FEEDING TO ~~PRODUCE~~ OR AVOID ACIDOSIS

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Lactic acidosis is a subclinical scourge of the dairy industry. In our attempts to meet animal energy requirements, we often feed rations that can actually decrease energy available to the animal and reduce overall productivity. The key to enhancing the feed efficiency and profitability of dairy cattle is to formulate and feed rations that meet their requirements and keep them healthy. This involves avoiding acidosis.

Acidosis

Faced with the challenge of feeding high producing and early lactation cows to meet their energy needs, nutritionists have formulated rations to maximize/optimize energy density. In the process, high levels of readily fermented carbohydrates, usually starches, were included. Animal performance on these diets was often poorer than expected. Cows showed increased incidence or severity of lameness, displaced abomasa, weight loss and low butterfat among other symptoms. Overall animal productivity was depressed on diets that were designed to enhance it. A major contributing factor to the poor performance was acidosis.

Acidosis is a metabolic disorder that has been associated with feeding large amounts of readily fermented carbohydrate. Symptoms are seen when the buffering capacity of the rumen and the ability of the animal to metabolize the acid load are overwhelmed (Underwood, 1992a). Rapid fermentation of carbohydrates produces large quantities of volatile fatty acids (VFA; acetic, propionic and butyric acids) which can result in a decline in rumen pH and inhibition of the fiber digesting bacteria (Strobel and Russell, 1986). Although lactic acid is usually a transient product of rumen fermentation (Van Soest, 1994), as the rumen becomes more acidic, more lactic acid is produced by relatively acid-tolerant starch-fermenting bacteria, such as *Streptococcus bovis*. Lactic acid accumulates in the rumen driving the pH even lower, to the point where *S. bovis* is also inhibited. If starch is still available, *Lactobacillus* species continue the production of lactic acid with further decrease in rumen pH (Russell and Hino, 1985). The duration and severity of the acidosis is related to the quantity, type and rate of fermentation of the nonstructural carbohydrates (NSC) consumed. In acute cases of acidosis, the animal may exhibit diarrhea, dehydration, metabolic acidosis and death (Underwood, 1992b).

Subclincal acidosis is the form most prevalent in the dairy industry. The cow's rumen pH may cycle to 5.5 daily, but she is not diagnosed as 'sick' because she does not exhibit acute symptoms. In herds suffering subclinical acidosis, increased incidence of sore feet (laminitis), displaced abomasa, periodic diarrhea, weight loss and low butterfat may be observed (Underwood, 1992b). What typically isn't discovered in large groups of cows is the cycling through high and low feed intakes of individual animals and the decrease in fiber digestion when rumen pH is lowered (Woodford and Murphy, 1988). The decrease in fiber digestion lessens the

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amount of energy available from the diet. Subclinical acidosis lowers milk production and overall animal productivity. Because it goes largely unnoticed and untreated, subclinical acidosis can become a very large drain on a dairy's profitability.

Challenge: Meeting Energy Requirements

Feeds and Acidosis

The main sources of energy in rations have distinctly different impacts on the incidence of acidosis. Neither fiber (NDF) nor fat contribute directly to lactic acidosis. Fat is relatively ruminally indigestible. Its inclusion in the diet may help prevent acidosis if it is substituted for starch on an energy basis. Fat provides energy to the cow, but not to the rumen microbes.

Neutral detergent fiber is slowly degraded carbohydrate which does not ferment to lactic acid. Feeding adequate amounts of total and effective NDF (eNDF) actually decreases the chance of lactic acidosis by diluting NSC in the diet and increasing rumination. Effective NDF is that portion of the fiber that encourages rumination, saliva flow and ruminal buffering (Fox et al., 1992). Generally, the larger the feed particle, the more time an animal will spend ruminating it and the more saliva will be produced (Table 1). However, determining how much eNDF is in a ration can be difficult because its "effectiveness" is affected by particle length, digestibility (degree of lignification), density and hydration within classes of feeds (D.G. Fox, personal communication). There is also variation in how effective the fiber of a feedstuff will be depending upon what other feeds are in the ration (Staples et al., 1995). The National Research Council (1989) recommended that 75% of ration NDF be provided as coarse or long chopped material to meet eNDF requirements. Another guideline is that eNDF provide 20% of ration dry matter (Fox et al., 1992). As reference points, the average proportions of NDF that acts as eNDF for alfalfa hay (46% NDF), bermudagrass hay (70% NDF) and corn silage (46% NDF) are 92%, 98 % and 81% of their NDF%, respectively (Sniffen et al., 1992). Cottonseed hull NDF is estimated to be 80% effective (Mertens, 1992). The absolute definition of eNDF is elusive, but it is certain that the cow is the final judge of how well her requirements are met. The best indicator that a diet contains sufficient eNDF is that approximately 50% or more of the dairy cows are ruminating at any point in time.

Table 1. Effect of feed source on saliva output.

Feed	Saliva Production qt/lb of DM	Eating Rate lb food/min
Pelleted concentrate	0.72	0.79
Fresh grass	4.29	0.60
Silage	3.61	0.55
Hay	3.86	0.15

Bailey, 1961.

The NSC are the most rapidly digested carbohydrates and are excellent energy sources, but they are also the main dietary contributors to acidosis. Although they are represented as a single, calculated value on feed analyses (Equation 1), the NSC are a diverse carbohydrate pool (Figure 1). The different types of NSC have distinctly different ruminal fermentation characteristics. Acids resulting from ensiling are included in NSC, but do not add to increased acid production in the rumen (Van Soest, 1994). Pectin and most other types of soluble fiber are rapidly fermented by fiber-digesting bacteria with little or no lactic acid production (Strobel and Russell, 1986). Similarly to NDF, pectin fermentation is depressed at low rumen pH (Ben-Ghedalia et al., 1989). Starches and sugars can be fermented to lactic acid and are the main contributors to lactic acidosis. The rate of starch fermentation depends largely upon processing method, particle size and source (Mertens, 1992). Concentrates that are flaked or finely ground will degrade more rapidly than coarsely ground materials, and small grains will ferment faster than corn or sorghum.

Equation 1. Calculation for nonstructural carbohydrate content of feeds.

$$NSC\ \% = 100\ \% - CP\ \% - (NDF\ \% - NDFCP\ \%) - Fat\ \% - Ash\ \%$$

where:
NSC = nonstructural carbohydrates
CP = crude protein
NDF = neutral detergent fiber
NDFCP = the crude protein in NDF

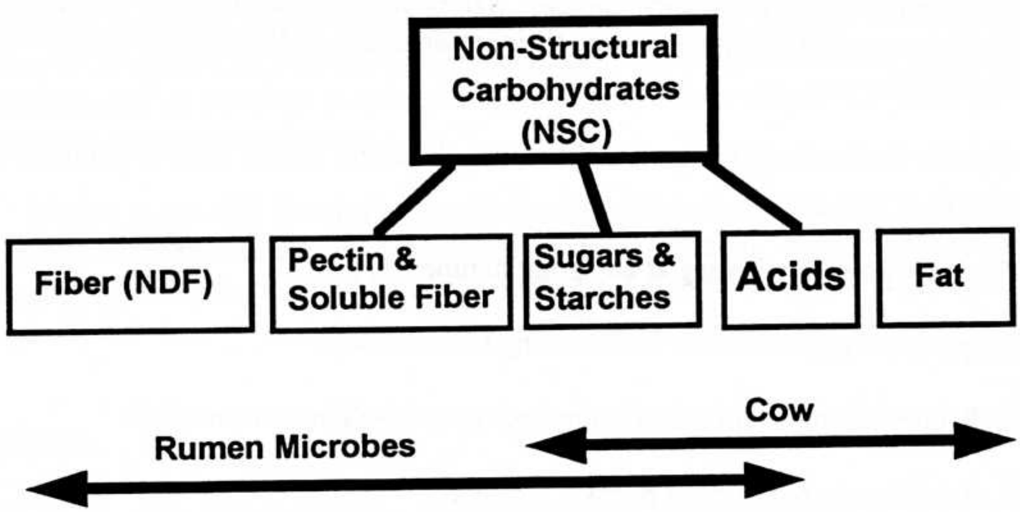

Figure 1. Major energy components of feedstuffs. Arrows indicate fractions digested by the cow or by rumen microbes.

Prevention Through Management

To prevent acidosis, a balance needs to be struck between providing energy to the cow and presenting excessively large amounts of rapidly fermented carbohydrates to the rumen. The key management strategies involved are to feed the correct amounts of the correct carbohydrates according to the correct feeding management:

1. Balance the ration for energy, protein, vitamins and minerals using current feed analyses.

2. Make sure that adequate fiber is included in the ration. The NDF should account for 28 to 35% of the ration dry matter of milking cows. Approximately 20% of the ration dry matter should be from effective fiber.

3. Limit NSC content of the diet. Hoover and Miller (1995) recommended that NSC be limited to 35 to 40% on high starch rations, and 40 to 45% on low starch rations. Feeds high in starch include corn, hominy, corn silage, bakery waste, small grains and potato waste. Feeds low in starch include citrus pulp, beet pulp, soybean hulls and whole cottonseed.

4. Do not make sudden ration changes. Cows that are switched from high forage to high concentrate diets (fresh cows) or have drastic changes made in their ration's ingredients are prone to acidosis. Limit changes or institute them gradually.

5. Do not "slug" feed. Do not give animals the chance to consume large amounts of rapidly fermented carbohydrate at once. Try to avoid feeding large meals of concentrate. Give animals free access to feed by limiting their time spent in holding areas or in front of an empty bunk.

6. Do not let cows make their own feeding choices. Salt is the only feedstuff that nutritionists have much faith that cows will consume to meet their requirements. Make sure feeds are well mixed to reduce sorting.

Observing the herd is the best way to monitor the ration. In a herd free of acidosis, you should see:

1. At least 50% of the cows ruminating at any point in time.

2. No roughage particles greater than 0.5 inches long in the manure.

3. The cows walk comfortably -- no animals hunched up and walking on sore feet.

4. Butterfat % of milk tends not to drop below 3.0 or 3.1.

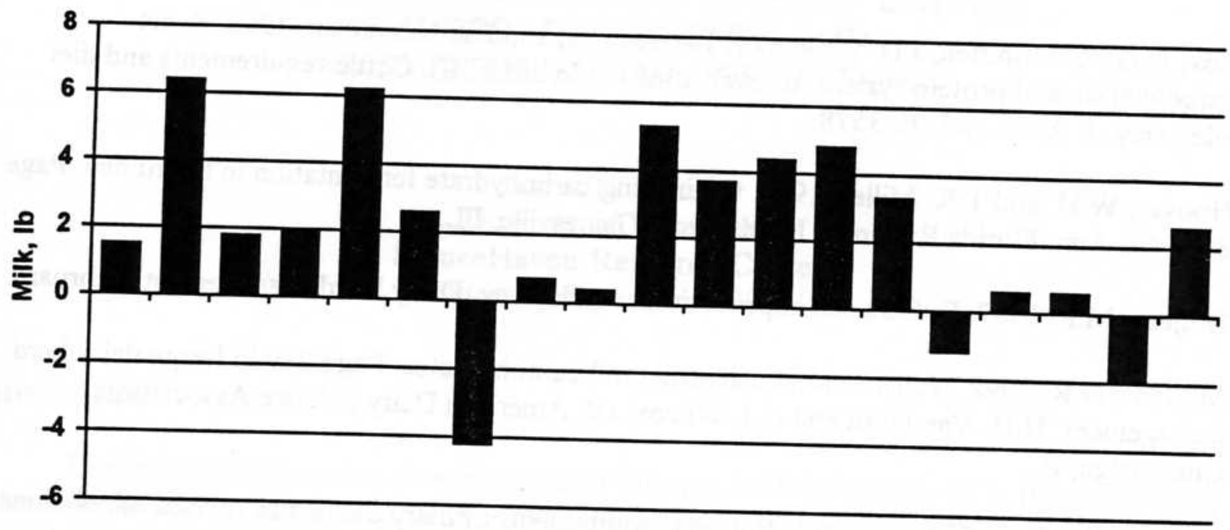

Figure 2. Milk response of cows supplemented with sodium bicarbonate. Bars represent milk production of supplemented cows minus that of unsupplemented cows. From Hutjens, 1987.

Buffers

Buffers, such as sodium bicarbonate fed at 1.0% of ration dry matter, can be a tool for managing acidosis in a herd, but do not cure the problem. Data from a number of research trials show that sodium bicarbonate can have a positive effect on milk production, but results vary (Figure 2). Efficacy of buffers likely depends upon the feeds in the ration, feeding management, etc. If a feed additive is used to minimize acidosis problems, make certain that there is a way to evaluate its performance and determine whether or not it is cost effective. Is production increased? Incidence of health disorders decreased? Are the changes due to the additive or to other changes that occurred at the same time? The additives can offer cheap insurance, or become an unnecessary expense.

We are faced with the challenge of balancing rations to meet animal requirements and giving the animal the chance to express their full production potential. Both can be accomplished through proper ration, cow and feed management. Acidosis is a problem that managers can manage to avoid.

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