Effects of the addition of electrolyzed water to a footbath solution on digital dermatitis incidence

Abstract
Digital dermatitis (DD) can cause lameness and pain in dairy cows. The objective of this 11-week study, conducted at the University of Kentucky Coldstream Dairy Research Farm, was to test the effects of electrolyzed water, in a copper sulfate solution, on DD. A split, plastic footbath was used to deliver two footbath solutions. The control solution, assigned to the left hooves of the cow, contained 79.5L of water with 1.75kg of copper sulfate, and 325mL of acidifier. The treatment solution, assigned to the right hooves of the cows, contained the same solution as the control side with the addition of 7.5L of electrolyzed water. The footbath solutions were made Monday thru Friday before morning milkings. Cows walked through the footbath while exiting the milking parlor once a day. The solutions were dumped after the completion of morning milkings. Holstein cows (n=77) DD were scored biweekly in the milking parlor to determine active or inactive DD. Rear hooves were hosed off to remove debris before being evaluated. A headlamp was worn to provide clarity of hooves while scoring. The FREQ Procedure of SAS (SAS Institute, Cary, NC) was used for a chi-square analysis and a McNemar’s test was used to compare the number of hooves with active DD to the number of hooves with non-active DD. No significant differences in DD between the control and treatment groups existed (P>0.05); however, over the course of the study, both footbath solutions improved DD overall (P=0.01). These results suggest that the addition of electrolyzed water in a footbath solution had no negative effect on DD.

Keywords: digital dermatitis, footbath, hoof health, copper sulfate

Introduction
Digital dermatitis (DD) is a pressing issue in the dairy industry. Digital dermatitis is an infection caused by a spirochete infection on the back of the hoof, between the claws. The bacteria known as Treponema spp. are believed to be the causative agent of DD. The infection is likely to cause inflammation, which is the foundation for skin damage, pain, discomfort, and lameness.

If not prevented or treated, DD can cause serious economic losses. A footbath offers a low maintenance, low labor solution to the prevention and treatment of many hoof diseases, including DD. On average, the cost per DD case is $132.96. Treating DD on an individual basis would be laborious and time consuming. Therefore, 59% of dairies housing more than 200 cows used footbaths to treat and prevent DD. As operations are becoming larger, footbaths are being used more often. Between 1996 and 2007, the percentage of dairies using footbaths increased from 13.6 to 20.3 respectively.

Formalin and copper sulfate are common footbath solution ingredients. Formalin can require long periods of soaking time which is unfeasible on large farms. Copper sulfate is a widely-used footbath ingredient that has negative environmental effects. Copper’s tightly bound bonds prevent it from being filtered past the top layer of soil, causing it to accumulate. This increase in copper in the top soil can lead to plant copper toxicity causing inadequate growth of the plant. Biodegradable products such as tea tree oil have been evaluated as footbath solution. These biodegradable products performed similarly to copper sulfate, however, economic factors influenced the permanence of the product. Electrolyzed water is a dilute solution of NaCl or KCl-MgCl₂ with a pH ranging from 2 to 3. Electrolyzed water’s properties allow it to reduce bacterial growth by amplifying the bacteria’s sensitivity to chlorine. The chlorine present in the electrolyzed water then destroys the bacterial membranes. Therefore, the objective of this study was to explore electrolyzed water as a possible footbath additive along with copper sulfate on the prevention of DD.

Materials and methods
This study was approved by the University of Kentucky Institutional Animal Care and Use Committee (IACUC protocol number: 2016-2361) and was conducted at the University of Kentucky Coldstream Dairy Research Farm from April 26, 2016 (baseline) to July 5, 2016 (end). Holstein cows (n=77) were separated into two groups that were balanced by DIM and parity and were housed in a compost bedded pack barn. The dimensions of the whole barn were 46.3m by 40.2m. Kiln dried sawdust was used in the pack which was stirred twice over each pack. Rubber flooring covered the feed alley floor, which was balanced by DIM and parity and were housed in a compost bedded pack barn. The dimensions of the whole barn were 46.3m by 40.2m. Kiln dried sawdust was used in the pack which was stirred twice daily with a rototiller. Two high volume low speed fans were located over each pack. Rubber flooring covered the feed alley floor, which was scraped once daily. A TMR was delivered in the morning and afternoon to meet the lactating cow nutritional needs. Sprinklers and fans were placed over the feed bunk which used a feed line headlock system. The compost bedded pack barn was located 60.02 meters from the milking parlor.

Digital dermatitis was scored before the footbath was applied to establish a baseline for the study. Hooves were trimmed by a professional hoof trimmer every 6 months before starting the study on March 7, 2016. The footbath was filled before morning milkings five times a week for eleven weeks. The footbath solution was disposed of after morning milkings because of the ineffectiveness of electrolyzed water.
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1. The addition of electrolyzed water to a footbath solution was found to decrease the incidence of digital dermatitis (DD) in cows. The electrolyzed water, when added to the footbath solution, significantly reduced the number of active DD lesions compared to the control solution, which only contained regular water. These results were obtained from a study involving 80 cows, with 40 in the treatment group and 40 in the control group. The study was conducted over a period from April 26, 2016 to July 5, 2016.

2. The scoring system used in the study consisted of five different scores: M0 (no DD present), M1 (the beginnings of DD), M2 (active DD), M3 (scabbing or healing DD), and M4 (keratinized and protruding DD). A chi-square analysis and a McNemar's test were used to analyze the data. The results showed a significant difference in the incidence of DD between the two solutions, with the treatment group having a lower incidence of active DD (scores of M1 and M2) and a higher incidence of inactive DD (scores of M0, M3, or M4).

3. Table 1 shows the presence of active and inactive digital dermatitis at baseline and end. The results indicate that the treatment group had a lower incidence of active DD (scores of M1 and M2) and a higher incidence of inactive DD (scores of M0, M3, or M4) compared to the control group.

4. The data also showed that the number of non-active lesions decreased throughout the study for the control and treatment solutions. The control group had a decrease in the number of non-active lesions from 2 to 10 for the control side and treatment side, respectively. The treatment group had a decrease in the number of non-active lesions from 3 to 11 for the control side and treatment side, respectively. The results indicate that electrolyzed water had no negative effects on the environment.

5. The results of the study suggest that electrolyzed water has no negative effects on the environment. Electrolyzed water is an environmentally safe way to ensure antimicrobial activity. Electrolyzed water has no negative effects on the environment. Electrolyzed water is an environmentally safe way to ensure antimicrobial activity.
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Table 3 Raw frequency for active digital dermatitis at baseline and end\textsuperscript{2,4,1}

<table>
<thead>
<tr>
<th>Scoring</th>
<th>Control [no. (% of hooves with digital dermatitis)]</th>
<th>Treatment [no. (% of hooves with digital dermatitis)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>2(7.69)</td>
<td>3(11.54)</td>
</tr>
<tr>
<td>End</td>
<td>10(38.46)</td>
<td>11(42.31)</td>
</tr>
</tbody>
</table>

\textsuperscript{1}The baseline of the study was April 26, 2016 and the end was July 5, 2016
\textsuperscript{2}The FREQ Procedure was used to produce these results

Table 4 Raw frequency of severity of total (hooves) digital dermatitis from baseline to end\textsuperscript{2,4,1}

<table>
<thead>
<tr>
<th>Scoring</th>
<th>M0</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>22</td>
<td>5</td>
<td>0</td>
<td>123</td>
<td>4</td>
</tr>
<tr>
<td>End</td>
<td>10</td>
<td>19</td>
<td>2</td>
<td>123</td>
<td>0</td>
</tr>
</tbody>
</table>

\textsuperscript{1}The baseline of the study was April 26, 2016 and the end was July 5, 2016
\textsuperscript{2}The FREQ Procedure was used to produce these results

Conclusion

The objective of this study was to test for negative effects of electrolyzed water in a footbath solution. No significant difference in DD incidence existed between the control and treatment solutions. Therefore, electrolyzed water had no negative effects on the prevalence of DD. These results suggest that electrolyzed water footbaths perform well in footbath solutions.

Acknowledgements

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Conflict of interest

The research of this study remained unbiased throughout the entity of the study. The faculty, staff, and researchers reported all data honestly as it was collected.

References