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A clinical and histopathological comparison of the effectiveness of salicylic acid to a compound of inorganic acids for the treatment of digital dermatitis in cattle

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ABSTRACT

Bovine digital dermatitis (DD) is a painful infectious disease, causing lameness, reduced animal welfare, and production losses in dairy herds. The main factors contributing to DD are an infection with *Treponema* spp. and poor hygiene. Topical treatment has primarily consisted of antibiotics; however, the demand for effective nonantibiotic alternatives is increasing. The objective was to evaluate the performance of 3 nonantibiotic topical treatments (salicylic acid and a compound of inorganic acids in a 20% solution and in a dry form) on DD in a commercial dairy herd. Within the 30-d test period, 42 DD lesions on 33 Holstein cows were assigned to receive 1 of the 3 treatments. Lesions were biopsied before and after treatment and were clinically evaluated 5 times. Improved lesions were clinically defined as either healed (regeneration of the skin) or healing (dry lesions covered by a scab). Unhealed lesions were defined as either active [with a raw, moist, strawberry-like (granulating) surface] or mature (with a raised papillomatous appearance). The effectiveness of treatment was evaluated histopathologically using the following scores: 0 (no spirochetes present), 1 (small number of spirochetes present in the epidermis), 2 (moderate number of spirochetes present and reaching an intermediary level in the epidermis), and 3 (large number of spirochetes present and reaching the deepest part of the epidermis or the superficial dermis). The improvement rate was 10/14 (71%) for salicylic acid, 11/15 (73%) for the inorganic acid solution, and 8/13 (62%) for the inorganic acid powder. The analysis showed no difference among treatments. The association between clinical score and histopathological score was determined by an odds ratio. The odds ratio of a healed lesion having spirochetes in the epidermis was 0.58 and that of an active DD lesion having spirochetes in the epidermis was 26.5.
Key words: digital dermatitis, clinical score, histopathology, nonantibiotic treatment

INTRODUCTION

Bovine digital dermatitis (**DD**) has become a major problem in countries with intensive dairy industries (Laven and Logue, 2006; Capion et al., 2008). Digital dermatitis is an infectious disease causing pain and lameness, which results in significantly reduced animal welfare and leads to production losses in dairy herds (Bruijnis et al., 2010; Ettema et al., 2010). The exact pathogenesis of DD is not fully understood, but the etiology is considered multifactorial. Spirochetes, especially *Treponema* spp., which are obligate anaerobic bacteria, are considered to be the predominant infectious agents (Read and Walker, 1998; Evans et al., 2008; Klitgaard et al., 2008) and have been shown to account for more than 90% of the bacteria found in DD lesions (Klitgaard et al., 2008). Spirochetes are only isolated in lesions and not in the adjacent healthy skin (Döpfer et al., 1997; Evans et al., 2009). Spirochetes can be visualized using different histopathological evaluation techniques, including silver staining (Demirkan et al., 1998; Cruz et al., 2001).

Treponema spp. are able to produce both ammonia and hydrogen sulfide (Chu et al., 2003). Ammonia is a skin irritant and even a short exposure can cause injury to the skin (Miller, 1981). Hydrogen sulfide can cause injury or death to epithelial cells (Beauchamp et al., 1984). The production of hydrogen sulfide is necessary for *Treponema* spp. to survive in oxygen-free atmospheres (Lai and Chu, 2008). In addition to infection with *Treponema* spp., poor hygiene is considered

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a main contributing factor to the development of DD (Holzhauer et al., 2006; Cramer et al., 2009; Relun et al., 2013). Cattle slurry has been found to have a pH of 8.4 (Mohaibes et al., 2011), and the pH of normal skin in cattle is 6.8 (Meyer and Neurand, 1991).

Antibiotic treatments have been found to be effective but the risk of antibiotic residues in milk and meat, as well as soil contamination, and concern regarding the development of antibiotic resistance have resulted in a growing interest in nonantibiotic treatment alternatives (Britt et al., 1999; Laven and Logue, 2006; Relun et al., 2012).

When evaluating the effectiveness of treatment and control strategies, several methods can be used, the most common of which is clinical evaluation of skin and lesions (Hernandez and Shearer, 2000; Higginson Cutler et al., 2013). However, the absence of pathogens in the deeper layer of epidermis is required for complete recovery, because clinical improvement or healing of the skin can sometimes be apparent even when bacteria are still present, resulting in a possible recurrence of the lesion within a short time (Döpfer et al., 2011; Gomez et al., 2012). Therefore, clinical and histopathological evaluation must be combined to evaluate the true effect of treatment.

Salicylic acid (**SA**), or 2-hydroxybenzoic acid, has been used for several decades in Denmark as a nonantibiotic topical treatment for DD lesions. It is a keratolytic, anti-inflammatory powder with bactericidal and antiseptic effects (Vane, 1971). A recent study has shown SA to be more effective in terms of healing and improvement of DD lesions than chlortetracycline spray (Schultz and Capion, 2013); however, it must be applied in a bandage, which is labor intensive, and effective nonantibiotic treatments that are easy to apply in a herd setting are therefore needed.

A nonantibiotic product that is a compound of inorganic acids (Agron, Alfafarm, Solrød Strand, Denmark) has been used for the treatment and prevention of DD in Danish dairy herds. The effectiveness of the product has not previously been clinically tested. The compound has a pH of 2.5 in a 20% solution and contains sulfates that form ammonium sulfate in reaction with ammonium, iron that forms iron sulfide in reaction with hydrogen sulfide, as well as astringents and coagulants. The product is not considered a disinfectant because its main action is to lower the pH on the skin; the effect is probably not impaired by manure and lesions do not need to be cleaned for effect. The product is said to have a drying effect and can promote scab formation (Alfafarm; http://www.alfafarm.com/).

The objective of this study was to perform a clinical and histopathological evaluation of the effectiveness of DD treatments using salicylic acid, a solution of the inorganic acids compound, and the same product in a dry powder, and to assess the correlation between the clinical stage of DD and a histopathological evaluation of the presence of spirochetes.

MATERIALS AND METHODS

Cows were randomly allocated to 3 treatment groups, and the effectiveness of the treatment was evaluated over a 30-d period. All procedures were carried out in agreement with the Danish Council for Animal Experimentation (Fødevarestyrelsen, Glostrup, Denmark).

Study Population

The study population consisted of 34 lactating Danish Holstein cows from a commercial dairy herd of 120 cows in Denmark. The population included 15 first-lactation cows, 13 second-lactation cows, 3 third-lactation cows, and 3 fourth-lactation cows. The farm had mattresses in the cubicles and a concrete slatted floor. The cows were milked twice a day in a herringbone milking parlor. The farm did not use footbaths or any other control measures for DD, and claw lesions were managed by the professional claw trimmer over 4 annual visits.

Clinical Scoring of DD

Lesions were scored clinically on observation days 0, 6, 15, 24, and 30. Lesions scored as active (acute and chronic) were round or oval; level with the surface of the skin or concave; raw, moist, red to gray; and had granular to strawberry-like surfaces (Hernandez and Shearer, 2000; Higginson Cutler et al., 2013). Mature lesions (chronic) were raised above the level of the normal skin and covered by filiform papillae (Hernandez and Shearer, 2000). Healing lesions were dry, covered by a scab, and displayed normal skin features (Higginson Cutler et al., 2013). If lesions had more than one clinical score; for example, a small part covered by a scab and another part with an active or mature lesion, the lesions were scored according to the active or mature lesion.

On observation days 6, 15, 20, 24, and 30, skin changes were scored for pain by palpation. Assessment was performed by the first author on cows standing or lying in cubicles according to the method previously described by Capion et al. (2012). In brief, the skin adjacent to the horn capsule and the interdigital cleft was inspected and palpated. The scores were as follows: 0 = skin looks normal, no pain or soreness, normal