

An Inside-Out Look at Ruminal Acidosis

Matt Wells, Dairy Nutrition Assistant, OMAFRA

Sub-acute ruminal acidosis (SARA) is a metabolic disease that can be difficult to spot, while silently affecting your bottom line. The development of a young calf's rumen depends primarily upon the calf's age and the pre-weaning feeding strategy (i.e. was adequate starter included?). Calves introduced to diets containing mostly concentrates, which rapidly ferment in the rumen environment, could be at risk for developing SARA, especially if the rumen is underdeveloped.

Feeding excessive high energy concentrates creates more volatile fatty acids (VFAs) than can be absorbed by the tiny finger-like projections on the rumen wall, called rumen papillae, as the feed ferments in the rumen. The three main VFA's are acetate, propionate and butyrate. VFAs are acidic and therefore excess can cause a drop in rumen pH. The literature varies on how severe and prolonged a drop in rumen pH must be before it is classified as SARA, but a conservative suggestion is a pH drop below 5.6 for a minimum of three hours. SARA reduces the diversity and changes the populations of the bacteria, which live in the rumen, and also causes changes to the cells lining the rumen. Understanding how SARA affects the biology of the rumen can improve awareness of proper feed management needed to avoid this metabolic disease.

Starting at the mouth, too many fine particles will cause inadequate chewing. Chewing is needed to produce saliva, which contains buffers such as bicarbonate and phosphate that help maintain normal rumen pH. In the rumen, these buffers bind the acidic hydrogen ions responsible for lowering the pH. It is important to note that the saliva of young calves contains a lower concentration of buffers compared with mature ruminants. Therefore, it is even more important that the diet contains some coarse feed, such as chopped straw or at the very least whole corn kernels, to encourage calves to chew their food.

Once the concentrates are in the rumen, bacteria quickly ferment the starch that produces the VFAs acetate, propionate and butyrate. The rumen becomes overwhelmed and unable to absorb all the VFAs produced. As the VFA load builds in the rumen, the result is a drop in rumen pH, causing a change in rumen bacteria once the pH falls below 6. The fibre digesting bacteria begin to die off first, reducing the animal's ability to digest fibre. When the pH drops below 5.5, a significant increase in the number of bacteria that make lactate, occurs. Lactate is a strong acid and is not as readily absorbed as acetate, propionate and butyrate and reduces the pH even more. When this situation happens, another group of rumen bacteria that consume lactate also begin to thrive and they can convert some of the lactate back to VFA's that are more readily absorbed by the rumen wall. However, it is important to know that lactate consuming bacteria reproduce at a slower rate than lactate producing bacteria, limiting their ability to stabilize rumen pH. Therefore, the production of lactate can prolong and worsen the downturn in rumen pH.

The cells that line the inside of the rumen wall are very specialized to allow functions like VFA absorption to happen. Butyrate is a key trigger to signal for normal rumen development to occur as the calf grows. However, a surplus of butyrate in the rumen leads to mixed messages when it comes to rumen cell development. Normally the cells lining the rumen have a closely regulated system that controls when the older cells die and when they are replaced by new cells. But, under conditions of SARA, the regulation between old cells and new replacement cells gets disrupted. SARA is believed to increase the rate of new cells developing, resulting in growth and reproduction of the cells lining the rumen.

Although the rumen finger like projections (papillae) on the rumen wall grow to improve the absorption of excess VFAs, the rapid cell turnover results in the hardening of the rumen papillae, known as rumenitis, the inflammation of the rumen. This is comparable to skin inflammation which over time leads to callous formation. The hardening may decrease nutrient absorption. Furthermore, the structure of the rumen wall lining begins to deteriorate when the inflammation happens. The result is that the rumen wall becomes more porous and rumen bacteria can pass through and enter the calf's bloodstream. Once in the bloodstream rumen bacteria can cause an assortment of complications including laminitis, inflammatory responses and potentially, liver abscesses.

One of the most obvious signs of severe acidosis is diarrhea with a bright yellow and foamy appearance. Although manure appears to have a liquid consistency, it has a greater dry matter content as less of the fibre is digested. The foamy appearance indicates that extensive fermentation is occurring in the intestines, known as hindgut fermentation. Hindgut fermentation produces not only VFAs, but also a variety of gases, including carbon dioxide. These gases show up as bubbles in the manure. Furthermore, the increased acidity of the hindgut leads to intestinal tissue damage. In order to protect the intestines from further damage, mucous is secreted. The presence of mucous casts in the manure indicates that intestinal damage has occurred and is easily visible in severe cases of acidosis.

To review, excess quantities of easily digestible carbohydrates results in a rapid drop in rumen pH and the subsequent changes to the rumen's cells and bacteria can have negative effects on the health of the calf. Remember, in order to reduce the risks of SARA some basic steps can be taken. First, include some form of roughage, such as chopped straw (minimum one inch in length), to provide a buffering action. Do not feed grains that are too fine as they will ferment extremely fast. Feeding whole grain at the very least will slow down the rate of fermentation, reducing the time and severity of the pH drop. Finally, spread out feedings and always have feed available to prevent the calves from slug feeding. Smaller, more frequent meals will reduce the overload of VFAs.

The key points to remember are:

SARA is a metabolic disease resulting from the rapid intake of easily digestible grains and the subsequent drop in rumen pH.

- The lowered rumen pH results in changes to the rumen bacteria.
- Excess VFAs in the rumen can trigger changes to the cells of the rumen wall lining.
- Changes to the rumen wall lining can allow rumen microbes to diffuse into the bloodstream, causing a variety of health problems throughout the body.

Feeding suggestions to lower the risk of SARA...

- Include some roughage, such as chopped straw, to stimulate chewing and provide buffering action.
- Do not feed grains high in fines as they will ferment extremely rapidly, feed more whole grains since they will ferment at a slower rate and further stimulate chewing.
- Spread out feedings and keep the bunk well managed. Smaller, more frequent meals will help prevent the overload of VFAs.

Matt Wells is a summer student who worked with Tom Wright, Dairy Cattle Specialist, OMAFRA and with Anita Heeg, Feed Ingredients and By-Products Specialist, OMAFRA, to write this article.