Copper Sulfate for Footbaths - Issues and Alternatives

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Summary

The control of digital dermatitis drives footbath use on U.S. dairy farms. Copper sulfate **($CuSO_4$)** and formalin are widely used as footbath disinfectants and show a positive effect in reducing lesions associated with digital dermatitis **(DD)**. Used copper sulfate solution has traditionally been mixed with manure slurry and disposed by land application. Once applied, copper **(Cu)** binds tightly to soil particles and accumulates, as crops withdraw very little copper. Because high copper may inhibit plant growth, regulators in some states have adopted limits on land application of copper. Dairy producers need to be aware that land application limits can be exceeded in time and should consider alternative strategies for DD control.

Introduction

Lameness is common on U.S. dairy farms, with a prevalence of 22% of cows affected (Cook, 2003; USDA, 2002). In the mid 1990's, it was estimated that 47% of herds experienced digital dermatitis (a.k.a. hairy heel warts, papillomatous digital dermatitis) and that 11.9% of the dairy cow population was affected with DD (USDA, 1997). More recent reports suggest that prevalence of digital dermatitis has increased (USDA, 2002).

The DD is associated with a mixed bacterial infection including *Treponema spp*, and application of antibacterials has resulted in rapid clinical improvement (Read and Walker, 1998). Dampness with maceration of the skin are predisposing factors for DD, and herd size, flooring type, access to pasture, purchasing replacement animals, and foot trimming management were associated with DD (Wells et al., 1999). Initial treatments of DD used antibiotics or disinfectants applied locally (under a bandage or sprayed on lesions directly) with success in relieving clinical signs (Moore et al., 2001; Hernandez and Shearer, 2000; Britt et al., 1996). However, lesions tended to reoccur in 60% of cases (Berry et al, 2004a). Control with vaccination has been attempted, but development of an effective vaccine for digital dermatitis remains elusive (Berry et al., 2004b).

Because DD tends to recur in spite of treatment, control is the management goal, rather than eradication. Whole herd post milking footbath application has become a favored control method.

Footbath Solutions

Footbaths can clean debris from feet and/or apply a disinfectant (or antibiotic) to the feet. In the U.S., footbaths are used largely in a preventive strategy and feature disinfectants. The most common disinfectants are formalin (2 to 5% concentration) and copper sulfate (5 to 10% concentration).

Formalin (2.5%) has been shown effective in DD control (Laven and Hunt, 2002). Formalin is an aqueous solution of formaldehyde and methanol.

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At the typical formaldehyde concentration of 37%, formalin is flammable. Formaldehyde has powerful disinfectant properties, and reacts with amino, carboxylic, and sulhydryl groups in proteins and enzymes, resulting in changes in conformation (Russell, 2003). Formaldehyde is a respiratory and contact irritant, and is considered a potential carcinogen. The main objection to formalin is the potential health hazard to farm workers, most of which is posed by the concentrated solution. Disposal of formalin presents no real environmental risk, and formaldehyde is said to be inactivated in air, water, and soil.

Copper sulfate has commonly been favored as a footbath disinfectant due to availability and ease of use, and it appears effective in reducing DD lesions (Bergsten et al, 2006; Laven and Hunt, 2002). Copper sulfate is bacterostatic by reaction of Cu++ with protein thiol groups in target organisms. Peracetic acid (1%) has also been shown to be effective in footbaths (Laven and Hunt, 2002).

A number of commercial products have become available for use as footbath disinfectants. Data on Double Action (WestAgro, Inc, Kansas City, MO) suggests it is effective in footbaths. Victory (WestfaliaSurge, Naperville, IL) and Hoof Pro Plus (SSI Corp, Julesburg, CO) were shown effective in direct topical application, and each of these has sister products for use in footbath solutions (Shearer and Hernandez, 2000; Britt et al., 1996). A myriad of other commercial products that are either non-Cu based or feature reduced copper concentrations are available. Testimonial or uncontrolled field trials suggest the possibility that they may be effective, but there is little peer-reviewed scientific evidence available (Laven and Logue, 2006). Producers contemplating use of these products must evaluate cost and perhaps perform a whole herd trial and forward their best estimate of effect.

Implications of Copper Sulfate Use

Typically, copper sulfate solution is considered effective for 150 to 300 cow passes. Used solution is mixed with manure waste and ultimately disposed by land application. Regulators in several states have expressed concern that soil copper could be increased to an unhealthy level by this practice and have established maximum (lifetime) loading rates of copper. An 8 ft x 2.5 ft x 5 inch foot footbath will contain approximately 62 gallons of water and 26 pounds of copper sulfate (charged at the 5% concentration). Since copper sulfate is 25% copper, each time the footbath is dumped, 6.5 pounds of copper is added to the disposal burden. The environmental effect of this copper depends on the volume of footbath solution disposed (a function of cow number and intensity of footbath use), concentration of copper sulfate, and the land area of application. Without careful attention, maximum soil copper loading rates may be exceeded by dairy producers in relatively short times (5 to 30 years). Plants require very little copper, so annual removal rates are less that 0.5 lb/acre for typical grain and forage crops. When copper sulfate is applied to soil, the copper has a high affinity for organic matter and accumulates in the upper soil layers (Stehouwer and Roth, 2004). In the period 1994 to 2004, the W.H. Miner Institute (Chazy, NY) estimates that approximately at 18% of the time, greater than 4 lb/acre of copper was applied to their agricultural land. A preliminarily report suggests that 4 lb/acre of copper supplementation may affect root development in certain grass plants under experimental conditions, though corn yields under similar circumstances were not affected (Flis et al, 2006a). A survey of Vermont dairy farms estimated that 1.4 lb/acre of copper was imported onto farm land in 2005, which was down from 2.1 lb/acre of copper in 2002 (Flis et al., 2006b). While this work is far from complete, it is clear that copper disposal from dairy farms can result in accumulation of soil copper in a short time, while soil copper will be naturally removed over several very long lifetimes.

Summary

Copper sulfate footbath use can radically change the copper disposal burden of a dairy farm. Producers must maximize foot health and should seek to decrease risk factors for infectious foot disease. Chief among these is improvement in environmental hygiene and exploring alternatives to footbath use in management of DD. When copper sulfate is used in footbath solutions, efforts to maximize effectiveness and minimize waste must be undertaken. Alternative products that feature reduced or no copper should be considered. Unfortunately, peer reviewed field trial data with most commercial footbath disinfectants is unavailable. Management consideration on the use and disposal of copper sulfate footbath solution requires immediate attention, as long-term high level use of copper sulfate footbaths, using conventional disposal, appears unsustainable.

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