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The Use of Buffers in Dairy Diets

As production per cow continues to climb, feeding programs must be adjusted to meet the need for more nutrients. But feeding higher levels of concentrate to meet energy needs can result in animals going off feed, lower fat tests, and rumen disorders. The ideal ration should maximize dry matter intake, maintain a constant and optimal rumen environment, stimulate rumen organic matter digestion, maximize rumen microbial protein synthesis and volatile fatty acid (VFA) production, and provide a flow of desired nutrients to target tissues.

The role of buffers

The ruminant animal has a complex acid-base regulating system with the rumen varying in pH from 5.5 to 7. If rumen pH is not optimal, dry matter intake will decrease, acidosis can cause health problems, and microbial yield of protein and energy decreases. The addition of dietary buffers to control rumen pH can be justified if bunk management and nutritional factors cause low pH. Successful applications of buffers result in higher feed intake, increased milk yield, and favorable milk composition (table 1).

Evaluating buffers

Chemically, buffers are a combination of weak acid and its salt which, in solution, resists changes in pH. Other compounds increase the pH of the rumen fluid (called alkalizing or neutralizing agents).

Sodium bicarbonate (bicarb) is a white crystalline compound derived from soda ash. The pH of a 1 percent solution is 8.4 and it buffers at a pH of 6.2. Bicarb is widely used as a buffer and has been heavily researched. Research has shown it increases rumen pH, produces a more desirable rumen fermentation, and increases rumen fluid outflow.

Sodium sesquicarbonate is sold under the trade name S-Carb™. It contains a mixture of sodium bicarbonate and sodium carbonate and is an alkalizing agent. The pH of a one percent solution is 9.9. Published experiments with sodium sesquicarbonate are limited and use sodium bicarbonate as a positive control . The price of sodium sesquicarbonate is typically lower than sodium bicarbonate.

COMPOUND	# OF STUDIES	--------------- CHANGE FROM CONTROL ---------------				
		MILK YIELD kg	FAT TEST %	MILK PROTEIN %	RUMEN pH units	DRY MATTER kg
Sodium bicarbonate						
Adequate forage	55	+0.2	+0.1	-0.04	+0.05	+0.2
Low forage	14	+0.2	+0.28	+0.06	+0.22	-0.1
Corn silage	17	+0.6	+0.16	-0.02	+0.07	+0.5
Alfalfa hay	8	-0.1	+0.03	-	-0.07	-0.1
Alf/grass silage	3	0	-0.03	+0.01	+0.04	+0.2
Alf slg & Corn slg	8	+0.3	+0.1	+0.04	-	+0.2
Potassium carbonate	3	+0.3	+0.40[a]	-0.01	+0.16	+1.3
Potassium bicarbonate	6	+0.6	+0.45[b]	+0.04	+0.95	-0.1
Magnesium oxide						
Adequate forage	11	+0.1	+0.16	-0.02	+0.05	-0.1
Low forage	9	-1.1	+0.35	-0.06	+0.15	-1.8
Sodium bentonite	4	+0.7	+0.09	-0.02	+0.06	+0.2
Sodium sesquicarbonate	6	+1.6	+0.23	-	-	-

Table 1 : Production comparisons of various compounds from published research.
[a]control milk fat test was 2.88%; [b]control milk fat test was 2.62%.

COMPOUND	grams/day
Sodium bicarbonate	110 - 225
Sodium sesquicarbonate	160 - 340
Magnesium oxide	50 - 90
Sodium bentonite	450 - 900
Potassium carbonate	270 - 410

Table 2 : Feeding recommendations of commonly used products for lactating cows.

Alkaten™ is sodium sesquicarbonate, but contains about 6 percent inert materials, is slightly lower in sodium, and is not as refined as S-Carb™.

Trona also is sodium sesquicarbonate, but contains 10 percent inert material (dolomitic marlstone, shale, shortite, mudstone, and other products). Research work has been limited. The presence of substantial amounts of foreign material in trona could cause problems and should be monitored in future experiments.

Magnesium oxide (mag ox) is used as a source of magnesium (54 percent) and as an alkalizing agent. Mag ox appears to regulate rumen fermentation and improves uptake of milk fat precursors by the mammary gland. Solubility and particle size can affect the action of mag ox.

Sodium bentonite, a clay mineral, is used as a pellet binder by the feed industry and is found in some buffer packs. It can prevent milk fat depression by changing VFA patterns. It also swells in the rumen (5 to 20 times its size), adsorbs and exchanges minerals and ammonia, and may add bulk to the ration.

Several other products are being used as buffers or in buffer packs. Potassium carbonate, potassium bicarbonate, magnesium carbonate, and sodium carbonate provide similar action to sodium bicarbonate. Potassium salts can be beneficial under heat stress and low potassium diets. The carbonate forms are alkalizing agents and are generally unpalatable.

Suggested levels of buffers and alkalinizers are listed in Table 2. Palatability of most buffers is low and requires careful management to avoid reduced feed intake.

Buffer use strategies

The key question is: when can dairy managers and nutritionists expect an economically favorable response to buffers? Several factors can dictate when positive buffer responses can be anticipated.

To quantitate each factor, the numerical rating system below was developed. A farmer, nutritionist, feed dealer, or veterinarian can 'add up' values for the group or herd to predict if buffers are needed. Calculating numerical values from five published research studies resulted in positive responses when the sum reached 15 to 20 points.

FACTOR	VALUE
High grain silage rations	+1 point per 10% increase over 50% of forage DM from grain silage
Wet rations	+1 point per 1% moisture increase over 50% moisture in the total ration
Low fibre rations	+1 point per 1% decrease in ADF below 19%
Added hay	-1 point per pound of long hay consumed
Haylage chop length	+1 point per eighth inch decrease in theoretical chop length below ½ inch
Concentrate feeding	+1 point per pound of concentrate over 6.5 pounds per meal
Concentrate form	+5 points for pelleted or finely ground concentrate
Grain moisture	+1 point per 1 percentage point increase in grain moisture level over 30%
Ration non-fibre carbohydrate level	+1 point per 1 percent increase in ration non-fibre carbohydrate over 40%
Fat test variation	+1 point per cow 1 full percentage point below herd or group average
Heat stress	+1 point per 1 wet bulb degree increase above 27°C
Feed intake depression	+1 point per pound of dry matter intake decline

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