Alberta Dairy Management
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Rumen Acidosis

Rumen acidosis is the number one metabolic disorder diagnosed by the University of Wisconsin Veterinary College. Two types of acidosis are reported in the field: *acute* and *subacute*. Acute acidosis is less common but more severe. Affected animals are depressed, off-feed, have an elevated heart rate, diarrhea and may die. Cows experiencing subacute rumen acidosis have mild diarrhea, lower dry matter intake and hemorrhages in the hoof. Rumen pH drops below 6 and remains low for several hours. Volatile fatty acid (VFA) patterns shift to higher levels of propionic acid with an acetic:propionic ratio less than 2.2:1. Diagnosing subclinical acidosis in the field is a challenge. The following signs can be useful, but can vary and be caused by other factors :

- Cows experiencing laminitis and foot problems, especially first lactation and fresh cows.
- Cows fed more than 6 pounds of concentrate dry matter per meal.
- Increasing concentrate intake after calving faster than 1.5 pounds per day.
- Shifting dry cows to a high concentrate TMR after calving without a transition ration.
- Individual cows one full fat test point below the herd average (for example, cows below 2.6 when the herd averages 3.6 percent milk fat).
- Individual cows having milk protein tests > 0.4 percentage point higher than milk fat test (for example, a cow with a 2.7% milk fat test and a 3.2% milk protein test).
- Milk fat test returns to normal when buffer is added to the ration.
- Cows crave or selectively consume coarse long forage (straw or grass hay).
- Cows consume sodium bicarbonate free choice.
- Manure appears loose or watery.
- Hoof surfaces have horizontal ridges or lines.
- Less than half of the cows are chewing their cuds.

Wisconsin workers describe two types of subclinical acidosis. *Fresh cow acidosis* occurs 7 days before calving to 20 days postpartum and is related to a lack of a transition diet or problems at calving. These cows are at risk because the rumen papillae need time to elongate for optimum VFA absorption, rumen microbes must shift to digest high energy rations and dry matter intake slowly increases.

Adapted acidosis affects cows 40 to 150+ days in milk. Rumen adaptation should have occurred but these cows are receiving diets that are short in functional fiber, high in starch, or the feeding system allows for feed selection. Both types of acidosis can be occurring and require different strategies to correct.

Rumen carbohydrate metabolism

Carbohydrates contribute 70 to 80 percent of the diet dry matter while protein, fat and minerals make up the remainder. Carbohydrates are the primary energy source for the cow and support rumen function and microbial growth. Two carbohydrate categories are found in feeds: *cell solubles* (sugar and starch) and *cell wall* (pectin, cellulose, hemicellulose and lignin). These carbohydrates are digested by rumen microbes converting them to VFA (table 1) which are the main source of energy for the cow. When the VFA ratios and levels shift, milk yield and components change.

Rumen availability and digestibility of cell wall and cell solubles vary depending on growth stage and maturity (forages), source of carbohydrate (starch or cellulose) and processing (grinding of grain or chopping of forages). Table 2 illustrates the effect of grain source and processing on starch digestion in the rumen.

CLASS	CARBOHYDRATE PREFERENCE	NITROGEN NEEDS	MAIN VFA PRODUCED	pH RANGE	TIME TO DOUBLE (hr)
Fiber bacteria	Cellulose Hemicellulose	Ammonia	Acetic Butyric	6.0 - 6.8	8 - 10
Starch and sugar bacteria	Starch Sugar	Ammonia Amino acids	Propionic Lactic	5.5 - 6.0	1 - 2

Table 1 : Characteristics of rumen bacterial classes.

Volatile fatty acid production

The primary end products of microbial digestion are the volatile fatty acids: acetic, propionic and butyric. These VFAs are absorbed from the rumen and serve as a source of energy for the cow. When evaluating VFA patterns, the ratio of acetic to propionic or A:P ratio reflects the rumen fermentation pattern. Under optimal rumen fermentation conditions, the A:P ratio should be greater than 2.2:1. High levels of acetate can indicate a high fiber, low fermentable carbohydrate ration. High levels of propionic acid can indicate reduced fiber digestion and acidosis. VFA analysis in the field is not available, but it would be a useful tool to evaluate rumen fermentation and digestion.

Rumen pH effects

Fiber digesting bacteria growth is favored when rumen pH is between 6. 0 and 6.8 while starch digesting bacteria growth is favored by a pH from 5.5 to 6.0. Thus, the high producing cow must maintain a pH near 6.0 for optimal growth of both bacteria populations, resulting in a favorable VFA pattern and yield. Several factors impact changes in rumen pH :

- The type of diet can shift pH, with high forage rations favoring a pH over 6. Forages stimulate higher rates of saliva secretion and saliva contains bicarbonate which buffers the rumen and increases acetate production. Forage carbohydrates (primarily cellulose and hemicellulose) are not degraded as rapidly by the rumen microbes as are carbohydrates in concentrates (primarily starch and sugar). Legume forages also have a higher natural buffering capacity.
- Physical form of feeds (ground, pelleted or chopped) will change the size of the feed particle. If forage particle size is too short, a forage mat in the rumen cannot be maintained, fiber digestion is decreased and rumen pH is lowered. Saliva production is also reduced due to less cud chewing time. Cows will typically spend over 500 minutes of chewing time per day, 12 to 15 minutes of chew time per pound of dry matter, and 50 percent of the cows should be chewing their cuds when resting. If concentrates are ground too fine, starch is exposed to microbial digestion and increased degradation. Rumen pH drops and propionic acid production increases, changing milk components (lower milk fat percentage and higher milk protein percentage) and lower milk yield. Steam rolling, pelleting or grinding will change starch structure (more available in the rumen for fermentation) which can be beneficial (increases rumen microbial growth) or negative (increases the risk of rumen acidosis).
- Level of feed intake changes rumen degradation and synthesis. Rumen pH can drop as more substrate (such as starch) is available for microbial use increasing acid production (negative effect). The amount of saliva produced per unit of dry matter can also decline.
- Wet rations can reduce rumen pH due to less saliva production to wet the feed for swallowing. If the wet feed is silage, less chewing is needed to reduce particle size, lowering rumination time. Silage can have a pH below 4, increasing acid load. Adding sodium bicarbonate to corn silage, raising pH above 5 prior to feeding, increased intake. If total ration moisture exceeds 50 percent due to ensiled and fermented feeds, dry matter intake can be reduced.
- Adding unsaturated fats and oils (such as vegetable and fish oils) can reduce rumen pH and shift VFA patterns. Unsaturated fatty acids can reduce fiber digestibility, decrease rumen pH, be toxic to fiber digesting bacteria and/or coat fiber particles, reducing fiber digestion. Processing of oilseeds (such as grinding or extruding) can rupture the cell wall of the seed releasing the oil in the rumen. Feeding whole oilseeds can reduce this risk. Limit oil from oilseeds to 1 to 1.5 pounds per cow per day (0.5 pound if the oil was extracted and fed as free oil).
- The method of feeding will change the rumen environment. Total mixed rations stabilize rumen pH, synchronize degradable protein and fermentable carbohydrate availability, increase dry matter intake and minimize feed selection. If concentrates are fed separately, limit the amount to 6 pounds DM per meal, avoid high levels of starch-containing grains and evaluate the effect of feed processing.

	DRY ROLLED	STEAM ROLLED
	% OF STARCH DIGESTED IN RUMEN	
Corn	75	85
Barley	79	85
Wheat	88	88
Oats	93	94

Table 2 : Rumen starch digestion of grains.

adapted and condensed from an article by :
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