

Footbaths for the Treatment or Control of Hairy Heel Warts (Digital Dermatitis) in Dairy Herds: Summary of Seven Studies

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Introduction

Lameness decreases milk production, reproductive efficiency, and the health and welfare of the dairy cow. Hairy Heel Warts, or (papillomatous) digital dermatitis (DD), is a common and painful disease that causes lameness in dairy cattle. Footbaths are used in many dairy herds to manage this condition, but the questions often remain:

What chemical should I use in the footbath? What concentration? How often?

The purpose of this factsheet is to summarize the results of recent clinical trials of footbath solutions on the treatment or control of digital dermatitis in dairy cattle.

Method

Online databases and search engines were used to identify published research on footbathing for digital dermatitis treatment and/or control. Clinical trials were included in this summary if they: (1) Were published after the most recent review paper on this subject was submitted for publishing, 2004 (Laven and Logue 2006); (2) The studies described the treatment groups; (3) The investigators used evaluation of digital dermatitis lesions as an measurement of treatment success, included prevalence of DD before and after treatment period, measured incidence of new DD lesions during the treatment period, and/or severity of DD lesions before and after the treatment period; and (4) Footbath solutions evaluated in the experiments contained a non-antibiotic disinfectant.

Findings and Discussion

In their 2006 review paper, Laven and Logue concluded that there was a lack of scientific evidence regarding the treatment and control of digital dermatitis with foot baths such that firm recommendations on what products and concentrations to use cannot be made. Our literature search identified seven research reports with multiple foot bathing regimens and clinical trials published since 2004 (Table 1.) Direct comparison of these foot bathing studies is difficult, because each study calculates statistical significance in comparison to

other treatment groups within that experiment, and not all used untreated or placebo treated control groups for comparison. Additionally, different end points or outcomes were reported, different levels of DD were present at the beginning of the study, and different regimens were used. Two compounds have more evidence about their effectiveness than others; copper sulfate and formaldehyde. The results of the clinical trials for each compound are discussed below.

Copper sulfate

A 2002 clinical trial by Laven and Hunt was discussed in Laven and Logue's 2006 review article, and found that **2% copper sulfate** used daily for 7 days was as effective as 2 days of an erythromycin footbath at reducing DD lesion severity score. This study only included animals with existing lesions and the cow's feet were cleaned with a hose before walking through the footbath treatments.

Teixeira et al (2010) compared **10% copper sulfate** to a proprietary footbath solution, **Dragonhyde™**, which according to the manufacturer does not contain copper sulfate or formalin (http://www.t-hexx.com/eu_brochure_1109.pdf). Investigators found that the odds of curing DD and the incidence of new lesions were the same for 10% copper sulfate and Dragonhyde™. There was no negative control group (untreated or placebo treated) in this study. Non-lactating (far-off dry) cows were the treatment subjects. The number of animals starting the treatment with a DD lesion was relatively low; therefore the numbers may be insufficient to have confidence that there is no difference in the odds of cure and new lesions between these treatment groups.

In a trial by Bergsten (2006) published in conference proceedings, one side of a cow (one front and one hind foot) was subjected to a footbath containing **7% copper sulfate** twice daily for 56-113 days while the other side remained untreated. The feet that walked through the footbath were 10 times less likely to have DD at the end of the study period and 2.5 times more likely to experience improvement of existing DD lesions. In an abstract by the same author, a trial similar to the one above but using a **copper sulfate and paracetic acid solution** found no effect on digital dermatitis, but did find a reduction in heel horn erosion by half.

Speijers (2010) compared **5% copper sulfate** used twice daily for two days every week to an untreated control group and found that more treated cows had no DD or healing DD lesions compared to the control group. Almost 60% of the herd was affected by DD at the start of this study. In a second experiment published in the same paper, the authors compared **5% copper sulfate** used as above to **2% copper sulfate** used the same way. They found that the proportion of cows with no DD lesion at the beginning of the study that remained free of DD lesions was the same for these two concentrations, but a greater proportion of cows in the 5% copper sulfate group had no DD lesions by the end of the study. These authors also compared using **5% copper sulfate twice daily for two days in a row every two weeks** to **tapwater** or **saltwater (10% sodium chloride)** in alternating weeks with the same copper sulfate treatment. They concluded that there appears to be no advantage to using tap water or saltwater versus no treatment in alternating weeks.

Formalin

The 2002 clinical trial by Laven and Hunt found that **2.5% formalin** used as a footbath daily for seven days was as effective as two days of erythromycin footbath at reducing lesion severity score. This study only included animals with existing lesions and cows' feet were cleaned with a hose before walking through footbaths. Holzhauser et al. (2008) compared **4% formalin** footbath used twice in one day every week to the same solution used twice in one day every two weeks. They found that more cows infected with DD stayed infected in the every two week group compared to the weekly-treated group ($P < 0.05$).

Teixeira et al. (2010) compared **5% Formalin** to a proprietary footbath solution, **Dragonhyde™** (http://www.t-hexx.com/eu_brochure_1109.pdf). The odds of DD at the end of the treatment period were 1.36 times higher for the formalin-treated cows. The incidence of new lesions was the same for 5% Formalin and Dragonhyde™. There was no negative control group in this study. Non-lactating (far-off dry) cows were used as treatment subjects and the number of animals starting the treatment with a DD lesion was relatively low; therefore the numbers may be insufficient to have confidence that there was no difference in the odds of new lesions.

For cows treated with a **4% formalin** footbath once per day for three days every two weeks compared to an untreated control group over a period of five months, Randhawa et al. (2008) found no statistically significant reduction in the average number of digital skin lesions per animal, but there was a reduction in heel erosions and some claw horn lesions. The cows used in the study had a low prevalence of lesions at the start of the study (0.17 and 0.09 average number of lesions per animal in treatment and control groups, respectively) which may be responsible for the lack of significant effect.

Other chemicals

Holzhauser et al. (2008) treated cows with a footbath containing a product called **Feetcare, ICI**, described only as a 2% multi-compound solution. More cows in the treatment group acquired painful lesions ($P = 0.02$) and more infected cows stayed infected ($P < 0.05$), compared to a reference formalin-treated group. An outbreak (>30% of the group found with painful lesions) occurred in the treatment group.

Silva et al. (2005) evaluated a **1% sodium hypochlorite (bleach)** footbath used twice daily for 30 days after debridement of the DD lesions. The footbath solution was renewed after passage of 120 cows. About 73% (22/30) of animals recovered (lesions no longer inflamed or painful) after the treatment period. The proportion of cows that recovered was significantly greater compared to a group treated with systemically-administered oxytetracycline.

Speijers et al. (2010) investigated use of a **2% hypochlorite** footbath twice daily for two days of every week compared to untreated controls. More cows had early stage lesions in the control group than the hypochlorite group ($P < 0.05$). The number of cows in both the control and 2% hypochlorite groups with active DD lesions increased over the treatment period, whereas in another treatment group in the same study (using 5% copper sulfate) the number with active DD lesions decreased.

Three different footbath solutions were compared to untreated control sides (within cow comparisons) (Thomsen et al., 2008): **gluteraldehyde** (Vircoïd, 1.5%), a mix of **hydrogen peroxide and organic acids** (Kickstart 2, 1%), and a **quaternaly ammonium compound** (Hoofcare, DA 2%). There were no significant differences in the probability of cured legs between treatment and control sides (Mean difference in percentage cured after treatment: Vircoïd 10.8% lower cure, Kickstart2 6.1% lower, and Hoofcare DA 16.5% higher cure; $P = 0.14$) and no difference in the percentage of new infections between treatment and control sides (Mean difference in new infections: Vircoïd 0.5% higher new infections, Kickstart2 4% lower, Hoofcare DA 3.5% higher; $P = 0.17$). Although there is no statistical significance, the Hoofcare DA appeared to perform better than the other two compounds when evaluating cure and may have some biological significance.

Bergsten et al (2006) compared a **peracetic acid and hydrogen peroxide foam** (Kovex) that the cows passed through twice daily for at least 56 days to untreated controls. They found no effect of treatment on DD lesions. In the 2002 clinical trial by Laven and Hunt, described in Laven and Logue (2006), **1% peracetic acid** footbath used daily for seven days trended to be less effective than two days of erythromycin treatment ($P = 0.07$).

In a Dutch study, Holzhauser et al. (2008) evaluated the use of a **3% sodium carbonate** (soda ash) solution twice per day, one day per week. An outbreak of more than 30% of animals affected by DD occurred in their treatment group, indicating that the treatment was not effective in prevention of new cases.

Conclusions

Based on this selection of research reports, copper sulfate footbaths in concentrations 5% and above have been shown to reduce new DD lesions and decrease existing DD lesions compared to untreated controls. Copper sulfate footbaths in concentrations 2% and above have been shown to be equivalent in preventing new infections in cows that are already unaffected. Formalin footbaths appear to have efficacy in comparison to other treatments but this has not been clearly demonstrated against negative controls. None of the other chemicals were shown to be effective against untreated controls, and statistical power was inadequate in experiments that showed no difference between treatment groups.

Due to environmental and workplace hazard concerns with copper sulfate and formalin footbaths, there is a need for additional research to find alternatives. Chemicals that have been suggested but for which clinical trials are lacking include zinc sulfate and various proprietary products. In addition, more studies are needed comparing frequency of use of the compounds. Clinical trials for footbaths should be designed with negative controls in addition to treatment comparisons and have adequate statistical power to demonstrate efficacy (or not) of footbath chemical alternatives. The degree of effect and what various factors influence efficacy should be evaluated in footbath studies so that dairy managers and consultants can make the best, cost-effective decisions for different footbath regimens.

References

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Table 1. Summary of experiments from 7 reports on footbaths for the treatment/control of Hairy Heel Warts (digital dermatitis-DD) in dairy cattle

	Ref. #	Chemicals compared	Frequency	Study length	Footbath size	Findings
A	2	10% CuSO ₄ vs. 5% Dragonhyde™	2x/week	4 weeks	1mx1.5mx0.1m	No difference in odds of curing DD lesions or odds of developing new DD lesion
B	4	7% CuSO ₄ vs. no treatment	2x/d	56-113 days	Hoof mat	7% CuSO ₄ group had 10x reduction in odds of DD at the foot level
C	4	CuSO ₄ and paracetic acid solution (DeLaval)	2x/d	4 months	Hoof mat	No effect on DD
D	9	5% CuSO ₄ vs. no treatment	2x/d for 2d/week	5 weeks	207cm x 79cm x 22cm	More cows had no or healing DD lesions compared to the no treatment group (p <0.05). % of feet with DD 21% and 70% at end of trial.
E	9	5% CuSO ₄ vs. 2% CuSO ₄	2x/d for 2d/week	8 weeks	207cm x 79cm x 22cm	more cows had no DD than the 2% group (p<0.05), but there was no difference in the % with no lesions that remained absent
F	9	5% CuSO ₄ vs. 2% CuSO ₄	2x/d for 2d/2weeks	8 weeks	207cm x 79cm x 22cm	No difference in proportion of cows with DD lesions remaining absent. More cows had no DD and fewer cows had early and chronic stage DD in the 5% group. Overall DD prevalence at the end of the study was similar for both.
G	2	5% Formalin vs. 5% Dragonhyde™	2x/week	4 weeks	1mx1.5mx0.1m	Odds of DD was 1.36 times higher for formalin than Dragonhyde™ (p=0.04). Odds of developing new DD lesion same*.
H	7	4% Formalin weekly vs. 4% Formalin biweekly	2x/d/1 week or 2x/d/2week	6 months	9.8'x2.6'x6"	More cows that were infected with DD stayed infected in the every biweekly group compared to the weekly group (p<0.05)
I	8	4% Formalin vs. no treatment	1x/d for 3d/2wk	5 months	3m x 1m x 15cm	No difference between treatment and control groups for DD (p>0.05)*
J	3	Gluteraldehyde (Vircoïd, 1.5%) vs. no treatment	2x/Day twice per week	8 weeks	20cm depth, 230cm length	No difference in percentage cured (P = 0.13) and no difference in percentage new infections (P = 0.88)
K	3	Organic acids (Kickstart 2, 1%) vs. no treatment	2x/Day twice per week	8 weeks	20cm depth, 230cm length	No difference in percentage cured (P = 0.88) and no difference in percentage new infections (P = 0.13)
L	3	Quaternary ammonium compound (Hoofcare DA, 2%) vs. no treatment	2x/Day twice per week	8 weeks	20cm depth, 230cm length	No difference in percentage cured (P = 0.13) and no difference in percentage new infections (P = 0.63)
M	7	3% sodium carbonate vs. 4% Formalin	2x/day/week	6 months	9.8'x2.6'x6"	Less cured lesions and more new lesions. An outbreak of >30% affected occurred in the sodium carbonate group
N	7	2% multi-compound solution (Feetcare, ICI) vs. 4% formalin	2x/day/week	6 months	9.8'x2.6'x6"	More cows acquired painful lesions (p=0.02) and more cows that were infected stayed infected (p<0.05), compared to reference formalin group. An outbreak (>30% of group with painful lesions) occurred.
O	4	Peracetic acid and hydrogen peroxide vs. no treatment	2x/day	56-113 days	Walk through foam	No effect of treatment
P	6	1% sodium hypochlorite vs. systemic oxytetracycline	2x/day	30 days	Not reported	73% recovered, significantly greater than group treated with systemic therapy alone.
Q	9	2% sodium hypochlorite vs. no treatment	2x/d for 2d/week	5 weeks	207cm x 79cm x 22cm	Less cows had early stage lesions (p <0.05) in treatment group. No other differences in DD level.
R	9	10% sodium chloride vs. water vs. no treatment (all alternating weeks with 5% CuSO ₄)	2x/d for 2d/2week	10 weeks	207cm x 79cm x 22cm	No significant differences between groups for DD lesions remaining absent. Some differences in proportions of lesions, but authors concluded no advantage to using saltwater or water in intervening weeks with 5% CuSO ₄ .

The most recent review paper¹ on footbaths for the control of digital dermatitis (DD) was written in 2004. The authors concluded that there was little scientific evidence for footbath recommendations. Clinical trials on footbathing for DD control published since 2004 are summarized in the above table.

Copper sulfate (CuSO₄)

- Copper sulfate at concentrations greater than 5% are effective at reducing DD lesions^{9,5}
- Copper sulfate at concentrations greater than 2% are equivalent at preventing DD lesions⁹

Formalin

- Studies on Formalin treating and preventing DD are inconclusive, but higher recovery from DD with more frequent versus less frequent formalin footbathing shows it likely has effect (H). Absence of effect in other studies may have been due to low numbers of cows.

Other chemicals

- **No alternative chemicals have been shown to be effective in comparison to no-treatment under typical farm conditions**
- One study showed an effect of **sodium hypochlorite** (P) compared to systemic treatment but in this study all DD lesions were debrided prior to the treatment period. The footbath solution was used 2 times per day and changed after every 120 cow passes.
- The trials of **Dragonhyde™** (A,G) as an alternative treatment did not compare it to an untreated group and had insufficient numbers of cows with pre-existing DD to determine that there was no difference in rates of DD cure.
- Alternative chemicals that have been suggested previously like **zinc sulfate and acidified copper sulfate have not been adequately evaluated in clinical trials**. One experiment looking at an acid/copper sulfate product (C) used a hoof mat instead of a footbath. Additionally, it was only published as an abstract and did not describe the concentrations of these chemicals.

Experiments marked with a * in Table 1. had statistical power < 0.8, which means that their sample size is too low to be confident that there is truly no difference between the treatment groups – in other words, the sample size may have been too small to detect a difference if one did exist.

Online databases and search engines were used to identify published research on footbathing for digital dermatitis treatment and/or control. Clinical trials published after 2004 and using evaluation of DD lesions as a treatment outcome were included.