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The Effects of Feeding MIN-AD® and Sodium Bicarbonate on Early Lactation Performance of Dairy Cattle

Abstract

To determine the effects of MIN-AD on early lactation performance, 56 pregnant primi- and multiparous Holstein cows were allotted randomly to one of two treatments. Treatment groups included: 1) Bicarb (lactation ration with 1.2% of dry matter from sodium bicarbonate) and 2) MIN-AD/Bicarb (lactation ration with 0.6% of dry matter from each of MIN-AD and sodium bicarbonate). Treatments were arranged in a randomized complete block design, with the blocks consisting of parity, date of calving, and previous lactation performance or genetic potential for milk production. Upon calving, cows were divided into their respective treatment groups, housed in a free-stall barn, and group-fed the assigned total mixed rations for 56 ± 3 d. All diets were formulated using the CPM Dairy® model version 3.0. No statistical differences were noted between the two treatments; however, over the course of the entire study, cows receiving the MIN-AD/Bicarb treatment produced 3.4% more milk with 2.9% more fat compared with cows receiving the Bicarb treatment. Table 1 summarizes the major lactational parameters evaluated in the study.

Table 1. Lactation performance of dairy cows supplemented with either Bicarb or MIN-AD/Bicarb for the first 56 d after calving.

Item	Bicarb	MIN-AD/Bicarb	SE
Mean milk, lb	72.27	74.71	3.99
3.5% FCM, lb	82.36	86.84	4.30
Fat, %	4.56	4.69	0.12
True protein, %	3.01	2.97	0.04

Results from this study indicate that supplementing dairy cows with a combination of MIN-AD and bicarbonate is as effective as supplementing dairy cows with sodium bicarbonate alone. Further, supplementing cows with this combination could result in increased total milk production and increased milk fat.

Introduction

For thirty years, MIN-AD has been successfully used in beef and dairy cattle diets as a buffer and source of supplemental calcium and magnesium. In order to gain a greater understanding of MIN-AD's role in cattle nutrition, numerous trials have been conducted to determine its efficacy in cattle diets. When evaluated via *in vitro* fermentation methods, addition of MIN-AD resulted in increased microbial efficiency regardless of feed source or fermentation pH when compared with control and sodium bicarbonate treatments. In addition, this research showed that MIN-AD plus bicarbonate was a more effective buffer than bicarbonate alone in situations when pH was less than 5.7. When evaluated in production trials, addition of MIN-AD increased total milk production by 4.96% and increased fat per cow by 6.01%, when compared with cows not receiving any supplemental buffer. The purpose of this research was to further elucidate production responses to MIN-AD when used to replace half of the sodium bicarbonate in an early lactation type diet.

Materials and Methods

Cows and Diets

Fifty-six pregnant primi- and multiparous Holstein cows were used to evaluate the effects of replacing one half of the sodium bicarbonate in an early lactation diet with MIN-AD. Cows were randomly assigned to one of two treatment groups: 1) Bicarb (lactation ration with 1.2% of dry matter as sodium bicarbonate) and 2) MIN-AD/Bicarb (lactation ration with 0.6% of dry matter from each of sodium bicarbonate and MIN-AD) in a randomized complete block design. Blocks consisted of parity, date of calving, and previous lactation performance or genetic potential for milk production. The trial was conducted at the W. H. Miner Agricultural Research Institute in late 2003 early 2004.

After calving, animals were moved into their respective treatment groups, housed in a free-stall barn, and group-fed total mixed rations containing their assigned treatments for 8 wk ± 3 d. Health was recorded and analyzed for all animals that started the study. Milk production was analyzed on animals that had completed a minimum of 4 wk of lactation. Only one animal was included in the final analyses that had not completed 8 wk postpartum.

Diets (Tables 2 and 3) were fed as total mixed rations (TMR) formulated using the CPM Dairy® model version 3.0. Although the feedstuffs used to formulate the rations changed over the course of the study, the TMR nutrient constraints remained relatively constant. The average chemical composition of the diets is shown in Table 4. All TMR contained similar nutrient concentrations, which were approximately 36% NDF, 17% CP and 4.7% fat on DM basis. Quality of forages varied over the 6-mo trial period with NDF digestibilities of hay crop silage ranging from a high of 55% to a low of 39% of NDF, and therefore, rations were reformulated as deemed necessary by the farm manager, nutritional consultant, and the research team to accommodate changes in nutrient composition of forages and other ingredients. Throughout the experiment, cows were fed once daily (1300 h) at 105% of expected DM intake, and the amount of feed offered and estimates of refused feed for both treatments were recorded.

Table 2. Ingredient composition of experimental diets (dry matter basis).

	Bicarb	MIN-AD/Bicarb
Ingredient	%	%
Corn silage	20.35	20.35
Hay crop silage – 3rd cut	20.02	20.02
Hay – 3rd cut	6.42	6.42
Cottonseed w/lint	3.15	3.15
Molasses, cane	0.87	0.87
Citrus pulp	9.04	9.04
Megalac R	1.14	1.14
Sugar	0.52	0.52
Sodium bicarbonate	1.16	0.58
MIN-AD	-	0.58
Concentrate mix[a]	37.04	37.04
Reashure choline	0.29	0.29

[a]Composition of the concentrate mix is shown in Table 3.

Table 3. Composition of the concentrate mix (dry matter basis).

Ingredient	%
Soybean hulls	22.55
Corn gluten meal	19.10
Ground corn (fine)	15.65
Bakery waste	12.00
Wheat red dog	10.60
Corn germ meal	9.00
Blood meal	2.35
Calcium carbonate	1.30
Salt	1.05
Wheat middlings	1.00
Dicalcium phosphate	0.75
Magnesium oxide	0.70
Urea	0.45
Calcium propionate	1.50
Potassium magnesium sulphate	0.35
Vitamin E 20 M U/lb	0.15
Organic trace mineral mix	0.10
854 Dairy 5x trace mineral/vitamin mix	0.07
Beacon trace mineral mix	0.05
Selenium 0.06	0.03
Tallow	1.25

Table 4. Average chemical composition of diets fed to early lactation cows.

Item	Bicarb	MIN-AD/Bicarb
Dry matter, %	48.87	50.2
NDF, %	36.90	36.27
Crude protein, %	17.13	17.10
Crude fat, %	4.77	4.93
Ash, %	7.27	7.37
Ca, %	1.08	1.16
P, %	0.37	0.36
Mg, %	0.33	0.36
K, %	1.33	1.25
Cu, ppm	19	18.67
Fe, ppm	321	364
Mn, ppm	70	70
Zn, ppm	106.67	109

Free-choice buffer consumption. Free-choice buffer of the respective treatments was offered in each pen on a daily basis. Amount of buffer offered and estimates of refused buffer for both treatments were recorded weekly. Free-choice buffer consumption was measured and consumption per cow was estimated weekly by pen.

Milk production and composition. Cows were milked twice daily. Milk yield was measured daily for each cow and a weekly average for each cow was calculated through 56 ± 3 d postpartum. Milk samples for each cow were collected from each milking once weekly and analyzed for fat, lactose, true protein, milk urea nitrogen (MUN), and somatic cells from wk 1 through 8 postpartum. The sampling day of the week and times were consistent throughout the course of the study. Clinical mastitis or other diagnosed health problems were recorded. Cows with health problems unrelated to the study were eliminated from the weekly data sets or dropped from the study.

***Body Condition Score*.** Body condition score was measured using the five-point scale (where 1 = thin to 5 = fat) by two trained investigators on a weekly basis from 1 to 8 wk postpartum.

Blood. Blood samples were drawn 2 and 4 wk postpartum. Samplings occurred 3 to 4 h after feeding and were obtained from the coccygeal vein using one 9.5-mL volume serum-separator vacutainer. Samples were chilled in ice, returned to the laboratory, and centrifuged for 15 min at 500 *x g*. Serum was aliquoted into three sub-samples: 1) NEFA sample; 0.5 mL was frozen and analyzed in the Miner Laboratory (2-wk sample only); 2) serum profile sample; 1.0-mL sample was analyzed at the Fletcher Allen Health Care laboratory (Burlington, VT) for vet bovine panel; and 3) back-up sample.

Results and Discussion

Intake and Health

Estimated dry matter intake was similar for both treatments, averaging 39.2 and 40.1 lb/cow/day for Bicarb- and MIN-AD/Bicarb-supplemented cows, respectively. Intake of free-choice buffer offered in each pen was similar for Bicarb- and MIN-AD/Bicarb-supplemented cows, 1.36 and 1.14 oz/cow/day, respectively. Incidences of health problems were generally similar for both treatment groups (data not shown). Both groups had a high incidence of ketosis, displaced abomasums, and uterine infections.

Lactational performance

Lactational data for weeks 1-8 is shown in Table 5. There were no treatment differences in milk yield, fat-corrected milk yield, milk fat percentage, milk total protein percentage, milk lactose percentage, milk urea N, linear somatic cell count, and body condition score among fresh group cows. Mean milk production was 72.27 lb/cow/d for cows receiving the Bicarb treatment and 74.71 lb/cow/d for cows receiving the MIN-AD/Bicarb treatment. Fat corrected milk yield for the total 8 wk trial averaged 82.36 and 86.84 lb/cow/d for the Bicarb- and MIN-AD/Bicarb- supplemented cows, respectively. Although not statistically different, this represents an increase of 4.6%, or 4.5 lb, as a result of MIN-AD. This difference was due to increases of approximately 2.5 lbs in mean milk production and 0.13% in fat for cows supplemented with MIN-AD/Bicarb when compared with Bicarb-supplemented cows.

Table 5. Dry matter intake, milk yield and composition, and body condition score of lactating cows during wk 1 to 8 postpartum.

Item	Bicarb	MIN-AD/Bicarb	SE	*P*
DMI, lb	39.24	40.12	…	…
Buffer intake, oz/d	1.36	1.14	…	…
Mean milk, lb	72.27	74.71	3.99	0.666
3.5% FCM, lb	82.36	86.84	4.30	0.463
Fat				
%	4.56	4.69	0.12	0.423
lb	3.17	3.37	0.18	0.415
True protein				
%	3.01	2.97	0.04	0.455
lb	2.14	2.18	0.11	0.744
Lactose				
%	4.74	4.80	0.03	0.288
lb	3.42	3.60	0.20	0.521
Milk urea N, mg/dL	10.55	10.58	0.28	0.934
BCS	3.40	3.33	0.07	0.469
BCS change (wk 1-8)	0.29	0.41	0.08	0.282

Tables 6 and 7 show the milk production and composition data divided into two periods, wks 1 to 4, and wks 5 to 8, respectively. As was seen for the total trial, there were no statistical differences between the two treatments in either period for any of the parameters evaluated. During wks 1 to 4, MIN-AD increased fat corrected milk by 7.2% (5.8 lb), while during wks 5 to 8; MIN-AD increased fat corrected milk by 4.6% (3.9 lb).

Results from the current trial are similar to those of earlier studies conducted examining the effects of MIN-AD in dairy cattle diets. A previous study (MIN-AD Technical Bulletin D-2) evaluated the performance of dairy cows receiving either sodium bicarbonate and magnesium oxide or MIN-AD. Results from this 265 d study showed that cows receiving MIN-AD produced almost 5% more milk and 6% more fat than cows receiving sodium bicarbonate and magnesium oxide.

Table 6. Milk yield and composition and body condition score of lactating cows during wk 1 to 4 postpartum.

Item	Bicarb	MIN-AD/Bicarb	SE	*P*
Mean milk, lb	65.81	68.30	4.17	0.673
3.5% FCM, lb	80.05	85.85	4.76	0.393
Fat				
%	5.07	5.35	0.14	0.153
lb	3.22	3.48	0.20	0.305
True protein				
%	3.19	3.13	0.04	0.369
lb	2.05	2.09	0.13	0.831
Lactose				
%	4.65	4.72	0.04	0.244
lb	3.04	3.22	0.20	0.567

Table 7. Milk yield and composition and body condition score of lactating cows during wk 5 to 8 postpartum.

Item	Bicarb	MIN-AD/Bicarb	SE	*P*
Mean milk, lb	77.12	81.13	3.88	0.465
3.5% FCM, lb	83.07	86.93	4.32	0.533
Fat				
%	4.06	4.04	0.12	0.891
lb	3.09	3.24	0.15	0.483
True protein				
%	2.83	2.81	0.04	0.595
lb	2.18	2.27	1.06	0.514
Lactose				
%	4.83	4.87	0.03	0.420
lb	3.70	3.97	0.20	0.353

Serum blood chemistry profile

There were no treatment differences in serum NEFA levels at 2 wk postpartum (Table 8). Both treatment groups had NEFA values considered higher than normal for that stage of lactation. Total protein, glucose, blood urea nitrogen, aspartate aminotransferase (AST), alkaline phosphatase, sodium and chloride levels were similar for both treatments when sampled at 2 and 4 wk postpartum.

Table 8. Blood chemistry profile of lactating dairy cows.

Item	Bicarb % of day	MIN-AD/Bicarb % of day	SE	*P*
NEFA[a] – mEq/L – 2 wk	574	604	61	0.727
Glucose – mg/dl – 2 wk	51.2	53.8	2.6	0.509
4 wk	60.5	58.2	1.5	0.298
Total Protein – g/dl –2 wk	6.9	7.1	0.14	0.272
4 wk	7.2	7.4	0.10	0.107
UreaN[b] – mg/dl – 2 wk	10.4	9.4	0.7	0.334
4 wk	11.2	10.8	0.5	0.598
AST[c] – U/L – 2 wk	129.4	131.0	20.6	0.957
4 wk	93.4	98.7	5.6	0.502
Alk Phos[d] – U/L – 2 wk	53.1	48.6	3.3	0.354
4 wk	56.0	56.8	2.2	0.812
Sodium –mEq/L – 2 wk	139.8	139.3	0.5	0.524
4 wk	139.4	139.2	0.5	0.796
Chloride – mEq/L – 2 wk	99.0	98.4	0.5	0.343
4 wk	99.4	98.9	0.4	0.386

[a]NEFA – Nonesterified Fatty Acids; [b]UreaN – Urea Nitrogen; [c]AST – Aspartate aminotransferase; [d]Alk Phos – Alkaline Phosphatase

Summary

Results from this study indicate that MIN-AD can be used successfully to replace at least 50% of the sodium bicarbonate used in dairy rations and can potentially increase milk production and fat percentage. This response was consistent throughout the 8 week study period.

In addition to the milk response, ration costs can be lowered since MIN-AD typically costs less than sodium bicarbonate and a portion of the supplemental calcium and magnesium from more concentrated sources can be reduced. This results in both lower ration costs and a smaller premix package.