

FINAL REPORT – Project # P0038505 (FCEB # 29)

Title: Chemically treating forages with alkali may improve digestibility and enhance beef cattle performance

Principal investigator

Nicolas DiLorenzo, Ph.D.

University of Florida - NFREC

3925 Highway 71

Marianna, FL 32446

Tel: (850) 526-1615

Email: ndilorenzo@ufl.edu

Co-Principal investigators

G. Cliff Lamb, Ph.D. – NFREC, Mariana, FL

Jose Dubeux, Ph.D. - NFREC, Mariana, FL

Chris Prevatt, MS. – RCREC, Ona, FL

Significance to the Florida Cattle Industry

Improvements of 23% in the DM digestibility of bahiagrass hay in situ were observed in a pilot study conducted in our laboratory when treating bahiagrass hay with CaO. While this approach has never been attempted on a larger scale, if we obtain a 10% improvement in digestibility (very conservative estimate considering our preliminary data) with chemical treatment of hay, this represents a savings of 117,000 tons of forage for the Florida beef cattle industry because of an improved utilization of currently available feed. This was calculated assuming approximately 1 million cows in FL consuming 26 lb of hay/d for 90 d/yr (winter). This translates into savings of \$9.36 million annually in feed costs in Florida only. On a producer-based scale, a 100-cow producer may save \$3,105 on a 90-day hay feeding season only, due to improved digestibility of hay and/or decreased amount of hay needed to buy or produce (see Page 2 of this proposal for more details about the calculations used for this estimate).

Objective

To determine the effects of chemically treating forages with alkali on digestibility, beef cattle growth, and economics of winter feeding programs.

Materials and Methods

Two studies were designed to determine the effects of adding calcium oxide on nutrient digestibility and beef cattle performance.

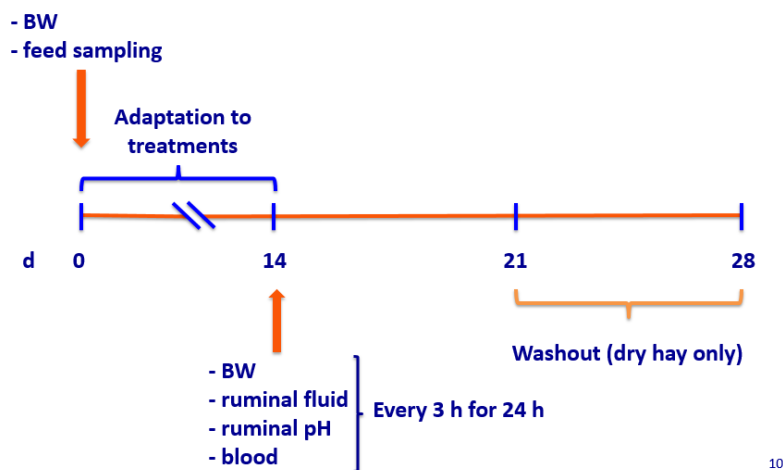
Experiment 1: Total tract digestibility of nutrients and ruminal metabolism of beef cattle consuming alkali treated bahiagrass hay.

Nine ruminally cannulated steers were used in a triplicated 3×3 Latin square design conducted at the UF-NFREC in Marianna. Each experimental period consisted of 14 d adaptation, 7 d collection and 7 d of washout, where steers were consuming untreated hay. The treatments were as follows:

- 1) Untreated dry bahiagrass hay (D)
- 2) Bahiagrass hay treated with 8.9% CaCO_3 (DM basis) + water (to 50% moisture) (CC)
- 3) Bahiagrass hay treated with 5% CaO (DM basis) + water (to 50% moisture) (CO)

All steers were fed ad libitum. Both treatments 2 and 3 were formulated to contain the same amount of Ca and were incubated with their respective Ca source for 7 to 14 d before feeding. Having the same amount of Ca in each treatment eliminates any potential effect of additional Ca in the metabolic response variables. While CaO will react with the moisture to form calcium hydroxide (Ca(OH)_2), limestone (CaCO_3) should not react with water, thus no effect on forage quality was expected. Total tract digestibility of nutrients was measured by collecting feed and feces for 4 consecutive d (twice daily) and using indigestible NDF as an internal digestibility marker. On d 15 of the experimental period, ruminal fluid and blood was collected for 24 h every 3 h to measure ruminal pH, VFA and $\text{NH}_3\text{-N}$ concentrations, and blood parameters such as blood urea nitrogen and glucose. This experiment was designed to test any potential metabolic responses from steers consuming hay treated with quicklime or limestone.

Fig. 1. Schematic of sampling schedule for Exp. 1.



Experiment 2. Effect of alkali treatment of bahiagrass on growing animal performance and economics

A total of 72 crossbred yearling heifers were used in a generalized randomized block design. Treatments will be similar as described in Experiment 2, with the exception that haylage was used instead of hay plus additional water, to mimic field conditions by using commercially produced and wrapped haylage with the addition of either CaO or CaCO_3 . Heifers (8/pen, 3 pens/treatment) were housed at the NFREC Feed Efficiency Facility where feed intake was continuously monitored. Heifers were fed the bahiagrass hay treatments ad libitum for 70 d, and growth performance was measured as feed efficiency (RFI and feed-to-gain), ADG and initial and final

BW. A shrunk weight (16 h withdrawal from feed and water) was obtained on d 0 and d 70, and unshrunk weights were obtained every 14 d.

Results

As observed in Fig. 2, treating hay with either calcium carbonate or calcium oxide after increasing the moisture to 50%, did not affect dry matter intake (DMI) when compared to dry bahiagrass hay. The bahiagrass hay used in this study had a CP concentration of 8% and a TDN of 53%, and steers had an average BW of 1,089 lb.

Fig. 2. Intake of DM by steers fed either dry hay (DH), hay treated with calcium carbonate (CC) or hay treated with calcium oxide (CO) in Exp. 1.

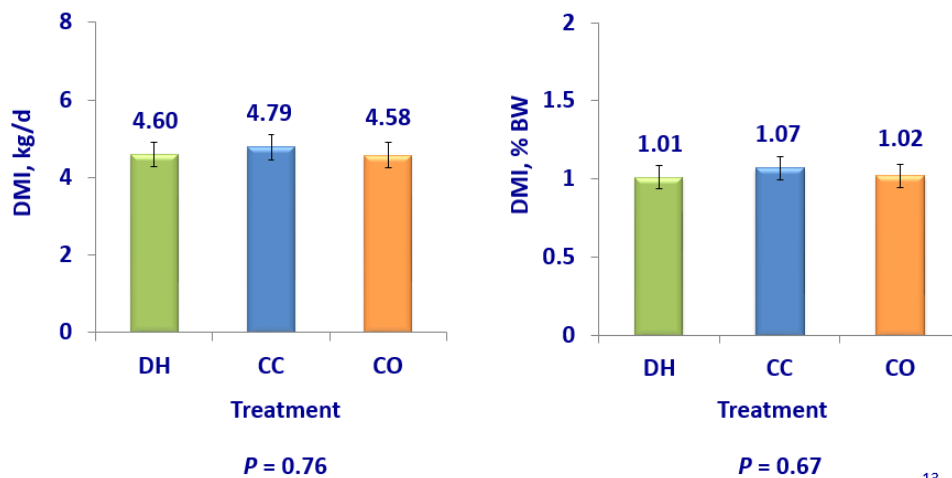
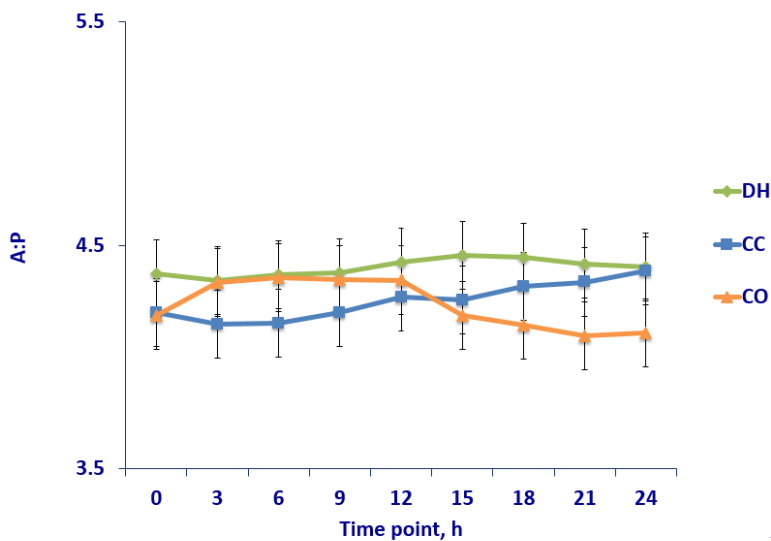


Table 1. Effects of feeding dry hay (DH), or hay treated with calcium carbonate (CC) or calcium oxide (CO) on ruminal fermentation.

Item	Treatment			SED	P-value		
	DH	CC	CO		TRT	TIME	TRT × TIME
Total VFA, mM	61.2 ^b	61.7 ^b	53.5 ^a	2.75	0.021	< 0.001	0.401
VFA, mol/100 mol							
Acetate	74.1	74.4	74.5	0.64	0.800	0.337	< 0.001
Propionate	16.9	17.6	17.9	0.68	0.376	0.105	< 0.001
Butyrate	7.7 ^b	6.8 ^a	6.6 ^a	0.26	0.002	< 0.001	0.143
BCVFA	0.7	0.7	0.6	0.09	0.450	< 0.001	0.074
A:P	4.4	4.3	4.2	0.17	0.643	0.073	< 0.001

Figure 3. Effect of feeding dry hay (DH), or hay treated with calcium carbonate (CC) or calcium oxide (CO) on ruminal fermentation on acetate-to-propionate ratio (A:P).



Treatment × time, $P < 0.0001$

19

Conclusions: Bahiagrass hay treated with 5% CaO after increasing the moisture to 50% may reduce ruminal fermentation as indicated by decreased total VFA concentration without altering DMI. Although a potential benefit may be expected from decreased acetate:propionate ratio when hay is treated with calcium oxide in terms of growth performance, the decrease in total volatile fatty acid (VFA) may offset this benefit. Additionally, treating bahiagrass hay with calcium carbonate did not provide any benefits relative to feeding dry hay.

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND- BUDGET JUSTIFICATION					
PROJECT TITLE: Chemically treating forages with alkali may improve digestibility and enhance beef cattle performance - Project # P0038505 (FCEB# 29)					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Materials and supplies to complete Experiments 1 and 2	27	100%	\$ 1,960.00	Calcium oxide, limestone, bags, crucibles, tubes, needles, reagents for analyses	9/1/2017
Nutrient digestibility analyses for Exp. 1 and 2	27	100%	\$ 14,740.00	Laboratory and data analyses of feed and feces to determine nutrient content and digestibility marker concentration. Analysis of data and final report.	9/1/2017
Feed sample analyses for Exp. 1 and 2	18	100%	\$ 630.00	Feed samples collected during the experiment and analyzed	9/1/2017
Blood and ruminal sample analyses for Exp. 1	81%	100%	\$ 10,250.14	Glucose , VFA , NH3-N , BUN analyses for 81 samples in Exp. 1 (9 steers, 9 samples/steer). Statistical analysis of data and final report.	9/1/2017
Research Animals (per diem) for Exp. 1	9%	100%	\$ 6,696.00	Cannulated steers for metabolism experiment housed at the Feed Efficiency Facility	9/1/2017
Research Animals (per diem) for Exp. 2	72	100%	\$ 6,212.06	Growing steers group-penned and housed at the NFREC Feed Efficiency Facility	9/1/2017
Indirect Cost			\$ 4,840.55		N/A
GRAND TOTAL: (equal to percentage of completion)			\$ 45,328.75		