SUMMARY OF PEER-REVIEWED PUBLICATIONS ON EFFICACY OF PREMILKING AND POSTMILKING TEAT DISINFECTANTS PUBLISHED SINCE 1980

(Updated January, 2004)

The last comprehensive review on postmilking teat disinfection was published by Pankey et al. (1983 *National Mastitis Council Proceedings* pages 52-86 and the *Journal of Dairy Science* 67:1336-1353) over a decade ago. In 1988, an attempt was made to develop what was referred to as "teat dip fact sheets". However, due to various concerns this document was never published. Consequently, a mechanism to disseminate information on efficacy of teat disinfectants in a timely manner was never developed. This issue resurfaced during the 1994 National Mastitis Council Annual Meeting. A request was made that the NMC Research Committee develop a bibliography of teat disinfectants as a means of providing factual information on teat disinfectant efficacy that would be available to members of the dairy community and other interested individuals. A motion was approved unanimously that the NMC Research Committee Chairman appoint a subcommittee to undertake this project.

The subcommittee's approach to this assignment was simple and straight-forward and was based on the following criteria: **1) Only information from peer-reviewed scientific journals published since 1980 was used.** A peer-reviewed scientific journal was defined as a journal with an editor and an editorial board that reviews the scientific merit of a manuscript that has been submitted for publication. **2) Only information from peer-reviewed scientific journals as presented in the published paper was used.** The subcommittee did not judge the merits of the research. **3) The study had to follow protocols essentially as described by the NMC** [most recently published in the 1991 *National Mastitis Council Annual Meeting Proceedings* and the *Journal of Dairy Science* (73:2580-2585)]. **4) Any reference to nonsignificant results were not included except for natural exposure studies that used a positive control. 5) Products with neither trade name nor manufacturer information mentioned in the publication were not included.**

Please note that not all products tested in accordance with NMC protocols have been published in peer-reviewed scientific journals. Many published research studies do not list trade names and some manufacturers' addresses have changed since initial publication. In compiling this summary, no attempt was made to determine whether or not the formulation of a product may have changed since publication in peer-reviewed scientific journals. For all of these reasons, users should not rely exclusively on summary tables as they evaluate products, but should also consider each supplier's current product offerings and request verification of efficacy testing of any product considered.

We hope that information contained in the teat disinfectant bibliography will be useful to those in the dairy community as an aid for preventing and controlling mastitis. This document (first published in the NMC 1995 Regional Meeting Proceedings) will be updated regularly to keep you informed of new developments in a timely manner.

Table 1. Summary of peer-reviewed research on efficacy of chlorhexidine postmilking teat disinfectants published since 1980.

Active ingredient(s) & concentration	Trade name	Manufacturer/ distributor	Type of study	Significant efficacy against	Reference number
Chlorhexidine (.35%)	Not mentioned	H. B. Fuller Co., Monarch Division, Minneapolis, MN	Natural exposure	*S. uberis* ($P < .01$) *C. bovis* ($P < .01$) *Staph.* species ($P < .005$)	1 (1990)
Chlorhexidine digluconate (.5%), glycerin (6%)	Virosan Teat Dip & Chapless Teat Dip	Bio-Ceutic Labs, Inc. and Anchor Labs, Inc., St. Joseph, MO	Experimental challenge	*S. aureus* ($P \leq .01$)	2 (1981)
Chlorhexidine gluconate (.5%)	Not mentioned	Babson Bros.Co., Naperville, IL	Experimental challenge	*S. aureus* ($P < .001$) *S. agalactiae* ($P < .005$)	3 (1990)
Chlorhexidine gluconate (.55%)	Tesan, Chapless Teat Dip	Whitmoyer Labs, Myerstown, PA	Experimental challenge	*S. aureus* ($P < .01$) *S. agalactiae* ($P < .01$)	4 (1983)
Chlorhexidine gluconate (.55%)	Ultra-Shield	IBA, Inc., Millbury, MA	Natural exposure - positive control (compared to FS-103 - 1% iodine)	Coagulase-negative staphylococci ($P \leq 01$) *Escherichia coli* ($P \leq .08$) Gram-positive bacilli ($P \leq .05$)	35 (1995)
Chlorhexidine (.4%), glycerine (10%)	Fight Bac	Deep Valley Farm, Brooklyn, CT	Natural exposure - positive control (compared to Nolvasan - .5% chlorhexidine & 4.9% glycerin)	Not significantly different from positive control for *S. aureus*, *Streptococcus* species, and coliforms	5 (1987)
Chlorhexidine gluconate (.5%), glycerin (4%)	Blue Ribbon	IBA, Inc., Millbury, MA	Experimental challenge	*S. aureus* ($P < .001$) *S. agalactiae* ($P < .05$)	37 (1997)

Table 2. Summary of peer-reviewed research on efficacy of iodine postmilking teat disinfectants published since 1980.

Active ingredient(s) & concentration	Trade name	Manufacturer/ distributor	Type of study	Significant efficacy against	Reference number
.05% iodine	Not mentioned	BASF, Wyandotte Corp., Wyandotte, MI	Experimental challenge	*S. aureus* (P < .01)	6 (1983)
.1% iodine	PRE-VAIL	IBA Inc., Sanitation Division, Millbury, MA	Experimental challenge	*S. agalactiae* (P < .005)	7 (1990)
.1% iodine	Not mentioned	H. B. Fuller Co., Monarch Chemicals Division, Minneapolis, MN	Experimental challenge	*S. aureus* (P < .01)	6 (1983)
.1% iodine	Not mentioned	IBA Inc., Millbury, MA	Experimental challenge	*S. aureus* (P < .01)	6 (1983)
.1% iodine	Not mentioned	BASF, Wyandotte Corp., Wyandotte, MI	Experimental challenge	*S. aureus* (P < .01)	6 (1983)
.1% iodine	Not mentioned	West Agro Chemical Co., Shawnee Mission, KS	Natural exposure -positive control (compared to Bovadine - 1% iodine)	Not significantly different from positive control	8 (1983)
.1% iodine, .75% glycerin	Not mentioned	West Agro Chemical Co., Kansas City, MO	Experimental challenge	*S. aureus* (P < .001) *S. agalactiae* (P < .05)	9 (1993)
.175% iodine	Not mentioned	West Agro Chemical Co., Kansas City, MO	Experimental challenge	*S. aureus* (P < .001)	9 (1993)

Table 2 (cont). Summary of peer-reviewed research on efficacy of iodine postmilking teat disinfectants published since 1980.

Active ingredient(s) & concentration	Trade Name	Manufacturer/ distributor	Type of study	Significant efficacy against	Reference number
.18% iodine, 15% collagen protein emollient	Not mentioned	Bristol-Myers Animal Health Care, Evansville, IN	Experimental challenge	*S. aureus* ($P < .001$) *S. agalactiae* ($P < .025$)	10 (1989)
.25% iodine	Not mentioned	H. B. Fuller Co., Monarch Division, Minneapolis, MN	Natural exposure	*S. aureus* ($P < .05$) *S. agalactiae* ($P < .05$) *C. bovis* ($P < .05$) *Staph.* species ($P < .05$)	11 (1991)
.25% iodine	Not mentioned	West Agro Chemical Co., Shawnee Mission, KS	Natural exposure- positive control (compared to Bovadine-1% iodine)	Not significantly different from positive control	8 (1983)
.25% iodine	Not mentioned	BASF, Wyandotte Corp., Wyandotte, MI	Experimental challenge	*S. aureus* ($P < .05$)	6 (1983)
.25% iodine	Not mentioned	BASF, Wyandotte Corp., Wyandotte, MI	Experimental challenge	*S. aureus* ($P < .01$)	6 (1983)
.3% iodine	Not mentioned	H. B. Fuller Co., Monarch Chemicals Division, Minneapolis, MN	Experimental challenge	*S. aureus* ($P < .01$)	6 (1983)
.5% iodine	Theratec	Babson Bros. Co., Oak Brook, IL	Natural exposure	*S. aureus* ($P < .001$) *S. agalactiae* ($.05 < P < .10$) *C. bovis* ($P < .001$)	12 (1986)
.5% iodine	FS-104	IBA Inc., Millbury, MA	Experimental challenge	*S. agalactiae* ($P < .005$)	7 (1990)
.5% iodine	Not mentioned	BASF, Wyandotte Corp., Wyandotte, MI	Experimental challenge	*S. aureus* ($P < .025$)	6 (1983)

Table 2 (cont). Summary of peer-reviewed research on efficacy of iodine postmilking teat disinfectants published since 1980.

Active ingredient(s) & concentration	Trade name	Manufacturer/ distributor	Type of study	Significant efficacy against	Reference number
.5% iodine	Not mentioned	H. B. Fuller Co., Monarch Chemicals Division, Minneapolis, MN	Experimental challenge	*S. aureus* (P < .01)	6 (1983)
.5% iodine	Not mentioned	IBA Inc., Millbury, MA	Experimental challenge	*S. aureus* (P < .01)	6 (1983)
1% iodine	Teat Kote	Babson Bros. Co., Oak Brook, IL	Natural exposure	*S. aureus* (P < .05) *S. agalactiae* (P < .001) Other streptococci (P < .001)	12 (1986)
1% iodine	Bovadine	West Agro Chemical Co., Bedford, NH	Natural exposure	*S. aureus* (P = .03) Streptococci (P = .01) *Staph*. species (P < .001) *C. bovis* (P < .001)	13 (1983)
1% iodine	Not mentioned	BASF, Wyandotte Corp., Wyandotte, MI	Experimental challenge	*S. aureus* (P < .01)	6 (1983)
1% iodine, 10% emollients (glycerin, lanolin & polyvinyl pyrolidine)	Teat Kote 10/III	Babson Bros. Co., Romeoville, IL	Natural exposure - positive control [compared to Bovadine (1% iodine, 10% glycerin)]	Not significantly different from positive control for streptococci & major pathogens. More coliforms (P < .05) & fewer *Staph.* species (P < .05) than positive control	14 (1994)
1% titratable iodine, glycerin (10%)	FS-103 X	IBA, Inc., Millbury, MA	Experimental challenge	*S. aureus* (P < .001) *S. agalactiae* (P < .1)	37 (1997)
.5% titratable iodine, glycerin (1%), lanolin (.5%), aloe vera (.5%)	Bac-Stop	IBA, Inc., Millbury, MA	Experimental challenge	*S. aureus* (P < .001) *S. agalactiae* (P < .005)	38 (1997)
1% titratable iodine, glycerin (2%)	FS-103 II	IBA, Inc., Millbury, MA	Experimental challenge	*S. aureus* (P < .1) *S. agalactiae* (P < .05)	38 (1997)
.5% iodine	Derma Kote	Westfalia-Surge, Naperville, IL	Experimental challenge	*S. aureus* (P < .001) *S. agalactiae* (P < .1)	41 (2000)
1% available Iodine, 10% glycerine	Bovadine with I-Tech II	West Agro, Inc. Kansas City, MO	Experimental challenge	*S. aureus* (P < .001) *S. agalactiae* (P < .005)	45 (2003)

Table 3. Summary of peer-reviewed research on efficacy of linear dodecyl benzene sulfonic acid postmilking teat disinfectants published since 1980.

Active ingredient(s) & concentration	Trade name	Manufacturer/ distributor	Type of study	Significant efficacy against	Reference number
Linear dodecyl benzene sulfonic acid, 1.94%	Blu-Gard	Economics Lab, Inc., St. Paul, MN	Natural exposure	*S. aureus* ($P < .05$)	15 (1984)
Linear dodecyl benzene sulfonic acid, 1.94%	Blu-Gard	Economics Lab, Inc., St. Paul, MN	Experimental challenge	*S. aureus* ($P < .05$) *S. agalactiae* ($P < .1$)	16 (1984)
Linear dodecyl benzene sulfonic acid, 1.94%	Blu-Gard	Economics Lab, Inc., St. Paul, MN	Natural exposure	*S. agalactiae* ($P < .005$)	17 (1985)
Linear dodecyl benzene sulfonic acid, 1.94%	Blu-Gard	Economics Lab, Inc., St. Paul, MN	Natural exposure- positive control (compared to Udder Guard- 1% iodine)	Significantly ($P < .05$) more effective than positive control for *S. aureus*	17 (1985)
Linear dodecyl benzene sulfonic acid, 1.94%	Blu-Gard	Klenzade Division, Economics Lab Inc., St. Paul, MN	Natural exposure	*S. aureus* ($P < .005$)	18 (1983)
Linear dodecyl benzene sulfonic acid, 1.94%	Blu-Gard	Klenzade Division, Economics Lab Inc., St. Paul, MN	Experimental challenge	*S. agalactiae* ($P < .01$) *S. aureus* ($P < .01$)	19 (1982)
Linear dodecyl benzene sulfonic acid, 1.9% plus .55% iodophor	Tandem	IBA, Inc., Millbury, MA	Experimental challenge	*S. aureus* ($P < .005$) *S. agalactiae* ($P < .025$)	20 (1985)

Table 4. Summary of peer-reviewed research on efficacy of other products used as postmilking teat disinfectants published since 1980.

Active ingredient(s) & concentration	Trade name	Manufacturer/ distributor	Type of study	Significant efficacy against	Reference number
1:3 dilution: Lauricidin ® (.25%), caprylic/capric acids (1.25), and lactic acid (1.5%)	Laurisan Complete Teat Dip Concentrate	Animal Care Products, 3M Co., St. Paul, MN	Experimental challenge	*S. aureus* ($P < .001$) *S. agalactiae* ($P < .001$)	21 (1988)
Lauricidin ® (1%), caprylic and capric acids (5%), lactic acid (6%), and lauric acid (.85%)	Lauricare® Teat Dip	3M Company, St. Paul, MN	Experimental challenge	*S. aureus* ($P \leq .001$) *S. agalactiae* ($P \leq .025$)	22 (1992)
Lauryl sulfate, solubilized milk protein, and glycerin (4.8%)	ALL DAY	Ag Products, Syracuse, NY	Experimental challenge	*S. aureus* ($P < .01$) *S. agalactiae* ($P < .005$)	20 (1985)
Unknown	Powdered Teat Dip and Frost Protectant	IBA Inc., Millbury, MA	Natural exposure-positive control (compared to Bovadine- 1% iodine)	Not significantly different from positive control against environmental pathogens	23 (1994)
Quaternary ammonium (.5%)	Surge Tegragon After Milking Teat Dip	Babson Bros.Co., Oak Brook, IL	Natural exposure	*S. aureus* ($P < .01$) *C. bovis* ($P < .01$)	24 (1982)
Quaternary ammonium (.5%)	Tegragon	Babson Bros. Co., Oak Brook, IL	Experimental challenge	*S. agalactiae* ($P \leq .025$)	25 (1983)
Concentrate contains 12% Septigon™ germicide, 22% aqueous solution of N-[2-[[2-(dodecylamino) ethyl]amino] ethyl] glycine + N-[3-(dodecylamino) propyl] glycine + related alkyl-amino derivatives. Use diluted to 1.5% active ingredients	Control™ Concentrate Teat Dip	Animal Care Products, 3M Co., St. Paul, MN	Experimental challenge	*S. aureus* ($P < .001$) *S. agalactiae* ($P < .005$)	26 (1986)
Sodium chlorite (.64%) and lactic acid (2.64%)	UDDERgold	Alcide Corp., Norwalk, CT	Natural exposure	*S. aureus* ($P < .01$) *S. dysgalactiae* ($P < .025$) Major pathogens ($P < .01$)	27 (1989)
Sodium chlorite (.64%) and lactic acid (2.64%)	UDDERgold	Alcide Corp., Norwalk, CT	Experimental challenge	*S. aureus* ($P < .001$) *S. agalactiae* ($P < .1$)	28 (1990)
Sodium chlorite (.64%) and lactic acid (2.64%)	UDDERgold	Alcide Corp., Norwalk, CT	Natural exposure- positive control (compared to Bovadine- 1% iodine)	Not significantly different from positive control for environmental pathogens	28 (1990)

Table 4 (cont.). Summary of peer-reviewed research on efficacy of other products used in postmilking teat disinfectants published since 1980.

Active ingredient(s) & concentration	Trade name	Manufacturer/ distributor	Type of study	Significant efficacy against	Reference number
Sodium chlorite and lactic acid	UDDERgold	Alcide Corp., Norwalk, CT	Natural exposure- positive control (compared to .5% iodophor teat dip)	Significantly (P = .06) more effective than positive control against all pathogens	29 (1990)
Sodium chlorite (.64%) and lactic acid (2.64%)	UDDERgold	Alcide Corp., Norwalk, CT	Experimental challenge	*S. aureus* (P ≤ .001) *S agalactiae* (P ≤ .1)	30 (1994)
Sodium chlorite (.64%) and mandelic acid (3%)	Not mentioned	Alcide Corp., Norwalk, CT	Experimental challenge	*S. aureus* (P ≤ .001) *S. agalactiae* (P ≤ .01)	30 (1994)
Sodium dichloro-s-triazene-trione (1.0%)	Not mentioned	Kendall Co., Boston, MA	Experimental challenge	*S. aureus* (P < .01) *S. agalactiae* (P < .025)	4 (1983)
Sodium dichloro-s-triazene-trione (1.7%)	Not mentioned	Kendall Co., Boston, MA	Experimental challenge	*S. agalactiae* (P < .025)	4 (1983)
Sodium hypochlorite (.6%)	Not mentioned	Kendall Co., Boston, MA	Experimental challenge	*S. aureus* (P < .05)	4 (1983)
Sodium hypochlorite (.9%)	Not mentioned	Kendall Co., Boston, MA	Experimental challenge	*S. aureus* (P < .01)	4 (1983)
2800 ppm of available chlorine as hypochlorous acid	Agrisept Tabs	Mick Doyle Marketing Int., Ltd., Naas, Ireland	Experimental challenge	*S. aureus* (P < .001) *S. agalactiae* (P < .001)	36 (1996)
3000 ppm of available chlorine as hypochlorous acid	EfferceptVet	Effercept Products, div. of Micrel Ltd., Inc., Phoenix, AZ	Experimental challenge	*S. aureus* (P < .001) *S. agalactiae* (P < .01)	36 (1996)
Chlorous acid and chlorine dioxide	Ciderm™	Arco Research, Inc., Melville, NY for Farnam Companies, Inc., Phoenix, AZ	Experimental challenge	*S. aureus* (P < .001) *S. agalactiae* (P < .005)	39 (1998)
Phosphoric acid (1.67%) and sodium chlorite (2.5%)	Farnam Pre and Post Milking Teat Dip Concentrate™	Arco Research, Inc., Melville, NY for Farnam Companies, Inc., Phoenix, AZ	Experimental challenge	*S. aureus* (P < .01)	39 (1998)
Phenol	Masticide	Sporicidin International, Rockville, MD	Natural exposure	*S. aureus* (P < .05) *S. uberis* (P < .05) *Staph.* species (P < .005) *C. bovis* (P < .005)	40 (1999)

Table 4 (cont.). Summary of peer-reviewed research on efficacy of other products used in postmilking teat disinfectants published since 1980.

Lactic acid (2.9%) and sodium chlorite (.7%)	Bi-Sept	Westfalia-Surge, Naperville, IL	Experimental challenge	*S. aureus* ($P < .001$) *S. agalactiae* ($P < .001$)	41 (2000)
Bronopol, quaternary ammonium, and isocyanuric acid	Actisept Pre Post	Activon Products, Fort Collins, CO	Experimental challenge	*S. aureus* ($P < .001$) *S. agalactiae* ($P < .05$)	43 (2002)
Sodium chlorite (.32%), 2.5% glycerin, .27% sodium dodecylbenzene sulfonic acid, and lactic acid (1.32%)	Red	Alcide Corp., Redmond, WA	Experimental challenge	*S. aureus* ($P < .05$) *S. agalactiae* ($P < .05$)	44 (2002)
Sodium chlorite (.32%), 2.5% glycerin, .53% sodium dodecylbenzene sulfonic acid, and lactic acid (1.32%)	Blue	Alcide Corp., Redmond, WA	Experimental challenge	*S. aureus* ($P < .05$) *S. agalactiae* ($P < .05$)	44 (2002)

Table 5. Summary of peer-reviewed research on efficacy of premilking teat disinfectants published since 1980.

Active ingredient(s) & concentration	Trade name	Manufacturer/ distributor	Type of study	Significant efficacy against	Reference number
Chlorhexidine (.35%)	Not mentioned	H. B. Fuller Co., Monarch Division, Minneapolis, MN	Natural exposure	Major pathogens ($P < .10$) *Staph.* species ($P < .05$) Major & minor pathogens ($P \leq .05$)	31 (1994)
Iodophor (.1%)	Pre-Vail	IBA, Inc., Millbury, MA	Natural exposure	Environmental pathogens ($P < .10$) Major pathogens ($P < .05$)	32 (1987)
Iodophor (.25%)	Bovadine II	West Agro Chemical Co., Kansas City, MO	Natural exposure	Environmental pathogens ($P < .05$) Major pathogens ($P < .025$)	32 (1987)
Iodine (.25%)	Predine	H. B. Fuller Co., Monarch Division, Minneapolis, MN	Natural exposure	Gram-negative bacteria ($P < .025$) Major pathogens ($P < .001$)	33 (1993)
Iodophor (.55%) plus linear dodecyl benzene sulfonic acid (1.9%)	Tandem	IBA, Inc., Millbury, MA	Natural exposure	Environmental pathogens ($P < .10$) Major pathogens ($P < .10$)	32 (1987)
Sodium chlorite (.64%) and lactic acid (2.64%)	4XLA	Alcide Corp., Norwalk, CT	Natural exposure	*S. aureus* ($P < .05$) *S. uberis* ($P < .05$) Major pathogens ($P < .01$)	34 (1993)
Phenolic combination	Masticide	Sporicidin International, Rockville, MD	Natural exposure	*S. uberis* ($P < .005$) *S. dysgalactiae* ($P < .05$) Gram-negative bacteria ($P < .05$) Coagulase-negative *Staphylococcus* spp. ($P < .025$)	42 (2001)

References

1. Oliver, S. P., S. H. King, M. J. Lewis, P. M. Torre, K. R. Matthews, and H. H. Dowlen. 1990. Efficacy of chlorhexidine as a postmilking teat disinfectant for the prevention of bovine mastitis during lactation. J. Dairy Sci. 73:2230.

2. Hicks, W. G., T. J. Kennedy, D. M. Keister, and M. L. Miller. 1981. Evaluation of a teat dip of chlorhexidine digluconate (.5%) with glycerin (6%). J. Dairy Sci. 64:2266.

3. Boddie, R. L., J. L. Watts, and S. C. Nickerson. 1990. In vitro and in vivo evaluation of a 0.5% chlorhexidine gluconate teat dip. J. Am. Vet. Med. Assoc. 196:890.

4. Pankey, J. W., W. N. Philpot, R. L. Boddie, and J. L. Watts. 1983. Evaluation of nine teat dip formulations under experimental challenge to *Staphylococcus aureus* and *Streptococcus agalactiae*. J. Dairy Sci. 66:161.

5. Westfall, G. J., L.S. Hinckley, W. H. Daniels, and J. DeCloux. 1987. Controlling mastitis with an aerosol teat disinfectant. Vet. Med. 87:752.

6. Pankey, J. W., W. N. Philpot, and R. L. Boddie. 1983. Efficacy of low concentration iodophor teat dips against *Staphylococcus aureus*. J. Dairy Sci. 66:155.

7. Boddie, R. L., and S. C. Nickerson. 1990. Efficacy of two iodophor postmilking teat germicides against *Streptococcus agalactiae*. J. Dairy Sci. 73:2790.

8. Bray, D. R., R. P. Natzke, R. W. Everett, and C. J. Wilcox. 1983. Comparison of teat dips with differing iodine concentrations in prevention of mastitis infection. J. Dairy Sci. 66:2593.

9. Boddie, R. L. , S. C. Nickerson, and R. W. Adkinson. 1993. Evaluation of teat germicides of low iodine concentrations for prevention of bovine mastitis by *Staphylococcus aureus* and *Streptococcus agalactiae*. Prev. Vet. Med. 16:111.

10. Boddie, R. L., and S. C. Nickerson. 1989. Efficacy of .18% iodine teat dip against *Staphylococcus aureus* and *Streptococcus agalactiae*. J. Dairy Sci. 72:1063.

11. Oliver, S. P., M. J. Lewis, S. H. King, B. E. Gillespie, T. Ingle, K. R. Matthews, H. H. Dowlen, P. A. Drechsler, E. E. Wildman, and J. W. Pankey. 1991. Efficacy of a low concentration iodine postmilking teat disinfectant against contagious and environmental mastitis pathogens in two dairy herds. J. Food Prot. 54:737.

12. Nickerson, S. C., J. L. Watts, R. L. Boddie, and J. W. Pankey. 1986. Evaluation of .5% and 1% iodophor teat dips on commercial dairies. J. Dairy Sci. 69:1693.

13. Eberhart, R. J., P. L. LeVan, L. C. Griel, Jr., and E. M. Kesler. 1983. Germicidal teat dip in a herd with low prevalence of *Streptococcus agalactiae* and *Staphylococcus aureus* mastitis. J. Dairy Sci. 66:1390.

14. Goldberg, J. J., P. A. Murdough, A. B. Howard, P. A. Drechsler, J. W. Pankey, G. A. Ledbetter, D. A. Richards, and L. L. Day. 1994. Evaluation of a 1% iodophor postmilking teat sanitizer. J. Dairy Sci. 77:740.

15. Pankey, J.W., R.L. Boddie, and W.N. Philpot. 1984. Evaluation of linear dodecyl benzene sulfonic acid as a teat dip in a commercial dairy. J. Dairy Sci. 67:1354.

16. Pankey, J.W., S.C. Nickerson, and R.L. Boddie. 1984. Evaluation of liner dodecyl benzene sulfonic acid teat dip under experimental challenge. J. Dairy Sci. 67:1327.

17. Pankey, J.W., J.L. Watts, and S.C. Nickerson. 1985. Field studies on linear dodecyl benzene sulfonic acid teat dip. J. Dairy Sci. 68:1523.

18. Fisher, G.C., and F.H.S. Newbould. 1983. Field evaluation of a teat dip containing dodecyl benzene sulfonic acid in preventing new mammary gland infections in a dairy herd. Can. Vet. J. 24:89.

19. Barnum, D. A., R. E. Johnson, and B. W. Brooks. 1982. An evaluation of a teat dip with dodecyl benzene sulfonic acid in preventing bovine mammary gland infection from experimental exposure to *Streptococcus agalactiae* and *Staphylococcus aureus*. Can. Vet. J. 23:50.

20. Pankey, J.W., R.L. Boddie, and S.C. Nickerson. 1985. Efficacy evaluation of two new teat dip formulations under experimental challenge. J. Dairy Sci. 68:462.

21. Boddie, R. L., and S. C. Nickerson. 1988. Efficacy of a fatty acid-lactic acid postmilking teat germicide in reducing incidence of bovine mastitis. J. Food Prot. 51:799.

22. Boddie, R. L., and S. C. Nickerson. 1992. Evaluation of postmilking teat germicides containing Lauricidin®, saturated fatty acids, and lactic acid. J. Dairy Sci. 75:1725.

23. Goldberg, J.J., P. A. Murdough, A. B. Howard, P. A. Drechsler, J. W. Pankey, G. A. Ledbetter, L. L. Day, and J. D. Day. 1994. Winter evaluation of a postmilking powdered teat dip. J. Dairy Sci. 77:748.

24. Stewart, G. A., and W. N. Philpot. 1982. Efficacy of a quaternary ammonium teat dip for preventing intramammary infections. J. Dairy Sci. 65:878.

25. Pankey, J. W., and J. L. Watts. 1983. Evaluation of spray application of postmilking teat sanitizer. J. Dairy Sci. 66:355.

26. Boddie, R. L., and S. C. Nickerson. 1986. Efficacy of dodecylaminoaykl glycine teat dip against *Staphylococcus aureus* and *Streptococcus agalactiae* mastitis. J. Dairy Sci. 69:258.

27. Oliver, S. P., S. H. King, P. M. Torre, E. P. Shull, H. H. Dowlen, M. J. Lewis, and L.M. Sordillo. 1989. Prevention of bovine mastitis by a postmilking teat disinfectant containing chlorous acid and chlorine dioxide in a soluble polymer gel. J. Dairy Sci. 72:3091.

28. Drechsler, P. A., E. E. Wildman, and J. W. Pankey. 1990. Evaluation of a chlorous acid-chlorine dioxide teat dip under experimental and natural exposure conditions. J. Dairy Sci. 73:2121.

29. Poutrel, B., F. Serieys, and M. Ducelliez. 1990. Efficacy of a germicidal post milking barrier-type teat dip in preventing intramammary infections. Vet. Rec. 126:638.

30. Boddie, R. L., S. C. Nickerson, and G. K. Kemp. 1994. Efficacy of two barrier teat dips containing chlorous acid germicides against experimental challenge with *Staphylococcus aureus* and *Streptococcus agalactiae*. J. Dairy Sci. 77:3192.

31. Oliver, S. P., B. E. Gillespie, M. J. Lewis, T. L. Ingle, and H. H. Dowlen. 1994. Evaluation of chlorhexidine as a premilking teat disinfectant for the prevention of intramammary infections during lactation. J. Food Prot. 57:614.

32. Pankey, J. W., E. E. Wildman, P. A. Dreshler, and J. S. Hogan. 1987. Field trial evaluation of premilking teat disinfection. J. Dairy Sci. 70:867.

33. Oliver, S. P., M. J. Lewis, T. L. Ingle, B. E. Gillespie, K. R. Matthews, and H. H. Dowlen. 1993. Premilking teat disinfection for the prevention of environmental pathogen intramammary infections. J. Food Prot. 56:852.

34. Oliver, S. P., M. J. Lewis, T. L. Ingle, B. E. Gillespie, and K. R. Matthews. 1993. Prevention of bovine mastitis by a teat disinfectant containing chlorous acid and chlorine dioxide. J. Dairy Sci. 76:287.

35. Hogan, J.S., K.L Smith, D.A. Todhunter, and P.S. Schoenberger. 1995. Efficacy of a barrier teat dip containing .55% chlorhexidine for prevention of bovine mastitis. J. Dairy Sci. 78:2502.

36. Boddie, R. L., and S. C. Nickerson. 1996. Efficacy of teat dips containing a hypochlorous acid germicide against experimental challenge with *Staphylococcus aureus* and *Streptococcus agalactiae.* J. Dairy Sci. 79:1683.

37. Boddie, R. L., S. C. Nickerson and R. W. Adkinson. 1997. Efficacies of teat germicides containing 0.5% chlorhexidine and 1% iodine during experimental challenge with *Staphylococcus aureus* and *Streptococcus agalactiae.* J. Dairy Sci. 80:2810-2815.

38. Boddie, R. L. and S. C. Nickerson. 1997. Evaluation of two iodophor teat germicides: Activity against *Staphylococcus aureus* and *Streptococcus agalactiae.* J. Dairy Sci. 80:1846-1850.

39. Boddie, R. L., S. C. Nickerson, and R. W. Adkinson. 1998. Germicidal activity of a chlorous acid-chlorine dioxide teat dip and a sodium chlorite teat dip during experimental challenge with *Staphylococcus aureus* and *Streptococcus agalactiae*. J. Dairy Sci. 81:2293-2298.

40. Oliver, S. P., M. J. Lewis, B. E. Gillespie, S. J. Ivey, L. H. Coleman, R. A. Almeida, W. Fang, and K. Lamar. 1999. Evaluation of a postmilking teat disinfectant containing a phenolic combination for the prevention of mastitis in lactating dairy cows. J. Food Prot. 62:1354-1357

41. Boddie, R. L., S. C. Nickerson, and R. W. Adkinson. 2000. Efficacies of chlorine dioxide and iodophor teat dips during experimental challenge with *Staphylococcus aureus* and *Streptococcus agalactiae*. J. Dairy Sci. 83: 2977-2981.

42. Oliver, S. P., B. E. Gillespie, M. J. Lewis, S. J. Ivey, R. A. Almeida, D. A. Luther, D. L. Johnson, K. C. Lamar, H. Moorehead and H. H. Dowlen. 2001. Efficacy of a premilking teat disinfectant containing a phenolic combination for the prevention of mastitis in lactating dairy cows. J. Dairy Sci. 84:1545-1549.

43. Boddie, R. L., and S. C. Nickerson. 2002. Reduction of mastitis caused by experimental challenge with *Staphylococcus aureus* and *Streptococcus agalactiae* by use of a quaternary ammonium and halogen-mixture teat dip. J. Dairy Sci. 85:258-262.

44. Oura, L. Y., L. K. Fox, C. C. Warf, and G. K. Kemp. 2002. Efficacy of two acidified chlorite postmilking teat disinfectants with sodium dodecylbenzene sulfonic acid on prevention of contagious mastitis using an experimental challenge protocol. J. Dairy Sci. 85:252-257.

45. Foret, C.J., W. E. Owens, R. L. Boddie, and P. Janowicz. 2003. Efficacy of Two Iodine Teat Dips during Experimental Challenge with *Staphylococcus aureus* and *Streptococcus agalactiae*. J. Dairy Sci. 86: 3783-3786

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