Rumenocentesis: A Technique for Collecting Rumen Fluid for the Diagnosis of Subacute Rumen Acidosis in Dairy Herds

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Introduction

Chronic subacute rumen acidosis is a common cause of significant dairy herd production and health problems. Subacute acidosis can be defined as a temporarily altered rumen fermentation rate or pattern which causes an accumulation of fermentation end products in the rumen, a decrease in rumen pH, and changes in the microbial population distribution; but the aberration is not severe enough or of sufficient duration to cause overt, pathognomonic clinical signs in the animal. Clinical signs of subacute acidosis may be most recognizable as a herd profile. Acidosis should be considered in the differential diagnosis of any herd profile that includes laminitis, poor appetite or cyclical feed intake, poor body condition in spite of adequate energy intake, hemoptysis, unexplained abscesses, intermittent diarrhea, and high herd cull rates for poorly defined health problems.

Although subacute rumen acidosis is common, the syndrome is frequently not recognized by veterinarians and nutritionists alike because the onset of clinical signs of subacute acidosis in the individual cow is usually separated from the inciting events by weeks or months. As a result, traditional diagnostic tests are usually performed after the fact and are either inconclusive or mislead the clinician to think multiple etiologies must exist to explain the herd symptoms. Similarly, nutritional analyses focus upon determination of the fiber adequacy of the ration of the highest production group on the dairy and fail to address the dynamics of rumen adaptation, the implications of low dry matter intake in the periparturient period, and variables such as ration structure (TMR vs component), feed delivery schedules, grain type, and particle size. Therefore, fiber estimations are an incomplete analysis.

The most definitive diagnostic test for subacute acidosis is pH determination of samples of rumen fluid from subgroups of cows at high risk for acidosis. This paper will discuss collection of rumen fluid by various methods, describe a collection technique by percutaneous needle aspiration or rumenocentesis, and will comment on interpretation of rumen pH results from a herd perspective.

Collection Techniques

The traditional method of rumen fluid collection is through various stomach tubes. The weighted stomach tube and the guidable probe[1] are both improvements over unmodified tubing. The weighted stomach tube is simple and inexpensive, but its position in the rumen cannot be determined or controlled, penetration of the mat layer is difficult, and the sample can become contaminated with bicarbonate-rich saliva. The guidable Dirksen probe allows some control of position within the rumen and can penetrate the mat layer, but the problems of saliva contamination and position determination remain.[1] In addition, the instrument is relatively expensive and unwieldy to carry within typical veterinary practice vehicles.

Because of these problems, rumenocentesis is the authors' method of choice for rumen fluid collection. Rumenocentesis was described in German literature in 1984,[2] but has not been adopted by practitioners. The technique is simple and inexpensive to perform and offers several advantages over stomach tubes. The sample can be collected from a relatively consistent location within the rumen, and most importantly, the sample is not contaminated with saliva.

The authors have compared the pH of rumen fluid collected with a Dirksen probe and rumenocentesis. Results from five cows in a single herd are presented in Table 1. The samples collected through the Dirksen probe were, on average, 1.1 pH units higher than rumenocentesis samples with differences ranging from

Table 1. Comparison of pH measurements by collection method.

Cow ID	Dirksen probe	Rumenocentesis
3	6.5	5.7
31	6.2	5.3
33	6.8	5.3
44	7.0	5.3
67	6.8	6.2

0.6 to 1.7 units. The differences can be accounted for by variations in collection site within the rumen and in the amount of saliva contamination. The pH of rumen fluid has been shown to vary by location within the rumen.[3] Given the limited positional control provided by the probe, intraruminal pH differences could add variability to the data. Dirksen and Smith[1] demonstrated that samples collected with a Dirksen probe averaged 9.9% saliva contamination with a range of 2-30%. Other variations of stomach tubes tested had similar or more saliva contamination compared to the Dirksen probe. It is difficult to estimate the actual pH of the rumen based on a sample of rumen fluid containing an unknown quantity of saliva.

Because rumenocentesis is an invasive procedure, there are risks to the animal associated with the technique. Potential adverse side effects include peritonitis, abscess in the body wall, and injury due to restraint. In the authors' experience with several hundred collections in a research trial, subcutaneous abscess at the puncture site has developed in 1-2% of animals sampled, but no other side effects have been observed.

Rumenocentesis requires more animal restraint than oral collection, both for the safety of the clinician and the animal. Kicking and jumping animals make collection more difficult and associated movement of abdominal muscles will sometimes bend the needle. Movements capable of bending needles increase the risk of rumen wall lacerations.

Rumenocentesis

Stated simply, rumenocentesis involves inserting a needle into the ventral rumen and aspirating a sample of rumen fluid. The specific method used by the authors is outlined as follows:

Equipment

1) 16 gauge 5 inch stainless steel needle
2) Syringe (eccentric tip)
3) Clippers
4) Surgical scrub
5) Hobbling device
6) Sedation
7) pH meter or pH paper

Procedure

The site for collection is approximately 15 to 20 cm caudoventral to the costochondral junction of the last rib (Figure 1). The ventral sac of the rumen should be identifiable beneath the body wall. The site is clipped and prepared using a standard three scrub surgical preparation. Light sedation is recommended but not essential. The authors use 20-25 mg Xylazine IV for 1300-1400 lb Holstein cows. Hobbling the rear legs is strongly recommended. Using a rope in a figure-eight hobble around the hocks allows the legs to be tied closely together, effectively limiting leg motion. While an assistant elevates the cow's tail, the needle is inserted through the skin only. The animal will usually object the most when penetrating the skin. When the animal is calm, the needle is inserted to the hub with a smooth thrust. With the needle in the rumen, rumen fluid is aspirated with a 10-20 ml eccentric tip syringe. The needle will occasionally become obstructed by ingesta which can be cleared by forcing a small volume of air through the needle. By orienting the syringe with the eccentric tip on the upper side, collected fluid can be retained in the syringe while clearing the needle with air. When the needle becomes obstructed, it is important to avoid creating a negative pressure within the syringe as CO_2 will leave the fluid and increase the pH. Typically, 3 - 8 ml of rumen fluid can be collected without difficulty. When a sufficient volume has been obtained, air is evacuated from the syringe and the pH is measured immediately. Because of greater precision, pH meters are preferred over pH indicator paper. Compact, field-ready pH meters that require only a small volume of fluid are available for a modest price (Figure 2)[a] Narrow range pH paper can be an acceptable substitute for a pH meter. Narrow range papers that span a pH range of 4.0 to 7.0 and show gradations at 0.2-0.3 units are adequate.[b]

Time of Collection

Rumen fluid pH drops following a meal and usually returns to the initial level within about 12 hours. To evaluate potential acidosis, rumen fluid should be collected when the pH is expected to be at or near its

[a] Cardy Twin Soil and Water pH Meter; Spectrum Technologies, Inc. Plainfield, IL

[b] S/P pH Indicator Strips, Scientific Products, Inc., Minneapolis, MN

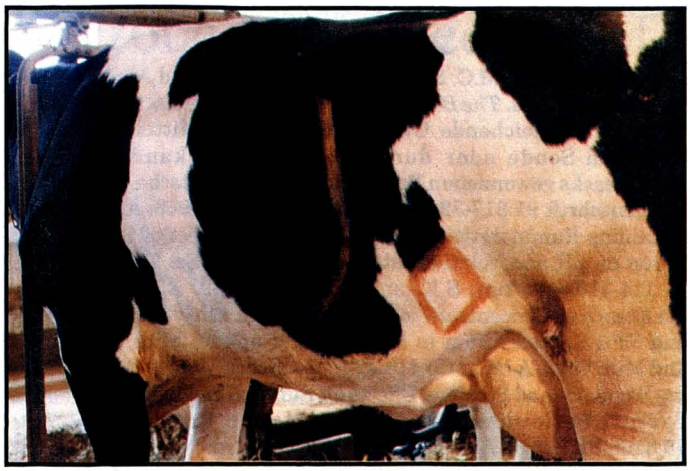

Figure 1.

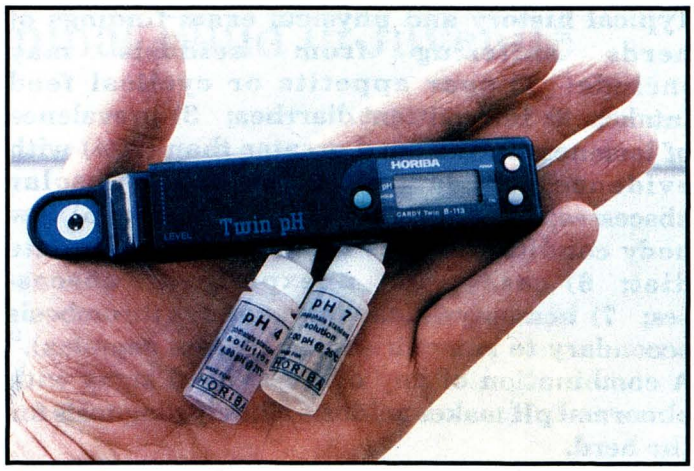

Figure 2.

nadir. The time of the nadir cannot be predicted precisely, but we offer the following guidelines. In herds where rations are fed as separate components, samples should be collected 2-5 hours following the primary concentrate meal. In herds fed a total mixed ration twice a day, samples should be collected 5-8 hours post feeding.[4,5,6]

Animal Selection

Individual cows in subgroups at risk of acidosis are chosen randomly. Herd records can identify cows in the late dry period, postpartum, and early lactation stages. The late dry period will include cows within 14 days of their anticipated next calving. We classify postpartum cows as 1 to 14 days in milk, but we will sample cows up to 21 days in milk if cow numbers are small. The early lactation cows are 21 - 60 days in milk. Six cows in each stage should be viewed as a minimal sample size to evaluate the group status. Two sampling days may be required to obtain six samples from subgroups in smaller herds. If samples are collected on different days, it is important that the samples be collected under similar conditions relative to feeds and feeding times.

Interpretation of Rumen pH

Rumen Ecology

A basic knowledge of the cascade of events leading to rumen acidosis is necessary to understand the implications of the range of pH values obtained from a herd. A brief summary of rumen ecology as it relates to the adaptation of the rumen to concentrate feeding and to acidosis is presented here.[7,8,9,10,11] The rumen evolved to digest cellulose slowly. In situations where cellulose is the primary carbohydrate source, energy is the limiting nutrient for microbial growth. Addition of a relative excess of rapidly fermentable carbohydrates removes the energy limitation and disturbs the balance between production and absorption of fermentation end products. As organic acids accumulate in the rumen, the pH decreases. The changes in pH and nutrient limitations exert selective pressure on the microbial population. With successful adaptation to a well balanced ration, the changes in the microbial population will occur gradually and permit a stable fermentation process to continue with only minor perturbations. With poor nutritional management, the changes will be sudden and severe, resulting in dramatic shifts in the types of volatile fatty acids produced, microbial numbers and species, and pH. The process of adaptation to concentrates is as important as the amount of concentrate fed.

Guidelines

The complex and dynamic nature of the rumen makes interpretation of rumen pH somewhat difficult. Acidosis should be thought of as a continuum of degrees of ruminal acidity.[10] The gradual nature of the adaptation process, the variation in animals' feed intake rates, and the biological variation between animals means there will be a range of pH values within a feeding group. The authors recommend the following ranges for classifying observed pH values:

≤5.5	abnormal
5.6-5.8	marginal
≥5.8	normal

It is important to avoid making a herd diagnosis based upon a single sample. If more than 30% of the samples in a sub-group have a pH less than or equal to 5.5, the group can be considered abnormal. Classifying the group as abnormal is saying that enough cows have an unstable rumen environment that detrimental effects on the health and production of the herd are likely. No test can be interpreted in isolation. The pH data must be considered a "test" to be interpreted in conjunction with the "physical exam" of the herd.

Typical history and physical exam findings of herds suffering from acidosis may include: 1) poor appetite or cyclical feed intake; 2) intermittent diarrhea; 3) prevalence of lameness in the herd greater than (20%) with evidence of laminitis and/or subsolar abscesses; 4) a cull rate of 45% or more; 5) low body condition scores on an energy adequate diet; 6) cases of unexplained abscesses; 7) hemoptysis (caudal vena cava thrombosis secondary to rumenitis/liver abscess complex).[12] A combination of any of these herd signs with abnormal pH makes acidosis a likely diagnosis for the herd.

Conclusion

Subacute acidosis is a common and serious problem in the dairy industry. Measuring rumen pH is a useful ancillary test in the diagnosis of subacute acidosis. Rumenocentesis is the easiest way to collect a rumen fluid sample free of saliva contamination. Acidosis occurs over a range of pH, therefore data must be interpreted at the herd level and in conjunction with other herd information.

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