Development and Evaluation of Experimental Chlorine Technology Pre and Post Milking Teat Dips on Teat End and Teat Skin Condition and Health

A.S. Leaflet R2885

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Summary and Implications

Objectives were to evaluate pre and post teat dip formulations using a novel chlorine disinfectant technology (ECAlogix™ System) and their effect on teat health and integrity. There were 2 trials with 2 pens (10 and 11) in both trials. Trial 1 (2 wk) was designed to evaluate maximal chlorine concentrations; trial 2 (3 wk) assessed emollient levels. Pen 11 (48 cows) was pre-dipped in a half udder design and all teats post dipped with herd commercial product (lactic acid barrier post- dip). Trial 1 compared 500 and 1000 ppm chlorine pre-dips. Trial 2 compared 1000 ppm predips with different emollient levels. In trials 1 and 2, Pen 10 (24 cows) was pre-dipped with commercial herd product (hydrogen peroxide predip) and post dipped in a half udder design. Trial one compared 1000 and 2000 ppm chlorine post dips. Trial 2 compared 2000 ppm post dips with different emollient levels. Teat skin (1=normal, 2=slightly dry; 3 = chapped) and teat end (1-1.5 = normal; 2-3= smooth ring; 3.5-4 = rough ring; 4.5-5 very rough ring) scoring was performed twice per week. Mixed procedure of SAS with repeated measured (mixed model with quarter within cow as a repeated measure) were used to analyze average teat skin score (TSS), average teat end scores (TES), and % rough teats, with $p < 0.05$ considered significant. Prior to trial initiation, all pens had similar TSS (1.08; 3 - 16% scoring 2), with pen 10 having slightly lower TES and % rough teats (2; 50%) compared to pen 11 (2.5; 60%). Trial 1 showed no overall change in TSS, TES, and % rough teat ends for pen 11 (prototype pre dips) with no differences between 500 and 1000 ppm chlorine pre-dips in Pen 11. Pen 10 (prototype post dips) showed significant improvements in TSS (1.01, $\leq$1% score 2), TES (1.7), and % rough teat ends (30%), with no differences between 1000 and 2000 ppm chlorine post dips. Trial 2 showed similar results to trial 1 (improved teat integrity with prototype chlorine post dips) with no additional benefits seen to extra emollient addition to either pre or post chlorine dips. No adverse effects were seen at any chlorine concentration. Chlorine technology afforded very good pre and post dips but must be tested against commercial products before commercialization.

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 use and commercialization. The objectives of these trials were to evaluate pre and post teat dip formulations using a novel chlorine disinfectant technology (ECAlogix™ System – Zurex Pharmagra) and their effect on teat health and integrity.

Materials and Methods

1. **Initial base germicidal product:** The initial base germicidal stock compound supplied to ISU generated through ECAlogix™ System (Zurex PHARMAGRA) was designed to have 8000 ppm chlorine. All chlorine dips developed and evaluated in this trial used appropriate dilutions of this base germicidal solution in addition to designated additives for pre and post milking teat dips.
2. **Cows**: All protocols were approved by ISU Committee on Animal Care (IACUC # 10-06-6228-B). Two pens (1 each: Pens 10 and 11) of 24 and 48 animals, respectively, were used to evaluate pre-dip (pen 11) and post dips (pen 10) prototypes only individually (trials 1 and 2).
3. **Trial design and farm practices:** Trial 1 was designed to evaluate optimal or maximal chlorine concentrations for pre / post dips. Trial 2 was designed to assess if additional emollients were necessary.
   - **Pen 10 Trials 1 and 2:** In trials 1 and 2, Pen 10 was pre-dipped with commercial herd product and post dipped in a half udder design where 2 ECAlogic post dips were compared. Trial one compared 1000 and 2000 ppm products with 7.27% ECAcept POST added (Chlorine concentration trial). Trial 2 compared 2000 ppm with 3.64% ECAcept PREP / POST (also blue coloring) against 2000 ppm with 7.27% ECAcept POST+ (emollient trial).
   - **Pen 11 Trials 1 and 2:** Pen 11 was pre-dipped in a half udder design where 2 ECAlogic pre dips were compared, and all teats were post dipped with herd commercial product. Trial 1 compared 500 and 1000 ppm products with .36% ECAcept PREP (chlorine concentration trial). Trial 2 compared 1000 ppm with .36% PREP (from trial 1) and 1000 ppm with 3.64% PREP / POST.

- Cows were milked 3X 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. All cows were post dipped following unit removal. Automatic detachers were set at 2.0 lb. flow rate and 0 second delay. Commercial herd pre milking teat dip was a .5% hydrogen peroxide with 5% emollient (Active Oxy55, Boumatic, Inc). Commercial post milking teat dips were a green lactic acid barrier teat dip (DeLaval, Inc). All cows were housed on the south side of the free stall barn with stalls containing a Packmat (subsurface rubber filled mattress 4" below curb height; Promat, Inc.) and 4-6" of deep bedded recycled manure solids (fiber).

4. **Teat skin and teat end health evaluations**: Data collection was initiated on June 15, 2012 and continued until August 23, 2012. Baseline data on teat end and teat skin health in all 3 pens was observed from June 15 – July 21. Trial 1 was initiated on July 21 and completed on August 5th. Trial 2 was from August 5 – 23. Teat skin and teat end scoring were performed using a variation of the Goldberg and Timms methods, respectively, by trained graders (Tables 1 and 2). Scoring was performed two times per week. Data was entered into an Excel database. Results were compiled and analyzed using SAS.
5. **Statistical models:** SAS was used in all data analysis. Mixed procedure of SAS with repeated measured (mixed model with quarter within cow as a repeated measure) were used to analyze teat skin and teat end data, and % cracked / rough teats, with $p < .05$ considered significant. The models were repeated measure analyses of variance models with treatment, date and their interaction as fixed effects, whereas pen, cow and quarter as random effects.

Results and Discussion

1. **Teat skin and teat end health and integrity:** Teat skin and teat end health for all trials follows.
   a) **Trial 1: Teat skin (TS) and Teat end (TE) health and integrity (July 21 – Aug 3):**
      i. **Teat skin health and integrity:** Average teat skin scores for pen 11 (pre) and 10(post) for Trial 1 (ECAcept concentration studies) are shown in Figures 1-2. Dipping with experimental dips started on July 21 so all previous dates have the same commercial pre and post dips on teats (baseline data). Teat skin scores were similar across pens prior to trial initiation.

      - **Pen 11 (ECAcept pre / commercial post):** There were no difference between control and treated teats (1000 and 500 ppm chlorine pre-dips). Average teat skin score range was 1.01 – 1.21 (1-21% teats scoring 2). Teat skin scores elevated very slightly for 1 week post trial dipping, then significantly jumped the last 4 days (related to a few cows and a green barrier post dip issue).
      - **Pen 10 (commercial pre dip / ECAcept post):** There were no difference between control and treated teats (2000 and 1000 ppm chlorine post-dips). Average teat skin score range was 1.00 – 1.01 (0-1% teats scoring 2) following trial initiation. Teat skin health was excellent in this group (significantly better) and may portray importance of post milking teat dips as they have longest skin contact time.
      - **Overall summary for teat skin: Trial 1:** Prior to trial initiation, all pens had similar teat skin with 3-16% scoring 2 or a little dry. Following trial initiation, Pen 11 (ECAcept predips) had very good teat skin health until final 4 days where some dry teats occurred (post dip related). Pen 10 (ECAcept post) had excellent teat skin.

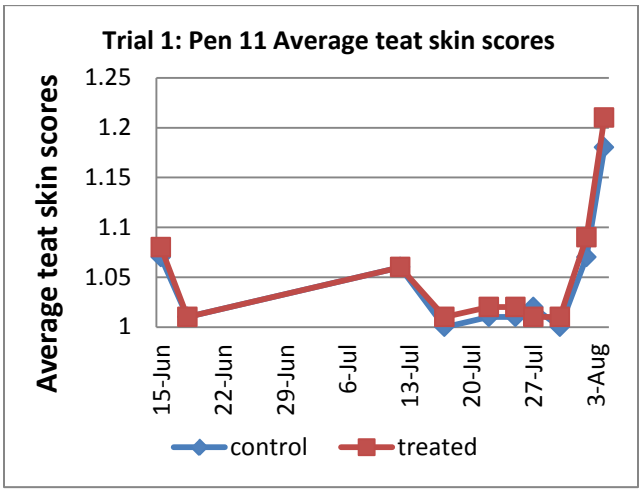

Figure 1. Average teat skin scores for Pen 11 in Trial 1 (ECAcept predips / commercial postdip).

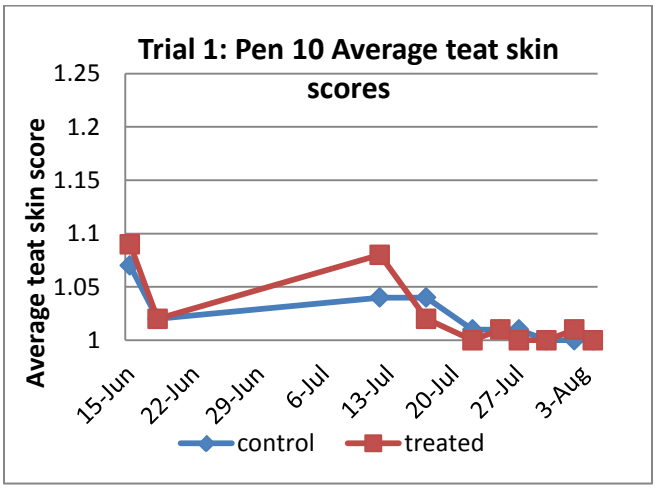

Figure 2. Average teat skin scores for Pen 10 in Trial 1 (commercial predip / ECAcept postdips).

ii. **Teat end health and integrity:** Average teat end scores and % rough cracked teats for Trial 1 (ECA concentrations) for pen 11, and 10 are shown in Figures 3-6. Dipping with experimental dips started July 21 so all previous dates have same commercial pre and post dips on teats (baseline data). Teat end scores were similar across pens in June but slightly lower in pen 10 prior to trial initiation.

- **Pen 11 (ECAcept pre / commercial post):** There were no differences between control and treated teats in ATES (1000 and 500 ppm chlorine pre-dips). Teat ends of all pens improved between 7/ 24 – 7/30 with .5 decrease in ATES and 20% decrease in rough teats, but these returned to original baselines by 8/3.
- **Pen 10 (commercial pre dip / ECAcept post):** There were no differences between control and treated teats in ATES (2000 and 1000 ppm chlorine post-dips). Teat ends of all pens improved between 7/ 24 – 7/30 with .5 decrease in ATES and 20% decrease in rough teats. However, ATES and % rough teat ends continued to decline through 8/4 whereas Pen 11 increased. This may have resulted from post dip having longer contact time and teat end interaction postmilking. Control dip (2000 ppm) had better ATES (p=.12) and lower % rough teats (p=.17) on 8/4.
- **Other summary points for trial 1:**
- ***Concentrations of 2000 ppm for ECA post dips and 1000 ppm ECA predips showed no adverse effects*** and similar teat skin and teat end integrity compared to lower concentrations, with 2000 ppm post dip having numerically better teat ends at trial end compared to 1000 ppm.

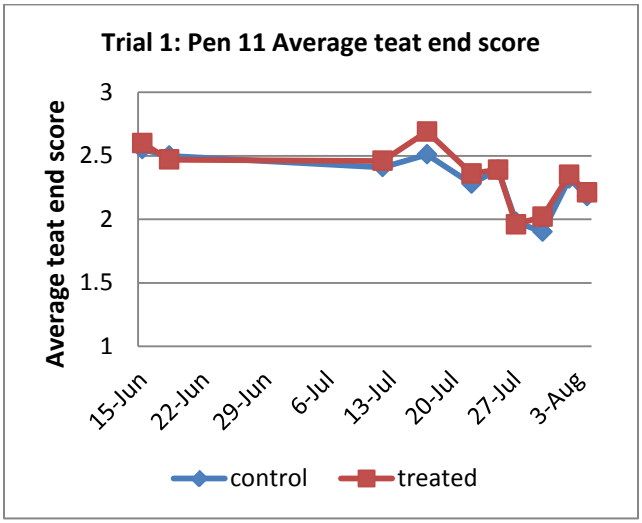

Figure 3. Average teat end scores for Pen 11 in Trial 1 (ECAcept predips / commercial postdip).

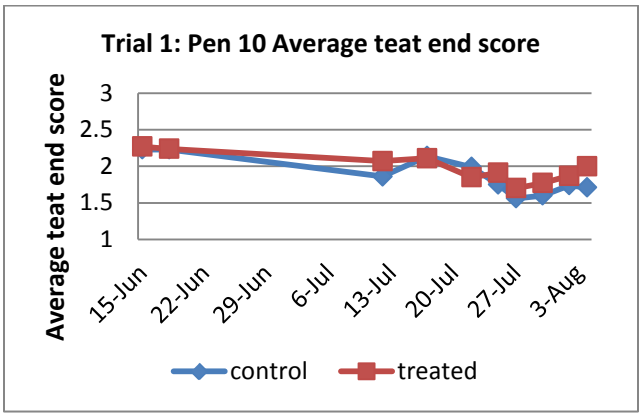

Figure 4. Average teat end scores for Pen 10 in Trial 1 (commercial predip / ECAcept postdips).

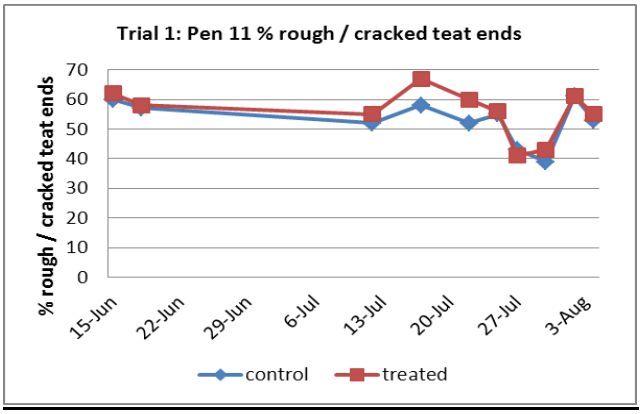

Figure 5. % rough/cracked teat ends for Pen 11, Trial 1 (ECAcept predips / commercial postdip).

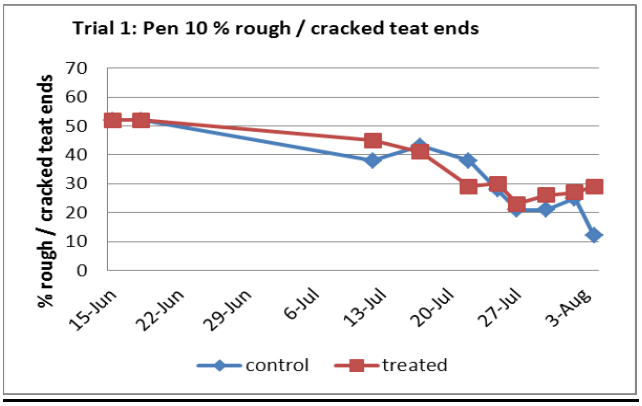

Figure 6. % rough/cracked teat ends for Pen 10, Trial 1 (commercial predip / ECAcept postdips).

- All pens had higher than normal teat end scores compared to previous trials at ISU. Higher average TES and % rough teats were due to a combined 3X milking interacting with some automatic take off teflon diaphragm issues. However, these problems were equal across all pens, and ECA post dip was able to overcome some of these effects and improve teat ends in the face of these herd issues.

b) Trial 2: Teat skin (TS) and Teat end (TE) health and integrity: (8/4-8/24; true 3X milk 8/8)

i. **Teat skin health and integrity:** Average teat skin scores for pen 11 and 10 for Trial 2 (emollient trial) are shown in Figures 7-8.

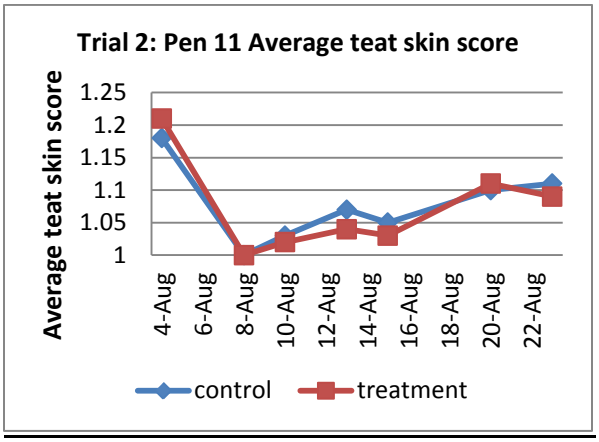

Figure 7. Average teat skin scores for Pen 11 in Trial 2 (ECAcept predips / commercial postdip).

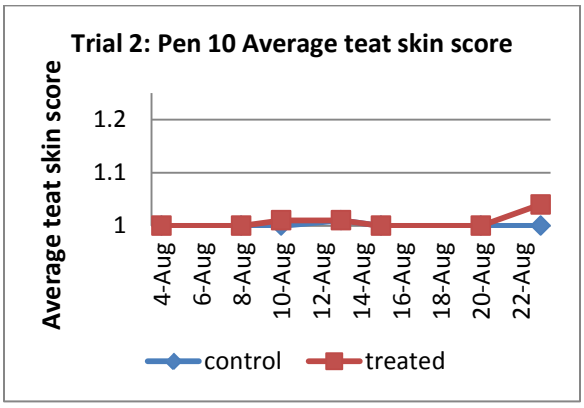

Figure 8. Average teat skin scores for Pen 10 in Trial 2 (commercial predip / ECAcept postdips).

- **Pen 11 (ECAcept pre / commercial post):** There were no difference between control and treated teats (1000 ppm chlorine pre-dips with different emollient levels). Average teat skin score range was 1.00 – 1.11 (0-11% teats scoring 2). Increase at trial end relate to commercial post dip.
- **Pen 10 (commercial pre dip / ECAcept post):** There were no difference between control and treated teats (2000 ppm chlorine post-dips with different emollient levels). Average teat skin score range was 1.00 – 1.04 (0-4% teats scoring 2). Teat skin health was excellent in this group (significantly better than Pens 11 and 12) and portrays importance of post milking teat dips as they have longest skin contact time. Additional emollients showed no advantage to teat skin compared to initial post dip.
- **Overall summary for teat skin: Trial 2:**
- Pen 10 (ECAcept post dips) had significantly better teat skin than Pen 11 (ECA pre dips)
- There was no improvement in teat skin score with additional emollients in ECAcept dips.

ii. **Teat end health and integrity:** Average teat end scores and % rough cracked teats for Trial 2 (emollient trials) for pen 11 and 10 are shown in Figures 9-12.

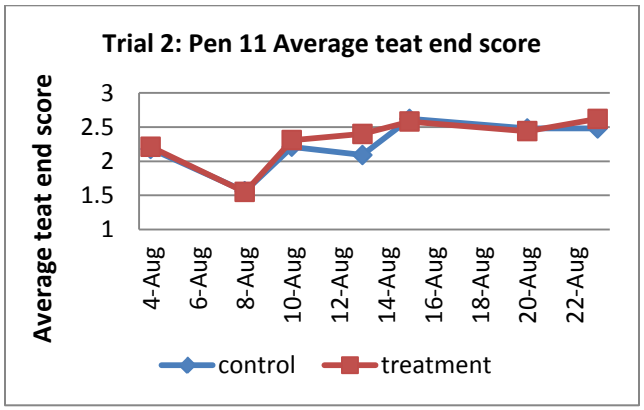

Figure 9. Average teat end scores for Pen 11 in Trial 2 (ECAcept predips / commercial postdip).

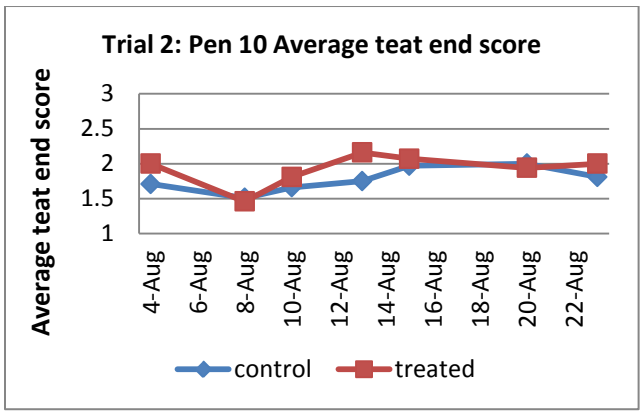

Figure 10. Average teat end scores for Pen 10 in Trial 2 (commercial predip / ECAcept postdips).

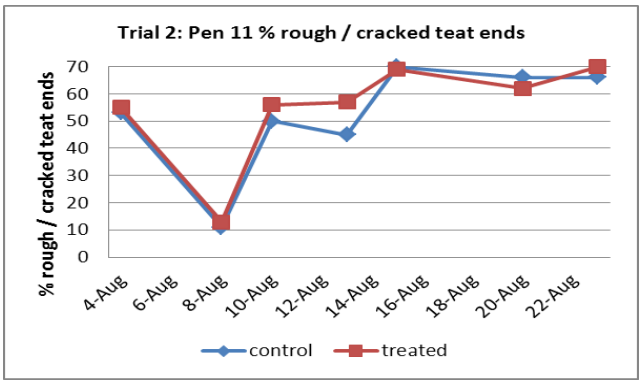

Figure 11. % rough/cracked teat ends for Pen 11, Trial 2 (ECAcept predips / commercial postdip).

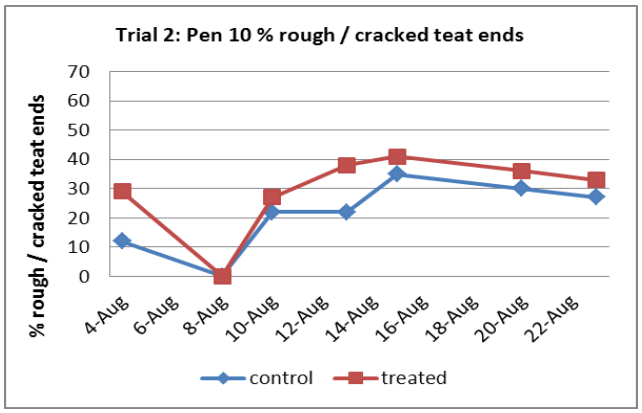

Figure 12. % rough/cracked teat ends for Pen 10, Trial 2 (commercial predip / ECAcept postdips).

- **Pen 11 (ECAcept pre / commercial post):** There were no differences between control and treated teats in ATES or % rough / cracked teats (regular vs. higher emollient ECA pre-dips)). Teat ends of both groups slightly worsened (ATES increased (2.1 to 2.4) and % rough teats increased (55 to 70%) following switch to full 3X equal interval milkings on 8/8. Scoring data on 8/8 was completed by a secondary scorer (trial scorer ill) and underestimated rough teat ends.
- **Pen 10 (commercial pre dip / ECAcept post):** There were no differences between control and treated teats in ATES and % rough teat ends (regular vs. higher emollient ECA post-dips). Teat ends of both groups very slightly worsened following switch to full 3X equal interval milkings on 8/8 but then improved back to baseline or better by trial end. Scoring data on 8/8 was completed by a secondary scorer (trial scorer ill) and underestimated rough teat ends. Teat ends in Pen 10 (ECA post dips) had significantly better teat ends than Pen 11(ECA pre dip).
- **Overall summary for teat ends: Trial 2:** Pen 10 (ECA post dips) had significantly better teat skin and ends (score and % rough) compared to Pen 11(ECA pre dip). Pen 11 (ECA pre dips) had significantly better teat skin but similar teat ends compared to pen 12 (herd sentinel with commercial dips). All pens saw slightly worse teat ends following switch to 3X equal interval milking on 8/8 but only Pen 10 (ECA post dips) adjusted and improved by trial end.
- **Other summary points for trial 2:**
  - Addition of extra emollients did not improve teat skin or teat end health and integrity of base ECAcept pre and post dips.

Overall Summary

1. **Chlorine concentrations and teat skin health:** All concentrations showed excellent teat skin health.
2. **Additional emollients:** Additional emollients did not improve product performances.
3. **Teat skin integrity:** Teat skin in trial 1 where ECAcept post dips were introduced showed significantly better teat skin and this remained across all trials, pointing out the critical role of post dipping in teat skin health (longer contact times).
4. **Teat end health and integrity:** Teats dipped with ECAcept post dips in trials 1 and 2 had significantly better teat ends (lower scores and % rough). ECAcept dips improved average teat scores by .5 (2.6 to 2.1) and % rough teats by 34% (60-40%). These results were evidenced by 7 days into Trial 1 and remained that way throughout both trials.

OVERALL CONCLUSION: ECAcept dips were stable and provided significantly better teat skin and teat end health compared to commercial products (Pen 12 herd sentry pen) with no irritation at any concentration. A half udder direct comparison with commercial dip is planned .

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