no benefit. Statistical grouping (b) included dry towel, teat. Some benefit was achieved from only the physical action on the teats. Preparations 5 through 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 towel. Preparation 13 had the lowest SPC which indicates that the physical force of the water from the hose plus hand action plus benefit of sanitizer with subsequent drying were of additive and maximum benefit. Data for coliforms and Staphylococcus species indicated similar trends as SPC.

TABLE 1. Experiment 1. Standard plate count.

Statistical grouping	Preparations	Standard plate count	Percent bacterial reduction
		-Bacteria per ml- $\bar{x}$	%
a	None	17,073	0
	Water hose, udder	19,496	(+13)**
	Water hose, sanatizer, udder	15,398	10
b	Dry towel, teat	10,654	38
c	Water hose, sanitizer, drying udder	5,547	68
	Water hose, teat	5,974	65
	Water hose, sanitizer, teat	5,632	67
	Water hose, drying, teat	4,139	76
	Wet towel, teat	5,033	71
	Wet towel, sanitizer, teat	6,547	62
	Wet towel, drying, teat	3,690	79
	Wet towel, sanitizer, drying, teat	3,763	78
d	Water hose, sanitizer, drying, teat	2,116	88

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

Experiment 2

Because 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 conducted to further test preparations dealing with cleaning and drying of teats only and use of postmilking teat dip 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 used and surface drainage from the udder surface and teats with no subsequent drying. There was no benefit of the physical action of dry towel in cleaning like there was in Experiment 1. Preparations 5 through 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. Statisical 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 only when used with the water hose with subsequent drying. Coliforms and Staphylococcus species followed similar trends as SPC. No significant differences existed among treatment means for Streptococcus species and psychrotrophic bacteria.

TABLE 2. Experiment 2. Standard plate count.

Statistical grouping	Preparations	Standard plate count	Percent bacterial reduction
		-Bacteria per ml- $\bar{x}$	%
a	None	6,380	0
	Water hose, teat	6,130	4
	Water hose, sanitizer, teat	6,196	3
	Dry towel, teat	6,117	4
b	Water hose, drying, teat	3,927	39
	Wet towel, teat	4,695	27
	Wet towel, sanitizer, teat	4,467	30
	Disinfectant dip, teat	4,203	34
	Disinfectant dip, delay, teat	3,802	41
c	Water hose, sanitizer, drying, teat	3,259	49
	Wet towel, drying, teat	2,337	63
	Wet towel, sanitizer, drying, teat	2,045	68
	Disinfectant dip, drying, teat	2,938	54

[a,b,c]Statistical groupings — Preparations within each grouping are not different (P >.05).
SE ± 911

Experiment 3

Means for teat rinses before udder preparation, before machine attachments 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, because only forestripping occurred. Dry towel, teat was in the second highest statistical grouping (b) for SPC. Statistical grouping (c) had lower counts which indicates that preparations with wet towel, with or without sanitizer reduced bacterial populations by cleaning with water and hand action. Statistical grouping (d) involved preparations of drying the

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

Preparations[1]	Before udder preparation		Before machine attachment		After machine removal	
	Bacteria per ml (SPC)					
	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
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	199,687[a]	40,908	34,045[d]	29,139	1,030[a]	509
Wet towel, sanitizer, drying, teat	183,143[a]	40,908	22,049[d]	29,139	1,094[a]	509
Disinfectant dip, drying, teat	182,950[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,d]Means with same letter in same column are not different ($P > .05$).

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 dip. 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.

Experiment 4

Bacterial counts are in Table 4. For SPC, preparations within statistical grouping (a) had the highest counts indicating dry towel 5 s was insufficient in reducing bacterial counts compared to no preparation. However, statistical grouping (b) indicated that dry towel 10 s and 15 s did lower bacterial counts apparently from the increased physical action against the teats. Groupings (a) and (b) were not statistically different for coliform counts which indicates inadequate cleaning of teat skin with the use of dry towel. Maximum reduction for SPC were for preparations included in statistical grouping (c). These preparations included the use of premilking teat disinfectant dips with different manual drying intervals. Bacterial counts were not significantly affected by the duration of drying. Apparently the wetting and antibacterial properties of the disinfectant dips were sufficient in reducing bacterial populations regardless of drying times. For coliform counts, preparations using DDBSA dip were significantly higher than preparations using iodophor and sodium hypochlorite dips. The property of DDBSA dip may have interfered with the physical action of paper towel in further reducing bacterial counts.

Experiment 5

Differences in treatment means before machine attachment did not differ, however, those for before machine attachment did differ statistically for SPC and coliform count. Bacterial counts are in Table 5. In statistical group (a), preparations involved wetting the teats with a towel with no subsequent manual drying. Group (b) preparations had lower bacterial counts for both SPC and coliform than those in group (a). This is attributed to manual drying of teats with dry paper towel (group b) compared to no drying (group a). Apparently, manual drying of teats was more important than the type of paper towel used, since there was no difference among towels. However, duration of manual drying and type of towel may be dependent upon the type of management system (i.e. variation in cleanliness of teats and milking practices) in achieving clean and dry teats prior to machine attachment. Use of water hose or wet towel did not differ suggesting restricting water to teats only and thorough manual drying are essential.

TABLE 4. Experiment 4. Bacterial counts in milk.

Preparations[1]	Composite milk			
	Standard plate count[1]		Coliform count	
	Bacteria per ml			
	$\bar{X}$	SE	$\bar{X}$	SE
No preparation	13,407[a]	1,780	18,338[a]	2,989
Dry towel, 5 s	12,988[a]	1,780	17,549[a]	2,989
Dry towel, 10 s	9,864[b]	1,780	14,986[a]	2,989
Dry towel, 15s	10,123[b]	1,780	14,245[a]	2,989
DDBSA dip, drying 5 s	7,500[c]	1,780	9,456[b]	2,989
DDBSA dip, drying 10 s	6,900[c]	1,780	8,910[b]	2,989
DDBSA dip, drying 15 s	6,742[c]	1,780	8,849[b]	2,989
Iodophor dip, drying 5 s	4,354[c]	1,780	5,543[c]	2,989
Iodophor dip, drying 10 s	2,701[c]	1,780	5,861[c]	2,989
Iodophor dip, drying 15 s	4,115[c]	1,780	5,759[c]	2,989
Sodium hypochlorite dip, drying 5 s	2,733[c]	1,780	5,268[c]	2,989
Sodium hypochlorite dip, drying 10 s	3,051[c]	1,780	5,320[c]	2,989
Sodium hypochlorite dip, drying 15 s	2,648[c]	1,780	4,724[c]	2,989

[1] Preparations are grouped according to statistical grouping for standard plate count.
[a,b,c]Means with same letter in same column are not different ($P > .05$).

TABLE 5. Experiment 5. Bacterial counts for teat rinses.

Preparations[1]	Standard plate count				Coliform count			
	Before udder preparation		Before machine attachment		Before udder preparation		Before machine attachment	
	Bacterja per ml							
Wet Sani-Prep towel, no drying	210,540[a]	46,499	41,562[a]	18,239	290,011[a]	62,551	59,235[a]	28,659
Wet single-fold towel, no drying	196,611[a]	46,499	39,524[a]	18,239	286,477[a]	62,551	56,560[a]	28,659
Wet Kowtowl, no drying	230,432[a]	46,499	34,411[a]	18,239	275,423[a]	62,551	56,114[a]	28,659
Water hose, drying Kowtowl	189,123[a]	46,499	13,566[b]	18,239	233,249[a]	62,551	27,694[b]	28,659
Water hose, drying, Sani-Prep towel	186,566[a]	46,499	12,119[b]	18,239	275,418[a]	62,551	27,100[b]	28,659
Water hose, drying, single-fold towel	225,364[a]	46,499	12,093[b]	18,239	298,608[a]	62,551	24,334[b]	28,659
Wet single-fold towel, drying	215,410[a]	46,499	11,298[b]	18,239	301,205[a]	62,551	23,976[b]	28,659
Wet Sani-Prep towel, drying	201,040[a]	46,499	11,054[b]	18,239	266,579[a]	62,551	21,464[b]	28,659
Wet Kowtowl, drying	198,197[a]	46,499	10,566[b]	18,239	234,993[a]	62,551	20,564[b]	28,659

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

Experiment 6

Sediment values are in Table 6. 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 through 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 preparations involving the water hose. Duration of cleaning with the water hose within 5 to 20 s had no significant effect. Dry towel 10 s, 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 20 s, teat, further reduced the sediment compared to dry towel 10 s, 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 20 s. Wetting of the teats with the disinfectant with immediate drying was adequate in removing sediment. Lowest sediment was achieved for preparations 10, 11, 12, and 13 within statistical grouping (d). These preparations involved the use of wet towel for 10 and 20 s with and without manual drying. These data indicate that the combination of the wetness and physical manipulation of the teats with wet towel was adequate in removing sediment without subsequent drying.

TABLE 6. Experiment 6. Milk sediment.

Statistical grouping	Preparations	Sediment
		ug/l $\bar{X}$
a	None	2.4
	Disinfectant dip, teat	2.3
b	Dry towel 10s, teat	1.6
	Water hose 5s, teat	1.6
	Water hose 10s, teat	1.9
	Water hose 20s, teat	1.7
c	Dry towel 20s, teat	1.3
	Disinfectant dip, drying 10s, teat	1.4
	Disinfectant dip, drying 20s, teat	1.4
d	Wet towel 10s, teat	1.2
	Wet towel 20s, teat	1.0
	Wet towel 10s, drying 10s, teat	.95
	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 7

Effects of udder preparations consisting of a 1% iodophor teat dip used as a premilking disinfectant dip on iodine residue in milk are in Table 7. No significant difference 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 10 s 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

TABLE 7. Experiment 7. Mean iodine in milk (ug/100 ml) for different premilking treatments.

Preparations	Control period	Treatment period	Difference[d]
	ug per 100 ml		
	$\bar{X}$	$\bar{X}$	$\bar{X}$
Control	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.

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.

Experiment 8

Effects of udder preparations consisting of .5 and 1.0% iodophor teat dips used as a premilking disinfectant dip on iodine residue in milk are presented in Table 8. No difference existed between the treatments with teat dipping did increase the iodine residue by 3.2 μg per 100 ml but not significantly. The drying of teats for 10 s 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 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 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.

TABLE 8. Experiment 8. Mean iodine in milk (ug/100 ml) for different premilking treatments.

Preparations	Control period	Treatment period	Difference[d]
	ug per 100 ml		
	$\bar{X}$	$\bar{X}$	$\bar{X}$
Premilking disinfectant dip, drying, postmilking disinfectant dip, teat (.5% iodine)	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.

Experiment 9

Effects of using .1 and 1.0% iodophor premilking disinfectant dips on iodine residue in milk were determined in a field study. The iodine residue data are in Table 9. Preparation of no premilking disinfectant dip, with .1% postmilking disinfectant dip had the lowest median value of iodine residue. The addition of .1% iodophor premilking disinfectant dip increased iodine residue by .9 μg per 100 ml but not significantly. Preparation of no premilking disinfectant dip, with 1.0% postmilking disinfectant dip significantly increased iodine residue compared to either significantly contributed to the iodine residue by 2.2 μg per 100 ml. These data suggest that lower concentration of iodophor disinfectant dip contributed less to iodine residue in milk. Primary source of iodine in milk is from postmilking disinfectant dip and other sources rather than from premilking disinfectant dip with adequate drying of teats. Even in a field study with different management programs and people milking, the practice of premilking disinfectant dip, especially with low concentration of iodine, with subsequent drying contributed a small quantity of iodine to milk compared to other sources of iodine.

TABLE 9. Experiment 9. Median values for iodine in milk (ug/100 ml) for different premilking treatments.

Preparations	Pretreatment	Treatment	Difference
	ug per 100 ml		
	Median	Median	
No premilking disinfectant dip, .1% premilking disinfectant dip	22.1	26.7	4.6[a]
.1% premilking disinfectant dip, drying, .1% postmilking disinfectant dip	22.0	27.5	5.5[a]
No premilking disinfectant dip, 1.0% postmilking disinfectant dip	23.4	31.1	7.7[b]
1.0% premilking disinfectant dip, drying, 1.0% postmilking disinfectant dip	25.1	35.0	9.9[c]
.1% iodophor teat dip			
1.0% iodophor teat dip			

[a,b,c]Values with same letter in same column are not different (P>.05).

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) teats need to be clean and dry prior to machine attachment to achieve low sediment in milk; 7) manual drying of teats with paper towels after premilking disinfectant dipping of teats is needed to reduce iodine residue in milk; and 8) iodine residue in milk varies according to concentration of iodine in the premilking disinfectant dip and postmilking teat dip. 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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