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Review Article

Enterotoxemia: The Deadly Disease Affecting Goats and Sheep Production

George F. W. Haenlein*, Young W. Park

[1]*Department of Animal and Food Sciences, University of Delaware, Newark, United States;* [2]*Department of Animal and Food Sciences, Fort Valley State University, Fort Valley, United States*

ABSTRACT

Roughages and plant cell walls are not digestible in human gastrointestinal system. However, ruminants, such as cow, goats and sheep are designed by nature to thrive on roughage and fibrous feeds and are great converters of such feeds which are neither very digestible nor nutritious among humans, into meat, milk and wool fiber. In fact, ruminants, as the host animals play a symbiotic relationship with a multitude of beneficial bacteria in their rumen, where these rumen microorganisms digest the fiber, while the ruminant animal plays the role of bacterial host benefitting from the microbial digestion products of roughage feeds. Maintenance of an optimal pH is one condition that is essential for these beneficial bacteria to survive and multiply. However, when the pH optimum gets disrupted or changed, other pathogenic bacteria species (Eg. *Clostridia* spp.) will take over, releasing deadly toxins in the rumen environment, called entertoxemia which could prove to be detrimental. Based on the practical experience it is herewith affirmed that when disturbances in rumen ecosystem is recognized, it can be potentially reversed to normal environment by providing appetizing feed containing fiber such as sunflower seeds and entertoxemia can be cured by prompt feeding management without necessarily resorting to otherwise effective vaccinations against the offending *Clostridia* bacteria.

Keywords: Ruminant; Rumen bacteria; Rumen pH; Fibrous feeds; *Clostridium perfringens*; Enterotoxemia

INTRODUCTION

Clostridia spp. are widely recognized group of pathogenic bacteria affecting livestock, companion animals, wildlife animals and also human beings. These bacteria are usually found in the soil or as part of the normal microflora in the gastrointestinal tract of healthy sheep and goats. Under normal conditions, these bacteria are found in low numbers within the gastrointestinal tracts of all sheep and goats. These microorganisms are also inhabitants of normal intestinal microflora in most of the other animal species also. Enteroxemia is a frequent yet a severe disease affecting sheep and goats regardless of their age. This disease is mainly caused by disproportionally rapid growth of two strains of bacteria termed as *Clostridium perfringens* type C and type D. Enterotoxemia, is also known as overeating or pulpy kidney disease, where the condition is usually caused by *Clostridium perfringens* type D [1].

Under certain specific and altered conditions, these bacterial strains multiply rapidly in the intestines and produce substantial quantities of toxic compounds. Normally, these organisms are present in low numbers in the small and large intestine and appear to be in a relatively quiescent state in the normal, healthy animal. However, the changes in the animals' diet trigger them to instigate disease. Increase in the quantity of ingested grain, protein supplement, milk or milk replacers, like in case of lambs and kids as well as changes associated with the grass source that the sheep or goat is consuming represent the most likely dietary changes that gives rise to conditions favorable for pathogenesis. Collectively, these altered feeds are rich in starch, sugar and/or protein. Unusually high levels of these nutrients make their way into the intestine and as a consequence facilitate explosive growth of *Clostridium perfringens*, thus elevating its numbers and proportion rapidly within the intestine.

Correspondence to: George F. W. Haenlein, Department of Animal and Food Sciences, University of Delaware, Newark, United States, Tel: 304-743-8909; E-mail: ghaenlein@gmail.co

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When *Clostridium perfringens* grow in number, they release very potent bacterial toxins that cause severe harm to the host animal, such as damage to the intestine as well as numerous other organs of the ruminant. The toxins can be absorbed into the blood causing toxemia. *Clostridium perfringens* type D is the most common cause of mortality among goats and sheep worldwide and it can develop at any age. This hazardous overeating condition can result in fatalities of the ruminants, particularly in the non-vaccinated animal or in the newborn lamb or kid whose dam has not been vaccinated.

About 15 different types of toxins in various combinations can be produced by *Clostridium perfringens* and these toxins are mainly divided into 5 main types, namely A, B, C, D and E depending on the type of toxin they produce. Among them epsilon toxin produced by *C. perfringens* type D is considered as the most toxic and most potent toxin causing entertoxemia. Young animals are highly susceptible to this disease. Occasionally this disease can cause sudden and high mortality rates among lambs and kids. Although adult animals are also susceptible to enterotoxemia, they may potentially develop immunity due to frequent exposure to low doses of these toxins [2].

In traditional dairy goat, sheep or cow feeding management, the milking herds are grazed, so that milk production is the sole result of ingesting the fibrous range or pasture forage. Under intensive management, the does, ewes or cows are fed extra grain rations to sustain high milk production. This grain ration has high levels of starch and protein contents which are usually easily and highly digestible. When an opportunity is given to young and adult animals, they like to engorge on a grain ration, due to its high palatability. However, the rapid fermentation of starch in the rumen alters the usual bacterial environment and causes serious drop in the pH of the rumen contents on the acidic side thus leading to a toxic condition called acidosis. This altered condition is favorable for the growth of *Clostridia perfringens* allowing them to thrive and grow exponentially and release toxins causing goat, ewe or cow to be feel very sick and if this condition remains untreated it can lead to fatal convulsions and coma. The "sudden-death" among kids could be the first direct indication for incidence of this deadly disease. Therefore, many goat and sheep owners believe in taking precautionary measures in fight against this serious disease rather than depending on vaccination of bacterin toxoid type C and type D, usually administered at least twice annually.

The purpose of this article is to review the definition, occurrence and signs of enterotoxemia among ruminants, especially in goats and sheep and to reiterate the prevention methods against enterotoxemia based on feeding strategies among ruminant animals.

LITERATURE REVIEW

Causative factors associated with enterotoxemia outbreaks

Enterotoxemia can occur when *Clostridium perfringens* type D is overgrown in the intestine of sheep, goats and other ruminants. Hines postulated the following situations that are associated with outbreaks of enterotoxemia in goats and sheep:

- When goats, sheep or ruminant animals consume excessive amount of milk or feed with high proportion of grain.
- When the quantity of carbohydrate rish grainsin ration is high with very low content of roughage.
- In situations when the natural immunity of the animal is compromised such as conditions when the animal is either sick or recovering from an illness or when the animal is stressed out.
- When gastrointestinal tract motility gets the slowed down.
- When animals have heavy gastrointestinal parasites, including nematodes, cestodes (tapeworms) and coccidian [3].

The signs of enterotoxemia in goats and sheep

Enterotoxemia can progress very quickly and the affected animals may die with no previous signs or major symptoms of disease. van Metre suggested the following signs may be observed in the events of the outbreak of enterotoxemia: (i) Diarrhea may develop; (ii) in some cases, visible blood may appear in the loose stool (iii) infected animals may lose the ability to stand on their legs and lay on their sides and (iv) infected animals could be observed to extend their legs, with their head and neck extended back over their withers, a posture which is attributed to the harmful effects of the pathogenic bacterial toxins on the brain. After this sign appears, the animal commonly dies within minutes to hours.

Treatment of enterotoxemia

The success rate of treatment depends upon the extent of enteroxemia disease progression caused by *Clostridium perfringens* type D. However, in extremely severe cases treatment of enteroxemia may not be successful at all. Veterinarians generally treat mild cases with analgesics, probiotics (containing good bacteria), oral electrolyte rehydration solutions, antisera (containing a concentrated solution of anti-bodies) that are capable of neutralizing the bacterial toxins. Relatively more severe cases are treated by administering intravenous fluids, antibiotic therapy and supportive care that includes oxygen supplementation [4].

Similarly, for treatment of enteroxemia, Hines made the following recommendations:

- Use of antitoxins against *Clostridium perfringens* type C and D as per the pharmaceutical manufacturer's instructions (subcutaneous administration of Ca 5 mL of type C and D antitoxin).
- Anti-biotic therapy for eg. Penicillin.
- Oral administration of antacids.
- Anti-bloating medication.
- Use of pain relievers for pain reduction.
- Intramuscular administration of thiamine (vitamin b1) to prevent or treat encephalomalacia.
- Supportive therapeutic approaches such as intravenous or subcutaneous administration of fluids and corticosteroids.
- Feeding with probiotics after antibiotic therapy to facilitate repopulation of beneficial intestinal microflora [5].

Prevention of clostridial infections in goats and sheep

It has been known that prevention of enterotoxemia is far more important than trying to treat the disease. There are basically two major enterotoxemia prevention methods in goats and sheep, which are dietary control and vaccination to the animals.

The enterotoxemia disease occurs when the numbers of *Clostridium perfringens* bacteria rapidly increases and the hosts immune system is unable to cope. This situation often occurs as a result of stress or a sudden change in diet, whereby maintaining a steady and consistent diet is vital for limiting the risk of the disease outbreak. When feeds high in sugar or protein content (high risk feeds) are fed to the animals, the producers should be careful and they should divide the daily ration into as small feedings as possible, in order to prevent overeating. In addition, roughages must be fed before offering high risk feeds to the animals. With respect to strategy of dietary modification, it has been emphasized to make sure that the animals are fed slowly and gradually [6].

Effective vaccines against *Clostridia* spp. have been available for vaccination of clostridial infections in goats and sheep. Establishment of larger commercial units are advised to meet the demand of regular vaccination against clostridial diseases. Lambivac (MSD Animal Health) or heptavac P (MSD Animal Health) is generally used for goats and sheep. Boosters should be given at least every 6 months, while the primary course is as indicated in the data sheet. A booster dose in pregnant does and ewes should be given 4 weeks prior to kidding, in order to boost colostral immunity.

The option of vaccination remains crucial for prevention of enteroxemia. Multiple vaccines are available for goats and sheep that induce immunity to the *Clostridium perfringens* type C and D toxins. Since these vaccines induce protection against three types of bacteria, namely *Clostridium perfringens* type C (causing enteroxemia), type D (causing enteroxemia) and *Clostridium tetani* (causing tetanus), they are often referred to as "three-way" vaccines. All the enteroxemia/tetanus vaccines need to be administered in two doses while initiating vaccination in a given adult goat or sheep, in order to induce immunity effectively. As far as frequency of vaccination is concerned, the doses and ewes are normally vaccinated with a gap or interval of 10 to 14 days. Once each adult goat or sheep received these two doses, subsequent repeat vaccination should be done at least once per year. Pregnant doses and ewes need to be vaccinated approximately one to two months before the expected parturition date, in order to maximize the quantity of antibodies in the colostrum (first milk). More frequent vaccination for enteroxemia may be warranted for growing adult goats and sheep as they are generally fed with carbohydrate or grain rich diets and for those animals which are allowed to graze lush pastures [7].

Feeding strategies for preventing enterotoxemia

Ruminant livestock such as goats, sheep and cow should not be allowed to ingest excessive amounts of feedstuffs that contain high proportions of grains, silage or hay, lush pasture, milk or milk replacer or protein supplements.

When the animals consumes such excessive levels of grains or nutrient concentrated feeds, rapid fermentation of starch in the rumen occurs and changes the usual intestinal bacterial environment *Clostridium perfringens*, the causative bacteria of enteroxemia are get triggered to proliferate explosively in the intestine and produce large amounts of toxins. In order to prevent this deadly enterotoxemia disease and its progression, the animals must be fed sufficient quantity of roughages and hays before feeding diets containing high levels of carbohydrate rich grains or protein. Certain complete feeds such as pellets can also trigger this disease if fed in excess amounts.

If animals have to be fed with the high-risk feedstuffs, then the daily allowance of these feeds per each animal must be divided into as many small feedings as feasible, rather than providing such nutrient dense feeds in a single, large meal. Feeding roughages or hays prior to feeding high amounts of concentrates or gains, makes the animals to become full beforehand. This would prevent the possibility of overeating on high-risk feedstuffs [8]. When the amount of grain feeding to a herd is planned, it is advisable to have gradual increment of grain quantity offerings spanning over several days, which can aid the beneficial intestinal bacteria to adjust and accommodate to the altering diet in the stomach and making it less likely for the troublesome bacteria to get access to the nutrients.

When animals are allowed to graze on pasture after they have been fed hay or other stored feeds, they should be allowed only for about 10 minutes of grazing time on the first day. Then on the next day, allow them double the time and with each subsequent day, which will take approximately one week for them to adjust onto the pasture feeding for a full 24 hours. Allow more roughage and less concentrated feed for heavy milking dams for restricting excessive milk production which may endanger their offspring [9].

DISCUSSION

Studies on feeding hay

The dietary and nutritional approaches to prevent and counter enteroxemia include providing dietary fiber of specific length of dietary fiber in the ration like for example hay, rather than in the form of finely ground fiber. Commercial processing of the grains for preparation of feeds is often proceeded by finely grinding the ingredients even if the hay is included. Elaborate research and development activities were taken up on these aspects of feeding hays, at the USDA agricultural research station in Beltsville, Maryland and the University of Delaware. These studies were focused on the development of necessary machinery for production of mobile "pelleted" or "wafered" forms of hay during field harvest as well as on the nutritional qualities of such densely packaged forms of hay. It appears that preparation of pellets having less than 1/2 inch diameter is a common commercial practice to facilitate packaging of bulky ground grains [10].

The study revealed that when the hay pellet diameter was at least 1 inch in diameter it has provided the necessary means of dimension and size for dairy cattle and goats to chew before swallowing.

This way of creating such need for chewing the lengthy fiber contents is beneficial for prevention of acidosis and enteroxemia. The studies have further revealed that a minimum of 17% fiber content in the daily ration of feeds is not sufficient enough and the fiber had to be of a minimum 1 inch in dimension to prevent acidosis in cows and goats. In Europe, the practice of feeding the pelleted hay having this large 1 inch diameter became popular under the name "cobs", while in USA, feeding of chopped hay in the form of "complete" ration after mixing with other grains especially for dairy cows was found to be more economical and equally effective in preventing acidosis. Goats are more fastidious when hay is fed and feeding in this form is wasteful as they keep searching for good palatable portion of grains. Therefore, in order to provide dietary fiber, another form of feed is necessary for effectively preventing health disorders and that has been demonstrated successfully with sunflower seeds [11].

Feeding sunflower seeds

The sunflower seeds have a unique characteristic of containing an ideal combination of highly nutritious content, in a high fiber wrapper. Sunflower seeds generally have two varieties namely, "striped" and "black". The difference between the two varieties is that the black seed has more fat content, while the striped seed has more of overall nutrient content. The sunflower seeds are very palatable, equal to a grain ration and attract goats.

Striped sunflower seeds are rich in dietary fiber, protein and fat content when compared to oats and corn. Regardless of the quantity of striped sunflower seeds that the goat could consumes, it provides adequate dietary fiber of almost 31% whereas oats and shelled corn supply only 12% and 2% of total dietary fiber, respectively. Therefore, striped sunflower seed is considered as ideally suited to prevent rumen acidosis. Similarly, the fat and protein content of sunflower seeds are 28% and 18%, respectively, compared to 6% and 14% in oats and 4% and 11% in corn, respectively. Thus sunflower seeds can be utilized as a "complete" grain ration substitute with additional benefits of sufficient dietary fiber to prevent acidosis and exteroxemia [12].

Sunflower seeds also have higher contents of Ca, P, K, Fe and Mn minerals than oats and corn while their metabolizable and net energy contents being in between that of oats and corn. Due to the presence of higher and yet balanced proportions of nutrients in sunflower seeds, they can potentially replace commercial grain ration either partially or completely. About one to three pounds of Sunflower seeds per day is usually sufficient to maintain high milk production among fresh goats and prevent the risk of enteroxemia. In fact, the milk production was found to increase by 13% in dairy cows when their rations were substituted with 10% sunflower seeds as observed in the studies at South Dakota State University. Normally, the goat feces are pelleted or in form of bowls but when they have loose bowls representing cow manure, then it is an indication that they are not consuming enough dietary fiber in their daily ration.

Practical considerations in feeding management for goats and sheep

Excessive intake of nutrient rich highly digestible grain ration predisposes the goats and sheep to enteroxemia outbreak and therefore the prevention strategy should include alteration of the feed and feeding schedule management as well as taking care by way of other measures such as securing proper fencing towards the top height and bottom gap, such that the goats may not accidentally breakout from their pens and come upon the feed stores containing sacks of commercial grain rations and feed supplements [13].

CONCLUSION

High milk producing dairy goats and sheep need supplementary grain ration in order to support milk output; however, care has to be taken to ensure that such goats do not over eat the grain ration. This can be achieved through preventing goats and sheep from escaping and discovering grain ration stores and develop and establish feeding schedule which enable supply of much needed long fiber that is usually missing in the grain ration. Long fiber can be fed to goats and sheep by offering appetizing and attractively smelling grass, alfalfa or clover hay. Commercial grain or home-mixed grain ration lacking long fiber leads to rapid gastrointestinal digestion of the grains thus providing favorable conditions for disproportional growth of pathogenic *Clostridia* bacteria species in intestinal population. This overgrowth of pathogenic strains release massive amount of toxic compounds in the ruminant's intestines, endangering their health and milk production.

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