Evaluation of Experimental Chlorine Based Post Milking Teat Dips vs. a Commercial Iodine Post Milking Teat Dip on Teat End and Teat Skin Condition and Health

A.S. Leaflet R2974

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Summary and Implications

The objective of this study was to evaluate the effects of experimental chlorine based post milking teat dips compared to a commercial iodine post milking teat dip on overall teat end and teat skin condition and health using a half udder within cow control model. A secondary aspect was to try to assess whether chlorine concentration or presence of additives had any effects. There were 3 trials with 3 pens (5, 6, and 1) in this study. Each pen (trial) evaluated an experimental chlorine post dip vs. Theratec utilizing a half udder design where left teats were dipped post milking with Theratec and right teats were dipped with the chlorine product. Chlorine products were 4000 ppm w/ no additive or additives for pens 5 and 6, and 2000 ppm + additive in Pen 1. 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 two times 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 $p < .05$ considered significant. There were no significant differences between Theratec and all the chlorine based teat dips (except teat ends during the first week for 2000 ppm Cl + additive) regarding teat skin and teat end health and integrity. All teats maintained excellent teat skin throughout the trials (teat skin score 1). Although there were no significant differences between dips in regards to teat end health and integrity, there were significant changes in teat end scores and % cracked teats over time related to weather and temperature changes. Changes to colder temperatures resulted in a higher average teat end score and greater % teats cracked, while changes to warmer temperatures showed a reverse trend. Addition of additive to the dips seemed to speed up the healing process on teat ends. Although the temperature effects were not completely blocked by the dips, the teat ends did remain hydrated and soft (not dry). Overall, the chlorine based teat dips performed as well as an excellent commercial iodine post milking teat dip.

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 objective of this study was to evaluate the effects of experimental chlorine based post milking teat dips compared to a commercial iodine post milking teat dip on overall teat end and teat skin condition and health using a half udder within cow control model. A secondary aspect was to try to assess whether chlorine concentration or presence of additives had any effects.

Materials and Methods

1. **Initial base germicidal product:** The initial chlorine based germicidal stock compound supplied to ISU generated through ECAlogix™ System (Zurex PHARMAGRA) was designed to have ~8000 ppm chlorine (designated NCharge Concentrate, GEA Farm Technologies). All chlorine post dips evaluated in these trials used appropriate dilutions of this base germicidal solution in addition to designated additives.
2. **Dips used:** Control dip was Theratec (.5% iodine dip with 3% triple emollient system, GEA Farm Technologies). 3 experimental or treatment dips were made twice weekly and each was used in a separate trial and pen of dairy cows in this study. Appropriate dilutions of the stock chlorine compound were made and appropriate amounts of post dip additives (7.5 oz or 222 ml of NCharge Post Additive, GEA Farm Technologies) were combined to make the following dips for the study: a) 4000 ppm chlorine with no post dip additive (4000-); b) 4000 ppm chlorine with post dip additive (4000+); and c) 2000 ppm chlorine with post dip additive (2000+). A chloride titration testing kit was used to assure proper chlorine concentration in initial dips as well as when used during the trials.
3. **Cows**: All protocols were approved by ISU Committee on Animal Care (IACUC # 10-06-6228-B). Three pens of 48 lactating dairy were used (one pen of 48 cows for each dip comparison).
4. **Trial design and farm practices:** There were 3 trials with 3 pens (5, 6, and 1) in this study. Each pen (trial) evaluated an experimental chlorine post dip vs. Theratec utilizing a half udder design where left teats were dipped post milking with Theratec and right teats were dipped with the chlorine product. All teats of all cows in all pens were predipped with the herd predip product (700 ppm ECAcept chlorine predip with ECAcept PREP additive (14 ml/ gallon of dip)). Prior to

and after trials, teats were post dipped with a 1% iodine product (WestDip, DeLaval, Inc.).

- **Pen 5:** had left teats dipped with Theratec and right teats dipped in a 4000 ppm chlorine product with no post dip additives (4000-)
- **Pen 6:** had left teats dipped with Theratec and right teats dipped in a 4000 ppm chlorine product with NCharge post dip additive (4000+)
- **Pen 1:** had left teats dipped with Theratec and right teats dipped in a 2000 ppm chlorine product with NCharge post dip additive (2000+)

Cows were milked three times a day in a double 12 parallel parlor. Cows were pre-dipped (6 cow sequence), then forestripped (3 strips/teat), then dried with terry cloth towels prior to milker unit attachment. Automatic detachers were set at 2.0 lb. flow rate and 0 second delay. All cows were housed on the north side of the ISU Dairy free stall barn (modern curtain walled free stall barn, minimal wind chill or drafts) with stalls containing a Pasture Mat (above surface 5" rubber filled mattress with a 1" foam pad and top cover on top); (Promat, Inc.) and 1-3" of recycled manure solids (fiber) bedding on top.

5. **Teat skin and teat end health evaluations**: Data collection was initiated on December 1, 2013 and continued until January 26, 2014. Baseline data on teat end and teat skin health in all 3 pens was observed on Dec. 1 and 3 am milkings prior to trial dips allowing for a 2 milking baseline score for all quarters and cows. Experimental chlorine and commercial iodine post dips were applied in all trial pens (5, 6, and 1) at every milking (3X/ day) following the Dec. 3 am milking through the Dec 30 pm milking (28 days). Pens 5 and 1 returned to the herd pre and post dips on following the Dec 31 am milking while Pen 6 remained on the trial dips (Theratec v. 4000+) for an additional 4 weeks (until 1/26/2014 so 8 weeks total). 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.
6. **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 teat ends, 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 health and integrity:** Teat skin health and integrity (as measured by teat skin scoring) was excellent before (baseline), during (trial dips being used), and after (return to commercial herd dips following dip trial) the trials or study. Most all teat skin scored excellent (1) and there were no significant differences within or across treatments within a pen. Although dips or compounds can't be directly evaluated across pens, dips within a germicide class (iodine and Cl) showed excellent and similar teat skin condition properties across all pens.
2. **Teat end health and integrity / weather and temperatures:** Average teat end scores for all products and pens are shown in Figures 1-3, while % rough / cracked teat ends (higher infection risk) are shown in Figures 4-6. When average teat end scores increase, it is important to delineate whether it is just an increase in thickening or callousing (hyperkeratosis) but no cracking or roughness (limited increased mastitis risks), or the increase is associated with higher percentages of cracked or rough teats (which are associated with increased mastitis risks). Weather and temperature, especially cold and changing temperatures, can have significant effect on teat tissue, especially teat ends. Daily temperature data (minimum, average, and maximum) for all pens is shown in Figure 7.
   a) **Pen 5: Theratec vs. 4000- ppm Cl (without additive) post milking teat dips (Figures 1 & 4):** There were no significant differences in average teat end scores or % teat ends > 3.5 (rough and/ or cracked) between dip treatments. There were significant increases in average teat end score and % rough / cracked teat over the trial period for both dips (average teat end scores increased from 1.75 to 2.7; % rough teats increased from 22% to 63%). Most rough / cracked teats scored 3.5 which is associated with a minor crack with limited teat skin thickening or hyperkeratosis. Changes (up or down) in average teat end score and % cracked teats paralleled temperature (Figure 7) with increased cracks with shifts to lower temperature and reduced cracks when temperatures increased. Most teats end remained very moist, however (limited dryness).
   b) **Pen 6: Theratec vs. 4000+ ppm Cl (with additive) post milking teat dips (Figure 2 and 5):** There were no significant differences in average teat end scores or % teat ends > 3.5 (rough and/ or cracked) between dip treatments. There were significant increases in average teat end score and % rough / cracked teat over the trial period for both dips (average teat end scores increased from 1.6 to 3.0; % rough teats increased from 21% to 70%). Most rough / cracked teats scored 3.5 which is associated with a minor crack with limited teat skin

thickening or hyperkeratosis. Changes (up or down) in average teat end score and % cracked teats paralleled temperature (Figure 7) with increased cracks with shifts to lower temperature and reduced cracks when temperatures increased. Most teats end remained very moist, however (limited dryness).

c) **Pen 1: Theratec vs. 2000+ ppm Cl (with additive) post milking teat dips (Figures 3 and 6):** There were significant difference in teat end score and % cracked teats between dips during the first 10 days of the trial with the chlorine dip showing higher average teat end score and % cracked teats. There were no significant differences in average teat end scores or % teat ends > 3.5 (rough and/ or cracked) between dip treatments following week 1 of the trial. There were significant increases in average teat end score and % rough / cracked teat over the trial period for both dips (average teat end scores increased from 1.5 to 3.0; % rough teats increased from 12% to 70%). Most rough / cracked teats scored 3.5 which is associated with a minor crack with limited teat skin thickening or hyperkeratosis. Changes (up or down) in average teat end score and % cracked teats paralleled temperature (Figure 7) with increased cracks with shifts to lower temperature and reduced cracks when temperatures increased. Most teats end remained very moist, however (limited dryness).

d) **Weather and temperatures (Figure 7):** Daily temperature data (minimum, average, and maximum) for all pens across all trials and the study is shown in Figure 7. There were significant changes in temperatures throughout the weeks and trials with average low temperatures being 10-20 degrees below normal temperatures for those days. Also, higher temperature days tended to be 5-10 degrees higher than normal. This resulted in some large delta changes in temperatures. Weather and temperature, especially cold and changing temperatures, can have significant effect on teat tissue, especially teat ends. Our previous dip work showed delta change in temperature has as significant effect on teat end tissues changes as actual daily temperature. Most changes in average teat end scores and % cracked teats getting worse or better were associated with negative and positive delta changes in temperature, respectively.

e) **Overall teat end health and integrity with comments regarding chlorine concentrations, teat dip additive, and temperatures:**

i. **Differences between control (Theratec) and chlorine based post dips (and within chlorine based post dips):**

- **Teat end integrity decreases**: Outside of the first 10 days post dipping with trial dips in Pen 1 (2000 ppm CL with additives vs Theratec), there were no significant differences in average teat end scores or % rough / cracked teats between all chlorine dips and Theratec. During the 1st 10 days following initiation of dipping in the trial (12/3) in Pen 1, chlorine dipped teats had significantly higher teat end scores and cracked teats compared to Theratec. These were very small cracks with minimal teat end thickening and teats remained soft. Although no direct comparisons were done between chlorine dips (all on different cows in different pens), discussion of dip factors or differences is warranted in explaining this Pen 1 result. Pen 1 had lower chlorine concentration than Pens 5 and 6 but we do not believe this was the factor that influenced this since higher chlorine should not improve teat tissue. Pen 1 had additive but so did Pen 6 (pen 5 did not) so we do not believe this was an additive effect. One factor is that teats of cows in Pen 1 had lower average teat scores and % cracked in the baseline monitoring period (possibly more teats prone to change). Second, pens 5 and 6 had marginally higher (non-significant) average teat end scores and % cracked during the first 10 days. Although dips were changed on both Theratec and chlorine dipped teats at trial beginning, all teats prior to the study were post dipped in an iodine dip. Possible differences in the early part of the trial may be related to switching from iodine to chlorine. Finally, there was a cold weather shift that week (lower temperatures). We believe the slight difference, with Pen 1 especially, was an interaction of initial teat end health, germicide change, and weather.
- **Teat end integrity improvements:** Average teat end scores and % cracked teats improved (decrease) when temperatures fluctuated and rose higher. Again, although chlorine dips were in different pens and no direct comparisons, chlorine dips that contained additive showed a more rapid improvement in teat end health compared to no additive when temperatures improved, possibly supporting the value of additive in improving and healing teat tissue.

ii. **Differences related to temperature and weather:** For most of the time, trials, and pens, there were no significant differences in teat end integrity between Theratec and chlorine based post dips. However, there were significant changes across all dips with time and temperature. Over the course of the trial

average teat score increased (1.5 – 1.7 to 2.7-3.0) as well as % rough / cracked teats (10-22% to 63-70%). Most times these increases in teat end scores and cracking (deteriorating teat end integrity) were associated with cold temperatures, especially following a change to colder temperatures. Although there was increased teat roughness or cracking, most was very mild (teat score 3.5) with very little callousing or hyperkeratosis. Also, teat ends remained fairy hydrated and soft with minimal dryness or hardness. There were, however, times during these trials where teat end integrity improved, and this was almost always associated with increased temperatures. Pen 6 graphs offer the best visual analysis of this as only Pen 6 was dipped with Theratec vs. chlorine dip during the whole temperature monitoring period (Figure 5) excluding the first few days in December (1-3; baseline period and scoring). It can be seen in comparing Figure 8 (% cracked teats in pen 6) and Figure 7 (temperatures) across time, deterioration or improvement in teat integrity was associated with changes to colder or warmer temperatures, respectively. This shows that although dips, cow housing and environment, etc. are important in minimizing teat end issues associated with winter and cold weather, colder temperatures still results in increased teat end cracking and mastitis risk.

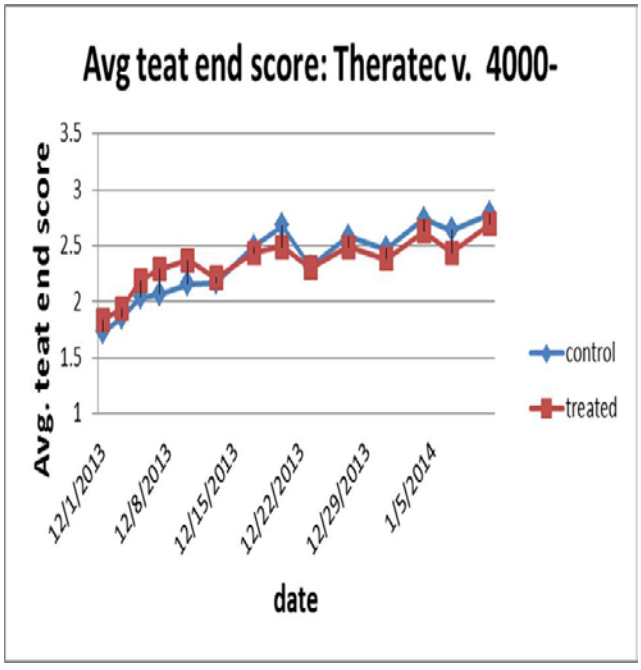

Figure 1: Average teat end scores for Pen 5 control = Theratec; treated = 4000- ppm Cl (no additives).

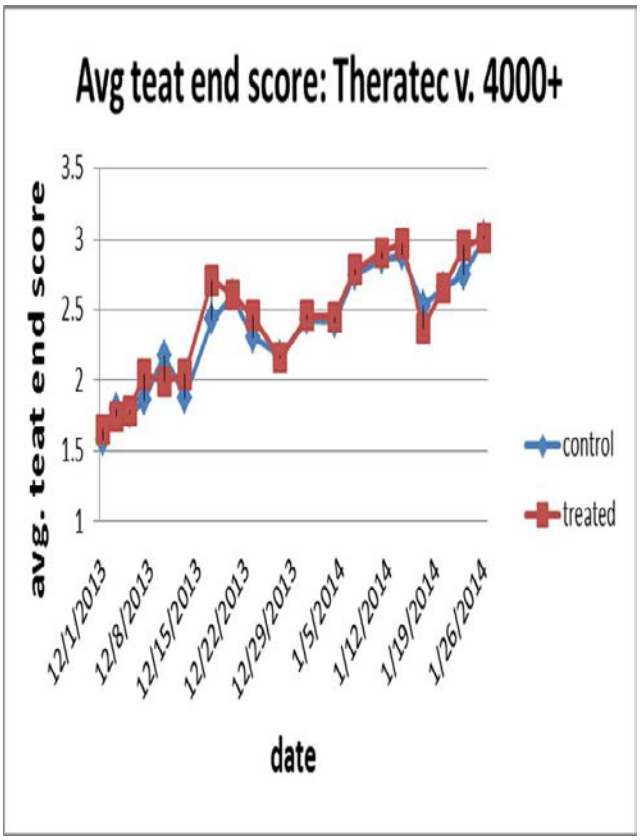

Figure 2. Average teat end scores for Pen 6 (control = Theratec; treated = 4000+ ppm Cl with additives).

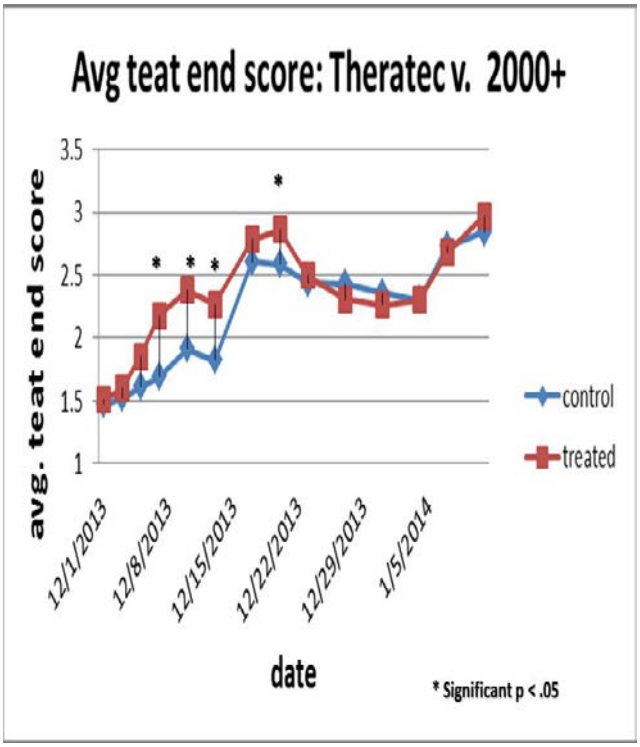

Figure 3. Average teat end scores for Pen 1 (control = Theratec; treated = 2000+ ppm Cl with additives).

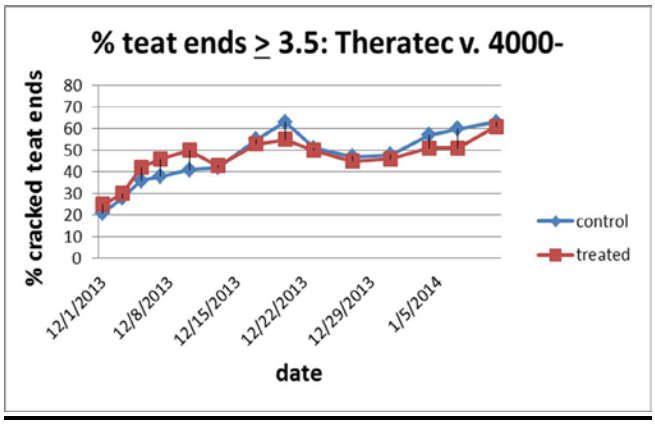

Figure 4. % rough / cracked teat ends for Pen 5 control = Theratec; treated = 4000- ppm Cl (no additives).

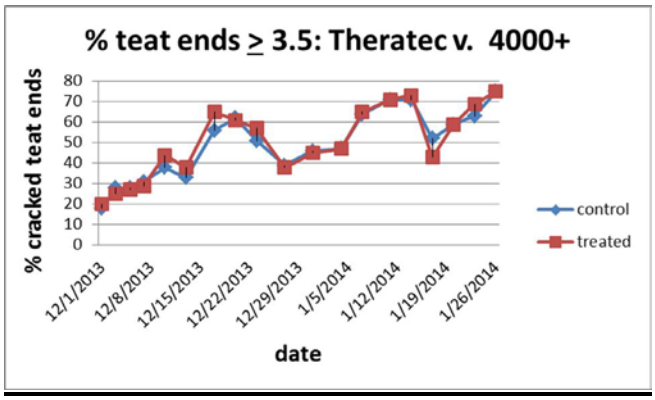

Figure 5. % rough/ cracked teat ends for Pen 6 control = Theratec; treated = 4000+ ppm Cl (w/ additives).

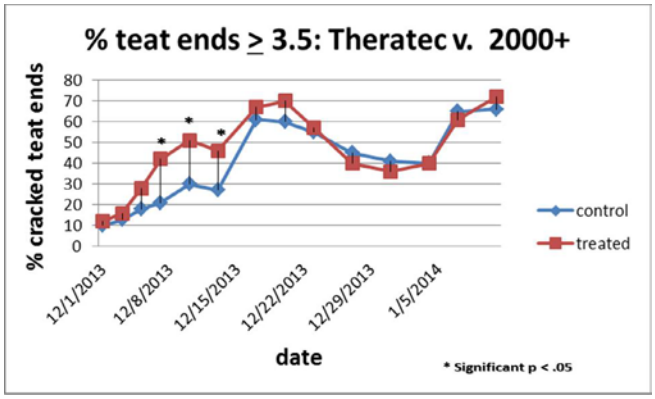

Figure 6. % rough/ cracked teat ends for Pen 1 control = Theratec; treated = 4000+ ppm Cl (w/ additives).

Overall Summary

1. **<u>Teat skin health and integrity:</u>** Excellent teat skin!!! No significant differences across dips or time.
2. **<u>Teat end health and integrity:</u>** Outside of week 1 in Pen 1 (2000 ppm CL) with additive, there were no significant differences in teat end integrity (average teat end scores or % rough / cracked teats) between Theratec and the chlorine dips. There were, however, similar significant increases in average teat end score and % cracked across all dips throughout the trial, more associated with cold weather changes and temperature fluctuations.
3. **<u>Weather and temperature effects:</u>** 2013-14 winter was one of the coldest on record. In addition to lower than average temperatures, there were temperature shifts each week that led to higher than average temperatures also, so large delta changes. Delta changes to colder temperatures were associated with increased average teat end scores and % cracked teats, while delta change to warmer temperatures resulted in improvements in teat integrity. Multiple delta changes to cold temperatures over the trial period resulted in an increase in average teat end scores (1.5 to 3.0) and % rough cracked teats (12% to 70%).
4. **<u>Chlorine concentrations and additional emollients:</u>** **Chlorine concentration:** Although these factors were not directly tested against each other within cow (each in separate pens), some general observations and comments can be made. Although there were significant difference in week 1 in pen 1 (2000 ppm Chlorine with additive), we do not believe this related to chlorine concentration. Previous work with 2000 ppm CL with additives showed excellent teat end condition. We believe results in Pen 1 was an interaction of lower % of cracked teats to start (more at risk), change to a different germicide compound (iodine to chlorine) and a cold weather change, rather than chlorine concentration. **Additives and / or emollients:** While additive did not seem to influence % of teats that cracked when temperatures changed, there seemed to be a more rapid, enhance healing when temperatures increased. To confirm this, dips with and without additive must be tested directly against each other within cows.

<u>OVERALL CONCLUSION:</u> There were no significant differences between Theratec and all the chlorine based teat dips (except teat ends during the first week for 2000 ppm Cl + additive) regarding teat skin and teat end health and integrity. All teats maintained excellent teat skin throughout the trials (teat skin score 1). Although there were no significant differences between dips in regards to teat end health and integrity, there were significant changes in teat end scores and % cracked teats over time related to weather and temperature changes. Changes to colder temperatures resulted in a higher average teat end score and greater % teats cracked, while changes to warmer temperatures showed a reverse trend. Addition of additive to the dips seemed to speed up the healing process on teat ends. Although the temperature effects were not completely blocked by the dips, the teat ends did remain hydrated and soft (not dry). Overall, the chlorine based teat dips performed as well as an excellent commercial iodine post milking teat dip.

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

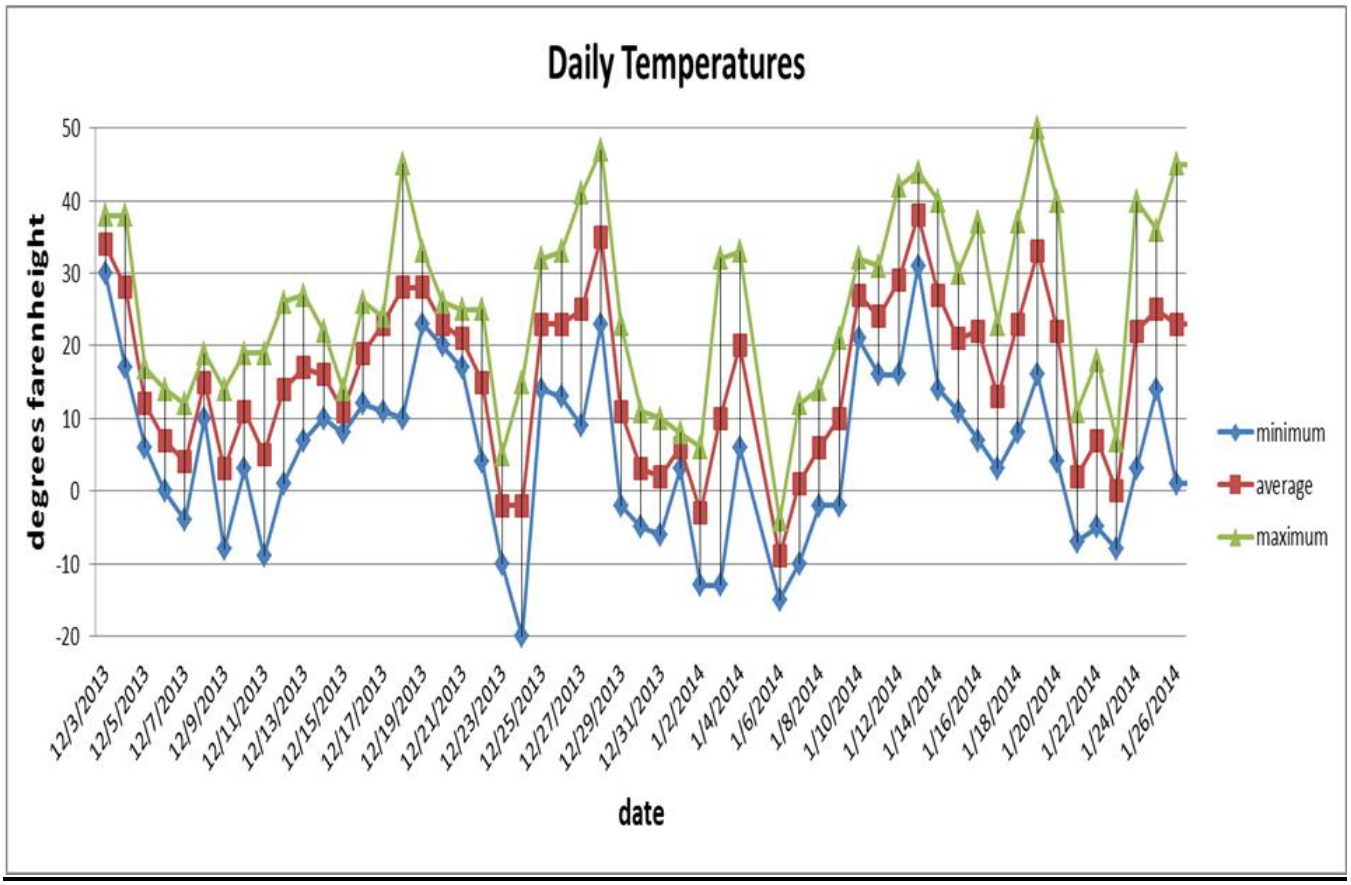

Figure 7: Minimum, average, and maximum daily temperatures (Ames, IA) across the study period.