Evaluation of a Experimental Chlorine Dioxide (Base/Activator) Teat Dip on Teat End / Teat Skin Condition and Health

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Summary and Implications

A teat conditioning trial was run for a period of 60 days at the Iowa State University dairy farm under winter conditions, starting Nov 22, 2008 and ending Jan 21, 2009. Objective of this study was to evaluate the teat conditioning properties of an experimental chlorine dioxide teat dip formula (containing sorbitol as the emollient agent) against a currently marketed chlorine dioxide product using a split udder design. Left teats were dipped in the control product (4XLA) and right teats were dipped in the experimental product (372-75-2). Generally, teat condition score was measured every three days for the duration of the study, totaling 18 teat scoring events. Results showed no statistical difference between the two products in both teat skin condition scores. However, statistical differences in teat condition were only observed when time in trial was analyzed and which were associated with climatic changes. On daily average, temperatures below 32^{o}F were observed 90% of the trial period time. The average *teat skin* condition at the start of the trial was 1.15 for both products and ended at 1.08 (4XLA) and 1.07 (372-75-5). On 10 out of 17 occasions, teat skin score remained relatively unchanged. On 6 other occasions it worsened, reaching a maximum of 1.49 ($P<0.01$), and in 1 occasion it improved, reaching a low of 1.04 ($P<0.01$). The *teat end* condition was 2.23 (4XLA) and 2.14 (372-75-2) at the start of the trial, and ended at 2.88 (4XLA) and 2.74 (372-75-2). In general it was observed that teat end condition remained relatively stable during the first 40 days, and then it worsened until the trial ended ($P<0.01$). It is concluded that both 4XLA and 372-75-2 had a similar teat conditioning efficacy during the 60d trial period under winter conditions in the USA. There were, however, significant changes in teat condition scores across times and dates, with similar trends across groups and products, signifying that other factors besides teat dips influence teat condition. Changes in teat condition were associated with temperature changes and often worsened (increased scores) with cold temperatures.

Introduction

Maintaining good teat end / skin health is recognized as an essential element in mastitis prevention and animal welfare. In addition to excellent germicidal activity, all teat dips should have both teat end and teat skin health data evaluation, and show excellent teat health prior to commercialization. Objective of this study was to evaluate a potentially new chlorine dioxide teat dip (base and activator mixed each milking) on overall teat end and teat skin condition and health compared to an industry commercial control dip using a split udder design. A split udder design study was performed to minimize risk of experimental bias and maximize chances of seeing teat dip effects. Experimental dips were only used postmilking.

Materials and Methods

Dips used: Two chlorine dioxide dips where a base and activator were mixed in equal proportions before every milking were used in this study. Control dip was a commercial product (4XLA, Ecolab, Inc.) and experimental dip was coded 'Green' (372-75-2) (DeLaval, Inc.). Before being shipped to the farm, products were labeled 'Yellow' (4XLA) or 'Green' (372-75-2). No details regarding the product name and/or composition were shown on the labels, apart from its proper usage and precautions. At the farm, teat dip cups and cows were color marked so that milkers would identify a cow easily and dip them with the appropriate treatment. It was agreed with the investigator that left teats of cows would be dipped with the Yellow product and right teats with the Green product. Fresh product was prepared for each milking and remains were discarded.

Cows: All protocols were approved by ISU Committee on Animal Care (IACUC # 10-06-6228-B). A total of 212 cows were used in the trial. Cows were sourced from three different pens, pen 4 (37 animals), pen 5 (77 animals) and pen 6 (98 animals). For the analyses, data were available for 147 cows (pen 4 = 23, pen 5 = 55 and pen 6 = 69). Pens 5 and 6 were experimentally dipped pens while pen 4 served as an internal herd control (used herd dips and practices).

Trial design and farm practices: Trial used a split udder design. Left teats of cows in Pens 5-6 were post dipped with a commercial chlorine dioxide product (4XLA, Ecolab, Inc.) while right side teats were post dipped with an experimental dip coded 'Green' (372-75-2) (DeLaval, Inc.) The trial was 9 weeks in duration where dipping with these dips was done for 8weeks sandwiched between .5 week periods where the herd used its standard herd commercial pre and post dips (pre milking teat dip was a 0.25% iodine, 2% skin conditioning product (BacStop, IBA) and post dip was a .5% iodine, 12% emollient iodine barrier dip (Transcend, IBA)). Pen 4 (internal herd control) used these dips and practices for all 9 weeks (except in extremely cold weather where a powder based dry dip for winter was used). All other farm and milking practices were similar across all 9 weeks and all groups.

Cows were milked twice a day in a double 12 parallel parlor. Cows were forestripped (3 strips/teat) and pre-dipped (6 cow sequence), then dried with terry cloth towels prior to milker unit attachment. Automatic detachers were set at 1.8 lb. flow rate and 1 second delay. All cows were housed in a single pen in a free stall barn with mattresses and separated manure solids bedding.

Teat skin and teat end evaluations: Data collection was initiated on Nov. 19, 2008 and continued until Jan. 21, 2009. Test products were applied starting Nov. 22 or on the 4th day of the trial following 2 baseline evaluations. Trial dips were discontinued on Jan. 18 with 2 after trial baseline evaluations (return to herd's usual dips). Teat skin and teat end scoring was performed using a variation of the Goldberg and Timms methods, respectively, by a single trained grader (Tables 1 and 2). Scoring was performed twice per week. Data was entered into an Excel database. Results were compiled and analyzed using SAS.

Statistical models: Trial data for TCS were analyzed using repeated measures ANOVA, where the dependent variables were TCS at the evaluation dates and scoring date (Date) as categorical factors. Multilevel modelling software (MLwiN 2.10, University of Bristol) was used to assure that correlations between scoring dates on the same quarters, and quarters within cows would not bias the result. In the final model, the variable 'treatment' (teat dip) was dropped in the 'teat skin' analysis because it was not significant. Inclusion of cows for the analyses included: a) derived from pens 5 (55 cows) and 6 (69 cows), which were using the 4XLA or 372-75-2 products, and b) those animals that had a minimum of 5 consecutive scoring date values. Data from a total of 23 cows belonging to pen 4 and that had teat condition scores for at minimum of 5 scorings are included in the tables or figures for reference purposes. Data from theses cows were not used in the final analysis.

The final model was as follows:

$$y_{ijk} \sim N(XB, \Omega)$$

$$y_{ijk} = \beta_{0i}x_0 + \beta_1 x_{1ijk} + \beta_2 x_{2ijk} + \beta_3 x_{3ijk} + \beta_4 x_{4ijk} + \beta_5 x_{5ijk} + \beta_6 x_{6ijk} + \beta_7 x_{7ijk} + \beta_8 x_{8ijk} + \beta_9 x_{9ijk} + \beta_{10} x_{10ijk} + \beta_{11} x_{11ijk} + \beta_{12} x_{12ijk} + \beta_{13} x_{13ijk} + \beta_{14} x_{14ijk} + \beta_{15} x_{15ijk} + \beta_{16} x_{16ijk} + \beta_{17} x_{17ijk}$$

$$\beta_{0i} = \beta_0 + e_{0ijk}$$

where: y = independent variable (teat skin or teat end score), B_0 = constant, and B_1-B_{17} = coefficients for 17 scoring dates (starting 11/24/08 and ending 1/21/09). The point of reference was teat condition at 11/22/08.

Results and Discussion

Both test products had similar teat conditioning efficacy over the 60 day trial period (Figures 1 and 2).

Teat skin scores over the trial period for internal herd control and experimental control and treatment dipped teats are shown in Figure 1. The average *teat skin* condition at the start of the trial was 1.15 for both products and ended at 1.08 (4XLA) and 1.07 (372-75-5). On 10 occasions teat skin score remained relatively unchanged. On 6 other occasions it worsened, reaching a maximum of 1.49 ($P<0.01$), and in 1 occasion it improved, reaching a low of 1.04 ($P<0.01$). On Dec 16, teat skin condition decreased by 0.44 units in only 3 days (1.49 to 1.05). This is a strange result, as teat condition was 1.49 on Dec 13 and 1.43 on Dec 19. It was noted that average temperature of the two days prior to scoring were 30°F (Dec 13), 2°F (Dec 16) and 17°F (Dec 19), a harsh temperature change that may have been a cause of this teat skin change. The control group showed the same trend over the same period of time, starting at 1.17 on Dec 13, decreasing to 1.01 on Dec 16, and then worsening on Dec 19.

Teat end scores over the trial period for internal herd control and experimental control and treatment dipped teats are shown in Figure 2. The *teat end* condition was 2.23 (4XLA) and 2.14 (372-75-2) at the start of the trial, and ended at 2.88 (4XLA) and 2.74 (372-75-2). On average, teat end condition of 372-75-2 teats was lower than 4XLA ($P<0.01$). In general it was observed that teat end condition remained relatively stable during the first 40 days, and then it worsened until the trial ended ($P<0.01$). Teat end condition diverted sporadically from the general trend on Dec 19, increasing 0.43 units in only 3 days and then returning to previous levels in the following score date (Dec 24). The average daily temperatures for these dates were 4°F (Dec 16), 20°F (Dec 19) and 8°F (Dec 24).

Weather conditions, mainly temperature, were monitored for the duration of the trial (Figure 3). Average temperatures on most days were below freezing with some dramatic drops in temperature below zero farenheit during mid- December and mid Jan. through trial end. These temperature drops were often associated with teat condition changes (increased scores and poorer teat condition).

Overall Summary

Overall teat end and teat skin health were similar for both products during the trial period. There were, however, significant changes in teat end and skin scores across time or sample dates for all groups (including the herd internal control group) signifying other factors besides teat dips affecting teat condition. Most increased in scores (associated with poorer teat condition) were associated with changes in temperatures, primarily drops in ambient temps.

Table 1. Teat Skin Scoring Scale.

Score	Description
0	Teat skin has been subjected to physical injury (stepped on/ frost bite)
1	Teat skin is smooth, soft and free of any scales, cracks, or chapping.
2	Teat skin shows some evidence of scaling especially when feeling (areas of dryness by feeling drag when sliding a gloved hand along the teat barrel &/or seeing areas of lower reflective sheen to the surface of the skin).
3	Teat skin is chapped. Chapping is where visible bits of skin are visibly peeling.
4	Teat skin is chapped and cracked. Redness, indicating inflammation, is evident.
5	Teat skin is severely damaged / ulcerated / open lesions.

Table 2. Teat End Scoring Scale (0*- 5).

Teat End Scoring system	**Degree of hyperkeratosis or callousing**				
Cracking	none	minor	mild	moderate	severe
No cracking	**1**	**1.5**	**2**	**2.5**	**3**
Cracked	**---**	**3.5**	**4**	**4.5**	**5**

0* zero score – physical injury of teat not associated with trial

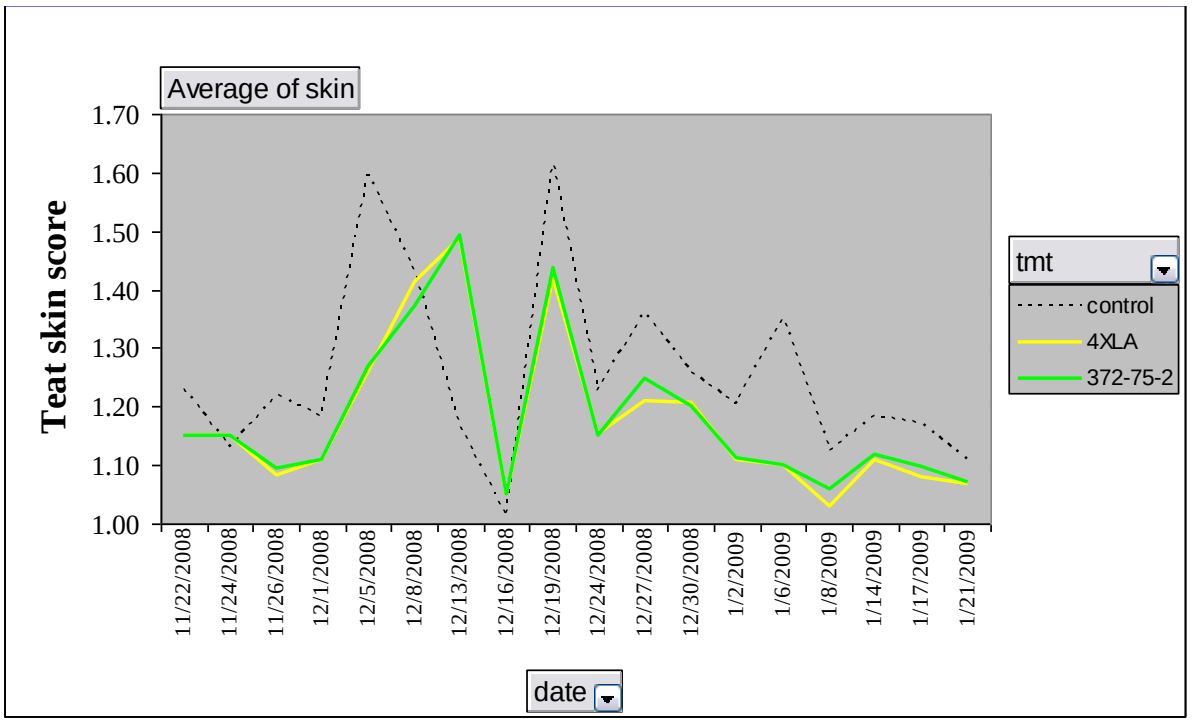

Figure 1. Average teat skin scores for control teats (Pen 4 internal herd control); 4XLA or experimental control teats (left side teats - Pens 5-6) and treated teats (right side teats – Pens 5-6).

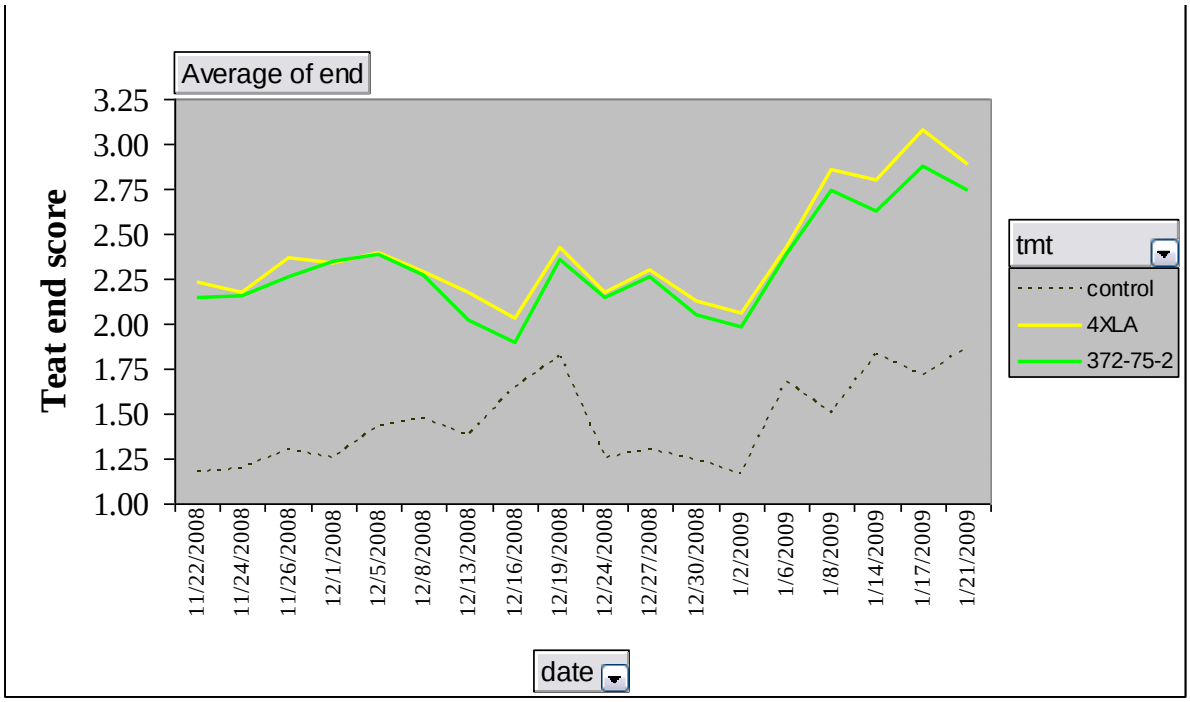

Figure 2. Average teat end scores for control teats (Pen 4 internal herd control); 4XLA or experimental control teats (left side teats - Pens 5-6) and treated teats (right side teats – Pens 5-6).

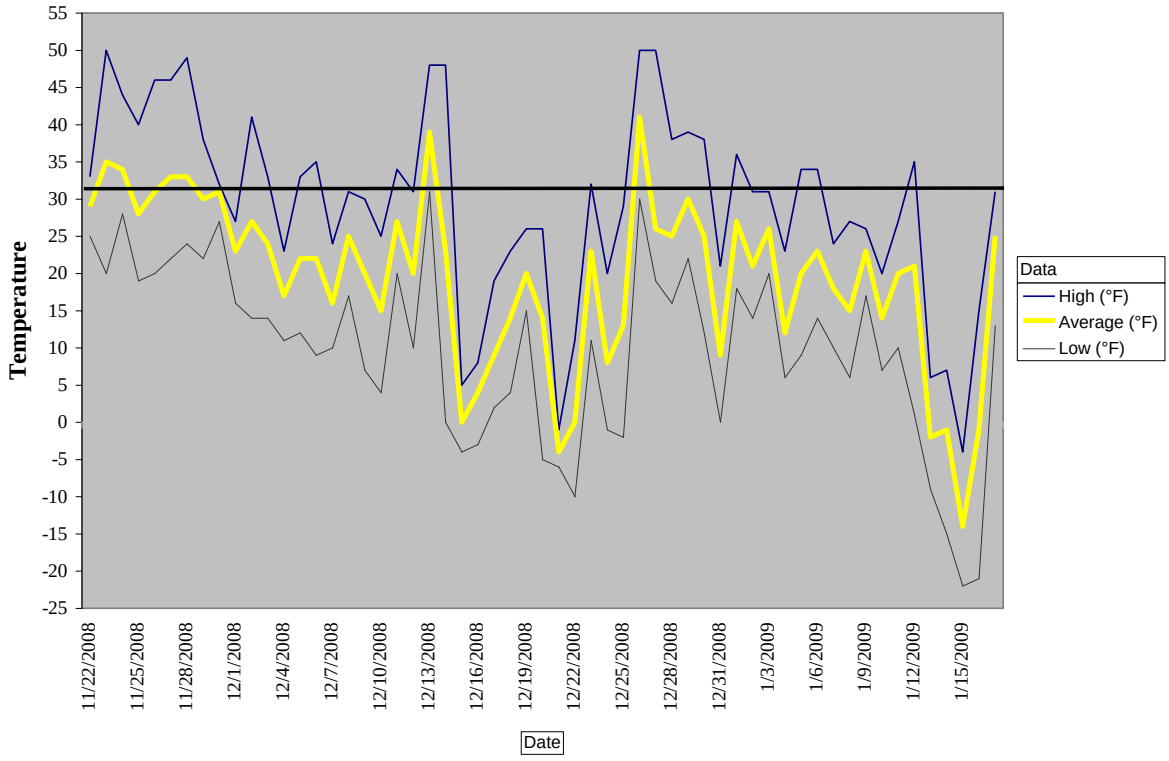

Figure 3. Temperature (°F) values over the 60 day trial period (high or maximum, average, and low or minimum daily temperatures).