Rebalancing th

Researchers explore how shifts in diet affect bacteria populations, rumen function and the incidence of bloat in grain-grazing cattle.

by ***Ed Haag***

It is no secret that serious bloat problems can develop when cattle change their diet from dry hay to grazing wheat.

Recently, in response to this issue, a research team led by Bill Pinchak, beef cattle nutritionist at the Texas AgriLife Research and Extension Center at Vernon, conducted a pair of studies using ruminally cannulated steers.

The results of both projects were presented at the 2007 American Dairy Science Association-American Society of Animal Science (ADSA-ASAS) conference. Both were designed to monitor and evaluate shifts in rumen bacterial populations associated with diet changes from Bermuda-grass hay to wheat pasture grazing during a 70-day period. The first specifically looked at bacteria populations in the rumen associated with bloat. The second evaluated the effects of supplementation with naturally occurring, condensed tannin extracts on those bacteria and the incidence of bloat.

"We see a change in rumen bacterial populations when cattle go from being fed Bermuda-grass hay to grazing wheat," Pinchak says. "These changes occur over about 30 days."

For Pinchak, the real "take home" news was that the bacteria distribution in steers that suffered from bloat was distinctly different from steers that were bloat-free.

"Bloat occurs when there is a shift in rumen microbial populations," he says, adding that the research confirms that wheat pasture bloat is most likely related to increased production of biofilm by specific bacterial species that capture rumen fermentation gases.

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In a normally functioning rumen, a population of bacteria, fungi and protozoa located in the forestomach helps the animal assimilate fibrous feed by predigesting this material. In the process, these microorganisms produce large quantities of gas that must be expelled.

In a non-bloat situation, the gas produced in the rumen separates from the solid and liquid contents and then rises to the top of the rumen, where it collects as a large bubble. When the gas pressure in the rumen reaches a certain level, receptors in the esophagus area sense the presence of pressure in the rumen. The esophagus then relaxes as the animal takes a deep breath, drawing the gas up the esophagus. Much of the gas enters the lungs, with the remainder being expelled through the mouth.

But before this action can take place, receptors in the walls of the rumen sense whether the pressure is actually caused by a free gas. If it is caused by a liquid or foam, the esophagus will remain closed and the belch will not occur. Researchers surmise that this mechanism is present to prevent fluid or foam from accidentally entering the lungs, causing aspiration pneumonia.

Rumen gases trapped

In a situation where bloat occurs, the expiry gas produced by the microorganisms fails to separate from the liquid in the rumen. Instead, it is trapped in the biofilm in the form of small bubbles. As more expiry gas is produced, a frothy emulsion, or biofilm, is formed consisting of rumen contents, fluid and the gas. This biofilm eventually fills the rumen and is detected by receptors in the rumen wall. Because they detect the frothy foam matrix and not a gas, the esophagus remains closed, preventing the animal from releasing the gas trapped in its rumen.

"In severe cases, animals can die from cardiac or pulmonary arrest associated with excessive pressure in the rumen," Pinchak says, noting that some animals can tolerate moderate frothiness of rumen contents without exhibiting bloat.

In addition to determining that the bacteria distribution in steers that suffered from bloat was distinctly different from steers that were bloat-free, the researchers also confirmed that feeding supplements

containing natural tannins did reduce the incidence and severity of bloat in study animals.

"We have found that these tannins have some antimicrobial activity at the rumen level," Pinchak says. "This applies, in particular, to *Streptococcus bovis*, a bacterium we know produces the low-gas-permeable biofilm synonymous with bloat."

He adds that he and his fellow researchers did identify a positive response to the supplementation. "There was a marked reduction in bloat with tannin supplementation," Pinchak says. "We saw an improvement in average daily gain (ADG) of between 15% and 20% during peak bloat season."

Positive response to tannins

Pinchak speculates that the likely causes of the improved gain were decreased methane production in the rumen and increased bypass protein. "In order to confirm, this will require more research," he says. "But those are the two most likely reasons for better average daily gain."

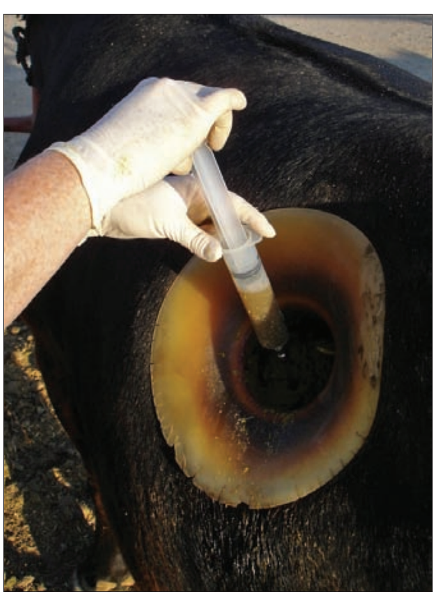
Meanwhile he and his research team do see similarities between the role tannin supplements play with grain grazers and the use of surfactants and ionophores.

"We find that the tannin behaves similarly to an ionophore, but for bloat it appears to be more effective," Pinchak says. "The daily gains we are seeing with tannin supplementation are higher than what we are seeing using an ionophore supplementation on wheat pasture."

The research team was also able to replicate this effect of tannin on the bacteria associated with bloat in the laboratory using a culture of rumen fluid extracted from a cannulated steer. "When we did in vitro analysis we found that we were able to inhibit the specific growth rate of *Streptococcus bovis* by exposing it to tannin," Pinchak says. "In a culture setting the specific growth rate was reduced by 85%."

He notes that this information could prove significant to the cattle industry, especially in the Southeastern Plains States. In north central and northwest Texas alone, where the practice of turning cattle out for grazing grain plants is common, Pinchak estimates that the cattle losses attributed directly to pasture bloat are $24 million a year. "Wheat pasture bloat is the major nonpathogenic cause of death in the Texas stocker cattle industry," he says, adding that it accounts for a 1%-3% death loss in cattle grazing winter wheat pastures.

Pinchak says that having a better understanding of the mechanisms that cause bloat and identifying an agent that inhibits the disorder are excellent first steps, but, he cautions, further research is required to determine the appropriate levels of condensed tannins for commercial applications that will require future Food and Drug Administration (FDA) approval as well as developing a practical self-fed supplementary delivery system.



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►Cannulated steers are instrumental in the monitoring of bloat-associated bacteria populations in the rumen.

He adds that these are basic requirements before his center's research translates into tangible dollar savings for the beef producer.

Tannins in another form

One area of inquiry that has been pursued by wheat researchers in Oklahoma is the possibility of developing a strain of wheat that has high enough levels of tannin to have a negative effect on bloat.

"Tannins are already present in many varieties of wheat," says Oklahoma State University (OSU) wheat breeder Brett Carver. "The red color in red wheat is due to tannins."

Carver believes that a high-tannin wheat variety, if and when it is developed, could play a very important role in controlling bloat in regions that are now plagued with the disorder. "We always look first for a genetic solution whether it is disease resistance, insect resistance or drought tolerance," he says. "In the long term it is the cheaper way to go and definitely lower maintenance."

Another aspect of the problem that lends itself to developing a high-tannin wheat is the capricious nature of bloat. While some feeding-related disorders in livestock are predictable and can be attributed to a single time or event, bloat is not one of them. Bloat can be triggered by a variety of stimuli, ranging from the maturity of the plants being grazed to changes in the intensity of the sunlight.

Because of this, predicting bloat is always an issue, and with it comes the question of when is it practical and cost-effective to supplement as a preventative measure. "With the necessary tannins already in the wheat this becomes a moot issue," Carver

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says. "The tannins will always be there when they are needed."

Unique collaborative effort

Because of the obvious advantages of growing wheat that already contains enough tannins to suppress bloat, the Oklahoma Wheat Commission provided seed money to initiate a study designed to measure tannin content and variability in wheat cultivars and experimental lines to determine the feasibility of using traditional breeding methods to give producers a passive choice to reduce the incidence of bloat.

Working at the U.S. Department of Agriculture–Agricultural Research Service (USDA-ARS) Grazinglands Research Laboratory in El Reno, Okla., in collaboration with a research team led by resident plant pathologist Charles MacKown, the scientists collected and analyzed plant samples from more than 200 diverse experimentals and four check cultivars. Carver notes that while the research team observed marked differences in tannic substances among the experimentals, they were unable to identify any specific line that had tannin levels and the specific attributes that would qualify it as a candidate that could produce bloat-free forage.

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He speculates that the next logical step in the quest for a high-tannin wheat is to expand the search for germplasm with the intent of identifying those experimental lines with the most abundant tannin levels that could be used in a traditional breeding program to increase the level of tannins in wheat forage.

Carver adds that one source of difficulty in the research, so far, has been the cost and time involved in testing plant tissue for tannins. He points out this could all change dramatically if the DNA marker for tannin in wheat was identified. "That would certainly change the picture," Carver says, adding that the testing procedures would be dramatically simplified.

Once the appropriate germplasm has been identified, Carver says that the plant breeding process can begin. "From that point it is an eight- to 12-year process to the point that a new variety of wheat is released," he says. "We are talking about a major commitment in time and resources."

With some estimates of national bloat-related losses topping $50 million annually, the money and energy spent on breeding a higher-tannin wheat variety might be well worth the investment.

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