



Dairy Research & Technology Centre

Dietary Buffering Requirements of Lactating Dairy Cows

Buffers are compounds which in aqueous solution help resist changes in rumen pH when high grain, low forage, fine-chopped and fermented forage (silage) are fed. Requirements for buffering agents in dairy cow diets are a function of salivary buffer secretion, feedstuff buffering capacity, acid-producing potential of the diet and feed acidity. Buffers are used largely to reduce the effect of acidic conditions produced by the relatively high grain rations fed to dairy cows. Dietary buffers have been very well researched and are widely used in the dairy industry. The term buffers is loosely applied to several compounds, including bicarbonates, carbonates, hydroxides, and oxides.

The cow has three primary means of buffering acid ingested (from silage) or acid produced by rumen fermentation. These include:

- buffer naturally occurring in saliva,
- buffering capacity of ingested feed, and;
- added dietary buffers.

Buffering ability of animals

Cows produce 10 to 32 L of saliva per kg of feed dry matter (DM) with an average of 18.2 L/kg DM. The production of saliva is much higher when roughage is consumed than when grains are consumed. Factors that are important in saliva secretion are the dry matter content of the feed, forage intake, and forage particle size. The saliva produced by cattle, contains 125 milliequivalents (meq)/L bicarbonate and has a pH of 8.4. Rumen pH ranges from 5.5 to 7.0 and, therefore, the buffering effect of saliva becomes very important in maintaining a desirable rumen pH. The fermentation of grain by rumen microorganism results in acid production, and silage contributes preformed acid in the rumen. This acid must be neutralized or buffered by cows via their saliva to maintain rumen pH within 5.5 to 7.0.

Cows fed 20 kg of dry matter can produce the equivalent of 3418 to 3617 g/d sodium bicarbonate in their saliva, depending on the level of forage in the diet (table 1). Thus, forage intake plays an important role in amount of buffer required by the animal. If a cow is fed a diet with a 70:30 grain to forage ratio, the diet would have to be supplemented with about 0.5% sodium bicarbonate to produce the same natural buffering capacity as a cow fed a diet with a 50:50 grain to forage ratio. Therefore, it is clear that the manner in which we feed dairy cows

contributes to the need for supplemental dietary buffer.

	Forage, % in dietary DM		
	70	50	30
DM intake, kg/day	20	20	20
Saliva flow, litres/day	292	284	276
Salivary NaHCO ₃ , g/day	3066	2982	2989
Salivary NaHPO ₄ , g/day	1057	1028	999
Total NaHCO ₃ equivalent ¹	3617	3517	3418
¹ Acid-consuming capacity of Na ₂ HPO ₄ converted to NaHCO ₃ equivalents, g/day			
source: Erdman J. Dairy Sci. 71:3246 (1988).			

Table 1 : Estimates of the effects of dietary forage on salivary buffer flow.

Buffering capacity of feed

Buffering capacity of forages can be defined as the degree to which forage material resists changes in pH. Forages with high buffering capacities will resist large reductions in the rumen pH. Legumes tend to have a higher buffering capacity than grass and barley silage. Since forages differ in their buffering capacities, the dietary buffer requirement of cows fed different forages would be different. Therefore, it is possible that cows fed barley silage would respond better to added buffers than cows fed alfalfa silage or hay. Protein, total ash and cation (Na, K) content of forages are good indicators of total buffering capacity. Buffering capacity increases as these measures increase.

Added dietary buffer

Where feeding conditions for high producing dairy cows dictate that large amounts of grain be fed, addition of buffers to the diet may be required to supplement natural buffers in saliva.

Low fibre diets

Scarcity of high quality forage often results in feeding high grain diets to meet the energy requirements of lactating dairy cows. As the proportion of grain in the diet increases, rumen pH, rumen acetate:propionate ratios and milk fat percentage decreases (see article **1F2**). Rumination and salivation are also reduced as a result of reduced dietary fibre intake. Reduced salivation, caused by inadequate effective fibre (long chopped forage) in the diet, may be compensated for by feeding rumen buffers to augment the natural buffering ability of cow. In diets containing low concentrations of fibre, addition of dietary buffers results in increased rumen pH. The effect of added buffers on

rumen pH would be most beneficial 4 to 9 hours after initial feeding when rumen pH tends to be lowest. The suggested optimum range of pH for maximum cellulose digestion is 6.4 to 6.8. When rumen pH is at 6.5, 40% of the NDF in the diet would be digested, while at pH 5.5 digestion is less than 20%, and at pH 5 there is essentially no NDF digestion.

Decreasing ADF content of the diet by one percentage unit results in a 0.0564 unit decline in rumen pH. Reduction in rumen pH in dairy cows results in a 3.6 unit decline in ADF digestion for each 0.1 pH unit decrease when rumen pH is below 6.3 and may result in depressed feed intake. Maintaining fibre level at a minimum of 19% ADF has been suggested to maintain normal rumen pH and milk fat percent. Milk fat test would increase by 0.145 percentage units if the dietary ADF increases by one percentage unit (at ADF levels above 14%). To increase the butter fat test by 0.145 percentage units, the equivalent of 108 g of bicarbonate and 54 g of magnesium oxide (Mag Ox) would need to be added to the diet.

The bottom line

The most common reasons for adding buffers to the diet are to compensate for reduced saliva secretion of cows fed inadequate amounts of forage and to neutralize excess rumen acidity resulting from fermentation of starchy grains. Ideally, buffers should be released during the interval of most severe acid production in the rumen or they should provide a continuous release to prevent sudden drops in rumen pH. Palatability is a consideration when selecting a buffer. Palatability is usually not a problem when buffers are fed in a TMR or when mixed with the silage portion of the ration. Because high-energy diets are fed in early lactation, it is practical to include buffers during this stage.

Sodium bicarbonate.....	0.25 to 0.50
Sodium sequicarbonate.....	0.25 to 0.50
Magnesium oxide.....	0.10 to 0.20
Potassium carbonate.....	0.60 to 0.90
Rumen-mate®.....	1.20 to 1.50

Table 2 : Buffer recommendation for lactating cows (lb/cow/day).

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