Acidosis in Cattle: An Overview

Rick Stock, *PhD*
Cargill Corn Milling
8009 Lowell Ave
Lincoln, NE 68506

Introduction

The cattle feedlot and dairy industries in the United States have evolved to intensively managed systems using grains as the primary source of energy. Grain feeding developed primarily because production exceeded demand for the crop and thereby lowered its market value. The combination of low grain price and high energy density has resulted in economical costs of production for feedlot and dairy operations.

In feedlots, grains are easier to store, handle, and mix in diets compared with bulky, lower energy forages. Even in times of high grain prices, grain has continued to be fed to cattle during the finishing period because consumers in the United States prefer the taste and flavor of grain-fed beef and have been willing to pay a premium for Choice grade beef. In dairies, milk production (lb per head per day) continues to increase due to improvements in the genetic potential of the cow and use of metabolic modifiers. The increased milk production requires the cow to consume large quantities of energy daily. Grains have been the most economical source of energy for dairy operations. Therefore, the feeding of grains to feedlot and dairy cattle appears likely to continue for a long time to come.

As with all feedstuffs consumed by ruminants, grains are subject to microbial fermentation in the rumino-reticulum part of the stomach complex. Ruminants evolved digesting forages. Therefore, digestion of grain by the ruminal ecosystem is a relatively foreign situation. Consumption of large, single meals and microbial fermentation not only favored energy and protein utilization of forages, but also allowed ruminants to survive from other predators. However, these feeding habits create problems when high grain diets are fed. The microbial fermentation of starches contained in grains can proceed too rapidly causing the rumen to become acidotic. The severity of the acidosis may range from mild to life threatening. Genetic selection of beef cattle over the last 50 years has done little to reduce the incidence of acidosis. Possibly, the selection of Holsteins for increased milk production may have indirectly selected for decreased acidosis by increasing saliva flow (bicarbonate buffer) and increasing rate of passage.

In many situations, the consequences of acidosis affect feedlot cattle and dairy cattle similarly. However, there are also unique feeding and management differences between these two industries. In general, I will discuss the two industries together. Where specific feeding and management differences occur, I will discuss these livestock industries separately.

Acidosis Defined

For this discussion, the definition of acidosis is "an array of biochemical and physiological stresses caused by rapid production and absorption of ruminal organic acids and endotoxins when an animal over consumes a meal of readily fermentable carbohydrates. Acidosis is an array of stresses and is not confined to a single symptom such as ruminal pH." This definition is a collective term for all associated facets and includes the effects of organic acid production, ruminal pH, salivary flow, rate of passage, starch fermentation, feed intake, etc. This definition is an attempt to explain feeding problems related to ruminal acidosis, but does not necessarily include the effects of metabolic acidosis. The term organic acid, rather than just lactic acid production, was chosen because the problem of acidosis is a result of overproduction of organic acids produced in the rumen and not just lactic acid, and certainly not just the D-isomer of lactic acid. Acidosis is difficult to measure in cattle operations. Even in metabolism studies, it is difficult to measure all the effects of acidosis, because as ruminal pH declines, cattle adjust by decreasing feed intake and altering eating patterns.

Ruminal acidosis is associated with many feedlot and dairy problems that have a major impact on the profitability of these industries. Brent[3] detailed founder, polioencephalomalacia (PEM) and ruminitis as feedlot problems related to acidosis. Certainly, hoof problems associated with founder are critical issues within the dairy industry as well. Britton and Stock[5] added sudden death syndrome, reduced feed intake, reduced absorption, liver abscesses, grain bloat, and clostridial infections to the list of acidosis related problems. Reduced feed intake results in reduced gain and efficiency and severe feed aversions may additionally result in decreasing the animal's overall health status. There are probably other physiological disorders that are related to acidosis. Most of the feeding management recommendations that feedlot and dairy nutritionists make today are to avoid acidosis. Therefore, acidosis is the most important nutritional problem that feedlots face daily and is a major challenge for dairies as well.

Acidosis is not one disease, but rather a continuum of degrees of acidosis. For simplicity, I have characterized acidosis as acute and subacute based on overt clinical symptoms. The actual ruminal pH where subacute becomes acute is difficult to determine and probably not very important.

Acidosis – Feedlot Economics

Actual economic losses associated with acidosis are difficult to adequately assess. Brink *et al*[4] categorized liver abscesses from 0 (none), A-, A, to A+ (severely abscessed) in individually-fed cattle (Table 1). Cattle with A+ liver abscesses exhibited reduced daily gain (16.1%), feed intake (5.1%), feed efficiency (13.9%), and dressing percentage (2.4%) and increased cost of gain ($7.61/cwt). Montgomery,[29] using ten pens of commercially fed cattle, noted similar carcass trends. Cattle with A+ liver abscesses had less dressing percentage (61.0 vs 62.9%) and more total carcass trim (.3007 vs .0256%) compared with cattle having no liver abscesses.

Attempts to determine the economic loss from subacute acidosis have been made under a variety of dietary studies. In the first study, cattle were fed dry rolled wheat diets containing either 0 or 7.5% roughage.[38] Wheat starch is rapidly fermented in the rumen and causes acidosis easily. Addition of roughage to wheat diets reduces acidosis. In this study, roughage increased intake, gain, and efficiency and decreased cost/gain. In this trial (Table 2), the effect of acidosis in the all wheat diet was a loss of approximately $9.40 per steer (assuming 400 lb of weight gain). The performance obtained from the cattle fed wheat and no roughage was very acceptable and similar to predicted performance,[30] which emphasizes the point that subacute acidosis is an insidious problem that is difficult to detect.

In a second series of studies, wet distillers byproducts (wet grains and thin stillage) replaced approximately 50% of the grain in a dry-rolled corn finishing diet. Diets were fed to three groups of yearling steers over a three-year period. Steers were implanted and fed monensin and tylosin.[19, 23] Cattle fed wet distillers byproduct gained faster (10.5%) and more efficiently (19.2%) than cattle fed the dry rolled corn control (Table 3). The improved feed efficiency agrees with results previously reported by Farlin[14] and Firkins *et al.*[15] To place these results in perspective, the improvement in gain and efficiency are greater than most results obtained in clearance studies for new implants and feed

Table 1. Feedlot performance and carcass characteristics by severity of liver abscess score[a]

	Liver abscess severity[b]			
Item	0	A-	A	A+
No. of steers	405	52	37	72
Initial wt, lb	671	704	695	684
Final wt, lb[c]	1034	1065	1049	1014
Adjusted final wt, lb[d]	1027	1058	1041	981
Hot carcass wt, lb	636	656	645	607
Dressing percentage	61.5	61.6	61.5	60.0
Daily DM intake, lb	18.46	18.19	18.52	17.51
Daily gain, lb[e]	2.73	2.68	2.66	2.29
Feed/gain	6.62	6.71	6.90	7.69

[a]Data from Brink *et al.*[4]
[b]O = unabscessed liver; A- = one or two small abscesses; A = two to four small, active abscesses; A+ = one or more large, active abscesses.
[c]Live weight recorded approximately 24 hours before slaughter.
[d]Live weight estimated from hot carcass weight with 62% dressing percentage.
[e]Calculated with adjusted final weight.

additives when compared to nontreated controls. The wet distillers byproducts contained 48% more net energy than corn. The wet distillers byproduct contained approximately 29% fiber (NDF), 22% crude protein, 14% starch, 12% fat, and 11% ethanol. Because cattle of similar type and weight have not responded to additional escape protein,[34] the improved gain and efficiency from feeding wet distillers byproducts is not likely due to a protein deficiency. The additional energy from the fat would only account for 9% more energy than corn. The ethanol would be rapidly absorbed from the rumen and metabolized to acetate. The additional energy extracted from ethanol would only account for 2 to 5% more energy than corn. A major factor appears to be reduced subacute acidosis as the result of replacing starch (corn) with a highly digestible corn fiber. Whether subacute acidosis accounts for 30% of the improved efficiency or 70% is probably not important. The most important conclusion is that the importance of subacute acidosis in typical feedlot diets has been underestimated because it is not easily observed or measured.

Acute Acidosis

In acute acidosis, the animal may be sick to the point of death or may have impaired some physiological function, like absorption.[1,25] Animals that have been severely foundered, have severely abscessed livers, exhibit signs

Table 2. Grain type and roughage level on feedlot performance and cost of gain[a]

	Dry rolled corn		Dry rolled wheat	
Item	0% roughage	7.5% roughage	0% roughage	7.5% roughage
Daily DM intake, lb				
Complete diet	22.88	26.25	21.21	22.46
Concentrate portion[b]	21.56	23.50	20.04	20.13
Daily gain, lb[c]	4.00	4.20	3.43	3.76
Feed/gain	5.71	6.22	6.22	6.01
Cost/gain, $/cwtd[d]	41.11	43.15	45.50	43.16

[a]Data from Stock *et al.*[38]
[b]Includes dry matter contributed from grain, molasses, dry supplement, and corn silage (multiplied by .5).
[c]Based on carcass weight adjusted with 62% dressing percentage.
[d]Ration cost = $5/cwt; yardage, interest, health costs = $.50/day.

Table 3. Effect of wet distillers byproduct on finishing performance[a]

Item	Control	40% wet distillers byproduct
Daily DM intake, lb	24.88	22.67
Daily gain, lb	3.50	3.82
Feed/gain	7.13	5.95
Improvement, %		
Diet	---	16.5
Distillers vs corn	---	47.0

[a]Data from Larson *et al*[28] and Ham *et al.*[19]

of PEM, or died from grain bloat likely have also experienced acute acidosis. These problems, except for impaired absorption, are easily recognized by managers and can be minimized relatively easily with proper management.

During acute acidosis, blood flow to the gastrointestinal tract is reduced thereby, reducing the absorption of all organic acids from the rumen. Prolonged exposure to low ruminal pH may damage the ruminal epithelial tissue and further reduce the absorptive capacity of the tissue. In the feedlot or dairy, these afflicted cattle may be labeled as chronics or poor-doers. The reduced absorptive capacity reduces ruminal pH which favors lactate producing bacteria and allows lactate to accumulate in the ruminal fluid which, in turn, has led to the false conclusion that lactate was primarily responsible for acidosis; hence the term lactic acidosis. Although lactic acid may dominate in the ruminal fluid when an animal experiences acute acidosis, it is not the only organic acid involved. Furthermore, lactic acid does not accumulate in the ruminal fluid during subacute acidosis.

The classical aspects of acidosis have been reviewed.[10,11,12,24,35] Many of these reviews used the term D(-) lactic acidosis to characterize the heart of the disturbance because it accumulated in ruminal fluid. D(-) lactic acid was also thought to be a particularly difficult acid for the animal to metabolize[2,23] and ruminal epithelial metabolism of D(-) lactate was reported to be slow[18,20,21,22,31,32] demonstrated that ruminants have the capacity to metabolize D(-) lactate efficiently. The term D(-) lactic acidosis is too confining to describe acute acidosis and is a misnomer. The problems associated with acute acidosis are due to the cumulative effects of all organic acids produced in the rumen.

Subacute Acidosis and Intake

Most managers, nutritionists, and veterinarians associate acidosis with only acute acidosis because the symptoms are observable while the major manifestation of subacute acidosis is reduced intake.[16] Optimum feed intake is very important because daily gain and subsequently, feed efficiency, are based on the amount of metabolizable energy consumed in excess of maintenance needs. However, it is virtually impossible to determine maximum metabolizable energy intake for a pen of cattle. Feedlots and dairies can only estimate feed intake. Therefore, it is much easier to discount the presence of subacute acidosis than to suggest it may exist. As nutritionists, many times we disguise subacute acidosis and call it bunk management. Advising feedlots and dairies on how to process grains, mix diets, adjust intake, etc., are all attempts to manage subacute acidosis. To achieve maximum profitability, the factors that affect subacute acidosis must be understood. In the feedlot, the goal is to control/manipulate acidosis not to totally eliminate it from occurring. In a dairy operation, the goal is less clear. Because cow longevity is very important for dairies, total elimination of acidosis perhaps should be the goal.

Acidosis, ruminal starch digestion, and starch (primarily grain) intake are closely intertwined. As rate of ruminal starch digestion increases, extent of ruminal starch digestion increases, and thus, the potential for acidosis increases. In addition, the severity of the acidosis is greatly affected by the amount of starch consumed.

The most important animal response observed with subacute acidosis is reduced feed intake. A corollary to that statement is anything that interrupts normal consumption patterns can precipitate acidosis. Environment impacts an animals desire to eat. Impending storms cause animals to eat more before the storm arrives which keeps cattle feeders with one eye on the weather map. Factors, such as heat, cold, or mud can impact intake patterns and cause acidosis. Other factors like proper pen design and bunk management are important factors in maintaining normal intake patterns in cattle.

It is common for dairy cattle to consume 50 to 60 lb of dry matter daily. Most dairy diets contain 40 to 50% grain (DM basis). Thus, many dairy cows may consume 20 to 35 lb of grain daily. In many Midwest dairies, fine ground corn is the grain source fed to the cows. As a result of the large amount of surface area, rate of ruminal starch digestion of the fine ground corn is rapid. The large amount of grain fed in conjunction with a fast rate of starch digestion can result in acidosis. To counter this problem, coarsely chopped forage must be fed. Unfortunately, the density of fine ground corn and coarsely chopped forage are quite different, and diets containing these ingredients may be easily sorted by the cows; thus, negating the ability of the forage to control acidosis.

Monitoring intake and intake patterns is important in assessing subacute acidosis. The relationship between intake regulation and ruminal energy metabolism is imperfect as evidenced by the problem of acidosis. As previously stated, cattle evolved as grazing animals consuming forages. Ruminal production of organic acids from fermentation of plant cell walls is slow; therefore the need for rapid control of intake was not necessary. Intake by the grazing animal is most likely governed by ruminal fill or a combination of ruminal fill and energy sensing mechanisms (chemostats) coordinated in the brain. Cattle entering feedlots are usually fed forage based diets and must be adjusted from these forage diets to high-energy diets. This is a very critical time as the ruminal microbes are adapting to different substrates while the animal intake control mechanisms are shifted to energy sensing mechanisms and not ruminal fill. This is a likely time for occurrence of subacute acidosis. All feedlot cattle experience varying degrees of subacute acidosis during the grain adaptation period. Experiencing acidosis is likely a part of the animal's ability to adjust to adjust to high grain diets. This adaptation period amounts to about 15 to 20% of the total feeding period. Minimizing acidosis could reduce the time needed for this adaptation period and improve efficiency.

It would be wrong to assume that intake of feedlot and dairy diets are only affected by subacute acidosis. Differences in feed intake may be due to differences in the digestibility of the grain or to acidosis. As digestibility of the finishing diet increases, feed intake decreases but daily gain usually remains constant. However, when severity of acidosis is reduced, both feed intake and daily gain increase.[38] Therefore feedlots, and perhaps dairies, can use low feed intakes coupled with low animal gains or low milk production as indicators of subacute acidosis.

Subacute Acidosis and Intake Patterns

Intake patterns are also important barometers of subacute acidosis. Fulton and coworkers[16] increased concentrate levels from 35, 55, 75 to 90% in feedlot cattle being adjusted to high energy diets and monitored intake. Each level was fed for 5 days and then cattle were switched to the next higher concentrate level. The grains used in this experiment were dry-rolled corn and hard red winter wheat. Intake patterns (average of days within level) of the cattle fed corn appeared to be smooth and indicative of feedlot cattle adjusting normally to a high concentrate diet (Figure 1). Intake of the cattle fed the wheat diets appeared level as intake did not increase. Closer examination of these data on a daily basis revealed a lot of variation in intake patterns across each concentrate level in both groups (Figure 2). Fluctuations in intake were evident in both groups, but were not as great for the cattle fed corn until the 90% concentrate level, at which time intake decreased sharply. These intake fluctuations were much more pronounced in the wheat fed cattle. The wheat fed cattle would experience acidosis and reduce intake dramatically for a couple of days. Then, the cattle would eat again when they recovered, but they were unable to thoroughly adjust to the wheat. These data emphasize that looking at average intakes can be misleading.

Intake patterns of these cattle over a 24-hour period within each concentrate level changed drastically (Figure 3). Cattle fed the corn diet were meal eaters. The meal size decreased as concentrate level increased, but nevertheless a meal (5 to 6 lb) was still consumed when fresh diet was offered. The wheat fed cattle ate a meal at the 35% concentrate level, but changed their eating habits as the concentrate level increased. They became nibblers more than meal eaters. In this way, they were able to reduce the ruminal acid load by slow-

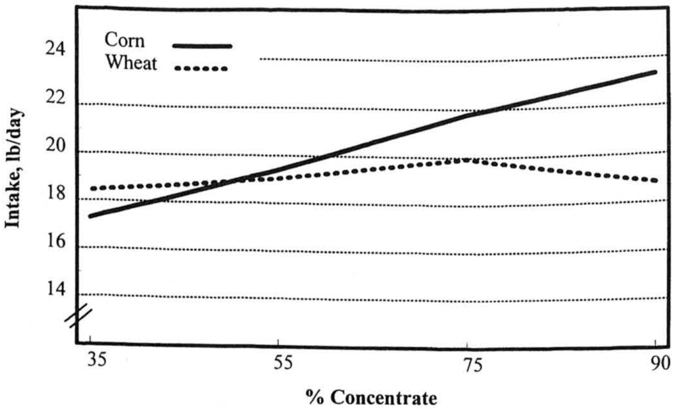

Figure 1. Changes in feed intake – avg. of 5 days per concentrate level.

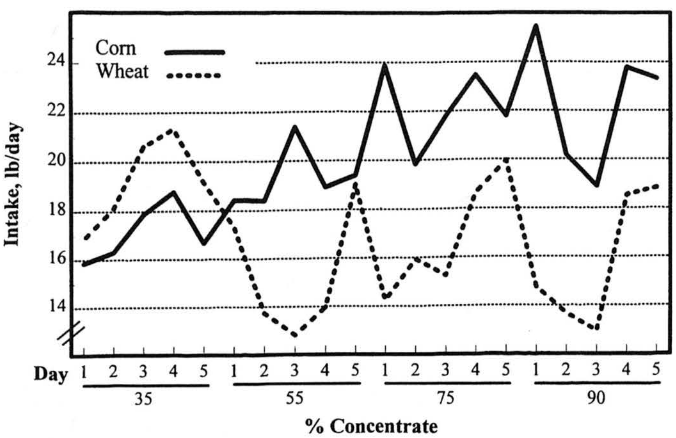

Figure 2. Daily changes in feed intake during grain adaptation.

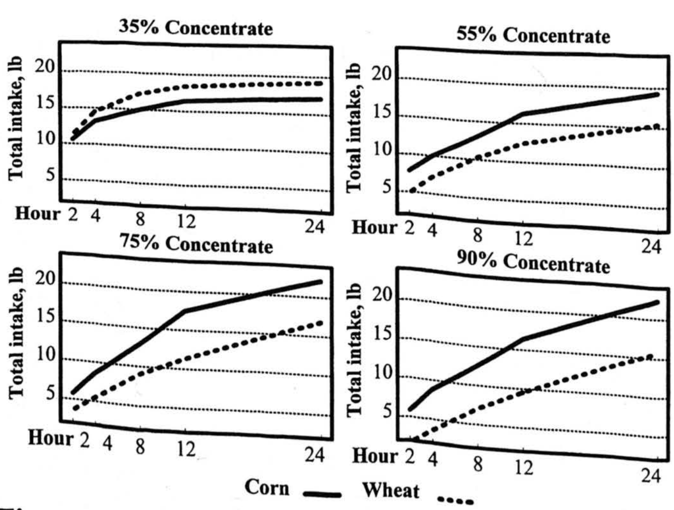

Figure 3. Total intake of grain by hour and concentrate level.

ing the rate of eating. Ruminal pH throughout the day was lower for the wheat fed cattle even though they consumed less feed. Observation of the pH data suggested that the cattle ate when ruminal pH was 5.6. Other work reported by Fulton and coworkers[17] showed that cattle fed wheat diets with ruminal pH manually adjusted above 5.6 had intake patterns similar to the cattle fed corn. It appears to be critical to maintain ruminal pH above 5.6 to minimize the intake depression seen in subacute acidosis.

It is important to remember that although feedlots and dairies feed a pen of cattle, they are actually feeding a pen of individuals. Many times the feed intake of half of the cattle is increasing at the same time the feed intake of the other half of the cattle is decreasing. The result is daily fluctuation in feed intake in the pen may be small. This "averaging" effect of feed intake is especially true as the number of cattle per pen increases.[28] Other animal symptoms become important indicators of subacute acidosis such as lethargy, diarrhea, panting, excessive salivation, kicking at the belly, and general signs of discomfort/stress.

Controlling Acidosis in the Feedlot

Diet composition can have an impact on subacute acidosis. Level and type of roughage, type and amount of grain, method of grain processing, use of grain milling byproducts, and feed additives can influence the incidence and severity of subacute acidosis. Traditionally, roughages added to finishing diets were used as a means of controlling acidosis and adjusting cattle to high grain diets in feedlots. Adding roughages during the adaptation phase allows cattle to adapt to smaller changes in digestible energy density of grains versus roughages. This is still the primary method of adjusting cattle to finishing diets when they enter the feedlot. Roughages in the finishing diet are also a method to control acidosis. Adding roughage to an all concentrate diet increases feed intake, gain, and efficiency if acidosis is a problem. If acidosis is not a problem, adding roughage to an all concentrate diet, increases intake, does not affect gain, but reduces feed efficiency (Table 2; Stock *et al* 1990). Feeding roughages causes problems for the feedlot because of handling and mixing bulky feeds. Therefore, the trend has been to feed diets with less roughage and usually smaller particle size. Both low roughage levels and small roughage particle size exacerbate acidosis. Roughage levels in feedlot diets are lower today (0 to 8% of the diet dry matter) than 20 years ago (10 to 15% of the diet dry matter) because of a better understanding of acidosis, improved dietary formulation, and due to the inclusion of ionophores. Another reason for lower roughage levels is that the cost of a unit of digestible energy is much higher with roughages than grain.

Starch digestion plays an important role in subacute acidosis. Figure 4 depicts the relative rate of starch digestion in the rumen for grains commonly fed in the U.S. Wheat and barley have the fastest rates of starch digestion of the grains whereas dry whole corn and dry-rolled grain sorghum are generally the slowest. This figure was made without absolute rates because variation within grains and processing may alter the rate of fermentation and, therefore, the order of ranking. Grains with the fastest rates of starch digestion generally cause the most acidosis. Another factor to consider is that slower fermenting grains will also alter the site of digestion from the rumen to the lower tract. Both changes in acidosis and site of digestion could have effects on efficiency of utilization of the grains fed. Stock *et al*[36] used mixtures of fast (high moisture corn) and slow fermenting grains (dry rolled sorghum) to test these hypotheses. The effect of the grain mixtures was apparent within the first 28 days of the feeding period (Table 4). Acidosis was minimized by including the sorghum with the faster fermenting high moisture corn. The inclusion of 25% sorghum exhibited a positive associative effect on reducing feed/gain in the total trial.

As previously reported, wet distillers byproducts have been shown to improve performance of feedlot cattle. Not only are distillers byproducts high in energy, but they help control subacute acidosis. Wet corn gluten feed has also been shown to improve animal performance and reduce acidosis when fed to replace a portion of the grain in the diet. Researchers at the University of Nebraska have evaluated two different wet corn gluten feed products. When averaged across all wet corn gluten feed levels, wet corn gluten feed increased dry matter intake 0.03 to 5.4%, increased daily gain 0.4 to 11.4%, and improved efficiency of gain 0.3 to 5.1%.[37] The net energy values of the two wet corn gluten feed products were estimated to be 1 to 14% more than that for corn grain. The increased feed intake and

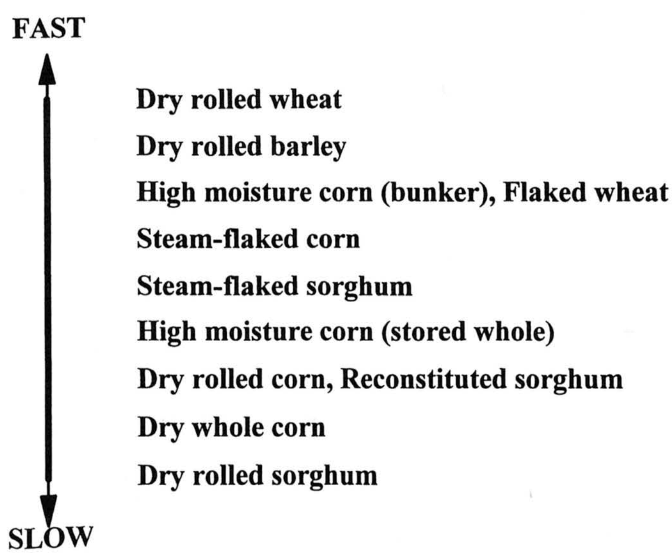

Figure 4. Grains categorized by rate of ruminal starch digestion.

Table 4. Feeding mixtures of high moisture corn and dry-rolled grain sorghum – 3 trial summary[a]

	High moisture corn:dry-rolled grain sorghum			
Item	100:0	75:25	50:50	0:100
	First 28 days			
Daily DM intake[b], lb	20.68	20.13	20.57	20.72
Daily gain, lb	3.23	3.37	3.32	3.10
Feed/gain[b]	6.33	5.88	6.10	6.49
	Entire feeding period			
Daily DM intake[bc], lb	20.50	20.48	20.97	22.15
Daily gain[d], lb	2.90	2.99	2.99	2.84
Feed/gain[bc]	7.04	6.71	6.99	7.75

[a]Data from Stock *et al*.[36]
[b]Quadratic effect (P<.05).
[c]Linear effect (.05).
[d]Quadratic effect (P<.10).

subsequent increased daily gain and improved efficiency indicates that wet corn gluten feed reduced subacute acidosis in these trials.

Krehbiel *et al*[26] evaluated the effects of feeding wet corn gluten feed on subacute acidosis. In a metabolism trial, ruminally fistulated steers were dosed with 100% corn, 50% corn: 50% wet corn gluten feed, or 100% wet corn gluten feed. Steers dosed with wet corn gluten feed recovered more quickly from the acidosis challenge than steers dosed with corn (Figure 5). Although wet corn gluten feed did not eliminate ruminal acidosis, it did reduce the length of time cattle were exposed to the insult. The reduced acidosis is due to the replacement of starch, from corn grain, with a highly digestible fiber fraction, from corn gluten feed. In addition, the digestion of the fiber fraction of wet corn gluten feed may be partitioned throughout the digestive tract with a significant amount of fiber digestion occurring post-ruminal;[33] consequently, there would be less total acid production in the rumen.

In an attempt to minimize daily intake fluctuations (acidosis), some feedlots restrict the amount of feed offered to a pen of cattle. Although feed records will show that variation in daily feed intake of the pen is small, this is an artificial situation that may not reflect the variation in individual's feed intake within the pen. Because bunk space is usually limited, restricting the amount of feed offered to a pen of cattle may not limit intake equally for all cattle. The dominant cattle will usually consume feed *ad libitum*, and thus, the feed intake of the less aggressive cattle is limited. In addition, restricting intake may increase rate of feed consumption by some of the cattle and create additional acidosis. Cattle may be trained to handle different feeding

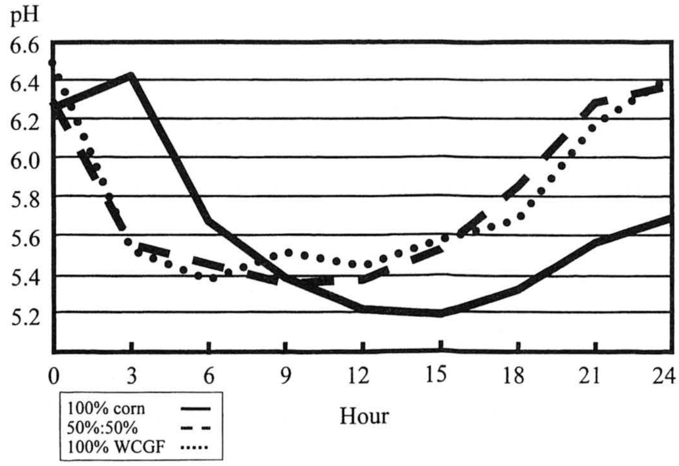

Figure 5. Effect of wet corn gluten feed on acidosis.

patterns without causing acidosis. Cooper *et al*[8] imposed feed intake variation of 4 lb per head per day and did not increase acidosis or decrease animal performance of finishing steers fed at *ad libitum* levels of intake. However, imposed feed intake variation of 3 lb per head per day increase acidosis of limit-fed steers. Steers fed *ad libitum* may adapt to a "routine" of imposed feed intake changes. However, random occurrences of intake variation may increase the incidence of acidosis.

Monensin has been shown to be effective in minimizing feed intake variation and modulating the effects of acidosis. Feedlot studies with cattle abruptly switched to high concentrate diets containing different levels of monensin[7] showed that Monensin does not prevent intake declines of cattle switched to a 95% concentrate diet. All treatments (0, 10 or 30 g/ton monensin) exhibited similar intake patterns. Closer examination of the data revealed that mean variance in daily intake of the cattle fed 30 g/ton monensin was lower than the other treatments, suggesting they experienced less acidosis. Britton *et al*,[6] using individually-fed steers, rapidly adjusted cattle to an all concentrate diet in 12 days. Feeding 25 g/ton of monensin reduced intake variation during days 8 to 12 (85% concentrate diet), days 13 to 28 (100% concentrate diet) and days 57 to 70. More recently, Cooper *et al*[9] reported that steers fed monensin had reduced acidosis as indicated by elevated ruminal pH and reduced area of ruminal pH below 5.6. Fanning *et al*[13] fed monensin at 0, 30, or 40 g/ton. Monensin decreased meal size and increased meal frequency without affecting feed intake. These data indicate that feed additives, like monensin, can be used as a tool to help alleviate the problems of both acute and subacute acidosis.

Buffers have also been used to control acidosis in feedlot and dairy cattle. The problem with buffers is that they are a preventative method. Once ruminal acidosis is present, feed intake decreases. The buffer in the ration will also be consumed at a lower level when, in fact, more buffer is necessary to correct the acidosis. Buffers neutralize acids in a short period of time; however, fermentation continues after neutralization, thereby producing additional organic acids.

It is likely that many of the same dietary modifications that have been used in the feedlot studies could also be of value to dairy operations. Feeding a combination grain and/or replacing 40 to 100% of the grain in the diet with a wet or dry milling byproduct may have even greater potential in dairy diets than has been shown with feedlot diets.

Summary

Acidosis continues to be a problem in feedlot and dairy cattle. The most important aspect of acidosis is the subacute phase that is primarily manifested by reduced intake. Consistent intake and intake patterns are necessary for efficient production. We must strive to provide means of minimizing acidosis by manipulating feed or ruminal microbes or ruminal environment. There is a fine line between maximum performance and acidosis. Cattle are fed for maximum animal and economic performance. By pushing these cattle too hard, we encourage acidosis. Our job as scientists, nutritionists, and veterinarians is to provide the means of reducing the acidosis problem. We must monitor intake of cattle fed high grain diets and make feeding decisions to maintain proper ruminal conditions.

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