MIN-AD

MIN-AD® Dairy Ration Fermentation Studies

MIN-AD has been successfully used in dairy rations for many years as a buffer and source of Mg and Ca, typically in partial replacement of sodium bicarbonate (bicarbonate) and magnesium oxide (MgO). The consensus of many nutritionists is that MIN-AD usually results in a milk response and better herd performance.

Four studies were conducted at the **Rumen Fermentation Profiling Laboratory** (RFPL) at West Virginia University to better understand the impact of MIN-AD on rumen fermentation. The studies were performed under the guidance of Drs. Will Hoover of the RFPL, Charlie Sniffen of the Miner Institute, and Ray Hinders of Hinders Nutrition. Details on the fermentors and the experimental conditions are provided in Appendix A.

Experiments 1 and 2 were conducted using forages and ingredients normally used in the eastern United States and Canada. Experiments 3 and 4 used ingredients commonly found on the West Coast. The diet compositions and analyses are given in Appendices B and C.

It was observed that MIN-AD increases microbial efficiency regardless of feed source or pH and that MIN-AD plus bicarbonate was more effective than bicarbonate alone as a buffer under situations of severe pH depression (pH < 5.7).

Acid Neutralization and pH Control

The mean pH values over time for all experiments and treatments are shown in Table 1. Both the control and bicarbonate treatments contained MgO; none of the MIN-AD or combination (MIN-AD plus bicarbonate) treatments contained MgO. The largest observed increase in mean pH from the control was 0.13 units. This occurred with the combination treatment in Experiment 2 and with the bicarbonate treatment in Experiment 3. In Experiment 4, the bicarbonate and combination treatments had a significantly higher ($P < 0.05$) pH than the control and MIN-AD only treatments at 2 and 4 hours after feeding (not shown). It was only in Experiment 2, in which the mean pH dropped to about 5.7, that there were statistically significant differences in mean pH values among the treatments.

The RFPL conclusions on buffering are as follows.

1. "In situations of severe pH depression, MIN-AD+bicarbonate was more effective than bicarbonate alone as a rumen buffer."
2. "In situations where pH depression is not as severe, MIN-AD is less effective than bicarbonate alone as a buffer."

3131 BELL, SUITE 101 AMARILLO, TX 79106 OFFICE: 806.331.3510 FAX: 806.331.3667 ORDERS: 1.888.848.8178 WWW.MIN-AD.COM

Table 1. Mean pH values over time for Experiments 1, 2, 3 and 4.

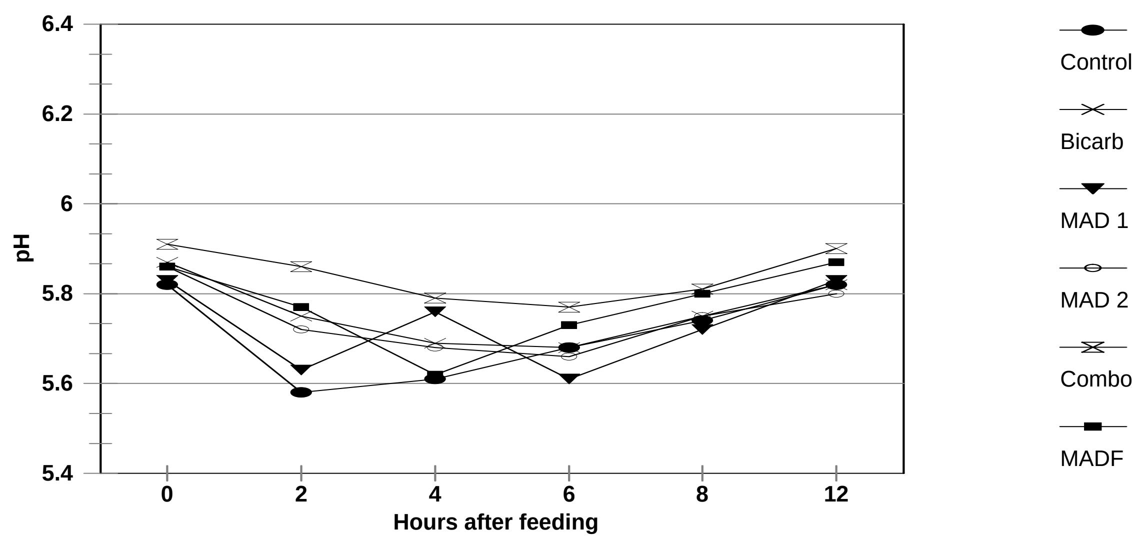
	Average pH			
Treatment %DM	Exp. 1	Exp. 2	Exp. 3	Exp. 4
Control	5.89	5.71[b]	5.76	5.77
Bicarb 1%	5.96	5.76[a,b]	5.89	5.83
MIN-AD .75%	5.87	----	----	----
MIN-AD 1.0%	----	5.72[b]	5.82	----
MIN-AD 1.25%	5.86	----	----	----
MIN-AD 1.5%	----	----	----	5.74
MIN-AD 2.0%	----	5.75[a,b]	5.80	----
Combo (MIN-AD +Bicarb)[1]	5.85	5.84[a]	5.79	5.78
MIN-AD Fines 1.0%	----	5.80[a,b]	----	----
MIN-AD Fines 1.25%	5.87	----	----	----

[1]0.94% MIN-AD + 0.31% Bicarb in Expt. 1; 0.5% of each in Expts. 2, 3,4.

[a,b,c]Values not sharing the same superscripts differ ($P<.05$)

Figure 1 shows the pH response as a function of time and treatment for Experiment 2. It can be seen that the combination of 0.5% MIN-AD + 0.5% sodium bicarbonate maintained a flatter pH profile than any of the other treatments.

Figure 1. Fermentation pH as affected by diet – Experiment 2.



MAD 1= MIN-AD @ 1% of DM, MADF = MIN-AD Fines @ 1% of DM, Bicarb = sodium bicarbonate @ 1% DM + MgO@ 0.11% of DM.

Microbial Efficiency and Growth

The most significant impact of the MIN-AD treatments was the observed microbial efficiency improvement. Microbial efficiency is defined as the grams of microbial nitrogen produced per kg of total carbohydrate digested (CHOD). Table 2 shows the percentage change in microbial efficiency for each MIN-AD treatment with respect to the canonical sodium bicarbonate and MgO treatment.

Table 2. Percentage change in microbial efficiency with respect to bicarbonate/MgO treatment.

Treatment -%DM	Expt. 1	Expt. 2	Expt. 3	Expt. 4
Bicarbonate 1%	base	base	base	base
MIN-AD 0.75%	+2.5%	---	---	---
MIN-AD 1.00%	---	+4.0%	+17.3%	---
MIN-AD 1.25%	+2.3%	---	---	---
MIN-AD 1.50%	---	---	---	+8.7%
MIN-AD 2.00%	---	+14.1%	+18.1%	---
MA Fines 1.25%	+2.6%	---	---	---
MA Fines 1.00%	---	+14.6%	---	---
MIN-AD + Bicarb	+11.2%	+15.5%	+10.6%	-4.6%

Improved microbial health will also manifest itself through the actual amount of protein that is degraded in the rumen. In any given experiment, all treatments were formulated with the same level of ruminally degradable protein (RDP). The following tables illustrate the effect of the treatments on the *measured* RDP and the total microbial N production. Results for Experiments 2 and 4 are given as they represent the most "realistic" feeding and ration regimes.

	Expt. 2 Treatments					
	Control	Bicarb@1%	MIN-AD@1%	MIN-AD@2%	Combo	MIN-AD Fines@1%
pH	5.71^{b}	$5.76^{a,b}$	5.72^{b}	$5.75^{a,b}$	5.84^{a}	$5.80^{a,b}$
CHOD (g)	42.9	41.9	41.4	41.1	42.3	39.6
RDP (% DM)	10.1	10.1	10.2	11.2	11.9	10.9
Mic. N/kg CHOD	39.8	40.4	42.0	46.0	46.6	46.2
Microbial N (g/d)	1.71	1.69	1.74	1.89	1.97	1.83

	Expt. 4 Treatments			
	Control	Bicarb@1%	MIN-AD@1.5%	Combo
pH	5.77	5.83	5.74	5.78
CHOD (g)	37.6	40.1	38.0	41.6
RDP (% DM)	9.3	10.1	10.4	10.0
Mic. N/kg CHOD	41.8	42.6	46.3	40.7
Microbial N (g/d)	1.57	1.71	1.76	1.69

It can be seen that production of microbial protein is increased as a consequence of the increased levels of RDP and higher microbial efficiency. This means that it is possible for a producer to reduce the amount of bypass protein needed to support high levels of production. It is also of significance for diets that do not support maximum microbial growth. Again, citing the RFPL experiment reports,

1. “regardless of the severity of pH depression, MIN-AD or MIN-AD + bicarbonate combinations improve microbial growth and microbial efficiency compared to bicarbonate alone” and
2. “MIN-AD can be recommended as a microbial growth enhancer and rumen buffering agent in a variety of dietary and feeding management situations.”

A statistical analysis of the data from all four experiments shows that MIN-AD increases microbial efficiency, regardless of feed source, pH, or amount of MIN-AD. The use of MIN-AD will result in increased microbial protein production requiring additional ruminal degradable true protein and ammonia. Dr. Will Hoover recommends that at least 11% of the ration be rumen-degradable protein with 50% of that being soluble or rapidly degradable. It is also important to carefully balance the fiber, starch, and sugars in the ration. This will allow MIN-AD to work maximally in stimulating microbial efficiency.

It is possible to take advantage of the increase in microbial efficiency within the CPM Dairy model to obtain the greatest economic return. In addition, the replacement of some sodium bicarbonate and MgO with lower cost MIN-AD will result in further savings.

Appendix A

Fermentors

Continuous culture fermentors

Liquid dilution rate: 12% per hour.

This represents the normal salivary input into the rumen. The saliva contains sodium and potassium bicarbonates as buffers. Urea is infused to mimic N recycling.

Solids retention time: 22 hours

Feed intake: 100 g DM/day

Time	g Dry Matter fed (for 6 feeding regimen)
8:00 a.m.	25.0
12:00 p.m.	12.5
4:00 p.m.	12.5
8:00 p.m.	25.0
12:00 a.m.	12.5
4:00 a.m.	12.5

Temperature: 39°C

pH: recorded at 2 hour intervals

	Expt. 1	Expt. 2	Expt. 3	Expt. 4
Rations	Eastern	Eastern	Western	Western
"Feeding" frequency[1]	2 times per day	6 times per day	6 times per day	6 times per day
Replications	3	3	3	4
Calculated RDP[2]	12.4%	12.2%	10.3%	11.1%

[1] Feeding frequency for fermentors corresponds to eating frequency for the cows.
[2] Rumen Degradable Protein, %DM.
Expt. 3 was conducted at lower than typical RDP levels without any canola meal or protein blend.

Treatment diets were fed as a total mixed ration with all of the ingredients ground to pass through a 4 mm screen attached to a Wiley Mill.

In Experiments 3 and 4, the levels of measured RDP were less than anticipated based on the calculated RDP. It is speculated that the grinding of the whole cottonseed to ensure adequate handling by the feeding system could have led to a rapid release of fat which theoretically could have resulted in a reduction in protein and fiber digestion.

Appendix B

Diet Composition and Analyses in Experiment 2.
All Values are Percentages of Dry Matter

Ingredient	Control	Bicarb	MA1%	MA2%	Combo	MA Fines
Corn Silage	30.1	29.9	30.1	29.7	30.1	30.1
Haylage	23.6	23.6	23.8	23.5	23.8	23.8
Ground Corn	25.0	24.5	24.6	24.6	24.6	24.6
Soy-44	19.5	19.5	19.5	19.5	19.5	19.5
Urea	0.37	0.37	0.37	0.37	0.37	0.37
MgO	0.11	0.11	----	----	----	----
TM Salt	0.35	0.19	0.35	0.35	0.35	0.35
Limestone	0.67	0.67	0.22	0.00	0.22	0.22
DiCal	0.28	0.19	0.22	0.15	0.22	0.22
MIN-AD	----	----	1.00	2.00	0.5	----
MIN-AD Fines	----	----	----	----	----	1.00
Sodium bicarb.	----	1.0	----	----	0.5	----
Component:						
Crude Protein	18.0	18.0	17.9	18.3	18.1	18.2
Soluble, %CP	29.0	36.8	33.7	36.3	28.8	36.3
NDF	30.2	30.5	30.6	30.6	30.9	30.5
ADF	17.5	18.5	17.9	16.7	18.5	17.5
NSC	39.7	35.8	38.8	36.4	38.6	37.1
Starch	35.6	31.6	34.9	32.3	34.4	33.0
Sugar	4.1	4.2	3.9	4.0	4.2	4.1
Ether Extract	3.0	2.7	2.7	2.5	2.9	2.7
Ash	5.8	6.5	6.3	7.3	5.9	6.4
NFC	43.1	42.3	42.6	41.3	42.2	42.3

Appendix C

Diet Composition and Analyses in Experiment 4.
All Values are Percentages of Dry Matter

Ingredient	Control	Bicarb	MIN-AD @1.5%	Combination
Corn Silage	11.1	11.0	11.0	11.0
Alfalfa Hay	27.1	26.8	26.8	26.9
Corn/Barl/Fat (70/25/5)	23.8	23.6	23.5	23.6
Cottonseed	10.1	10.0	10.0	10.0
Canola Meal	9.6	9.5	9.5	9.5
Citrus Pulp	5.8	5.8	5.7	5.8
Hominy	6.6	6.5	6.5	6.5
Molasses	2.9	2.8	2.8	2.8
*Protein Blend	1.3	1.3	1.3	1.3
Limestone	.46	.45	.45	.45
TM Salt	.18	.18	.18	.18
Calcium Carb.	.44	.43	.43	.44
Potassium Carb.	.27	.27	.27	.27
MgO	.13	.13	----	----
Calcium Phos.	.13	.13	.13	.13
MIN-AD	----	----	1.5	0.50
Sodium Bicarb	----	1.0	----	0.50
Component:				
Crude Protein	18.1	18.4	18.1	17.7
Soluble, %CP	30.1	30.1	29.6	27.7
NDF	24.4	24.9	24.8	26.1
ADF	18.6	18.1	18.5	20.4
NSC	38.9	38.8	38.9	38.2
Starch	30.9	30.7	31.0	30.1
Sugar	8.0	8.1	8.0	8.2
Ether Extract	5.3	5.1	5.3	4.8
Ash	7.3	8.0	8.4	7.7
NFC	45.0	43.7	43.4	43.9

*50:50, Fishmeal:SoyPass