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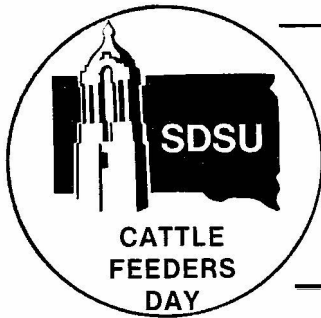
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BUFFERS IN RUMINANT DIETS

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There are two sets of dietary conditions under which the beef feeder may give consideration to the feeding of buffering materials. One is when the diet consists primarily of silages that by necessity contain preformed organic acids in quantities that may contribute an extra burden to the normal buffering capacity of the ruminant digestive tract. The other is under conditions of high-concentrate feeding when the rapid fermentation of readily fermentable carbohydrates by rumen microbes produces high concentrations of organic acids. These acids may overtax the normal buffering systems inherently present in the ruminant digestive tract and blood system resulting in the condition commonly referred to as rumen acidosis.

Feeding Buffering Materials With Silages

It has been estimated that 13 to 30% of the energy requirements of the ruminant are supplied through metabolism of volatile fatty acids (Bentley et al., 1956). While these acids are generally the product of rumen fermentation, some ruminant feeds such as those from fermented high-moisture feeds (silage, haylage, high-moisture corn, etc.) supply important quantities of preformed organic acids. On a dry matter basis, some silages have been found to contain in excess of 7% volatile fatty acids (Barnett, 1954). In the past, some researchers have successfully added mixtures of organic acids to ruminant diets. However, these have been found not to be consumed as readily as diets containing the salts of these acids (Essig et al., 1959).

Studies at other experiment stations have indicated that the intake of silages may at times be limited by their acidity. A 9 to 20% increase in dry matter intake from ryegrass silage was reported to be associated with partial neutralization of the acidity with sodium bicarbonate (McLeod and Wilkins, 1970; McLeod et al., 1970). Reversal of the buffer treatment through the use of lactic acid resulted in consumption of the silage at about the same level as for untreated silage. Sodium chloride which would have essentially no effect on the pH of silages also had no effect upon the amount of silage consumed.

Kansas researchers (Brethour and Duitsman, 1975) obtained increases in dry matter intake and weight gain with steers fed high-silage diets supplemented with 100 g of sodium bicarbonate daily. South Dakota researchers in reports given at earlier Cattle Feeders Days (Embry and Dye, 1970; Embry et al., 1968, 1969) reported that, when fed at the rate of 90 g per head daily, sodium bicarbonate gave a 7 to 10% improvement in weight gain during a 113-day feeding period; limestone had no effect and calcium hydroxide gave variable results.

Feeding Buffers With High-Concentrate Diets

Causes of Acidosis

A period of 2 to 4 weeks is normally required for adaptation of ruminants to high-concentrate diets. During that time the animal is more susceptible to "overfeeding" which may result in a generalized condition commonly referred to as acidosis. Consumption of large quantities of readily fermentable carbohydrates, such as those found in high-concentrate diets, beyond the rumen's normal fermentation capacity results in a rapid drop in pH and subsequent rapid growth of microorganisms producing lactic acid. An adapted microbial population, on the other hand, resists lactic acid build-up through competitive inhibition of lactic acid forming microbes and the growth of other microbes that utilize lactic acid.

Poor management is probably the greatest causative factor in acute ruminal acidosis. The most common management problems include making dietary changes too rapidly, irregular feeding and self-feeders that are empty a day or two before being detected. Beneficial results from the feeding of buffers during an initial 21 to 28 days of high-concentrate feeding have been high. However, the feeding of buffers to beef cattle and sheep following adaptation has generally shown little, if any, effect.

South Dakota researchers have used sodium bentonite, described as a naturally occurring montmorillonite clay, sodium bicarbonate and limestone in high-concentrate diets for lambs and/or beef cattle. While lambs have been suggested to be more prone to death losses from acidosis, experimental results from our work utilizing lambs are likely to be applicable to beef cattle.

Sodium Bentonite and Sodium Bicarbonate

Lambs brought to a full feed slowly over a period of 12 days appeared to respond optimally to 4% of sodium bentonite in a study involving 0 to 12% sodium bentonite added to an 80% concentrate diet (Huntington et al., 1977a). In that study, average daily gain in the 4% sodium bentonite group was doubled in the initial 28 days while feed consumption was increased only 5%. Although fed for a total of 110 days, bentonite provided no apparent benefit beyond the initial 28-day adaptation period.

Another study (Huntington et al., 1977b) compared 2 and 4% levels each of sodium bentonite and sodium bicarbonate. The lambs were brought to full feed over a period of 8 days using an 80% concentrate diet. Instead of the dust grade sodium bentonite used in the previous study, feed grade crumbles were used resulting in less refusal of fine materials. Under these circumstances, 2% sodium bentonite proved to be an optimum level increasing average daily gain by 78% and feed consumption 8.5% during the initial 21 days. Two percent sodium bicarbonate gave a 37% increase in average daily gain and a 3% increase in feed intake during that period. However, the 4% level of sodium bicarbonate proved to be too high offering no improvement. Over the longer term of the 98-day feeding period, neither sodium bentonite nor sodium bicarbonate offered any significant improvement in performance and the 4% level of each reduced performance.

These results prompted further attempts to improve performance during the later phases of the feeding period by decreasing the buffer level following a 21-day adaptation (Dunn et al., 1979). Lambs were placed on a full feed of a 92% concentrate diet without prior adaptation to concentrates. Severe acidosis occurred in a majority of the lambs on the third day and a death loss of 19% occurred in the control group. Two percent of either sodium bentonite or sodium bicarbonate reduced the severity of acidosis with a reduction in death losses to 3%. When fed in combination, 2% of the bentonite plus 2% of the bicarbonate, death losses were completely prevented. A trend toward higher (18.6% increase) average daily gain was observed for this combination treatment group. Reducing the buffer concentration to one-half of the previous levels in one group of the lambs and deleting it entirely in the other group showed no advantage for continued buffer feeding (for the remainder of the 75-day feeding period).

Beef steers were placed on a full feed of 92% concentrates by increasing the ration uniformly over a period of 4 days using the 2% buffer treatments described for lambs above (Dunn et al., 1979). No deaths occurred and again a trend toward improved weight gains during the initial 28 days was associated only with the combination 2% sodium bentonite plus 2% sodium bicarbonate treatment. Continued feeding of the buffers at the lower 1% level tended to reduce average daily gain during the remainder of the feeding period.

Based upon earlier work at the South Dakota Agricultural Experiment Station (Hoar et al., 1967) concerning the relationships of alkali-forming materials to occurrence of phosphatic urinary calculi, a word of caution appears to be in order. The feeding of sodium bicarbonate, especially in conjunction with elevated levels of dietary phosphorus, has regularly provided increases in urinary mineral deposits in most of the South Dakota studies described above. In some instances these have resulted in an increased incidence of urinary blockage (water belly).

Limestone

Limestone (calcium carbonate) is regularly incorporated into beef and lamb finishing diets to meet calcium requirements. We have conducted a study with lambs (Dunn et al., 1977) where limestone was fed at levels of 1 to 4% of the diet above that required to meet calcium requirements. They were placed on a full feed of a 92% concentrate diet without prior adaptation to concentrates. A death loss of 25% in the controls due to acidosis was reduced only by the highest level of limestone. However, the death loss still remained relatively high at 10%. Feed intake and average daily gain were increased by all levels of limestone during the initial 21 days. Although there were no significant differences in average daily gain during the remainder of the 121-day feeding period, animals fed the 1% level of limestone appeared to maintain a weight gain advantage that amounted to 18% over the controls at the end of the feeding period. Other workers (Wheeler and Noller, 1976) have shown limestone to affect pH to the greatest extent in the small intestine of ruminants, providing a more optimum pH for the action of the enzyme amylase that digests starch. They reported undigested starch excreted in feces of ruminants to be less for animals consuming supplemental limestone.

Alfalfa Hay

An area that remains inadequately explored is the potential buffering effect of alfalfa hay in ruminant diets. A recent report of data from New Mexico (Anonymous, 1978) showed that offering alfalfa hay free-choice to calves being placed on high levels of concentrates significantly reduced death losses and increased feedlot performance. However, similar to the effects of buffers, these effects were said to be significant only during the first 2 weeks of feeding. In studies (South Dakota State University) where comparisons were made with all-concentrate diets and low levels of hay, most beneficial effects of hay occurred during the first few weeks of the experiments. In the most recent South Dakota study with lambs, the usual brome or mixed hay as had been used in previous studies was unavailable and was replaced with an excellent quality alfalfa hay. Lambs receiving an 8% alfalfa hay (92% concentrate) diet experienced no death losses when placed on full feed without prior adaptation and showed no improvement in initial performance in response to bentonite and/or limestone treatments.

It is concluded that buffers may be of some benefit in the feeding of high-silage diets and during adaptation to high-concentrate diets. Their value following adaptation appears to be limited in feedlot lambs and cattle. However, digestive problems and death losses that may occur at infrequent intervals when cattle and sheep have free access to high-concentrate diets might be reduced by feeding buffering compounds. These may be minor from an experimental standpoint but could be of major economic importance.

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