PESQUISA VETERINÁRIA BRASILEIRA
Brazilian Journal of Veterinary Research
ISSN 0100-736X (Print)
ISSN 1678-5150 (Online)

Pesq. Vet. Bras. 43:e07321, 2023
DOI: 10.1590/1678-5150-PVB-7321

Original Article
Livestock Diseases
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Dorsal thermal necrosis in a Brazilian sheep flock[1]

Telma S. Lima[2], Silvio M.C. Fonseca[2], Givaldo B. Silva Filho[2], João Paulo G. Silva[2], Mayra S.M. Tenório[3], Ricardo B. Lucena[4], Elizandra T. Melo[5] and Fábio S. Mendonça[5]*

ABSTRACT.- Lima T.S., Fonseca S.M.C., Silva Filho G.B., Silva J.P.G., Tenório M.S.M., Melo E.T., Lucena R.B. & Mendonça F.S. 2023. **Dorsal thermal necrosis in a Brazilian sheep flock.** *Pesquisa Veterinária Brasileira 43:e07321, 2023*. Laboratório de Diagnóstico Animal, Universidade Federal Rural de Pernambuco, Rua Dom Manoel de Medeiros s/n, Dois Irmãos, Recife, PE 52171-900, Brazil. E-mail: fabio.mendonca@ufrpe.br

Thermal burn injuries are very uncommon occurrences in small ruminants worldwide, and in Brazil, there are no descriptions of this condition. Herein we describe an outbreak of dorsal thermal necrosis in a flock of sheep in the municipality of Boca da Mata, in the Forest Zone of the State of Alagoas, Northeastern Brazil. Twelve ewes were separated from the flock for a general clinical examination and evaluation the serum levels of urea, creatinine, gamma-glutamyltransferase, and aspartate aminotransferase. In addition, biopsies of the skin and liver were performed on two severely affected sheep. The flock was raised in semi-intensively management in a pasture area without shading and receiving approximately eight hours of insolation daily and developed severe dermatitis that evolved to severe necrosis of the dorsal skin. Grossly, these lesions were only observed in the dorsal skin of black sheep, while sheep with white dorsal areas of skin were not affected. Microscopically, the epidermis and deep dermis of affected sheep showed diffuse coagulative necrosis, pigmentary incontinence, and parakeratotic hyperkeratosis. Dorsal thermal necrosis occurs only in the dorsal skin of black sheep in situations of excessive exposure to sunlight due to the accumulation of ultraviolet radiation. The distribution of the lesions, restricted to the dorsal area of the skin, is an important clinicopathological aspect in these cases that can help differentiate lesions caused by photosensitization, as they usually involve other anatomical sites. To the authors' knowledge, this is the first report of dorsal thermal necrosis in sheep in Brazil.

INDEX TERMS: Thermal necrosis, sheep, solar radiation, small ruminants, skin, dry gangrene, Brazilian northeastern.

RESUMO.- [**Necrose térmica dorsal em rebanho ovino brasileiro.**] Lesões por queimaduras térmicas são ocorrências muito incomuns em pequenos ruminantes no mundo e no Brasil não há registros da ocorrência desta condição. Descreve-se um surto de necrose térmica dorsal em um rebanho de ovinos no município de Boca da Mata, Zona da Mata do Estado de Alagoas, Nordeste do Brasil. Doze ovelhas foram separadas do rebanho para realização de exame clínico geral e avaliação dos níveis séricos de uréia, creatinina,gama-glutamiltransferase e aspartato aminotransferase. Adicionalmente, biópsias de pele e fígado foram realizadas em duas ovelhas severamente afetadas. O rebanho era criado sob manejo semi-intensivo em uma área de pastagem sem sombreamento e recebiam aproximadamente oito horas de insolação diárias. Essas ovelhas desenvolveram dermatite severa que evoluiu para necrose da pele dorsal. Macroscopicamente, as lesões foram observadas apenas na pele dorsal de ovelhas negras, enquanto ovelhas com áreas dorsais brancas da pele não foram afetadas. Microscopicamente, a epiderme e a derme profunda das ovelhas afetadas apresentavam necrose coagulativa difusa, além de

[1] Received on June 4, 2023.
Accepted for publication on July 1, 2023.
[2] Graduate Program in Veterinary Medicine, Universidade Federal Rural de Pernambuco (UFRPE), Rua Dom Manoel de Medeiros s/n, Dois Irmãos, Recife, PE 52171-900, Brazil.
[3] Fazenda Estrela, Rodovia 316 s/n, Atalaia, AL 57690-000, Brazil.
[4] Laboratório de Patologia Veterinária, Universidade Federal da Paraíba (UFPB), Rodovia PB-079 Km 12, Areia, PB 58397-000, Brazil.
[5] Laboratório de Diagnóstico Animal, Universidade Federal Rural de Pernambuco (UFRPE), Rua Dom Manuel Medeiros s/n, Dois Irmãos, Recife, PE 52171-900, Brazil. *Corresponding author: fabio.mendonca@ufrpe.br

incontinência pigmentar e hiperqueratose paraqueratótica. A necrose térmica dorsal ocorre apenas na pele dorsal de ovelhas negras em situações de exposição excessiva à luz solar devido ao acúmulo de radiação ultravioleta. A distribuição das lesões, restrita à região dorsal da pele, é um importante aspecto clínico-patológico nesses casos que pode auxiliar na diferenciação das lesões causadas por fotossensibilização, pois geralmente envolvem outros sítios anatômicos. Este é o primeiro relato de necrose térmica dorsal em ovinos no Brasil.

TERMOS DE INDEXAÇÃO: Necrose térmica, ovinos, radiação solar, pequenos ruminantes, pele, gangrena seca, nordeste brasileiro.

INTRODUCTION

Solar radiation is composed of variable wavelengths of ultraviolet (UV) rays, mainly UVA (320-400nm) and UVB (290-320nm) rays (Ferramola de Sancovich & Sancovich 2006, Gonzáles-Púmariega et al. 2009, Luigi et al. 2016). The radiant energy of the sun, especially from UVB rays, is responsible for varying degrees of skin lesions, including burns, elastosis, fibrosis, comedones, adnexal cysts and keratosis (Mauldin & Peters-Kennedy 2015, Hossy et al. 2018, Rousselet et al. 2019). In addition, solar radiation is also responsible for photosensitization, an exacerbated form of sunburn caused by the photodynamic chemical activation in the skin that are frequent in cases of poisoning by plants (Albernaz et al. 2010, Araújo et al. 2017, Mendonça & Riet-Correa 2023). Despite producing lesions with some degree of similarity, solar dermatitis and photosensitivity are pathologically distinct.

The records of sun-induced dermatoses and tumors in humans have grown in recent decades, particularly in outdoor workers (Modenese et al. 2018, Gobba et al. 2019), which is directly related to the increase in radiation intensity (Kim & Kim 2018, Parker 2021) as well as the time of sun exposure. Despite the sporadic records in veterinary medicine, we believe that actinic diseases are underdiagnosed, particularly because the levels of sun exposure in the Brazilian Northeastern Region can be significantly high due to the proximity of this region to the equatorial line, and due to an increase in global temperature and thermal sensation, and reduction of the rainy days' frequency (Narayanan et al. 2010, Marengo et al. 2019, Costa et al. 2020).

Among actinic diseases, dorsal skin necrosis stands out. This condition was described in eight sheep in Uruguay. It was characterized by extensive, wide, and linear necrosis of the dorsal skin, extending from the interscapular to the lumbosacral area in eight sheep with black skin (García et al. 2019). The lesion is compatible with a burn and occurs because black skin absorbs approximately 45% more solar radiation than white skin and can produce thermal energy, causing tissue carbonization (Mauldin & Peters-Kennedy 2015). Despite its relevance and abundant predisposing factors in the Northeast of Brazil, there are no reports of dorsal skin necrosis in this region. The aim of this study was to report an outbreak of dorsal thermal necrosis diagnosed in a flock of sheep in the Forest Zone of the State of Alagoas, Northeastern Brazil.

MATERIALS AND METHODS

Animal procedures were carried out in accordance with the National Institutes of Health Guide for the Care and Use of Animals and the "Conselho Nacional de Controle de Experimentação Animal", "Ministério da Ciência e Tecnologia" (CONCEA/MCTI), Brazil.

An outbreak of dorsal thermal necrosis was observed in a flock of sheep in the municipality of Boca da Mata (S 9°38'31'' and W 36°13'11''), Forest Zone of the State of Alagoas, Northeastern Brazil, in the year 2022. The region has dissected relief and deep valleys, in addition to predominantly subperennial forest vegetation type, with parts of hypoxerophilic forest. The climate is tropical rainy, with a dry summer and a rainy period that begins in December/January and ends in September (Mascarenhas et al. 2005). During the disease investigation, 12 ewes, ~2-year-old showing deep and fetid skin wounds extending from the interscapular to the lumbosacral region, were evaluated. Clinical examination was performed according to Dirksen et al. (1993), and blood samples were collected using a vacuum collection system with silicone tubes with and without EDTA with a 5-mL capacity. The blood was centrifuged (110.682 G for 5 min), and serum was separated in polyethylene tubes, frozen at -20°C and stored for further analysis. Serum levels of urea and creatinine and serum activities of gamma-glutamyltransferase (GGT) and aspartate aminotransferase (AST) were evaluated using a colorimetric test using commercial kits in a semiautomatic biochemical analyzer LabQuest®.

Skin biopsies were collected aseptically using a 5mm skin punch from two severely affected sheep. In addition, a blind percutaneous liver biopsy was performed with a Menghini needle, according to Rocha et al. (2016). For this, a Menghini needle was introduced in the cranioventral direction, in the 11th right intercostal space, at the point of intersection with an imaginary line parallel to the spine, starting from the lateral end of the iliac tuberosity. After passing through the thoracic wall, the needle was introduced into the hepatic parenchyma for two to three centimeters to collect the samples. Samples were fixed in 10% buffered formalin (pH 7.2) for 24 hours. These samples were processed routinely to produce 4-µm thick sections stained with hematoxylin and eosin (HE). Additionally, the pasture was inspected to investigate toxic plants causing photosensitization.

RESULTS

This outbreak was diagnosed in twelve ewes (29.26%) out of 41 crossbred sheep, with predominantly short brown, black and black/white coats. This flock was bought from another farm in the same region to be used as breeders in the new farm. At the original farm, the sheep were kept exclusively in a confinement system with access to shaded areas. After being transferred and placed for grazing from 8:00 a.m. until 4:00 p.m. (~8h/day) in a pasture of *Panicum maximum* without shading, two out of the foreign ewes presented skin lesions nine days after they were transferred to the pasture and after 17 days, 10 ewes presented the same lesions (10/26). These lesions were restricted to the dorsum and were limited to the black or brown areas of skin in dark-colored sheep; however, sheep with black skin and white coats or areas of black/white transition were also mildly affected (Fig.1).

Initially, the skin showed a linear to serpiginous ulceration along the dorsum (Fig.2), which evolved over a week to complete necrosis and detachment (Fig.3). In the first two sheep affected, these areas were extensive and deep, revealing

the overlying *longissimus dorsi* and *spinalis* muscles (Fig.4). On average, the affected regions measured 48cm in length x 10cm in width. These animals had worse nutritional status (score 2) and arched their backs when handled. During the dermatological examination, the skin in the dorsal region continued to detach, exhaling a fetid odor combined with an adhered yellowish fibrillar material. The gangrenous skin was dry (mummified appearance) and dark gray to black. Nodular areas suggestive of granulation tissue, small fistulous tracts and epithelial retraction areas were additionally observed.

The other sheep were less affected and exhibited wounds gradually healing by secondary intention. Wool in white and black areas sheds easily, falling out in tufts. In short-haired animals, areas of white fur exhibited alopecia but no necrosis. No hematological alterations were observed in any sheep, and the serum levels of GGT, AST, serum creatinine and urea were within the reference values (Table 1).

Microscopically, a focally extensive area of coagulative necrosis was observed affecting the epidermis and dermis was noted (Fig.5). Numerous bacterial myriads in the epidermis, deep dermis and muscle fibers were also observed. In segments with the epidermis intact, microabscesses were found in the *stratum corneum* (intracorneal) and in the epidermis (intraepidermal), in addition to spongiosis of keratinocytes,

Fig.1-4. (**1**) Ewes showing varying degrees of skin necrosis. Note two severely affected ewes presenting lesions in the dorsal region and other individuals with smaller lesions, mostly in the dark skin or transitional areas. (**2** and **3**) Dry gangrene on dorsal skin, extending from the cervical to the sacral region. The edges of the necrotic skin were dry and firm. (**4**) Also note the diffusely reddened and raised overlying muscle, suggesting severe inflammation. The overlying muscle exhibited white to yellow (cervical region) and red to black (along the dorsum) devitalized areas associated with yellow fibrillar material.

Table 1. Serum biochemistry findings from affected sheep with sun-induced dermal necrosis (n=2)

Values	Sheep 1	Sheep 2	Reference values
AST(UI/L)	104.0	58.0	60.0-280.0
GGT (UI/L)	54.0	32.0	20.0-52.0
Urea (mg/dL)	37.0	40.0	36.6-92.0
Creatinine (mg/dL)	1.4	0.8	1.2-1.9

*Reference values according to Tennant (2008).

pigmentary incontinence and parakeratotic hyperkeratosis. Additionally, a focally extensive area of ulcer covered by a fibrinolytic membrane was noted. In the superficial dermis, there was a dense mixed inflammatory infiltrate, predominantly of neutrophils, followed by lymphocytes and macrophages. Extensive granulation tissue was noted in the deep dermis, accompanied by vasculitis and fibrin thrombi (Fig.6). No microscopic changes in the liver biopsy were noted in affected sheep (Fig.6 inset).

DISCUSSION

This manuscript seems to report for the first time in Brazil an outbreak of thermal necrosis of dorsal skin in sheep. The epidemiological data, skin lesions restricted to the dorsal areas of the body, the significantly higher occurrence and severity in black and brown ewes, and the biochemical and gross and microscopic findings of the affected skin strongly suggest a thermal injury associated with prolonged sunlight exposure; as well as the sudden change in the management, exposure of ewes, used to being in the shade, to long sunlight exposure, plus the absence of shading triggered the skin lesions.

Dorsal thermal necrosis (DTN) is an uncommonly recognized thermal burn injury attributed to prolonged sun exposure and high environmental temperatures. In this condition, black skin/coat is remarkably severely affected, as the skin absorbs approximately 45% more solar radiation than white skin. In addition, the absorption of visible light (400-700nm) can produce thermal energy, causing burns with the carbonization of tissues (Fadare et al. 2012, Mauldin & Peters-Kennedy 2015, Leite et al. 2018). The energy from solar radiation can damage the skin via direct cell injury, increased thermal burden, or both (Werner 2016).

Furthermore, it is important to highlight that the environment also affects the animal's temperature throughout the day: animals exposed to the sun at warmer times, such as 1:00 p.m., show remaining levels of heat stored until 8:00 p.m. (Pulido-Rodríguez et al. 2021). These findings strengthen our theory, particularly when we consider the climatological indices of the Brazilian Northeast region. The geographic location of this region favors a more constant pattern of solar irradiance, high temperatures and longer photoperiods (Silva 2006), whose values begin to increase from September onwards in the state of Alagoas (Amorim et al., 2019). In Uruguay, the lesion was described after sun exposure at 29°C, 8h/day, for ≥30 days. However, according to our results, average sun exposure at 30.7°C (MARKSIM®), 8h/day, for nine to fifteen days, was enough to cause severe skin lesions.

In animals experimentally exposed to the sun, more significant increases in body temperature were found in regions with a higher incidence of direct solar radiation, such as the back and shoulder (Pulido-Rodríguez et al. 2021), which may explain why this anatomical region is more severely affected because, in addition to direct exposure, it retains more energy absorbed during the day. Furthermore, in wooly breeds exposed to the sun of the Mediterranean climate, the wool surface reached 45°C. The skin temperature was 39.6°C, demonstrating that the effects of absorbed radiation remained mainly on the surface of the wool (Haddade et al. 2018), which may explain why the wooly sheep exhibited fewer lesions when compared to the short-haired sheep. In reports of thermal necrosis in sheep, recent clipping was the main predisposing factor to injury in sheep (Butler & Bergman 2006, García et al. 2019).

The heat applied to the skin can cause necrotizing lesions of varying degrees. In this study, it is believed that the lesions correspond to 4th-degree burns. In these conditions, heat extends from the epidermis to the subcutaneous fascia,

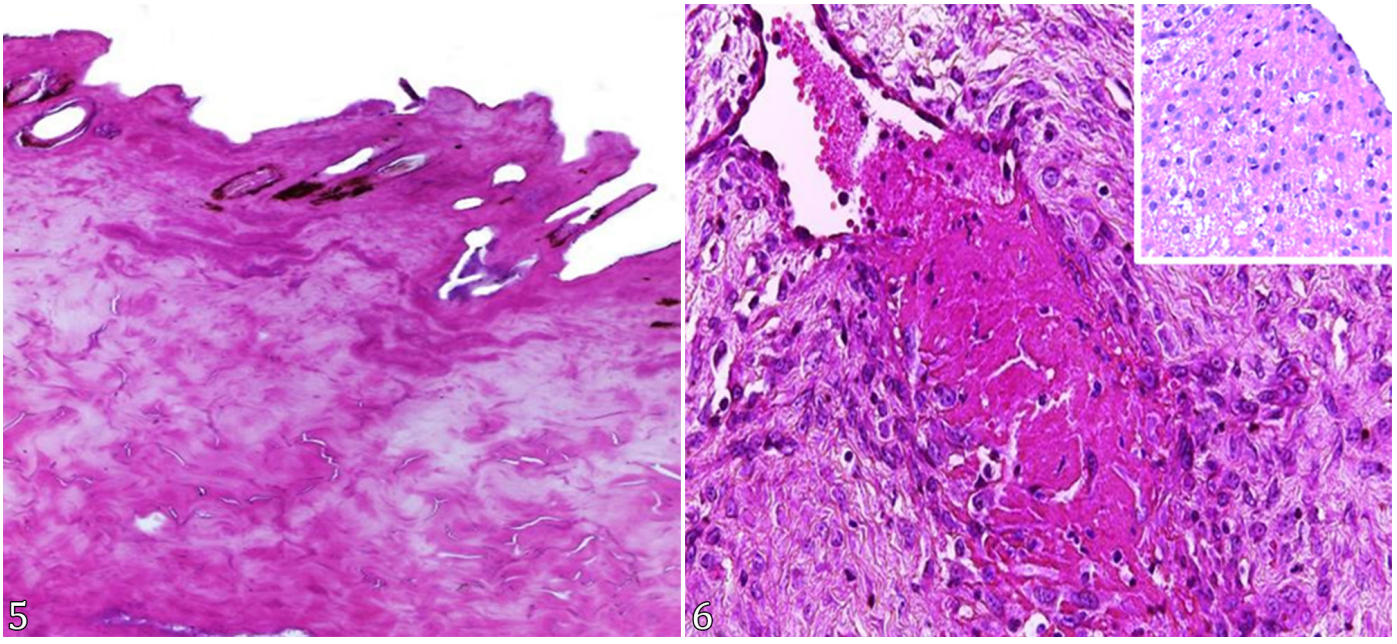

Fig.5-6. (**5**) Marked coagulative necrosis effacing the epidermis and infiltrate occupying the deep dermis. Note the occurrence of only remnants of skin appendages. HE, obj.10x. (**6**) Granulation tissue in the dermis, involving a fibrin thrombus in the center. Normal liver parenchyma of affected sheep from which it can be concluded that the skin lesions are not related to hepatogenous photosensitization (inset). HE, obj.40x.

affecting blood and lymphatic vessels. This causes coagulative necrosis of connective tissues, blood vessels, and appendages; thrombosis and vascular leakage; dryness and charring of the epidermis, which flakes off and is filled with granulation tissue (Mauldin & Peters-Kennedy 2015). These are the main mechanisms related to skin necrosis affecting mostly the dorsal areas of affected sheep in this study.

Previous reports of DTN in sheep are rare; it has only been described in Uruguay (García et al. 2019) and Australia (Butler & Bergman 2006). This lack of knowledge, in our experience, has resulted in frequent misdiagnosis of DTN as other forms of dermatological disease, mostly primary or secondary photosensitization, that are ordinary diseases caused by several toxic plants in Brazil (Schwartz et al. 2018, Mendonça & Riet-Correa 2023). DTN is also described in pigs (Frank et al. 2015) and dogs (Schwartz et al. 2018). Other causes of thermal lesions in animals include hot liquids (Quist et al. 2012), warming pads (Dunlop et al. 1989), fire (Sharpe et al. 2020, Rashid et al. 2021), and electrical burns (Pereira et al. 2020). However, the skin lesions in these situations can occur in any part of the skin and are not limited to the dorsal skin, as reported here.

Differential dorsal thermal necrosis diagnoses include toxic epidermal necrolysis, erythema multiforme major, bullous pemphigoid, pemphigus vulgaris, vasculitis, and trauma. In Brazil, photosensitization (Albernaz et al. 2010, Araújo et al. 2017) caused by *Brachiaria* spp., *Froelichia humboldtiana* and *Malachra fasciata* consumption should be considered. In these cases, the lesions are limited to white skin, mucous membranes, and vulvar and anal region areas. In fatal cases, heat stroke should be included (Bruchim et al. 2009). As for the pattern of skin injury, it should be considered that linear burns can occur on the back of animals exposed to hot water from hoses (Quist et al. 2012) and injuries on the dorsolateral trunk are described in animals secondary to radiant heat and are characterized by irregular, alopecic, erythematous and hyperpigmented areas (Walder & Hargis 2002).

CONCLUSIONS

Dorsal thermal necrosis (DTN) occurs due to multiple predisposing risk factors, including wool length, skin and wool pigmentation, prolonged sun exposure, high environmental temperature, and absence of shade.

The distribution of the lesions, restricted to the dorsal area of the skin, is an important clinicopathological aspect in these cases that can help differentiate lesions caused by photosensitization, as they usually involve other anatomical sites.

Acknowledgments. - To the "Coordenação de Aperfeiçoamento de Pessoal de Nível Superior" (CAPES), Finance Code 001, and "Conselho Nacional de Desenvolvimento Científico e Tecnológico" (CNPq), Process 304804/2018-5 and Process 409116/2021-1), for granting the necessary financial support for the development of this study.

Conflict of interest statement. - The authors declare no conflicts of interest.

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