

Clinical aspect and location of bovine digital dermatitis lesions in the north, southeast, and south of Brazil

Aspecto clínico e localização das lesões de dermatite digital bovina no norte, sudeste e sul do Brasil

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senting 342 claws, were evaluated. Among these, 59 BDD lesions were identified, corresponding to an infection rate of 17% of the claws and a prevalence of 34% of cows. BDD was present in all regions, with prevalence rates of 46.7% (PA), 44.4% (PR), and 14.4% (SP). The most observed anatomical site for lesions was the transition from glabrous to hairy skin between the heels. The BDD lesions were classified according to the M system (MSI), with the following distribution: M1 = 15.20%, M2 = 37.28%, M3 = 39.00%, M4 = 5.00%, and M4.1 = 3.40%. Direct palpation caused intense pain in cows with classic ulcerative lesions (M2) and those with chronic lesions featuring an acute lesion focus (M4.1). The prevalence of BDD observed in the different farms reflects similar findings from other studies in dairy cattle. No significant differences were observed in the clinical presentation, anatomical locations, or the origin of BDD lesions across the farms visited.

Keywords: Cattle. Claw disease. Clinical description. Prevalence.

Abstract

Bovine digital dermatitis (BDD) is a disease present in nearly the entire Brazilian territory; however, whether there are clinical differences between different regions in a continental country like Brazil remains unknown. The objective of this study was to observe the prevalence of BDD in five different herds from Paraná (PR), São Paulo (SP), and Pará (PA), as well as to investigate potential regional differences in the location and macroscopic clinical aspects of BDD lesions. Only the pelvic limbs were examined. A total of 171 cattle, repre-

Resumo

A dermatite digital bovina (DDB) é uma doença presente em quase todo o território brasileiro; no entanto, ainda não se sabe se existem diferenças clínicas entre diferentes regiões em um país continental como o Brasil. O objetivo deste estudo foi observar a prevalência da DDB em cinco rebanhos diferentes do Paraná (PR), São Paulo (SP) e Pará (PA), bem como investigar potenciais diferenças regionais na localização e nos aspectos clínicos macroscópicos das lesões de DDB. Apenas os membros pélvicos foram examinados. Um total de 171

bovinos, representando 342 unhas, foram avaliados. Entre estes, 59 lesões de DDB foram identificadas, correspondendo a uma taxa de infecção de 17% das unhas e uma prevalência de 34% das vacas. A DDB estava presente em todas as regiões, com taxas de prevalência de 46,7% (PA), 44,4% (PR) e 14,4% (SP). O local anatômico mais observado para as lesões foi a transição da pele glabra para a pele pilosa entre os calcanhares. As lesões de DDB foram classificadas de acordo com o sistema M (MSI), com a seguinte distribuição: M1 = 15,20%, M2 = 37,28%, M3 = 39,00%, M4 = 5,00% e M4.1 = 3,40%. A palpação direta causou dor intensa em vacas com lesões ulcerativas clássicas (M2) e naquelas com lesões crônicas com foco agudo (M4.1). A prevalência de DDB observada nas diferentes fazendas reflete achados semelhantes de outros estudos em gado leiteiro. Não foram observadas diferenças significativas na apresentação clínica, localização anatômica ou origem das lesões de DDB entre as fazendas visitadas.

Palavras-chave: Bovinos. Doença da unha. Descrição clínica. Prevalência.

Introduction

Bovine digital dermatitis (BDD) has been reported in several Brazilian states, including Rio Grande do Sul - RS (Cruz et al., 2001), São Paulo - SP (Marega, 2001), Mato Grosso do Sul - MS (Ferreira et al., 2002), Goiás - GO (Silva et al., 2001; Castro et al., 2008), Maranhão - MA (Machado et al., 2008), Minas Gerais - MG (Souza et al., 2007; Tomasella et al., 2014), Paraná - PR (Nascimento et al., 2015), Bahia - BA (Serra et al., 2017), Mato Grosso - MT (Rondelli et al., 2017), and Pará - PA (Silveira et al., 2018). Due to its unique politreponemal microbiological nature, BDD often requires laboratory confirmation (Nascimento et al., 2015), so clinical identifications still prevail, but clinical diagnosis remains common. The nomenclature for BDD was standardized in Brazil in 2017 (Borges et al., 2017), while the M system (MSI) is widely used internationally (Döpfer et al., 1997).

BDD lesions are characterized by varying levels of pain, erosive and proliferative tissue, and a characteristic odor. In severe cases, the lesions can take a verrucous form with hyperkeratotic projections, sometimes filling the space between the heels and

accessory claws (Choi et al., 1997; Cruz et al., 2001; Rasmussen et al., 2012). Environmental factors, such as prolonged exposure to moisture, cement floors, and high-concentrate diets, increase the likelihood of BDD development (Read and Walker, 1996). Studies also suggest that delayed hoof trimming (> 7 months) increases the risk of BDD (Somers et al., 2005).

Moreira et al. (2019) identified various risk factors for lameness and hoof lesions in grazing cattle, including husbandry practices, facility maintenance, and human-animal interactions, emphasizing its multifactorial nature. Additionally, they confirmed that poor hygiene and extended time in corrals increase the risk of both lameness and BDD. Moreira et al. (2018) further suggested that *Treponema* is the primary pathogen responsible for BDD, with *Dichellobacter nodosus* as a potential secondary pathogen. Various *Treponema* species are involved, and asymptomatic animals may act as reservoirs (Nascimento et al., 2015). Some studies propose that bacteria enter a cystic stage as a defense mechanism until the initial aggression stops (Döpfer et al., 2012; Biemans et al., 2018). Chronic M4 lesions, which are typically painless, may play a key role in maintaining the infection in the herd (Biemans et al., 2018). Recent research also suggests that certain bacterial taxa in the foot skin microbiota are associated with BDD development (Bay et al., 2023). Given Brazil's diverse climates and biomes, it is unclear whether BDD lesions maintain consistent clinical characteristics across different cattle-raising conditions.

The objective of this study was to observe the prevalence of BDD in five different herds from PR, SP, and PA, as well as to investigate potential regional differences in the location and macroscopic clinical aspects of BDD lesions.

Material and methods

The project was approved by the Animal Use Ethics Committee, registration No. 0972. The study was conducted in three Brazilian states (PR, SP, PA), with visits to dairy and beef cattle herds as part of the clinical routines at university hospitals of the Federal University of Pará (UFPA), University of São Paulo (USP), and Pontifical Catholic University of Paraná (PUCPR) and routine claw disease monitoring.

Farms without proper cattle handling facilities or those not free from brucellosis and tuberculosis were excluded.

Screening was performed through remote observation of BDD lesions or visual screening during milking, followed by manual or mechanical restraint using an electric immobilizer (Imoboi®) or hoof trimmer chute. Only the claws of the pelvic limbs were examined. The diagnosis was confirmed through visual clinical examination after washing the claw. Cattle in PA and SP were evaluated in the summer, while those in PR were evaluated during spring and summer.

The climate characteristics of the study locations varied significantly. In PA, located at 04°46'34" S, the climate is classified as AW (tropical), with an annual precipitation of 1,806 mm and an average temperature of 26.3 °C. PR, situated at 25°39'27"S, has a Cfb (temperate oceanic) climate, experiencing an annual precipitation of 1,283 mm and an average temperature of 16.7 °C. SP, positioned at 21° 59'46"S, is characterized by a Cwa (humid subtropical with dry winter) climate, receiving 1,238 mm of rainfall annually and maintaining an average temperature of 20.6°C (Köppen and Geiger, 1928).

BDD lesions were anatomically located according to Leão (2006) (Figure 1) and classified as per Döpfer et al. (1997): M0 = no lesion; M1 = circumscribed granulomatous area, small and non-painful; M2 = classic ulcerative, > 2 cm, painful; M3 = scab formation; M4 = hyperkeratosis, proliferative but not painful; M4.1 = chronic lesion with painful M1 focus. Sensitivity to palpation was classified as mild (retraction without kicking), moderate (kicking), or severe (repeated kicking).

All cows with DD were treated according to the veterinarian's recommendations. The cattle from PA were not included in the statistical analysis because they were not mechanically restrained. Some were visibly inspected during milking or were restrained with ropes and gently laid on the ground. In PR and SP, all cattle were evaluated using the hoof trimmer chute.

Statistical analysis

To compare the frequency of different lesion degrees, anatomical locations, and pain levels, the D'Agostino and Pearson normality test was used,

followed by the Mann-Whitney test (Petrie and Watson, 2009). Fisher's exact test was applied to compare frequencies between left and right limbs. A 5% significance level was adopted. All tests were performed using Statgraphics Centurion® version XVI software.

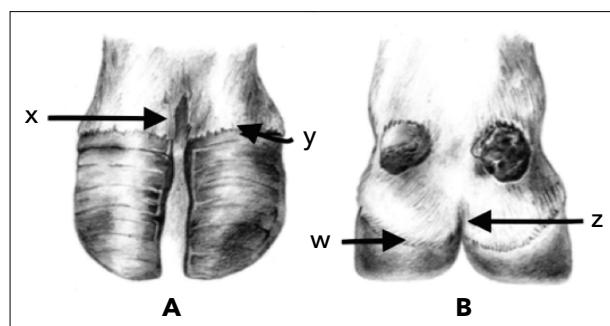


Figure 1 - Schematic representation of the dorsal (A) and palmar/plantar (B) aspects of the bovine digits. Regions X (dorsal interdigital space), W (border points between the skin and the coronary corium of the heels), Y (border points between the skin and the coronary corium of the abaxial wall of the corneal case), and Z (skin between the heels) are the areas where digital dermatitis lesions were diagnosed (According to Leão, 2006).

Results

A total of 342 hooves from five farms were analyzed: one in PR, three in SP, and one in PA. Farm characteristics are provided in Table 1.

Table 2 details the distribution of lesion severity, affected limbs, anatomical location, and pain intensity based on the examination of pelvic limbs from Holstein and Zebu crossbred cows across the three states. Notably, no cases of BDD were observed in one herd in SP.

Overall, injuries in the evaluated pelvic limbs were more frequent on the right side (54.2%) compared to the left (45.8%). In PA, 71.4 % of the lesions were on the right side and 28.6 % on the left. In PR, the right side accounted for 71.4% and the left for 28.6%. In PR overall, the distribution was 55% on the right and 45% on the left, while in SP, it was evenly split at 50% for each side. Non of this differences were statistically significant.

Table 1 - Number of cattle evaluated, location and characteristics of the farms

Farm characteristics	Location (Brazilian states)		
	Pará	Paraná	São Paulo
Number of cattle evaluated	15	45	111
Number of properties	1	1	3
Management system	Extensive	Semi-confinement	Semi-confinement
Breeds	Zebu crossbreeds	Holstein	Holstein and Girolanda
Food	Tropical grassland	Total mixed ration	Total mixed ration

Table 2 - Representation of the degree of lesions, affected limb, anatomical location and degree of pain on palpation of 342 examinations of pelvic limbs of Holstein and Zebu crossbreed cows (n = 171) in three different Brazilian states: Pará (PA; n = 15), Paraná (PR; n = 45); São Paulo (SP; n = 111)

States	Les	LTC	HL	Lesion degree (%)					Anatomical location (%)				Pain degree (%)		
				M1	M2	M3	M4	M4.1	X	Y	W	Z	L	M	S
PA	7	46.7	23.3	0.0	100	0.0	0.0	0.0	14.3	14.3	28.6	42.9	0.0	0.0	100
PR	20	44.4	22.2	10.0	10.0	65.0	10.0	5.0	0.0	0.0	10.0	90.0	75.0	10.0	15.0
SP	32	14.4	14.4	21.9	40.6 ^b	31.2 ^b	3.1 ^b	3.1 ^b	0.0	10.0	3.1	86.9	53.1 ^a	3.1	43.8 ^a
Total	59	34.5	17.2	15.2	37.3	39.0	5.0	3.5	1.7	6.8	23.7	67.8	54.2	5.1	40.7

Note: Les = number (No.) of lesions; LTC = No. of lesions/total cows (%); HL = No. of hoof lesions/No. of total of hoofs (%). Lesion degree: M1 = circumscribed granulomatous area, small and non-painful; M2 = classic ulcerative, > 2 cm, painful; M3 = scab formation; M4 = hyperkeratosis, proliferative but not painful; M4.1 = chronic lesion with painful M1 focus. Anatomical location (According to Leão, 2006): X = dorsal interdigital space; Y = border points between the skin and the coronary corium of the abaxial wall of the corneal case; W = border points between the skin and the coronary corium of the heels; Z = skin between the heels) are the areas where digital dermatitis lesions were diagnosed. Pain degree on palpation: L = light; M = moderate; S = serious. Different letters in the same column mean $p \leq 0.05$.

Discussion

The prevalence values found in this study (46.7% in PA, 44.4% in PR, and 14.4% in SP) are notably higher than those reported in national studies: 29.9% in RS (Cruz et al., 2001), 7% in SP (Marega, 2001), 25% in MS (Ferreira et al., 2002), 24.4% in GO (Silva et al., 2001; Castro et al., 2008), 8.7% in MA (Machado et al., 2008), 30.3% in MG (Souza et al., 2007; Tomasella, 2014), 7.5% in PR (Souza et al., 2015), and 0.9% in PA (Silveira et al., 2018). This variation may be attributed to the screening system used in the current study.

International studies report similar prevalence rates: 21.2% (Biemans et al., 2018) and 49.7-78.0% (Holzhauer et al., 2012) in the Netherlands, 37% (Smith et al., 2014) and 30% (Krull et al., 2016) in the United States, 15% in Canada (Solano et al., 2016), and 33% in Denmark (Oliveira et al., 2017).

In contradiction, studies more recent noted a rise in BDD prevalence from 5.3% to 20.7% at the cow level between 2002 and 2021 (Jury et al., 2024), while Fürmann et al. (2024) reported a 5.4% prevalence for BDD M2. Additionally, Mcpherson et al. (2024) detected lesions in 1,817 (11.5%) of 15,813 cows across 68 of 71 herds (95.8%). The median herd-level apparent and true prevalences of BDD were 8.5% and 18.1%, respectively, with considerable variation between farms.

The high prevalence of BDD indicates it is endemic and widespread globally. Only the pelvic limbs were assessed, as these are most affected (Graça, 2006). No significant differences were found in anatomical locations or affected limbs, suggesting that BDD lesions follow a consistent distribution, despite regional variations in breed, environment, and management practices.

Climatic conditions must be considered when evaluating livestock health. Silva et al. (2018) reported that BDD prevalence in Central Brazil peaks during the dry season (May to October), correlating with periods of lower annual rainfall. This trend was also observed in nutritional and metabolic diseases, while other infectious diseases were more prevalent during the rainy season. To improve BDD management, they recommend enhanced cattle management during the dry season, particularly in regions with seasonal rainfall patterns.

Climate factors, such as rainfall and soil temperature, may also influence BDD prevalence in pasture-based systems. Yang et al. (2019) observed that BDD prevalence is lower during the late lactation and dry period, likely due to climatic differences. A model used in New Zealand (Yang et al. 2019) highlighted the significant impact of climate on BDD prevalence, suggesting that future climate changes (e.g., wetter winters and drier summers) could reduce the model's predictive accuracy.

The most severe pain was observed in field assessments, although the difference was not statistically significant ($p = 0.165$). In PR and SP, lesions were occasionally accompanied by hair and featured irregular circular areas ranging from 1 to 4 centimeters in diameter with visible granulation tissue. These characteristics align with findings from Sullivan et al. (2013) and Nicoletti (2004), who described lesions with a white epithelial border, a reddish center, and white keratinized papillae, giving them a "strawberry-like" appearance.

The most observed lesion score in the field was M2, characterized by hyperemic erosive/ulcerative lesions, foul odor, and verrucous tissue growth. In Figure 2, images of BDD M2 lesions observed on farms in PR, SP, and PA are shown.



Figure 2 - From left to right, images of bovine digital dermatitis M2 lesions (classic ulcerative, > 2 cm, painful) observed on farms in Paraná, São Paulo and Pará.

A significant difference in lesion classification was noted between farms in PR and SP ($p = 0.007$), likely reflecting more acute cases in SP and chronic cases in PR, with many M3 cases in PR. Biemans et al. (2018) discussed the disease's progression in herds, noting the persistence of infectivity, especially through M4 cases. Krull et al. (2016) found that acute lesions typically develop over 133 days, with some cows remaining in the chronic stage for over 800 days.

The findings of this study provide valuable insights for the management of bovine health across different regions in Brazil. The high prevalence of BDD, especially in the PA and PR regions, underscores the importance of considering annual climatic variations and regional climate differences when defining prevalence rates and comparing locations. Understanding how seasonal changes and local climate factors influence the occurrence of BDD can guide the development of region-specific control strategies aimed at reducing both the incidence and severity of lesions. Proper management practices, such as maintaining clean and dry floors, using appropriate footwear, and controlling humidity in pens, should be emphasized as key preventive measures, tailored to the specific climate conditions of each region. Furthermore, continuous monitoring of cattle limb health, with a particular focus on the transitional areas between glabrous and hairy skin, is crucial for early identification of lesions. The classification of lesions according to the MSI can assist in assessing the severity of BDD and guide treatment decisions, highlighting the need for ongoing professional training to ensure accurate diagnosis. Implementing management practices that minimize pain and discomfort, such as controlling cow movement and reducing stressors, may also contribute to lowering the prevalence of BDD on farms. Continued regional studies, considering climatic factors and annual variations, are essential to better understand local variations in BDD occurrence and refine preventive and therapeutic approaches, ultimately promoting the well-being and productivity of dairy herds.

Conclusion

BDD lesions were present on all the farms studied. The prevalence of the disease was within the range observed in other national and international studies

on dairy cattle. No significant clinical, macroscopic, anatomical, or locational differences were observed in the lesions across the different herds in the visited Brazilian regions.

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