Sodium bicarbonate buffer in dairy cow rations

It may improve production but doesn't replace good feeding and management

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Sodium bicarbonate ($NaHCO_3$) has been used to buffer dairy and beef feedlot rations for many years. High-energy, low-fiber rations cause high acid levels in the rumen that can be detrimental to the papillae lining of the rumen. Damage to the papillae results in poor absorption of feed nutrients from the rumen, reduced feed intake, and decreased rate of gain and milk production. Furthermore, milk fat test frequently is depressed on high-energy, low-fiber rations because of changes in the amounts of various volatile fatty acids produced in the rumen. Sodium bicarbonate is able to buffer the acids produced in the rumen, thus maintaining normal acidity levels (pH) even when high-energy, low-fiber rations are fed.

In the past, sodium bicarbonate was added to dairy rations primarily to prevent severe milk fat depression when rations with inadequate amounts of roughages were fed. At times, nutrients from grains and other concentrate ingredients are cheaper than from forages and other roughages, encouraging maximum use of concentrates in dairy rations. Furthermore, high-producing cows in early lactation require high energy levels for milk production, thus encouraging use of large amounts of concentrate ingredients in dairy rations. When fiber levels in these high-energy rations are inadequate to maintain normal milk fat test, sodium bicarbonate supplementation helps to maintain fat tests at near normal levels.

Effects of supplementing

More recently, research at several university experiment stations has shown that sodium bicarbonate supplementation can result in increased milk production in addition to preventing severe milk fat depression. Various percentages of sodium bicarbonate in the total ration dry matter were fed to determine the optimum level in corn silage-based dairy rations.

The highest milk production was obtained when sodium bicarbonate was included as 0.8 percent of the total ration dry matter (table 1). Highest fat test was obtained at the 1.6 percent level, but milk production was lowest, possibly due to reduced palatability of the ration and lower feed intake.

These results were obtained with rations that contained only corn silage and concentrates. No dry hay was fed to the cows. Whether these results were applicable to cows fed rations based on alfalfa hay — a common practice in western states — was not known. Dry hay requires more chewing and salivation than does corn silage, and saliva contains high levels of bicarbonates. Furthermore, alfalfa has a high level of calcium, which is a good natural buffer.

Feeding trials

With this in mind, we conducted full lactation feeding trials in two commercial dairy herds in California to test the value of sodium bicarbonate in dairy rations based on alfalfa hay. One herd was in the Chino Valley of southern California; the other was in the San Joaquin Valley.

The Chino Valley herd was fed baled alfalfa hay and greenchop as the only forage sources. The remainder of the ration was composed of various feed ingredients fed on top of the alfalfa hay from a mixer truck. Additional grain was fed in the milking parlor. Cows were milked three times daily (3X).

The San Joaquin Valley herd was fed a limited amount of concentrates in the milking parlor and a combination of alfalfa cubes, corn silage, and other feed ingredients as a complete ration from a mixer truck. Cows were milked 2X.

In each herd, approximately half of the cows were fed the above rations and the other half the same rations with 0.8 percent added sodium bicarbonate. This was equivalent to approximately 0.4 pound per cow daily. In each herd, cows fed the control ration were milked in one parlor, and those fed the bicarbonates were milked in a different parlor because of the size of the herds. However, cows in both groups were fed by the same person from a common source of feed ingredients at each dairy. Average amounts of feed ingredients fed at each dairy are shown in table 2.

All Chino Valley cows were fed the same ration during the entire lactation, regardless of level of milk production. San Joaquin Valley cows grouped by level of production and stage of lactation were fed rations formulated for three levels of production within the herd. Amounts fed were recorded only for the high and medium groups, because sodium bicarbonate was not fed to the low group.

Milk production and composition data from monthly Dairy Herd Improvement Association (DHIA) records were collected for all cows that freshened after initiation of sodium bicarbonate feeding. Milk production data from all cows that completed 215 or more days were extended to 305-day records. Data from cows with previous DHIA records were adjusted by covariance according to their previous production. Cows with severe subclinical mastitis during the trials were eliminated from the statistical analyses. Data from the first lactation cows were analyzed by a one-way analysis of variance, and second lactation and third and higher lactation cows were analyzed by a two-way analysis of covariance.

Results

Results from the two herds differed (table 3). In the Chino Valley herd, there was a general trend for more milk pro-

duction from cows fed sodium bicarbonate, with statistically significant increases from the second lactation and the third and higher lactation groups. Milk composition was the same for both treatments, with no significant differences in percentage of milkfat or solids-not-fat (SNF). However, pounds of milkfat were significantly higher from all age groups fed bicarbonates, and pounds of SNF were significantly higher from the second lactation and third and higher lactation groups fed bicarbonates because of their higher milk production.

In the San Joaquin Valley herd, there was a significant increase in milk production from first lactation cows fed sodium bicarbonate, coupled with a significant decrease in milkfat test. However, cows fed sodium bicarbonate in their second lactation and third and higher lactations produced significantly less milk than did the controls, with no differences in milk composition. Pounds of milkfat were significantly lower from the third and higher lactation cows fed bircarbonates, whereas pounds of SNF were significantly higher from the first lactation cows and significantly lower from the third and higher lactation cows fed bicarbonates, again because of differences in milk production.

It is difficult to explain the differing results from the two herds. One confounding factor in the San Joaquin Valley herd may have been the fact that there were more mastitis problems in the bicarbonate-fed group. However, elimination of data from cows with severe subclinical mastitis during the trial did not change the general trends.

Feeding and management practices at the two dairies differed, a factor that may have contributed to differing results. Chino Valley cows were milked 3X and were fed the same ration, regardless of level of milk production. San Joaquin Valley cows were milked 2X and were fed according to milk production in production strings. The ration fed to the Chino Valley herd was higher in energy and lower in fiber than was the ration fed the San Joaquin Valley herd. It is likely that the cows in the Chino Valley herd were under higher metabolic demands because of 3X milking and their higher average milk production. The combination of higher milk production, 3X milking, and a higher-energy, lower-fiber ration would be expected to cause a situation where sodium bicarbonate would benefit cow health and production.

TABLE 1. Effects of various sodium bicarbonate percentages in full lactation (corn silage and grain) rations

Item	Sodium bicarbonate (%)			
	0	0.4	0.8	1.6
Milk (lb)	16,482	16,500	16,870	15,744
Milk fat (%)	3.54	3.53	3.58	3.61
Dry matter intake (% body weight)	3.14	3.20	3.19	3.09

TABLE 2. Average amounts of feed ingredients fed

Chino Valley herd		San Joaquin Valley herd		
			Lb/cow/day	
Ingredient	Lb/cow/day	Ingredient	High string	Medium string
Alfalfa hay	13.7	Alfalfa cubes	23.8	21.3
Alfalfa greenchop	29.1	Corn silage	16.4	19.2
Cottonseed hulls	1.0	Almond hulls	3.6	3.0
Almond hulls	3.2	Wet beet pulp	10.4	10.5
Barley	11.0	Wet citrus pulp	2.1	1.9
Dried beet pulp	3.2	Whole cottonseed	6.1	5.1
Wet citrus pulp	14.6	Parlor mix	19.9	16.6
Cottonseed meal	1.2			
Whole cottonseed	6.9			
Hominy feed	5.9			
Minerals	1.0			
Total dry matter fed	49.1		55.6	49.8

TABLE 3. Milk production and composition

Item	First lactation		Second lactation		3+ lactations	
	Control	$NaHCO_3$†	Control	$NaHCO_3$	Control	$NaHCO_3$
Chino Valley herd:						
No. of cows	62	95	50	68	98	106
Milk (lb)	16,515	17,032	18,438	19,380*	19,209	21,080*
Fat (%)	3.37	3.42	3.32	3.40	3.36	3.35
Fat (lb)	556	583*	613	659*	642	706*
SNF‡ (%)	9.18	9.12	8.87	8.96	8.83	8.89
SNF (lb)	1,515	1,557	1,630	1,742*	1,667	1,896*
San Joaquin Valley herd:						
No. of cows	95	146	89	85	206	180
Milk (lb)	14,991	15,780*	18,710*	17,817	19,416*	18,112
Fat (%)	3.59*	3.46	3.54	3.51	3.39	3.48
Fat (lb)	537	543	646	620	659*	631
SNF (%)	9.03	8.97	8.96	8.94	8.79	8.83
SNF (lb)	1,353	1,414*	1,606	1,603	1,728*	1,599

*Values with asterisks within the same lactation group indicate statistically significant differences ($p<0.05$).
†$NaHCO_3$ = sodium bicarbonate.
‡SNF = solids-not-fat.

Conclusions

General conclusions from these field trials are:

☐ Under some conditions, supplementation of alfalfa-based dairy rations with 0.8 percent sodium bicarbonate can result in increased milk production.

☐ Beneficial rsults from bicarbonate supplementation are more likely when cows are subjected to: (a) rations with low or borderline fiber levels, or (b) early lactation when voluntary dry matter intake is low, milk production is high, and large amounts of concentrates are being fed.

☐ Beneficial results are less likely when: (a) rations contain large amounts of dry roughages and high fiber levels, or (b) cows are in later lactation and are fed lower amounts of concentrates.

In any event, supplementation with sodium bicarbonate should not be considered a replacement for good feeding and management practices. Like many other supplements, sodium bicarbonate can have a beneficial effect on milk production and fat test. However, any beneficial effects can be masked by or overridden by such conditions as improper formulation or allotment of rations, and mastitis or fertility problems.

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