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FACTORS THAT CONTRIBUTE TO SUBACUTE RUMINAL ACIDOSIS

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General Approach to Field Investigations

In field investigations of suspected ruminal acidosis problems, we have found it practical to perform rumenocentesis on two groups of cows. The first group includes periparturient cows, usually between 3 to 20 days-in-milk. A diagnosis of subacute ruminal acidosis in this group will focus the investigation on ration adaptation problems and concentrate overfeeding to early lactation cows. The second group includes cows that are at or near peak milk. A diagnosis of subacute ruminal acidosis in this group will focus the investigation on ration formulation errors and feed delivery problems. By testing representative cows from each of these groups, a herd-based acidosis problem can be localized and identified quite efficiently.

Periparturient Cow Factors

Periparturient cows are at particular risk of ruminal acidosis because of two main reasons. First, the rumen and rumen microbes need to adapt from a very fibrous dry cow diet to the high energy lactation diet in a short period of time. Second, the periparturient cows reduces her intake of feed shortly before and after calving and many dairymen feed excess concentrates during this period of low intake.

Adaptation to high starch rations

Much research work on rumen acidosis has emphasized the adaptation of the rumen microbial population to increased levels of concentrates. Shifts of microbial populations include changes in the concentration of bacteria, as well as changes in the predominant genus and species. Bacteriological studies suggest that about 21 days are required to accomplish these changes and that concentrate levels should be increased at 5 to 7 day intervals throughout the period (Mackie and Gilchrist, 1979).

Dirksen et al. (1985) have emphasized the importance of adaptive changes of the rumen mucosa in the prevention of acidosis. Mean surface area of rumen papillae will increase from 10 mm^2 to 60 mm^2 when exposed to high concentrate rations, but the process takes from four to six weeks. The larger surface area of adapted papillae is related to increased VFA absorption rates three

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times greater than rates for unadapted, smaller papillae. If papillae have not elongated, rumen pH can fall, not due to excess production, but because of accumulation in a rumen poorly prepared to remove VFA's.

The take-home message is that the adaptation of microbes and papillae appropriate for a forage-predominant ration to a system capable of utilizing a high-energy lactation ration requires gradual changes over a period of more than three, and perhaps as much as six weeks of time.

Management of the adaptation from dry cow to lactation rations

As total mixed rations (TMR) have been increasingly adopted by smaller dairy herds in the upper Midwest, it has become a common practice to prepare one ration for the entire lactating herd. The single lactation TMR has made difficult the gradual introduction of concentrates to individual fresh cows in the weeks after calving. The single TMR can create acidosis problems for unadapted fresh cows and is necessitating the creation of transition rations between the dry cow and lactation ration.

Guidelines as to the maximal acceptable change between rations are scarce. Elam (1976) has recommended that the net energy of a ration can be safely increased about 10% at a time. For example, a change from an energy density of 0.70 mcal/lb. to 0.77 mcal/LB would be viewed as safe. National Research Council (NRC) recommended dry cow rations would have 0.58 mcal/LB and many lactation TMR rations have 0.78 mcal/lb. (NRC, 1988). Observation of the 10% guideline would require two intermediate rations.

However, practical experience suggests that most dry cow rations exceed 0.58 mcal/lb. The issue is not how many rations are fed. Rather, the issue is how great is the change. For example, if the early dry cow ration is estimated at 0.65 mcal/LB, a single intermediate ration accommodates the 10% guidelines.

Periparturient depression of dry matter intake

For years, dairy operators have been told to minimize the "negative energy balance" of early lactation and have attempted to maximize concentrate intake in early lactation. Field recommendations for the feeding of component-fed concentrates during the first three weeks are commonly excessive. For example, it is common to find cows fresh 7 days consuming 9 kg of dry matter from concentrates. Rations like these rarely meet the NRC (1988) fiber guidelines for early lactation cows because very little additional forage will be consumed. Cows at week one post-partum may be consuming only 13.5 kg DMI according to DMI prediction equations published by Kertz et al, (1991). Table 1 lists daily DMI for two example cows at each week post-partum for four weeks.

Unlike the traditional prediction equations for DMI, these equations address the dynamic changes in intake in the immediate post-parturient period.

Table 1. Dry matter intake predictions[8]

Week post-partum	First lactation, 550 kg BW[a], DMI,kg/day	Later lactation, 614 kg BW[b], DMI, kg/day
1	13	15
2	14.5	17
3	16	18.5
4	16.5	19.5

[a] First lactation cow expected to peak at 36 kg of 3.5% fat milk
[b] Mature cow expected to peak at 45 kg of 3.5% fat milk

Occasionally, the same situation applies to dry cows on component-fed "steam-up" rations. Bertics et al. (1992) has shown significant reductions in DMI in the last few days prior to parturition. If component-fed concentrates are consumed and "free-choice" forages refused as DMI drops, the dry cow may experience acidosis prior to calving.

Ration Formulation And Delivery Factors

Formulation issues

The risk of rumen acidosis comes from the rapidly fermented carbohydrates of starch, sugar, and pectin. Because analyses of these non-fiber carbohydrates in feedstuffs are not readily available, ration analyses focus upon various fiber measurements that measure cell wall carbohydrates of lignin, cellulose, and sometimes hemicellulose. Recommendations for fiber content of dairy rations have been developed by the National Research Council (1988). Modifications of these recommendations for typical dairy rations in the Midwestern USA are found in Table 2 (Shaver, 1993).

Table 2. Fiber guidelines for diets of lactating dairy cows

Fiber analysis	Minimum fiber as a % of dry matter
Crude fiber	15-17
Acid detergent fiber	19-21
Neutral detergent fiber	27-30
Neutral detergent fiber from forage	21-22

The National Research Council (1988) recommend that fiber guidelines should be modified for fiber type, particle size and distribution, total dry matter intake, bulk density of ration, buffering capacity of the forage, feeding frequency, and body condition and production level of the animal. Practices such as excessive mixing of total mixed rations and infrequent feeding of large meals increase the fiber requirement of a ration, even though the chemical analysis of the ration meets recommended nutrient densities. Our field experience suggests that it is uncommon for ration advisors to modify fiber recommendations to account for any of these factors.

Grain moisture and processing

Any process that makes starch granules more available for microbial digestion increases the risk of ruminal acidosis. In most cases, increased processing increases digestibility and potential animal performance, but also increases the risk of acidosis. Fine grinding, heat and pressure treatments like steam flaking, and high moisture storage of any grain will make the ration more likely to cause acidosis than if the dry, coarsely ground form of the grain is fed (Owens et al., 1998)

High fat content of the ration

High fat diets reduce the number of protozoa in the rumen. Protozoa engulf starch particles, reduce rumen bacterial numbers, retard acid production, and stabilize ruminal fermentation (Slyter, 1976). High levels of added fat (over 0.9 kg/cow/day) can tip a fiber-marginal ration into a problem zone.

Buffering capacity of feeds

Legume forages and high protein feeds have more buffering capacity than grains, low protein feeds and grass forages (Jasaitis, 1987). Two rations formulated to the same nutrient specifications, one based on grass silage and another based on alfalfa silage, will have different buffering capacities and cows on the alfalfa ration will be less likely to experience acidosis.

Short forage particle size

Forages that have been reduced to small particles will be less effective in stimulating rumination which will result in less saliva production. For example, cows produced 0.94 ml saliva/g of fresh grass, 1.13 ml/g of silage, and 3.25 ml/g of dried grass hay (Bailey, 1958).

Many nutritional advisors in the US carry particle separation boxes and have made particle size analysis a routine part of their service to dairy farms. The method focuses upon the proportion of "coarse particles" in the feed, that is, particles that remain on the screen with holes of 3.8 cm diameters. General guidelines have been developed for alfalfa silage that suggest that 15-25% of the forage should remain on the coarse screen. Guidelines for corn silage are less well developed, but many advisors have a goal of 5-10% of the corn silage as coarse particles.

Similarly, the usual target for TMR samples is 7-10% of the complete ration on the coarse screen. Sometimes the TMR fails this test because of the component silages that go into the mixer, but sometimes they fail because of excessive mixing times.

High dry matter intake

Ruminal pH is profoundly influenced by the total intake of ration. In unpublished data where the same TMR diet was fed at different rates, mean daily ruminal pH averaged 5.7 on the high intake group and 6.1 on the group where intake was limited to 75% of the high group intake. The take-home point is that as dairy genetics gives us cows capable of eating more and more feed, the risk of acidosis will continue to increase even though the same ration is fed.

Rapid increases in feed intake

It is common for researchers to induce ruminal acidosis by withholding feed for a period of 12 hours and then allow hungry animals to eat up to 150% of their normal day's ration. Situations where the interval between meals is increased will place the herd at risk of subacute acidosis. In hot weather, cows sometimes avoid the feedbunk during the day, but overeat in the cooler nighttime hours. Rapid increases in barometric pressure or reductions in humidity may stimulate cows to overeat and experience acidosis. Some sophisticated dairy managers have placed rules to the feeders that total feed intake per cow cannot be increased more than 5% in any single day, regardless of the appearance of the feedbunks.

Unbalanced TMR's due to feed moisture changes

Deviations from the desired ration nutrient content commonly occur because of failure to adjust for changes in the moisture content of forages. Our field experience suggests that a minority of TMR operators monitor moisture of forages on an at-least weekly basis. The majority of dairy operators do not monitor moisture, but observe the rate at which cows clean up the bunk and adjust the forage weight of the next batch. In the upper Midwest, the predominant forage is alfalfa haylage. If cows clean up the TMR feeding quickly, the weight of as-fed haylage is increased in the next batch mix. Conversely, if TMR is left, forage is reduced in the following batch. The practice is conceptually correct if the observed change in consumption is due to dry matter changes in the forage. However, if the change in consumption is due to anything other than the forage dry matter, the subsequent adjustments are incorrect. If the group of cows reduces its DMI and the dairy operator subsequently reduces haylage in the TMR, the ration usually becomes fiber deficient. Routine monitoring of the dry matter content of feed ingredients is an important task of TMR management.

The usual objection to monitoring forage dry matter is the time required to perform the test. Dairy extension services commonly recommend the use of a microwave oven for the determination. Oetzel et al. (1993) have compared a variety of methods. The use of an electronic meter (1210 Silage Tester; Farmex Inc., Aurora, OH) required the least operator skill and time, and accuracy was acceptable for haylage and high-moisture shelled corn. The electronic tester can help overcome objections to performing the test and reduce the risk of inappropriate TMR adjustments.

Delivery system factors with component-fed systems

Field investigators have long recognized the special risks of acidosis of component-fed rations. The risk of acidosis is reduced if the concentrate portion of the ration is 3 or 4 smaller portions per day, rather than larger portions delivered in two feedings.

Anecdotal information abounds about the impact of feeding sequence on acidosis. The general opinion is that some quantity of forage should be fed prior to concentrate meals, particularly in the morning feeding. We have observed problems with subacute acidosis when the interval between the morning concentrate feeding and a subsequent forage feeding exceeds two hours.

Some component feeding systems deliver forages in a competitive bunk area, but offer concentrates in individual stalls. This can place younger, timid cows at risk as they can consume full feedings of concentrates, but less forage than needed.

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