PEER REVIEWED

Outbreak of bovine stomatitis in a feedlot due to *Setaria lutescens* (yellow foxtail)

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Abstract

A case of poor-doing cattle in a feedlot in the prairie region of western Canada was investigated. Clinical examination revealed mild to severe chronic ulcerative stomatitis. Histopathological examination confirmed plant material embedded within the lesions. Yellow foxtail (*Setaria lutescens*) was grossly visible in clover silage fed to the cattle. This case highlights the need to consider plant awns as a potential cause of outbreaks of ulcerative stomatitis.

Key words: cattle, stomatitis, yellow foxtail, *Setaria lutescens*

Résumé

Un cas de bovins mal en point a été examiné dans un parc d'engraissement de la région des prairies de l'ouest du Canada. L'examen clinique a révélé une stomatite ulcéreuse chronique avec des lésions de bas ou de haut grade. L'examen histopathologique a confirmé la présence de matériel végétal dans les lésions. La sétaire glauque (*Setaria lutescens*) était visiblement présente dans l'ensilage de trèfle donné aux bovins. Ce cas souligne le besoin de considérer les barbes de plantes comme un agent pouvant causer des flambées de stomatite ulcéreuse.

Introduction

Stomatitis is characterized as an inflammation of the oral cavity, which may include the tongue (glossitis), palate (palatitis), and mucosa of the gums (gingivitis).[10] Etiological agents of stomatitis are generally classified as infectious, chemical or physical in nature. Infectious agents are considered to be the broadest group, encompassing viruses, bacteria, and yeasts. These are of particular concern because oral lesions are associated with a number of reportable bovine diseases in Canada and the United States, such as foot-and-mouth disease, vesicular stomatitis, and rinderpest.

A wide range of plants have been implicated in causing traumatic stomatitis. The most common are the annual grasses (Poaceae family), of which foxtail ("spear grass") is of particular concern. In western Canada, the two most common varieties of foxtail affecting livestock are *Setaria lutescens* (yellow foxtail or foxtail millet) and *Hordeum jubatum* L. (foxtail barley).[7] However, a number of other grasses pose a risk of mechanical injury to livestock, such as various cultivars of dwarf and rough-awned barley (*Hordeum vulgare*), rye grass (*Secale cereal* L.), wild oats (*Avena fatua* L.), porcupine grass (*Stipa spartea* Trin.), and downy brome. A taxonomic feature common to foxtail and other grasses is the awns (spikelets), which facilitate seed dispersal. Each awn is composed of a central shaft (rachis) with barbs pointing away from the hardened tip (callus). The callus penetrates the skin or mucosal membrane, while the unidirectional-oriented barbs facilitate the awn's migration through the tissues. The awns' ability to migrate has been associated with cases of parotitis in humans[12] and sheep,[8] and endocarditis in a cat.[4]

Case Description

In January 2008, local veterinary practitioners were presented with a complaint of reduced feed consumption and poor weight gains in a cohort of feedlot cattle located in the prairie region of western Canada. The feedyard had 3 separate groups of cattle all displaying similar clinical signs. The largest group consisted of around 1000 custom-fed calves that entered the feedyard between September 17 and October 26, 2007, weighing 500 to 600 lb (227 to 273 kg). The feedyard owner had also placed approximately 300 of his own calves into the

lot on December 14, 2007. In addition, there were 125 head of cattle on feed since November 2006 that were nearing slaughter weight.

On-arrival processing protocol for all custom-fed calves was as follows: metaphylactic antimicrobial treatment for bovine respiratory disease;[a] multivalent vaccine[b] for infectious bovine rhinotracheitis, bovine viral diarrhea virus (BVDV), parainfluenza virus, and bovine respiratory syncytial virus; and an 8-way clostridial vaccine.[c] The owner's calves received the same vaccine regimen prior to weaning.

Feedstuffs used in the rations included barley, corn, dried distillers grains with solubles (DDGS), grass hay, cereal (barley) silage, corn silage, clover silage, and a mineral supplement. Upon entry, custom-fed calves received a ration of clover silage, grass hay, barley, and supplement. Beginning on November 03, the barley was replaced with corn and DDGS; equal parts of corn silage and clover silage were also added to the ration. By November 07, feed consumption dropped, weight loss was evident, and a frothy oral discharge was visible on the pen bedding. Suspecting an issue with the feed, the owner submitted a sample of corn silage for nutritional analysis and for mold contamination testing.[d] Test results received on November 24 showed that the corn silage contained 500,000 cfu/g of mold. These test results prompted the owner to change the ration from 15% clover silage/85% corn silage to 15% corn silage/15% clover silage/70% cereal silage; the DDGS were also removed from the ration.

Concurrently, a black scum was found in the water bowls, heightening the owner's suspicion that the poor performance was related to a mold issue. Water bowls were subsequently cleaned and rinsed on multiple occasions. A second sample of corn silage submitted on December 06 showed that the mold count had increased to 1,960,000 cfu/g of feed, and the mold count for the total mixed ration was 17,000 to 96,000 cfu/g. By December 27 all corn silage had been removed from the ration and the roughage re-balanced to 15% clover silage/85% cereal silage.

On January 11, 2008, the local veterinarians were contacted and presented with a case history of feedlot cattle that had been doing poorly for the previous 2 months, which the owner attributed to moldy corn silage. A calf with a history of drooling, bruxism, ill-thrift, and having oral lesions was euthanatized. On necropsy, plant material was grossly visible in the oral lesions. Tissue samples from the oral cavity were submitted to a veterinary diagnostic laboratory[e] and the pathoanatomical diagnosis came back as chronic ulcerative stomatitis. The pathology report also noted that there was severe chronic active suppurative and pyogranulomatous inflammation with plant particles and mixed bacteria embedded within the lesions. At the time of the necropsy, the local veterinarian noted foxtail present in the clover silage and recommended that the clover silage be removed from the ration. The owner complied, and no clover silage was fed after January 15.

On January 16, the local practitioners submitted additional tissues taken from the oral cavity of 2 similarly affected calves. These calves had originated from the owner's own herd and had been placed on feed around mid-December. The owner noted that it took approximately 3 weeks for the calves to start showing clinical signs similar those of the custom-fed calves. Laboratory testing confirmed that one calf had a subacute, multifocal, erosive stomatitis consistent with BVDV, which was confirmed by immunohistochemistry (IHC) testing. The second calf had similar histopathological lesions, but was negative for BVDV by IHC testing. While the second calf was negative for BVDV, the finding of a BVDV-positive animal did raise the question as to whether BVDV was the underlying cause of the oral lesions and poor performance.

On January 28, two additional calves were euthanatized and submitted to the laboratory[e] for testing. One case was considered to be acute, whereas the second calf was deemed to be chronically affected. The acute case was diagnosed with moderately severe subacute ulcerative stomatitis, while the chronic case had severe chronic ulcerative stomatitis. Both calves were negative for BVDV on IHC testing and no other cytopathic viruses, such as papular stomatitis virus, were found. Both cases had diffuse or multifocal oral ulcerations extending deeply into the submucosa, and severe suppurative and pyogranulomatous inflammation with plant particles and mixed bacteria embedded within the lesions. Apart from mild erosive rumenitis and increased cellularity of the retropharyngeal and mandibular lymph nodes, all other tissues appeared normal grossly and on histopathological examination.

Along with the above submissions, local practitioners also submitted 35 ear notch samples for BVDV testing, all of which were negative. In addition, acute and convalescent serum samples were obtained from 12 calves. One calf had a high serological titer consistent with an acute BVDV infection, but no virus was isolated from the sample. Two additional calves had moderate titers considered suspicious of BVDV infection. Overall, the acute and convalescent serum samples did not show significant increases in neutralizing antibody titers to BVDV.

Despite the overwhelming evidence that the outbreak of stomatitis was attributable to foxtail awns, the owner remained somewhat skeptical of the diagnosis. In March 2008, the local practitioners requested the assistance of the Western College of Veterinary Medicine's Disease Investigation Unit. Two faculty members visited the feedyard on March 25. At this point in the investigation 15 to 20 animals had been euthanatized because

of ill-thrift, all of which had signs of a chronic erosive stomatitis. The investigators' initial clinical impression was that the majority of cattle were affected to some degree. Cases varied from reduced weight gain to severe weight loss, and evidence of bloody saliva and dysphagia. Foxtail awns were evident in the clover silage (Figure 1), but none were noted in other feedstuffs.

The investigators also examined the oral cavities of 15 to 20 calves, 70 to 80% of which were found to have oral ulcerations from which foxtail awns could be extracted (Figures 2, 3, 4, and 5). Although the presumptive source of the foxtail awns, clover silage, had been removed from the ration nearly 3 months earlier (January 15, 2008), the awns remained embedded in the oral lesions. Upon removal, the tips of the awns were very firm, showing little sign of maceration.

Figure 1. Clover silage *in situ* showing evidence of *Setaria lutescens* (yellow foxtail).

Figure 2. Chronic ulcerative glossitis with plant material embedded in the margins of the lesions.

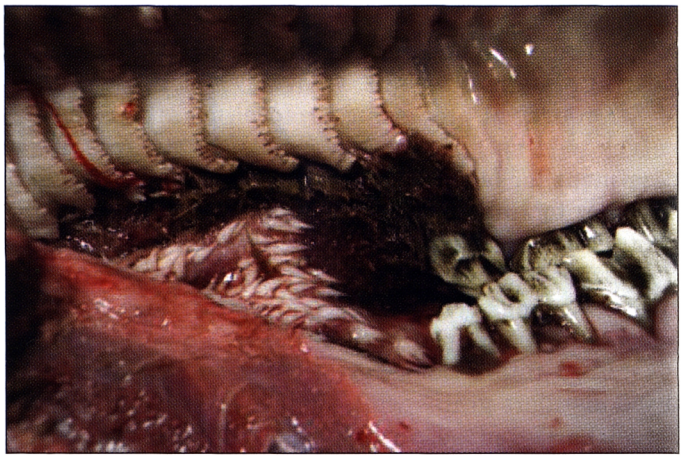

Figure 3. Ulcerative lesions of the hard palate with evidence of *Setaria lutescens* (yellow foxtail) awns embedded within the lesions.

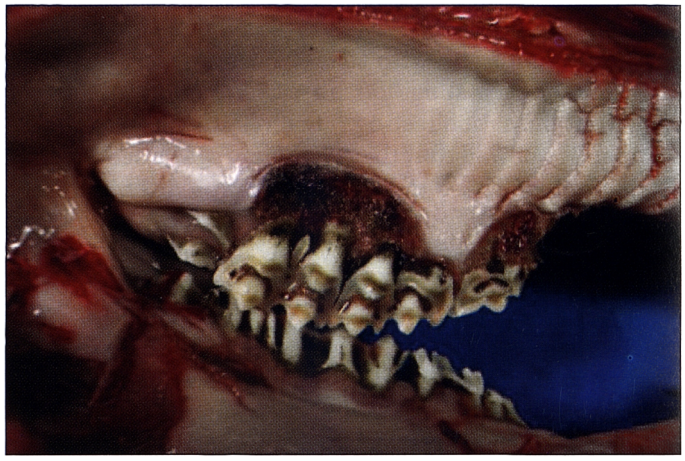

Figure 4. Ulcerative lesions of the gingival tissue resulting from *Setaria lutescens* (yellow foxtail) awns embedded in the tissue.

During the investigation, 2 of the most severely affected cases were euthanatized and tissue samples submitted to the laboratory located in Saskatoon, Saskatchewan.[e] The pathoanatomical diagnosis was consistent with reports from previous submissions; both animals had evidence of a severe ulcerative stomatitis associated with foxtail awns. The pathologist noted copious foxtail awns embedded in the ulcers and migrating deeper into the underlying tissues. Lymphadenopathy of the retropharyngeal lymph nodes was also noted. As per previous submissions, bacterial isolates of *Fusobacterium necrophorum* and *Actinomyces bovis*-like

Figure 5. Close-up view of *Setaria lutescens* (yellow foxtail) awn extracted from a lesion in the oral cavity of an effected feeder animal.

organisms were recovered from the oral lesions. A liver sample obtained at necropsy was also analyzed for 22 trace minerals, all of which were within normal ranges except for a marginally deficient level of iron (31.9 ppm).

In addition to the tissue samples, the investigators also submitted a sample of the clover silage for analysis to identify the origin of the awns.[f] The microscopist reported that the clover silage contained 0.39% cow cockle (*Saponaria vaccaria*) and 0.3% yellow foxtail (*Setaria lutescens*) seeds, confirming the awns to be yellow foxtail. A sample of clover silage, along with samples of corn silage taken from the surface of the silage pit, bottom of the pit, and near the top of the pit, were analysed for 17 different mycotoxins.[g] Mycotoxin concentrations for all samples were lower than the level of detection (<0.5 ppm) except for the surface sample, which had 1.2 ppm of deoxynivalenol (DON or vomitoxin); feedlot cattle can tolerate ≥10 mg DON/kg diet DM without adversely affecting health or performance.[3]

The investigators' final report concluded that there was overwhelming evidence that yellow foxtail was the source of the stomatitis outbreak. Subsequently, the cattle were moved to an unrelated feedyard where both feed intake and weight gain increased above average, suggesting compensatory gain. This latter finding led the owner to conclude that the foxtail was not the issue because he had removed the presumptive source (clover silage) from the ration 3 months previously.

Discussion

This case underscores the need to consider plant awns as a differential diagnosis in cases of ill-thrift and chronic ulcerative stomatitis of herbivores. The ubiquitous nature of foxtail, and other awned cereal grasses, may lead producers and veterinarians to dismiss them as etiological agents of stomatitis. In reality, plant-induced stomatitis is probably much more common than appreciated. In a large study involving 28,500 feedlot cattle from southern Alberta, an association was found between oral lesions at slaughter and 3 different types of silage diets: semi-dwarfed barley stem with rough awns (SDRA), normal stem with rough awns (NSRA), and normal stem with smooth awns (NSSA).[6] The overall prevalence of tongue ulcers was 19.1%; however, this varied by ration. Nearly a third (29.3%) of calves fed the SDRA ration had oral lesions at slaughter compared to 11.8% of the calves fed the NSSA ration. Significantly, the majority (69.1%) of the animals had awns embedded in the oral lesions at the time of slaughter. Although the incidence of lymphadenopathy was low, it was 5 times higher in animals with oral lesions compared to those without lesions.

Outbreaks of ulcerative stomatitis associated with plant awns are not unique to the bovine. Turnquist *et al* described an outbreak in a Missouri stable in which 20 of 25 horses developed ulcerative and hemorrhagic gingivitis associated with prairie foxtail (*Setaria geniculate*).[13] Foxtail awns were embedded within the ulcerative lesions and associated with pyogranulomatous lesions seen on histopathological examination. The literature also contains a number of case reports in which ulcerative stomatitis was associated with feeding foxtail[2,5,11] and triticale[9] to cattle and horses.

A common finding in cases of foxtail-induced traumatic stomatitis is that the plant awns remain embedded within the ulcerated lesions. In this case the clover silage, which was presumed to be the sole source of the foxtail awns, had been removed from the ration 3 months prior to the investigation. Yet, foxtail awns were grossly visible within the oral cavity of the affected cattle. The possibility remains, however, that the clover was not the sole source of the foxtail; it is possible that the cereal silage also contained foxtail. At the time of the investigation, only the clover silage was found to be grossly contaminated with foxtail awns; however, foxtail tends to grow in patches in the fields and hence it may not have been present in large enough amounts in the other feedstuffs to have been detected.

The ensiling process does not degrade plant awns. Therefore, foxtail control must be instituted at the pre- and post-harvest stages. Pre-harvest control is predicated on good crop management practices and the use of herbicides. If foxtail is discovered during the growing season, it can be fed safely to cattle provided the heads are very green; once the foxtail matures, then grinding in a hammer mill is recommended. Foxtail tends to become less palatable as the plant matures, therefore

consideration should be given to both grinding and diluting with other feedstuffs.

If foxtails are implicated as the cause of stomatitis, steps should be taken to physically remove the plant material from the lesions. Failure to remove the awns invariably results in a sustained inflammatory response that impedes proper healing and epithelialization. Removing awns from a few affected animals is possible; however, this is a daunting task when presented with a large number of cases. Furthermore, in this case lesions were both diffuse and multifocal and involved soft tissue structures that were difficult to access without the use of sedation and proper restraint.

An interesting aspect of this case was the producer's steadfast denial that something as common as plant awns could be responsible for the outbreak. The producer had the feedstuffs analyzed for molds before the local veterinarians were contacted. Finding mold in the feed and watering bowls only reinforced his suspicions that mold and/or associated toxins were the cause. In hindsight, the amount of mold in the total mixed ration was well below 1,000,000 cfu/g, a level generally considered safe for consumption by cattle.[1,3] Despite overwhelming evidence that plant awns were embedded in the lesions, there was still reluctance by the owner to acknowledge that foxtail was the issue. This skepticism was further reinforced when one animal was found positive for BVDV. The producer continued to maintain that awns were not the primary cause of the outbreak, because in his opinion cattle performance improved after they were moved to another feedlot, despite still having oral lesions.

This case underscores the difficulty that practitioners often face in trying to dispel preconceived notions that owners may have regarding the cause of a problem. In this particular case, it was perhaps difficult for the producer to appreciate that a common grass, such as foxtail, could cause such dramatic lesions. Furthermore, this case is not unique. Nearly half of the investigations performed by the Disease Investigation Unit, which include cases relating to poor performance (i.e., growth and reproduction) find a nutritional or toxicological basis for the problem. The local veterinarians often correctly identify the problem, but are unable to convince the owner of the diagnosis. Paradoxically, the more obvious the answer, such as malnutrition, the more difficult it can be to convince the cattle producer of the cause, which may hamper instituting treatment regimens and prevention strategies.

Endnotes

[a]Draxxin®, Pfizer Animal Health, Quebec, Canada
[b]Bovishield Gold 5®, Pfizer Animal Health, Quebec, Canada
[c]Tasvax 8®, Merck Animal Health, Quebec, Canada
[d]A & L Canada Laboratories Inc., London, Ontario, Canada
[e]Prairie Diagnostic Services Ltd, Regina, SK
[f]Windsor Laboratories, Mechanicsburg, PA
[g]Veterinary Diagnostic Laboratory, North Dakota State University, Fargo, ND

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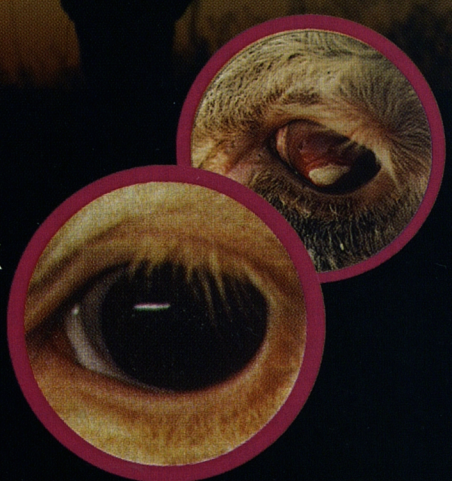

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