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Review on Bloat in Cattle

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Abstract

Bloat (ruminal tympany) is abnormal distension of the rumen and reticulum caused by excessive retention of the gases of fermentation; either in the form of persistent foam mixed with the rumen contents or as free gas separated from the ingesta. Bloat is a multi-factorial disease, which is mainly caused by legume pasture feed, legume hay feed, high concentrate feed, acidosis and rumenitis and other lesions. Bloat can be categorized as frothy bloat, which is caused by the formation of stable foam in the rumen or free gas bloat, which is due to excessive production of gaseous compounds from fermentation or as a result of an obstruction preventing the escape of gas compounds. In normal situations, these gases are eructated (belched) out of the animal. Legume pasture, legume hay and high concentrate feed bloat are caused by retention of gas in the rumen contents as a "frothy" or "foamy" mass. Persistence of the frothy condition in the ingesta appears to be due to lack of coalescence of the gas bubbles. Explanations for this condition are sought in terms of the nature of surface-active material in the ingesta and viscosity of the ingesta. Bloat is a common cause of sudden death. Cattle that are not observed closely, such as pastured and feedlot cattle and dry dairy cattle usually are found dead without showing any clinical signs. In describing the bloat, occurring in animals fed high concentrate rations, cattlemen often distinguish between free gas and frothy bloat on the basis of response to the stomach tube. Every effort should be made to relieve the gas with a stomach tube, followed by the administration of anti-foaming agents through the stomach tube in case of frothy type of bloat. Surface-active materials may be either pro-foaming or anti-foaming. Management practice such as good field and grazing pasture management are important for prevention of bloat in cattle. Poloxalene is effective for the prevention of legume pasture and legume hay bloat but it is not recommended for prevention of high concentrate or free-gas bloat. Breeding of bloat-resistant cattle and bloat free varieties of alfalfa and clovers should have to be favored.

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Introduction

Bloat (ruminal tympany) is abnormal distension of the rumen and reticulum caused by excessive retention of the gases of fermentation; either in the form of persistent foam mixed with the rumen contents or as free gas separated from the ingesta. Normally, gas bubbles produced in the rumen coalesce, separate from the rumen contents to form pockets of free gas above the level of the contents and finally are eliminated by eructation. Bloat can be a serious issue and even occasionally result in the loss of an animal [1].

Bloat can be categorized as frothy bloat, which is caused by the formation of stable foam in the rumen, or free gas bloat, which is due to excessive production of gaseous compounds from fermentation or as a result of an obstruction preventing the escape of gas compounds. In normal situations, these gases are eructated (belched) out of the animal. Bloat can result in loss of animal performance and in severe cases, death. When fermentation gas is prevented from escaping the rumen, it builds up and the rumen becomes distended or stretched. As the pressure in the rumen increases, breathing is affected, because the diaphragm cannot expand and create the negative air pressure in the lungs necessary to inhale. In severe cases, this inability to inhale may cause death from suffocation [2].

The fact that surface-active agents, i.e., oils, fats and detergents, are effective in the prevention and treatment of pasture bloat provides unequivocal evidence that entrapment of gas in the rumen contents is the primary cause of legume pasture bloat. Hence, the concentration of soluble protein in dehydrated alfalfa is lower than in fresh or air-dried alfalfa and the bloat causing properties of dehydrated alfalfa are unlikely to be due to a high concentration of soluble proteins. More likely, the reduction in particle size by milling and pelleting contributes to the bloat which occurs on dehydrated alfalfa. A frothy bloat may occur when a high concentrate, low roughage ration is fed. Unlike legume pasture bloat, the frothiness of rumen contents and the severity of bloat increase over a period of several weeks after the bloat-provoking ration is fed [3].

The greatest danger from bloat results from its unpredictable occurrence. A cattleman may have no bloat for a period of years and then unexpectedly have significant death losses before appropriate preventive or therapeutic measures can be applied. The fear of bloat often presents a limitation to the level of productivity obtained. Several investigations have shown that bloat reduces animal productivity, primarily by reducing feed intake. Economic losses from sub-lethal bloat probably exceed the economic losses from death due to bloat [4].

It is important to distinguish between the free and frothy types of bloats when selecting therapeutic or preventive measures. Mild bloat is often treated effectively by chasing the animal for 20 to 30 minutes to stimulate elimination of gas from the rumen. In severe cases, when the animal is down and distressed, the rumen must be tapped. Skillful management is a key element in bloat prevention and one often hears the opinions that bloat occurs when management is poor. Good management reduces the chances for occurrence of bloat but in view of the complex nature of the condition it is impossible to predict when bloat will occur and even with the best management, bloat presents a danger at high levels of productivity [5]. Therefore, the objectives of this paper are:

- To review the causes and types of bloat in cattle.
- To highlight possible treatment, prevention and control approaches used for bloat in cattle.

Literature review

Bloat in cattle

Types of bloats

Two categories of bloat are (1) frothy bloat caused by diets that lead to the formation of a stable froth or foam in the rumen, (2) free gas bloat caused by diets that lead to excessive gas production and concomitant low intraruminal PH. When bloating occurs, these gases cannot escape, and they continue to build up and cause severe distention of the abdomen, compression of the heart and lungs, and eventually death [6].

Causes of bloat

Bloat is an over distention of the rumeno-reticulum with the gases of fermentation, either in the form of a persistent foam mixed with the ruminal contents called primary or frothy bloat, or in the form of free gas separated from the ingesta called secondary or free-gas bloat. Bloat is a complex problem and several factors are known to cause it. Most researchers agree that the primary cause is excessive foaming of the rumen contents. The species of plants, the differences in individual animals, and the types of microorganisms in the rumen all seem to be involved. For many years researchers have known that legumes cause bloat more often than other plants. Death by bloat can occur with all legumes, but it sometimes occurs with other species. Proteins are the major foam-promoting compounds. The type of protein is more important than the amount. Immature grasses may provoke bloat since they usually contain large amounts of foam promoting proteins. The incidence of bloat decreases with the increasing maturity of most bloat provoking plants [7].

Legume pasture feed

Bloat caused by pasture legumes is an acute and frothy form of bloat. Pasture bloat is due to the foaming qualities of the soluble leaf proteins in bloating legumes and other bloating forages ingested by cattle on pasture. Frequency of bloat is greatest during the pre-bloom stage of growth. Field conditions which allow rapid vegetative growth of the legume forage, i.e., adequate soil moisture and moderate air temperature are associated with high bloat incidence. Cool nights, which may result in heavy dew, are frequently associated with severe outbreaks of bloat [6]. Bloatiness is lost during dry weather and may return three to seven days after a rain. When this occurs, alfalfa is the predominant forage grazed by the animals. There may also be a greater risk of bloat at the time of the first fall frost. In spite of the fact that certain field conditions are associated with greater risk of bloat occurrence or of greater severity, bloat can occur at any time. It can occur on dry forage, on warm days and at full bloom [8].

Legume hay feed

Good quality, leafy alfalfa hay has a reputation for causing bloat. The effects of weather on the incidence of bloat may appear complex, but can be understood by relating weather conditions to their effects on plant growth. Bloat may occur on hay alone but it occurs more commonly when hay is fed in combination with cereal grains. Alfalfa barley rations are frequently

cited by feeders as causing bloat. Alfalfa hay is dangerous when fed in excess of 10% in a feedlot ration and freshly cured hay is worse than aged hay. The extent of leaf loss and leaching during haying operations are probably the major factors affecting any reduction in bloat potential of alfalfa hay compared to fresh alfalfa [3].

High concentrate feed

A frothy bloat may occur when a high concentrate, low roughage ration is fed. Unlike legume pasture bloat, the frothiness of rumen contents and the severity of bloat increase over a period of several weeks after the bloat provoking ration is fed. The texture of the ration is an important element in the occurrence of high concentrate bloat. Severity of bloat and frothiness increase when the concentrate is finely ground and risk of bloat is increased when the roughage component in feedlot rations is finely ground. The gas is trapped in many small bubbles dispersed throughout the rumen contents and does not readily separate into liquid and solid layers upon standing [9].

High concentrate bloat increases in severity over a period of weeks suggesting the accumulation of specific micro-organisms or chemical substances in the rumen. Most investigations into the cause of frothing in high concentrate bloat have been on factors affecting viscosity of the rumen ingesta. In animals fed a high grain ration, viscosity of whole rumen contents was not related to bloat incidence, but viscosity of rumen fluid was positively correlated with bloat incidence. Viscosity of rumen fluid also increased in association with bloat incidence in cattle fed a finely ground ration [10].

Acidosis and rumenitis

Rumen pH is low on high concentrate and finely ground rations. Rumen motility ceases at low rumen pH and it has been assumed that eructation may also be impaired. However, a direct effect of acidity on eructation has not been shown and there is only circumstantial evidence that low rumen pH causes bloat. Rumenitis is related to acidosis in that associated with feeding high grain rations. Lesions in the area of the cardia can impair eructation and cause a free gas bloat. To the extent that free gas bloat may be caused by acidosis or rumenitis, it may be prevented by exercising appropriate care in starting animals on high grain rations [11].

Other pathological lesions

Reports of bloat apparently caused by pathological lesions have been published. These include esophagitis resulting from shipping fever, lesions of the vagus nerve, esophageal papilloma, afibroma in the area of the cardia and an enlarged mediastinal lymph node. Bloat may also occur secondary to traumatic reticuloperitonitis. If an animal bloats as a result of pathological lesions, it will bloat repeatedly and disposal of the animal is recommended [12].

Pathogenesis

Normally, gas bubbles produced in the rumen fluid coalesce, separate from the rumen contents to form pockets of free gas above the level of the contents, and are finally eliminated by eructation. In frothy bloat, the gas bubbles remain mixed with rumen contents, duo to production of slime material from legume food or heavy growing pasture producing an abnormal increase in the volume of the ruminoreticular contents and, consequently, inhibiting eructation [13].

In primary ruminal tympany or frothy bloat, the cause is entrapment of the normal gases of fermentation in stable foam. Coalescence of the small gas bubbles is inhibited and intraruminal pressure increases because eructation cannot occur. Several factors, both animal and plant, influence the formation of a stable foam. Soluble leaf proteins, saponins and hemicelluloses are believed to be the primary foaming agents and to form a monomolecular layer around gas rumen bubbles that has its greatest stability at about pH 6.0. Salivary mucin is antifoaming, but saliva production is reduced with succulent forages. Bloat producing pastures are more rapidly digested and may release a greater amount of small chloroplast particles that trap gas bubbles and prevent their coalescence [12].

The development of the foam in feedlot bloat is uncertain but is thought to be either the production of insoluble slime by certain species of rumen bacteria in cattle fed high-carbohydrate diets or the entrapment of the gases of fermentation by the fine particle size of ground feed. Fine particulate matter, such as in finely ground grain; can markedly affect foam stability as can a low roughage intake. Feedlot bloat is most common in cattle that have been on a grain diet for 1–2 mo. This timing may be due to the increase in the level of grain feeding or to the time it takes for the slime-producing rumen bacteria to proliferate to large enough numbers [14].

In secondary ruminal tympany or free-gas bloat, physical obstruction of eructation is caused by esophageal obstruction due to a foreign body (i.e., potatoes, apples, turnips and kiwifruit), stenosis or pressure from enlargement outside the esophagus (as from lymphadenopathy or sporadic juvenile thymic lymphoma). Interference with esophageal groove function in vagal indigestion and diaphragmatic hernia may cause chronic ruminal tympany. This also occurs in tetanus. Tumors and other lesions, such as those caused by infection with Actinomyces bovis, of the esophageal groove or the reticular wall are less common causes of obstructive bloat [15].

Ruminal tympany also can be secondary to the acute onset of ruminal atony that occurs in anaphylaxis and in grain overload. This causes a reduction in rumen pH and possibly an esophagitis and rumenitis that can interfere with eructation. Ruminal tympany also develops with hypocalcemia. Chronic ruminal tympany is relatively frequent in calves up to 6-month-old without apparent cause; this form usually resolves spontaneously. Unusual postures, particularly lateral recumbency, are commonly associated with secondary tympany. Ruminants may die of bloat if they become accidentally cast in dorsal recumbency or other restrictive positions in handling facilities, crowded transportation vehicles or irrigation ditches [3].

Clinical findings

Bloat is a common cause of sudden death. Cattle not observed closely, such as pastured and feedlot cattle and dry dairy cattle usually are found dead. In lactating dairy cattle, which are observed regularly, bloat commonly begins within one hour after being turned onto a bloat producing pasture. Bloat may develop on the first day after being placed on the pasture but more commonly develops on the second or third day [12].

In primary pasture bloat, the rumen becomes obviously distended suddenly and the left flank may be so distended that the contour of the paralumbar fossa protrudes above the vertebral column; the entire abdomen is enlarged. As the bloat progresses, the skin over the left flank becomes progressively tauter and

in severe cases, cannot be tented. Dyspnea and grunting are marked and are accompanied by mouth breathing, protrusion of the tongue, extension of the head and frequent urination. Occasionally, vomiting occurs. Rumen motility does not decrease until bloat is severe. If the tympany continues to worsen, the animal will collapse and die. In a group of affected cattle, there are usually several with clinical bloat and some with mild to moderate abdominal distention [2].

Diagnosis

Visually, the distension resulting from frothy bloat is indistinguishable from free gas bloat. In the case of frothy bloat on pasture, the clinical symptom is the presence of stable foam that sequesters the gas products of fermentation and retains them in the rumen [16]. Free gas bloat may have a different etiology, but in an animal grazing legume pasture, a bloat may be a combination of free gas and frothy types. Again, for intact animals, the only reliable external diagnostic procedure is palpation of the left flank to establish whether the rumen contents are abnormally uniform, due to the presence of foam or stratified normally as is the case in free gas bloat.

In describing the bloat, occurring in animals fed high concentrate rations, cattlemen often distinguish between free gas and frothy bloat on the basis of response to the stomach tube. They describe the condition as free gas bloat if the gas is released through a stomach tube. If the tube is occluded by frothy rumen contents, they describe the condition as frothy bloat. However, even in frothy bloat, a pocket of free gas is always present in the dorsal, blind sac of the rumen and release of this gas through a stomach tube may give partial relief from the bloated condition. Thus, a definite diagnosis of free gas or frothy bloat can only be made by examination of rumen contents and the frequency of high concentrate frothy bloat relative to free gas bloat remains an open question [17].

Treatment

Few advances in treatment methods have been made in recent years. The severity of the Treatment approaches depends on the circumstances in which the bloat occurs, whether the bloat is frothy or free-gas and whether or not it is life threatening. Degrees of bloat severity vary, and a different method of treatment may be necessary in each case [3]. When treating bloat among feedlot animals, a diagnosis of free gas or frothy bloat is essential for effective treatment. Every effort should be made to relieve the gas with a stomach tube, followed by the administration of anti-foaming agents through the stomach tube. Frothy bloat caused by legume pasture, legume hay or high concentrate rations may be treated with antifoaming agents. Commercial preparations contain detergents and other anti-foaming substances, which provide rapid dispersion of the foam. Mineral oil and vegetable oils are also effective and give satisfactory treatment. Vegetable oils are degraded in the rumen more rapidly than detergents or mineral oils and will prevent foaming for a shorter period of time unless given in larger amounts [5].

If free gas bloat is suspected, the stomach tube may be the first treatment because it is the only suitable treatment for free gas bloat and it will frequently provide partial relief from high concentrate frothy bloat. If the animal is not deflated via the stomach tube alone, an anti-foaming agent should be administered. If passage of the stomach tube relieves the excess pressure, then the anti-foaming agent collapses the foam. The animal begins to belch within 10 to 15 minutes and should recover within an hour. The trocar and cannula method and the emergency rumenotomy should be used only when an animal cannot be relieved with the stomach tube. Those more intrusive treatments pose a greater risk to the bloat-affected animal. More recently, intraluminal injection of the detergents alfa or anti gas emulsion has been completely effective in the treatment of pasture bloat [18].

Prevention and control

No single method of bloat prevention is adequate under all circumstances. However, management practices, as well as drugs, can help. Prevention methods for prevention of pasture bloat are conveniently grouped into two classes: pasture management and administration of anti-foaming agents [19].

Pasture management

Field management: Fertilization and grazing management may be used to maintain a 50:50 mixture of grass and alfalfa. Nitrogen fertilizer and heavy or frequent grazing promote grass growth at the expense of alfalfa. In areas where the incidence of bloat is high, the critical upper limit of alfalfa may be as low as 25 to 30 percent of the stand. Reducing the proportion of alfalfa when seeding a mixed pasture may be necessary in some areas to reduce bloat. As well, mixtures grown in sandy areas, which are more prone to drought than heavy soils, are less likely to produce bloat. Although alfalfa grass mixtures may be seeded to produce the desired proportion of alfalfa and grass, selective grazing and variation in the terrain of, the field may allow an excessive intake of alfalfa, resulting in bloat. The period following mechanical harvesting or intensive grazing of alfalfa grass mixtures may pose a potential risk of bloat. Because alfalfa generally recovers more quickly than grass after cutting [20].

The ideal companion grass should have the same seasonal alfalfa, but its regrowth after grazing or cutting is much slower than that of alfalfa. Consequently, pasture bloat may occur when an alfalfa smooth brome grass mixture is used in rotational grazing system. There must be sufficient time between rotations to allow for the regrowth of the smooth brome grass. Sometimes, ideal growing conditions at seeding result in a new alfalfa grass mixture with too much alfalfa. It may then be necessary to defer grazing during the spring flush of growth or to restrict grazing to a portion of the field. Other options are overgrazing or applications of nitrogen fertilizer, which will increase the grass growth and reduce the proportion of alfalfa in the stand [21].

Grazing management: Uniform and regular intake is the key to managing animals on legume pastures. Waiting until the dew is off before placing animals on pasture is a common practice and is useful when animals are first exposed to a legume pasture. In fact, it has been proven that bloat is less likely to occur if animals are turned out to pasture in the afternoon than in the morning. Before animals are placed on a legume pasture, they should be given a full feed of coarse hay. This regimen discourages them from gorging themselves and overeating the fresh, lush legume forage. Thereafter, they should remain on the pasture. Daily feeding of grass hay before grazing alfalfa can reduce the occurrence of pasture bloat in cattle [3].

If the legume pasture remains highly bloat potent, the animals should be removed from the pasture until the legume becomes more mature and thus less bloat potent. Bloat is often associated with intermittent grazing, i.e., removing animals from legume pastures for a short time, such as overnight. In fact, re-

searchers use this technique to maximize the risk of bloat when they are studying methods of bloat prevention. Similarly, outbreaks of pasture bloat may occur when grazing is interrupted by adverse weather (such as storms) or by biting flies or other insect pests. These factors alter normal grazing habits, generally resulting in more intensive, shorter feeding periods that may increase the incidence of bloat risk [22].

Administration of anti-foaming agents

Surface-active agents, which are effective for the prevention of pasture, bloat fall into two groups: (i) synthetic surfactants and (ii) vegetable oils, mineral oils and animal fats. Among the synthetic surfactants, Poloxalene is a highly satisfactory bloat preventive when administered at the recommended level of 10-18 g/day in two daily doses. It has no adverse effects on feed intake or animal productivity when used at recommended doses and no residues are present in milk or body tissues [12].

Mineral oil reduced bloat incidence but its side effects limit its usefulness as a bloat preventive. Additions of synthetic surfactants to feedlot rations have given variable responses. Some cattlemen feed laundry detergents to prevent bloat but in view of the general ineffectiveness of many surface-active agents, it is doubtful if laundry detergents have any beneficial value as preventive agents. Addition of water to grains before grinding or rolling will prevent excessive pulverization [8].

Conclusion and recommendations

Bloat is a fatal disease mainly caused by different kinds of feeds, acidosis and rumenitis as well as with other pathological lesions. Frothy and free gas bloat are the two main types of bloats and stomach tube is an essential instrument use to distinguish them. Bloat can result in loss of animal performance and in severe cases, death. When fermentation gas is prevented from escaping the rumen, it builds up and the rumen becomes distended or stretched. As the pressure in the rumen increases, breathing is affected, because the diaphragm cannot expand and create the negative air pressure in the lungs necessary to inhale. In severe cases, this inability to inhale may cause death from suffocation. The frothiness of rumen contents and the severity of bloat increase over a period of several weeks after the bloat provoking ration is fed. The texture of the ration is an important element in the occurrence of high concentrate bloat. In generally bloat can reduce the productivity of animals and cause sudden death of animals.

Therefore, based on the above conclusion the following recommendations are forwarded:

- Feed given for cattle should be coarsely chopped and hay should have to be mixed with the grain to increase the dry matter content of the feed.
- Substitute low-quality legume or non-legume roughage for part or all of the alfalfa hay (adjust the protein, vitamin, and mineral supplement appropriately at the same time).
- Avoid turning of animals onto fresh high bloat-potential pasture, which is moist with dew, rain or irrigation water.
- Avoid grazing of cattle on legumes before they begin to bloom.
- Efforts should be directed toward breeding bloat-resistant cattle and bloat free varieties of alfalfa and clovers.

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References

1. Dennis H. Georgia Cattleman, Forage Extension Specialist. The University of Georgia. 2012.
2. Lehmkuhler J, Burrism R, Arnold M, Smith R and Lacefield G. Managing Legume-Induced Bloat in Cattle. UK University of Kentucky College of Agriculture. 2011.
3. Majak W, McAllister A, McCartney D, Stanford K, Cheng J. Bloat in Cattle. 2008.
4. Popp J, Mccaughey W and Cohen R. Effect of grazing system, stocking rate and season of use on herbage intake and grazing behavior of stocker cattle grazing alfalfa -grass pastures. Can. J. Anim. Sci. 2020; 77: 677-682.
5. Majak W, Hall J and McAllister T. Practical measures for reducing the risk of alfalfa bloat in cattle. 2001.
6. Irsik B. Bloat in Cattle vm12200. 2019.
7. Alabama Extension.
8. Majak W, Lysyk T, Garland G and Olsen M. Efficacy of Alfasure for the prevention and treatment of alfalfa bloat in cattle. Can. J. Anim. Sci. 2005; 85: 111-113.
9. Hironaka R and Sonntag B. Feedlot finishing of cattle. Agric. Can. Publ. 2013; 30: 1591.
10. Warner G. Grazing beef cattle on irrigated alfalfa in J. Johnson, ed. Proceedings of the 2nd National Alfalfa Grazing Conference, Omaha, NE, 16 August. Certified Alfalfa Seed Council, Davis, CA. 2016; 65-68.
11. Galyean M and Rivera I. Nutritionally related disorders affecting feedlot cattle. Can I Anim Sci. 2003; 83: 13-20.
12. Merck E. The Marek veterinary manual 10th edition. In Cynthia M. K, and Scott, L. editions. White house station, N.J: Merck and Co. 2010.
13. Mohammad A. Ruminal Tympany (bloat). 2019.
14. Thompson D, Brooke B, Garland G and Majak W. Effect of stage of growth of alfalfa on the incidence of bloat in cattle. Can. J. Anim. Sci. 2000; 80: 725727.
15. Bretschneider G, Santini F, Fay J and Faverin C. Effect of maize silage supplementation before Lucerne grazing on the occurrence of bloat in cattle. N. Z. J. Agric. 2001.
16. Moate W. Pasture management systems for reducing the risk of legume bloat in cattle. J. Anim. Sci. 2018; 73: 1493-1498.
17. Berg B, Majak W, Mcallister T, Hall J, McCartney D, et al, Bloat in cattle grazing alfalfa cultivars selected for a low initial rate of digestion. Symp. Ruminant Bloat. 2010; 24-28.
18. Perry T and Cecava J. Feedlot disease. In: and M. J. Cecava (Ed.) Beef Cattle Feeding and Nutrition (2nd Ed.). Academic Press, San Diego, CA. 2015; 283-290.

19. Hall J, Cheeke P and Majak W. Plant and animal factors in legume bloat. Cheeke, P. R, ed. Toxicants of plant origin. Vol. III, Proteins and amino acids. CRC Press, Boca Raton, Fla. 2011: 93-106.

20. Hall J, Walker I and Majak W. Evaluation of two supplements for the prevention of alfalfa bloat. Can. Vet. J. 2003; 35: 702.

21. Cheng K, McAllister T and Popp I. A review of bloat in feedlot cattle. J Anim Sci. 2011; 76: 299-308.

22. Garry F. Evaluating motility disorders of the bovine forestomach. Vet. Med. 2010: 634-642.