Toxicon 125 (2017) 65–69

Contents lists available at ScienceDirect

Toxicon

journal homepage: www.elsevier.com/locate/toxicon

Short communication

Primary photosensitization caused by ingestion of *Froelichia humboldtiana* by dairy goats

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ARTICLE INFO

Article history:
Received 9 October 2016
Received in revised form
22 November 2016
Accepted 23 November 2016
Available online 24 November 2016

Keywords:
Goat disease
Photodermatitis
Skin necrosis
Low milk production

ABSTRACT

This study aimed to describe the first report of an outbreak of primary photosensitization in dairy goats caused by *Froelichia humboldtiana*. The disease occurred from March to May 2014, in a mixed flock of 15 Saanen, Alpine, and crossbred lactating goats. The entire flock was affected; however, the Saanen and cross-bred goats developed more severe lesions, and their milk production decreased by as much as 75%. Lesions were progressive and consisted of skin hyperemia, edema, and necrosis, especially in depigmented areas. An experimental study with two goats resulted in photodermatitis, similar to that observed in the natural cases, 10–14 days after the beginning of plant ingestion. Serum activities of aspartate aminotransferase (AST) and -glutamyltransferase (GGT) and, direct, indirect, and total bilirubin serum concentrations were within the normal ranges. In conclusion, *F. humboldtiana* causes primary photosensitization in goats with a negative impact on milk production.

Photosensitization is a cutaneous disorder caused by the photodynamic activation of different agents in the skin when exposed to long wavelength ultraviolet radiation (UV) or, less frequently, to visible light (Haargis and Ginn, 2007). Three types of photosensitization have been identified. Type 1, named primary photosensitization, is associated with the ingestion or administration of photodynamic substances; type 2 is a congenital condition related to the synthesis of aberrant pigments; and type 3 is secondary to a primary hepatic lesion (Radostits et al., 2007). Animals with this syndrome present dermatitis, hyporexia, and weight loss, and eventually, death may occur (Knupp et al., 2014).

In Brazil, the plant known as "ervanço" (*Froelichia humboldtiana*) causes major outbreaks of primary photosensitization in equids (Knupp et al., 2014), cattle (Souza et al., 2012), and sheep (Pimentel et al., 2007). The disease has been experimentally produced in horses, sheep, and cattle (Souza et al., 2012; Pimentel et al., 2007). Natural cases occur during the end of the raining period in pastures invaded by large amounts of *F. humboldtiana* (Knupp et al., 2014). Animals normally recover after being removed from the areas invaded by the plant; however, there is a variable duration of recovery, according to the intensity and distribution of the lesions (Pimentel et al., 2007). Elevated mortality has been observed in donkeys, resulting from self-inflicted traumas and secondary myiasis (Knupp et al., 2014). According to farmers, this plant also causes photosensitization in goats (Souza et al., 2012). However, to the best of our knowledge, photosensitization in goats associated with ingestion of *F. humboldtiana* has not yet been studied.

The clinical, pathological, and epidemiological aspects of an outbreak of photodermatitis in goats caused by the spontaneous ingestion of *F. humboldtiana* are described in this study. In addition, this report describes the impact of spontaneous and experimentally-induced primary photosensitization on milk production in goats.

Epidemiological and clinical evaluation data were obtained during visits to a dairy goat farm where a cutaneous disease was

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http://dx.doi.org/10.1016/j.toxicon.2016.11.258
0041-0101/

occurring. The farm was located in Assú (05°34′37.2″ S; 36°54′32.4″ W), in the state of Rio Grande do Norte, a semi-arid region of Northeastern Brazil. The local climate is dry and hot, with only two defined seasons: a rainy season from March to April, and a dry season during the rest of the year. The average annual rainfall is 750.8 mm (IDEMA, 2008).

Clinical data were obtained from owners and veterinarians that had previously examined the goats. Two visits were performed at the end of March and in May to perform clinical evaluation of dairy goats. Total rainfall during this period was 542 mm. Biopsies were performed from the skin areas of two goats with dermatitis. Samples collected were fixated in 10% buffered formalin and then routinely processed and stained with hematoxylin-eosin (H&E), periodic acid-Schiff stain (PAS) and Grocott's methenamine silver stain (GMS).

Serum samples were collected by jugular vein puncture with a disposable needle and a 15-mL capacity vacuum tube (without anticoagulant). Serum activities of aspartate aminotransferase (AST) and γ-glutamyltransferase (GGT) were determined by kinetic UV tests and kinetic colorimetric tests, respectively, at a temperature of 25 °C, using commercial kits (BioSystems®), according to the method described by Schmid and von Forstner (1986). Bilirubin assay was performed with a direct colorimetric method of diazotization (Jendrassik and Grof, 1938), using a commercial kit (Celm®).

Further, in 2014, to induce the disease experimentally, two adult lactating goats, a Saanen and a crossbreed, with depigmented skin areas, were placed for 14 days in a pasture composed predominantly by *F. humboldtiana* with no other plant previously known to cause photosensitization. The experiment was performed during the rainy season. The goats were examined daily for the presence of photodermatitis. After 14 days, the goats were removed to a covered area with no access to the plant and observed daily for 30 days. Two other adult lactating goats, one Saanen and one crossbreed, used as controls, were maintained for the same period in a pasture without *F. humboldtiana*. The goats stayed with their kids (two per goat) during the morning, while in the afternoon and at night, the kids were maintained indoors, separated from their mothers and supplemented with concentrated feed. Legal and ethical Brazilian requirements were followed in the animal experiments.

The outbreak of photodermatitis occurred in a flock composed of 15 lactating goats (three Saanen, nine Alpine, and three Saanen x Alpine crossbreeds). The flock was maintained during daylight in a three hectare area of native pasture. At night, they were moved to a covered house and supplemented with a concentrate ration, which was also provided after milking early in the morning. Mineral salt formulated for dairy goats and water were provided *ad libitum*. Milk production was assessed individually every day during milking. There were 20 lactating goat kids, which were maintained during part of the morning with the adult goats. Then, the kids were separated from their mothers, maintained indoors, and supplemented with concentrated feed.

The photodermatitis outbreak occurred from March to May 2014, during the rainy season, in a pasture composed predominantly by flowering *F. humboldtiana* (Fig. 1). According to farmers and observations performed during visits, *F. humboldtiana* is palatable to goats.

The signs of photosensitization varied from mild to severe (Table 1). All Saanen goats and a crossbreed with depigmented skin areas were severely affected. Clear signs of photodermatitis initiated approximately 10 days after goats were placed in the pasture infested by *F. humboldtiana*. The first signs were hyperemia and itch in the depigmented skin areas of the ears, back, and udders (Fig. 2A and B). Then, these areas showed edema evolving to ulcerative, necrotizing, and exudative dermatitis, with loss of epidermis in extended areas (Fig. 2C). A crossbreed with fully pigmented skin presented udder hyperemia and intense itch associated with bilateral self-inflicted trauma in the skin of flank and members (Fig. 2D). This goat did not present necrotizing dermatitis, and lesions were restricted to skin areas where the mouth could reach (self-trauma). The remaining goats developed only udder hyperemia associated with milk production loss.

Saanen goats were removed from the pasture and maintained in a covered area, protected from the sun. A week later, itch regressed and skin fissures began to heal, with full reepithelization after 30 days. However, lesions regressed soon after goats were reintroduced to the pasture infested by *F. humboldtiana*. The farmer chose not to remove crossbreeds from the pasture during the outbreak. Itch and hyperemia in these goats ceased by the end of May, when the plant seeded.

Histopathology of skin biopsies revealed superficial dermal inflammation around blood vessels, composed by mastocytes, lymphocytes, and some plasma cells. In some areas, the epidermis presented extended ulceration, covered by fibrin, associated with neutrophilic infiltrate and several superficial basophilic bacterial aggregates. Fungal hyphae were not observed in the PAS or GMS stains.

Serum activity of AST, GGT, and bilirubin concentrations were within normal range values for the caprine species.

Goats showed a severe decrease in milk production. The daily average of milk production of the goats before the photodermatitis outbreak was approximately 2 kg. During the outbreak, the mean daily production decreased to nearly 800 g, and Saanen goats, which were the most affected within the flock, produced only 500 g of milk daily.

After the fifth day grazing in the area infested with *F. humboldtiana*, the two experimental goats developed unrestful behavior and hyperemia of the skin of the back and udders. Milk production decreased from nearly 2 kg daily per goat to 1 kg. In 10 days, the skin lesions evolved gradually to alopecia, intense hyperemia, and itch, also affecting the ears. After 14 days, each goat produced 500 g and 800 g of milk daily. In this period, itch was intense, associated with edema, mainly in ears and back, with ulcerative, necrotizing, and exudative photodermatitis. In some areas of the skin, there was epidermal loss. AST and GGT serum activities were within the normal range for the species. Itch ceased two days after the goats were removed to a covered area, without the presence of the plant. Reepithelization and hair growth occurred 25–30 days after the removal of the goats from the pasture. Goats used as controls did not present any clinical signs, lesions, or decrease in milk production.

The primary photosensitization diagnosis in dairy goats associated with the ingestion of *F. humboldtiana* was established by epidemiological investigation, characteristic clinical signs, and skin lesions. Hepatic-linked photosensitization was eliminated as a cause of the lesions because the serum activities of both GGT and AST were within normal ranges.

Primary photosensitization reports in goats are scarce. Causative agents for this syndrome in this species include phenothiazine (Smith and Sherman, 2009) and the following plants: *Fagopyrum esculentum* and *Hypericum* spp., which contain naphthodianthrones (Cheeke, 1998), and *Thamnosma texana* and *Ammi majus*, which present furocoumarins with photodynamic activity (Ivie, 1978; Scott, 2007). Considering these species, only *Ammi majus* have been described in Brazil as causing primary photosensitization in cattle (Méndez et al., 1991), but not in goats. This plant is found only in Southern Brazil, unlike *F. humboldtiana*, which grows in the Northeast and Central-West regions of Brazil (Tokarnia et al., 2012).