

Footbaths: Solution to a Problem or a Problematic Solution?

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Disinfecting feet to help prevent infectious claw lesions, such as digital dermatitis (D), interdigital dermatitis (I) and heel horn erosion (E), can be improved through the use of a footbath. The footbath may still be considered a crude and unsophisticated tool given there's a minimal amount of research that exists to establish the optimum solution and management practices for greatest efficacy. However, it is the best solution that we have available at this time. The goals of footbathing should include: 1) prevent infectious claw lesions, such as D, I and E, 2) not compromise skin integrity, 3) not harm cattle or people, and 3) be reasonably priced, while doing no harm to equipment, structures during storage, during use and after disposal.

Digital Dermatitis Basics

Digital dermatitis results from a primary breakdown in the innate immune system. The infection begins with compromised skin integrity, which allows an opportunity for bacteria to enter the skin and begin to colonize. To flourish, the affecting bacteria require a low-oxygen environment often resulting from manure accumulation on the skin and claw of the foot. Research at the University of Wisconsin showed that placing bacteria that cause digital dermatitis on healthy skin did not result in development of digital dermatitis lesions.

Digital dermatitis is often classified using a 5-point M-stage scoring system (M0 – Normal healthy claw; M1 – Early subclinical, small lesions < 0.75”; M2 – Painful acute ulcer, red active lesion > 0.75”; M3 – Healing lesion, firm and scab-like; M4 – Chronic lesion, hyperkeratotic or proliferative “hairy warts”; M4.1 – Chronic lesion with new active M1 lesions on the surface).

When To Use A Footbath

The primary goal of a sound foot bathing program is to aid in prevention of the initial infection, while helping reduce development of M1's into more active and painful M2 stage lesions. Footbaths are ineffective at treating M2 stage lesions (raw, red painful lesions) which means M2 lesions must be treated topically with an antibacterial. However, footbaths may be effective at inhibiting the transformation of chronic M4.1 stage lesions back into raw, red M2 stage lesions.

Unfortunately, poorly managed footbaths may increase foot health problems and the incidence of infectious claw lesions. Common reasons for footbath failure or contribution to increased disease development include: poor design (length, depth, width, flooring), weak chemical solutions, inconsistent use, areas of manure/urine accumulation after the footbath, chemical solution pH is too low, side stepping the bath, and others.

Footbath Design Matters

What is the correct footbath size? Research conducted by Dr. Nigel Cook et al., at the University of Wisconsin School of Veterinary Medicine showed that cows will achieve at least two dunks in the treatment solution per rear foot per pass when the footbath length is 10 feet to 12 feet (or greater). These researchers also reported improvement in steps per bath when the in-step and exit curb heights were at least 10 inches. The higher in-step curb height forces cows to step up and over into the bath while the higher exit step curb height prevents cows from striding through the bath. In comparison, cows moving through a typical 6 foot bath usually achieve only 1 to 1.5 dunks per rear foot in the treatment solution.

Most dairies desire to have a single-pass footbath while minimizing their investment in treatment solution. One way to achieve this goal is through the use of a 12 foot long by 1.5 foot wide footbath width at the base (note: 36 inch width at hip height) as this will achieve nearly twice the number of dunks per foot vs. the conventional 6 foot by 3 foot bath. However, when designing and placing a longer bath, it is critical to ensure the bath is located on a level surface. For example, a 10 foot bath located on a 4% slope will be 4.8 inches lower in elevation from one end to the other (possibly more than the depth of the bath). For larger dairies, with rapid exit parlors, it is often necessary to design wider baths to allow multiple animals to pass at one time through the treatment solution. We have seen baths up to 12 feet wide work quite well, as long as a length of 10 feet to 12 feet is maintained. The footbath should also have solid sides (36 inches to 54 inches high or more) with absolutely no place for a cow to put her foot other than in the bath. Other important footbath features to improve performance consistency include: 1) a large drain (4 inches) on one end built into the floor of the bath, 2) 2 inch or larger water supply line or hose located on the upper end of the bath to flush and fill quickly, 3) no low spots in the concrete or areas allowing for manure, urine or foul water accumulation upon exit from the footbath, 3) build and locate the footbath to account for inclement weather by adding floor heat under the bath, infrared heat over the area, warm storage area for chemicals such as formaldehyde and any other premixes that need protection from freezing. The use of auto baths can work well too. Another option is to use a large electric pump to turbo blast out the bath (note: this does require a sloped curb on the exit). Other necessary features to improve footbath efficacy include: a smooth floor in the bath that does not cause trauma to the claws (epoxy or rubber) and ensuring that cows are permitted to bypass the bath when it is not in use. Also be sure there are no reasons why the footbath could not be used 365 days per year (if necessary).

Hygiene and Footbath Frequency Considerations

Foot wash systems are often used to clean off the feet and there are many different forms available. One advantage of cleaning off the feet and claws using this method is that it exposes the skin to oxygen, which may in turn help reduce the frequency of foot bathing required per week. However, using a washer system is not without its challenges. For example, it increases the amount of waste water created, thus increasing manure volume and handling costs.

Factors affecting footbath efficacy in controlling infectious claw lesions include:

- Number of times used per week
- Cow passes per bath
- Cow hygiene

- Claw contact time with treatment solution (time the feet are in the bath, time on feet before the claws get diluted with other “stuff”)

Frequency of footbath use per week should be determined by hygiene of the feet and legs of the cow. Cow hygiene scores are as follows:



1. Clean: little or no manure contamination on the lower limb
2. Slightly dirty: the lower limb lightly splashed with manure
3. Moderately dirty: there are distinct plaques of manure on the foot, progressing up the limb
4. Very dirty: confluent plaques of caked-on manure on the foot and higher up the lower limb

There is a very strong relationship between leg hygiene score and infectious claw disease. The chart below compares cow hygiene scores to suggested frequency of footbath use:

Proportion of cows with hygiene scores of 3 and 4	Suggested footbath frequency **
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<25 %	As required
25-50 %	2 days/week
51-75 %	5 days/week
>75 %	7 days/week

** Footbath frequency guidelines serve only as an initial recommendation given that control of infectious claw lesions is influenced by many factors.

Other Considerations

Selecting an effective footbath chemical can be a daunting task. Chemical concentration is one of the greatest issues of concern in footbath management. But first, when determining footbath concentration it is important to determine how full is full for the bath? If the goal is a minimum of 4.5 inches of solution depth, employees must be able to easily assess solution depth to determine the need for additional solution or complete replacement. However, when baths vary from 3 to 10 (or more) inches in depth, it is imperative that a quick and easy system to measure solution depth be provided, as manure and urine can quickly dilute chemical treatments while solution is splashed from the bath. There are a number of systems used to aid with this concern: mount a 4.5 inch length of 2x4 by the curb, mount a 4.5 inch stainless steel marker on the side of the bath, or our favorite option which is using a 4.5 inch length of small PVC pipe mounted to the side of the bath. As the

frequency of more concentrated products increases, such as footbath acidifiers, monitoring of footbath depth will become a greater issue.

A second system that helps to get and keep footbath chemical concentrations accurate is to use a premixing system. These systems do not need to be complex, as an old bulk tank or plastic barrel with an agitator and a transfer pump are all that is needed. These systems can improve accuracy of mixing, allow for mixing of greater solution volume, reducing labor needed to prepare footbath solutions and in addition, may improve worker safety too. During use, these systems often save considerable time in refilling the bath and/or allow for greater use of automated filling systems too.

One of the greatest concerns of dairy producers is determining what footbath solution will be most efficacious in their operation. Key points of consideration are economics, effectiveness, and environmental impact. Water composition can affect how much chemical is needed as mineral contaminants and pH affect chemical solubility and efficacy. Water is the primary solution within the bath and thus should not be ignored as it often varies by location and possibly by season. One of the most common solutions utilized in footbaths is a 2% to 3% formalin solution. However, as with many chemical solutions, more is not better. Formalin solutions tend to be the least expensive products used for control of digital dermatitis and other common infectious claw lesions. Fortunately, bacteria are not able to develop resistance against formalin mixtures. Advantages to using formalin solutions include that it mixes well (soluble) in water and is highly researched and proven to reduce incidence and severity of claw lesions. Fortunately, when diluted by manure, urine and waste water, formalin solutions will become inactive as they are converted to CO₂ and H₂O and do not create an environmental hazard. However, formaldehyde has some disadvantages too. It is a suspected carcinogen, while the International Agency for Research on Cancer has concluded that there is limited evidence for the carcinogenicity of formaldehyde in human beings (IPCS INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY, Health and Safety Guide No. 57). All formalin solutions should be handled with protective clothing, gloves and goggles or a face shield to protect exposed skin. Formaldehyde is not effective below 45° F and should be protected from freezing while in storage or prior to use. It is not suitable for application to open wounds, such as an active M2 digital dermatitis lesion. It is relatively easy to create formaldehyde burns with high concentrations harming skin, cow's feet and teats as this chemical replaces the water in living cells with a gel-like matrix.

Copper sulfate at a 3% to 5% concentration is an effective antibacterial and hardening agent. Copper sulfate is relatively inexpensive but more costly than formalin. While copper sulfate will go into suspension somewhat easily in water, dilution can be improved through acidification and use of warmer water. Acidifiers (such as inorganic and organic acids) tend to improve copper ionization and may allow for less (up to 50%) copper sulfate needed to achieve effective digital dermatitis control. However, lower footbath solution pH is better only to a point. Normal pH of the bovine skin is around 3.6. When there are issues with foot rot and proliferative DD lesions, footbath solution pH should not be below 3.0. We have observed multiple herds with increased frequency of foot rot and development of proliferative digital dermatitis lesions (out of control infections) when footbath pH solution was below 3.0 due to use of acidification products. Research conducted by Dr. Dorte Dopfer and associates at the University of Wisconsin School of Veterinary Medicine documented the negative effects of excessively low footbath pH. To evaluate the effects of footbath solutions on digital dermatitis control, we need to start recording not only the number of cows with digital dermatitis lesions but also the state of lesion chronicity (hyperkeratotic or proliferative) as cows with

proliferative lesions are chronically infected with very contagious M2 and/or M4.1 lesions. Fortunately, if the footbath is working properly we should be able to find signs of the digital dermatitis lesion healing. During trimming events or in the parlor, look for loose flaps on the digital dermatitis lesions reflecting healing. These flaps are layers of loose healing skin sluffing from the wart surface as it progresses through the healing process. Lastly, disposal of copper sulfate solutions is an environmental concern and may negatively affect performance of manure composting and energy creating systems.

Zinc sulfate at a 10% to 20% solution can work nearly as well as copper sulfate while at 75% of the cost of copper sulfate. However, zinc products do not readily go into solution but acid (lower pH) and hot water helps. One advantage to using zinc in footbaths is that it is required by corn well above what we would put out on the soil thus reducing environmental concerns when compared to copper sulfate. Copper has also been documented to reduce corn yield as it increases in soil concentration. Controlled research in control of digital dermatitis is however lacking with zinc sulfate.

Soap and water should also be considered in most footbath management regimes. A soap and water solution should be part of a normal footbath rotation schedule. Herds that have significant accumulation of mud or manure on the claws benefit by using a 1% solution (1 quart of soap per 25 gallons of water) on a routine basis.

There are many factors affecting the frequency of changing a footbath solution:

- Manure/organic matter load
- Size of bath (length, width, depth)
- Water conditions, including temperature (mineral contaminants, pH)
- Solution pH
- Chemicals used
- Chemical concentration used
- Many others...

Recently a test was developed by Zinpro Corporation and the University of Wisconsin School of Veterinary Medicine to help answer the question of footbath chemical efficacy in control of growth of aerobic and anaerobic bacteria (those responsible for development of digital dermatitis). The process requires repeated sampling of the footbath for aerobic and anaerobic bacterial load as the number of cow passes increases. In general, when the aerobic bacteria counts reach above 100,000 cfu/mL, it is time change the footbath solution. The program shows when the bacterial counts increase in response to cow passes and thus when the solution is no longer effective. The goal is to achieve optimal control of infectious bacteria and thus claw lesions while at the same time achieving maximum utilization of the treatment solution. This test now allows us to accomplish both tasks. Field experience has demonstrated that in some cases producers have been able to cut footbath costs by 50% and just as importantly lower the amount of copper excretion on their land. For example, producers have gone from 7 lbs CuSO_4 /cow/year down to as low as 2.5 lbs /cow/year. This is significant given the major effects of copper on reducing crop yields. This should be of particular significance to some dairymen as there are certain parts of the USA that have naturally high soil copper concentrations.

Trimming records, pen walks or parlor evaluations are effective means of monitoring the results of any footbath program and especially for evaluation of changes to a footbath system and/or changing a footbath chemical. Records are essential in any effort to adequately evaluate if digital dermatitis remains under control and/or if a change worked or not. Often times it only takes 2 to 4 weeks before you're able to identify a difference in your trimming records. But beware that digital dermatitis is a long-term infection and true changes in digital dermatitis control must be evaluated over a period of 6 to 12 months in order to accurately assess digital dermatitis control. Do not accept research from any company showing results over a period of only 2 to 8 weeks.

Conclusion

Footbaths need more science to determine chemical choice, solution concentration, frequency of use and ultimately digital dermatitis control efficacy. Fortunately the base of solid scientific evidence is growing. A well-placed and managed footbath can prevent new digital dermatitis lesions and reoccurrence but we must treat M2's topically. Installation of a level 10 to 12 foot long bath with 10 inch curbs and splash guards on the sides will achieving more dunks of the rear feet and increase effectiveness with no more than a conventional 6 foot fiberglass bath.

As herdsmen, we must strive to keep our cows clean thus reducing the need for increased footbath use. Make sure your system is setup to be very user-friendly and repeatable to ensure it gets changed on a timely basis. Make the system safe for people, cows, and the environment. Testing your footbath solution is now possible and can either help increase efficiency or reduce costs along with reducing chemical contamination of the environment. Please use trim records or pen walks to decide if your change worked or not in controlling digital dermatitis or other common infectious claw lesions.

References available upon request.

Notes: