Sugarcane Silage, Sodium Hydroxide- and Steam-Pressure-Treated Sugarcane Bagasse, Corn Silage, Cottonseed Hulls, Sodium Bicarbonate, and *Aspergillis oryzae* Product in Complete Rations for Lactating Cows[1]

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ABSTRACT

Five experiments compared silages, by-product roughages, and added sodium bicarbonate. Thirty-four cows were fed diets containing 1) 30% cottonseed hulls, 2) corn silage to supply 25% of dry matter intake from nongrain portion, 3) alkali-treated sugarcane bagasse silage, or 4) sugarcane silage both to supply 25% of dry matter intake. Only dry matter intake differed for diets 1 and 2 which excelled 3 and 4 for daily dry matter intake, milk yield, and protein percent. With 36 cows, sugarcane silage, enzyme-treated sugarcane silage, nongrain portion of corn silage, and pelleted cottonseed hulls with sodium bicarbonate (0 or 1%) and an enzyme product from *Aspergillus oryzae* (0 or 56.7 g/day) were compared. Milk yield was decreased and fat percent increased by silage compared with pelleted cottonseed hulls. Bicarbonate increased milk fat percent and fat-corrected milk in silage-containing rations. For the effect of sodium bicarbonate in early lactation, 36 cows were in a continuous feeding trial of corn silage, cottonseed hulls, or steam pressure-treated sugarcane bagasse, with sodium bicarbonate (0 or 170 g/cow per day). Lactation curves for feed intake, milk yield, and milk fat percent showed no effects of sodium bicarbonate. Cottonseed hull diets excelled corn silage diets. For the same cows and diets plus additional forms of steam pressure-treated bagasse (pelleted and wetter), bicarbonate was detrimental to feed intake and milk yield in pelleted bagasse diets but tended to be beneficial to milk yield in corn silage. Four groups of cows (152 cows/group) receiving 0 or 150 g sodium bicarbonate in a corn silage-based ration for 30 days did not differ in a field study.

INTRODUCTION

Corn silage is the major roughage source in dairy cattle diets in much of the country. In tropical and some subtropical areas corn is grown less extensively whereas sugarcane produces large tonnages of forage and may be made into silage. This crop may be ensiled, or where juice is used for sugar production, the residue, bagasse, is available as a feedstuff. Treatment of low quality roughages such as straws and bagasse with sodium hydroxide improved forage quality and animal performance for rations containing the treated roughages (12, 13). Steam pressure treatment also showed promise of increasing digestibility (9). Cottonseed hulls have been a source of roughage in complete rations of dairy and feedlot operations in many parts of the country. Generally, feed intake has been highest on complete rations containing this roughage (14, 16), but no studies have compared directly milk production from diets based on corn silage and cottonseed hulls.

Our studies were to compare complete rations containing sugarcane silage, NaOH-treated bagasse silage, steam pressure-treated bagasse, and corn silage, and to compare these with similar formulation containing cottonseed hulls as the roughage source.

Sodium bicarbonate has given variable

Received April 13, 1982.

[1] Florida Agricultural Experiment Station Journal Series No. 3788. This research was supported in part by Church and Dwight Company, Inc., Two Pennsylvania Plaza, New York, NY 10001 and STAKE Technology, Ltd., 220 Wyecroft Rd., Oakville, Ontario, Canada L6K 3V1.

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results in several experiments (2, 6, 7, 8, 11, 15) with beneficial effects seemingly associated with rations of corn silage (2, 7, 11) although results were not all positive for this type diet (6, 8). Also, local interest has developed in an enzyme derived from *Aspergillus oryzae* as a silage additive. Therefore, these additives were factorialized into comparisons of various silages with cottonseed hulls.

MATERIALS, METHODS, AND RESULTS

Experiment 1

This experiment was designed to compare sugarcane silage and sodium hydroxide-treated sugarcane bagasse silage with corn silage and cottonseed hull-based rations. Wet sugarcane bagasse was treated with 5% sodium hydroxide. Subsequently, 2.5% urea and 15% cane molasses were added, and the mixed material was ensiled in a vertical silo.[3] Fresh cut sugarcane grown on sand land in south Florida was hauled to Gainesville (about 370 km) and stored in a conventional tower silo.[4]

Four complete rations were formulated for comparison. The cottonseed hull rations contained 70% concentrate and 30% hulls dry matter. This percent hulls appeared about minimum to maintain milk fat test with the type rations (18). Twenty-five percent roughage from nongrain portion of silages was used because this is near minimum needed to maintain fat test. In our corn silage, 53.7% of total dry matter ensiled was stover (including husks), 8.2% cobs, and 38.1% grain, dry basis. This was determined by samples of corn plants at ensiling time, parts separated and dried. Stover, including husks and cob, was considered roughage (61.9% of dry matter). Grain in silage was concentrate. In the corn silage diet, 40% of dry matter was from silage; of this 40%, 15% was grain (40 x .381) which when combined with 60% of dry matter from concentrate mixture totaled 75% for the concentration portion (Table 1).

Thirty-four cows in early to mid-lactation were in a partially balanced incomplete block design with two 28-day periods. Cows were in individual pens and taken from these twice daily for milking. About 40% of allocated feed was offered at a.m. feeding (0800 to 0900 h)

[3] Sodium hydroxide-treated sugarcane bagasse silage was contributed by US Sugar Corporation, Clewiston, FL.

[4] Fresh cut sugarcane was cut and delivered for use in this experiment by A. Duda and Sons, Oviedo, FL.

TABLE 1. Composition of blended rations fed in Experiment 1.

Ingredients	Cottonseed hull ration	Corn silage ration[a]	NaOH bagasse ration[b]	Sugarcane silage ration[c]
	(% of ration dry matter)			
Cottonseed hulls	30.0	....	....	....
Corn silage	....	40.0	....	....
NaOH bagasse silage	....	....	25.0	....
Sugarcane silage	....	....	....	25.0
Citrus pulp	30.0	30.0	30.0	30.0
Corn	17.1	10.5	35.4	22.2
Soybean meal	20.7	17.4	7.5	20.7
Salt	.5	.5	.5	.5
Dicalcium phosphate	1.7	1.6	1.6	1.6
Roughage	30.0	25.0	25.0	25.0
Concentrate mixture	70.0	60.0	75.0	75.0
Silage grain	0	15.0	0	0

[a] Corn silage was 34.4% dry matter.

[b] NaOH-treated sugarcane bagasse silage was 42.7% dry matter.

[c] Sugarcane silage was 27.9% dry matter.

and 60% at p.m. feeding (1400 to 1500 h). With silage diets, allowance of silage was weighed and placed in the manger followed by correct proportions of concentrate to give desired total ration (Table 1). Silage and concentrate were hand-mixed in manger. Feed refusals were weighed individually before p.m. feeding and maintained between 3 and 5% of feed offered. Milk samples were DHIA (Dairy Herd Improvement Association) samples that were taken during the final week of each period. Body weights for each cow were taken at start of experiment and on last day of each period.

Results of Experiment 1 are in Table 2. Rations containing cottonseed hull and corn silage appeared equal in performance except feed intake ($P<.01$). Cows ate more when cottonseed hulls were included, but energy was not as great per unit as for corn silage diet. The NaOH-treated sugarcane bagasse diet gave poorest performance with sugarcane silage giving only slightly improved performance. Body weight gain was greater from sugarcane silage diet than from NaOH-treated bagasse silage.

All diets were marginal in maintaining fat percent, but no differences in fat percent or protein percent were significant. The pH's of silages were 3.95 for both corn and sugarcane silages and 4.80 for NaOH-treated bagasse silage. Sugarcane silage released a volatile compound(s) in removal of silage from storage that was irritating to eyes and lungs of feeders. It is presumed this was acetic acid because acetic acid was high and lactate lowest in sugarcane silage. Milligrams of acetate and lactate/g of corn, NaOH-treated sugarcane, and sugarcane silages were 4.2 and 15.5, 6.2 and 20.0, and 7.5 and 11.1. Molar ratio of lactate: acetate was only 1.1 in sugarcane silage.

Experiment 2

Thirty-two cows in mid-lactation and three 28-day feeding periods were in a 4 × 2 × 2 factorial in a partially balanced incomplete block design. This consisted of five roughage sources: pelleted cottonseed hulls (PCSH), sunflower hulls, corn silage, sugarcane silage, and sugarcane silage treated with enzymes (*Aspergillus oryzae* derivative) at time of ensiling. Also included in rations were two percentages of sodium bicarbonate supplementation (0 or 1% of total ration dry matter) and two quantities of *A. oryzae* enzyme addition (0 or 56.7 g/day hand-mixed in concentrate). Proximate analyses of silages are in Table 3. Fresh cut sugarcane was delivered as for Experiment 1 but stored in approximately 90.7

TABLE 2. Least squares means for Experiment 1 comparing cottonseed hulls (CSH), corn silage, sugarcane silage, and sodium hydroxide-treated sugarcane bagasse silage.

	Response variables						
Comparisons	DMI[a]	MY[a]	Protein	Fat	Fat yield	Protein yield	Weight gain
	(kg/day)		(%)		(kg/day)		(kg/28 days)
Ration							
CSH	23.0	25.5	3.18	3.19	.81	.81	+8.1
Corn silage	18.5	24.9	3.20	3.15	.79	.80	+2.0
NaOH-treated sugarcane bagasse silage	16.4	22.8	3.00	2.97	.67	.68	−6.3
Sugarcane silage	17.2	23.2	3.01	3.05	.69	.69	+8.8
Orthogonal contrasts							
CSH vs. corn silage	$P<.01$	NS	NS	NS	NS	NS	NS
Corn silage vs. 3, 4	$P<.01$	$P<.01$	$P<.01$	NS	$P<.01$	$P<.01$	NS
Bagasse vs. sugarcane silage	NS	NS	NS	NS	NS	NS	$P<.05$
Error mean squares s^2, 30 df	1.62	1.18	.012	.102	.009	.002	1.81

[a]DMI = Dry matter intake, MY = milk yield.

TABLE 3 Proximate analyses of silages in Experiment 2.

	Corn silage	Sugarcane silage	Enzyme sugarcane silage
	(%)		
Dry matter	29.3	26.4	26.0
Crude protein	2.4	.8	.9
Ether extract	.4	.4	.4
Crude fiber	8.5	9.4	8.5
Ash	4.9	1.5	2.1
NFE[a]	14.6	14.4	15.2

[a]Nitrogen-free extract.

ton, plunger-packed plastic bag silos. Enzyme was added on top of loads as received at 5 kg/ton. Composition of experimental rations is in Table 4. Ration 2 was included to give a preliminary evaluation of sunflower hulls which may be marketed as a by-product roughage. Sunflower hulls were substituted for cottonseed hulls.

Both sugarcane silage and enzyme-treated sugarcane silage were of excellent quality when removed for feeding. Corn silage was stored in a bunker silo. Rate of removal was slow at end of final period because no other cattle were being fed from this source to save enough silage to complete the experiment, and quality of corn silage deteriorated.

The first 14 days of each period were used to adjust animals to rations. Production data were recorded during the final 14 days. Milk yield, milk fat percent, feed intake, and body weight change were measured. Milk samples for measurement of milk fat percent were composite

TABLE 4. Experimental rations for Experiment 2.

Ingredient	Ration number 1	2	3	4	5	6	7	8
	(% of ration dry matter)							
Pelleted CSH[a]	35.0	10.0	....	....	....	....	....	....
Sunflower hulls	....	25.0	....	....	....	....	....	....
Corn silage	....	....	....	....	....	....	37.0	37.0
Sugarcane silage	....	....	22.5	22.5	....	....	....	....
Treated sugarcane silage[b]	....	....	....	....	22.3	22.3	....	....
Citrus pulp	28.5	28.5	30.9	30.4	30.8	30.4	30.9	30.0
Corn meal	18.9	18.9	23.0	22.7	23.2	22.8	11.2	11.2
Soybean meal	16.0	16.0	21.3	21.1	21.4	21.2	18.4	18.3
Dicalcium phosphate	1.1	1.1	1.7	1.7	1.7	1.7	1.9	1.9
Trace mineral salt	.5	.5	.6	.6	.6	.6	.6	.6
Sodium bicarbonate	....	....	....	1.0	....	1.0	....	1.0
Roughage	35.0	35.0	22.5	22.5	22.3	22.3	22.9	22.9
Concentrate mixture	65.0	65.0	77.5	77.5	77.7	77.7	63.0	63.0
Silage grain	....	....	....	....	....	....	14.1	14.1

[a]CSH = cottonseed hulls.

[b]*Aspergillus oryzae* enzyme product added at time of ensiling at rate of 5 kg/ton. Product for this and subsequent experiments contributed by Bio-Zyme Enterprises, Inc., 1231 Alabama, St. Joseph, MO 64504.

samples of morning and evening milk taken on the last day of each period.

Response data for Experiment 2 are in Table 5. No differences were detected in any measure among any of the silage treatments. No advantage was detected for enzyme treatment of sugarcane at time of ensiling although milk production was slightly elevated (25.3 vs. 24.7 kg/day). Sugarcane silage was equal to the nongrain portion of corn silage in all responses measured. No reduction in intake or animal performance was detected.

Comparison of all silages to PCSH showed a significant decrease of milk yield (27.0 vs. 25.0 kg/day) and increase in milk percent (3.21 vs. 3.60%). This probably was due to increased fiber of the silage rations and a decrease in overall digestible energy. Feed intake was significantly lower for animals consuming silage-containing rations as compared with animals on PCSH rations (23.5 vs. 28.6 kg/day).

Sodium bicarbonate when added at 1% of dry matter in silage diets increased milk fat percent ($P<.10$) from 3.50 to 3.70. Enzymes added at feeding had no significant effect on dry matter intake or milk yield in silage diets but tended to increase milk fat percent ($P<.10$) and fat yield ($P<.05$). Overall effect of enzyme was not significant, however, as effects tended to be negative for cottonseed hull diets.

Dry matter intake tended to be lower when 25% sunflower hulls were substituted for

TABLE 5. Least squares means for Experiment 2 comparing sodium bicarbonate and *Aspergillus oryzae* enzyme product additions in sugarcane silage, corn silage, and pelleted cottonseed hull diets.[a]

Ration comparisons[a]	DMI	MY	Milk fat	Fat yield	3.5% FCM	Body weight	Weight change
	(kg/day)		(%)	(kg/day)		(kg)	(kg/day)
Comparison of roughages							
Corn silage	23.3	25.1	3.51	.88	25.1	636	.58
Sugarcane silage	23.6	24.7	3.61	.89	25.1	643	.73
Treated sugarcane silage	23.9	25.3	3.71	.93	26.0	643	.39
35% PCSH	28.6	27.0	3.21	.85	25.5	632	.44
Comparisons within silage diets							
0% $NaHCO_3$	23.4	24.7	3.50	.86	24.6	638	.47
1.0% $NaHCO_3$	23.7	25.3	3.70	.94	26.1	639	.67
0 AOP	22.8	24.7	3.55	.87	24.7	631	.52
56.7 g/day AOP	24.3	25.3	3.66[b]	.93[c]	26.0[c]	641	.62
Comparisons within pelleted cottonseed hull diets							
0 AOP	27.3	26.9	3.41	.92	26.6	623	.18
56.7 g/day AOP	26.9	26.4	2.99	.79	24.2	628	−.10
Comparison of cottonseed hulls and sunflower hulls							
35% CSH	28.6	27.0	3.21	.85	25.5	632	.44
25% SFH + 10% PCSH	25.6	26.4	3.20	.86	25.3	618	−.36
Significant orthogonal contrasts							
0 vs. 1.0% $NaHCO_3$	NS	NS	$P<.10$	$P<.05$	$P<.05$	NS	NS
0 vs. 56.7 g/day AOP (within silage)	NS	NS	$P<.10$	$P<.05$	$P<.05$	NS	NS
Interaction of AOP in silage vs. CSH diets	NS	NS	$P<.10$	$P<.05$	$P<.05$	NS	NS
35% CSH vs. 25% SFH + 10% CSH	NS	NS	NS	NS	NS	NS	NS
Error mean squares							
s^2, 39 df	6.43	2.18	.135	.011	4.02	227.5	.57

[a]DMI = Dry matter intake, PCSH = pelleted cottonseed hulls, $NaHCO_3$ = sodium bicarbonate, MY = milk yield, AOP = *Aspergillus oryzae* product, SFH = sunflower hulls, CSH = cottonseed hulls.

[b]$P<.10$ greater than from 0 AOP diet.

[c]$P<.05$ greater than from 0 AOP diet.

pelleted cottonseed hulls, but performances were not affected significantly.

Experiment 3

Thirty-six Holstein cows were placed on experiment at calving, up to no later than wk 5 of lactation, to study the value of sodium bicarbonate in early lactation. Animals available for the study were selected from dry cows in a shade vs. no-shade experiment. The shade experiment, similar to Collier et al. (3), was designed to study effects of heat stress during the dry period on subsequent milk production. Ration treatments after calving were factorialized over the previous environmental treatments in a partially balanced incomplete block design. Cows were assigned randomly to receive one of the eight rations for the 11 wk as in Table 6. Roughages were corn silage, cottonseed hulls (CSH), and steam pressure-treated bagasse (SPTB) that was approximately 52% dry matter. Corn silage was stored in an approximately 90.7-ton, plunger-packed plastic bag silo. Half of the silage was treated with enzymes derived from *Aspergillus oryzae* which was added on top of loads at time of ensiling at 5 kg per ton (rations 3 and 4, Table 6). The plastic tube silo had treated silage at one end and control silage at the other end. Sodium bicarbonate (85 g/feeding twice daily) was added in diets for half of the cows receiving various roughage sources at feeding. Cows were managed in same pens as previous experiments. Milk composition was obtained from monthly sampling by the Dairy Herd Improvement program. All cows were weighed each week during the experiment before the afternoon milking.

Cottonseed hull rations contained 60% concentrates and 40% hulls dry matter. Corn silage rations were formulated to compare the nongrain portion of corn silage with cottonseed hulls and SPT bagasse in the manner of Experiments 1 and 2.

Ration means are in Table 7. Cottonseed hull rations increased daily dry matter intake, daily milk yield, milk fat percent, and fat yield

TABLE 6. Experimental rations for Experiment 3.[a]

Ingredients	Ration numbers					
	1 & 3	2 & 4	5	6	7	8
	(% of ration dry matter)					
Corn silage[b]	48.0	47.5	....	....	....	....
SPT bagasse[c]	....	....	25.5	25.3	....	....
Cottonseed hulls	....	....	....	....	40.0	39.6
Corn meal	34.8	34.5	49.1	48.6	38.2	37.8
Soybean meal	10.4	10.3	17.4	17.2	14.6	14.5
Sunflower meal	5.2	5.2	5.8	5.8	5.0	5.0
Salt, trace	.5	.5	.6	.6	.6	.6
Calcium carbonate	.8	.8	1.0	1.0	1.0	1.0
Dynafos	.3	.3	.6	.6	.6	.6
Sodium bicarbonate	....	.9[d]	....	.9[d]	....	.9[d]
Roughage	29.7	29.4	25.5	25.3	40.0	39.6
Concentrate mixture	52.0	52.5	74.5	74.7	60.0	60.4
Silage	18.3	18.1	....	....	....	....

[a]Rations 3 and 4 were made from corn silage treated with enzymes derived from *Aspergillus oryzae* which was added at the rate of 5 kg/ton at time of ensiling. Otherwise formulation identical with rations 1 and 2.

[b]Corn silage averaged 44.2% dry matter. Dry basis component percents were: crude protein, 7.0; ether extract, 1.5; crude fiber, 21.5; ash, 3.2; NFE (nitrogen free extract), 67.0.

[c]STP = Steam pressure treated. STP bagasse averaged 52% dry matter. Dry basis component percents were: crude protein, 4.3; ether extract, 1.2; crude fiber, 34.6; ash, 6.1 nitrogen-free extract, 54.0.

[d]Cows receiving sodium bicarbonate consumed 170g/day hand-mixed with ration at time of feeding. Percent of diet thus varied depending on amount of dry matter consumed, averaging .9%.

TABLE 7. Ration least squares means for Experiment 3.[a]

Treatment comparisons	DMI	MY	F	FY
	(kg/day)		(%)	(kg/day)
Comparison of roughages and $NaHCO_3$				
Corn silage	17.4	23.2	3.28	.75
Corn silage + $NaHCO_3$	16.8	22.8	3.27	.79
CSH	21.0	27.7	3.91	1.08
CSH + $NaHCO_3$	21.3	26.0	3.53	.95
SPT bagasse	18.9	28.1	3.11	.90
SPT bagasse + $NaHCO_3$	18.1	24.3	3.16	.74
Overall effect of $NaHCO_3$				
No $NaHCO_3$	18.7	25.5	3.43	.87
170 g/day $NaHCO_3$	18.2	24.0	3.32	.82
Significant orthogonal contrasts				
Corn silage vs. CSH diets	$P<.05$	$P<.05$	$P<.05$	$P<.05$
Error mean squares				
s^2, 30 df	63.6	243.8	.35	.072

[a]DMI = dry matter intake, MY = milk yield, F = milk fat, FY = milk fat yield, SPT = steam pressure-treated, $NaHCO_3$ = sodium bicarbonate, CSH = cottonseed hulls.

($P<.05$) compared with corn silage rations. Because SPT bagasse diets were not significantly different from cottonseed hull diets, it appears that SPT bagasse also was superior to corn silage in milk yield. However, preselected orthogonal contrasts did not make this direct comparison. No differences were significant for sodium bicarbonate during the study of early lactation.

Although overall means in a continuous feeding trial of this type usually have a relatively high error variance (note 243.8 error variance for milk yield in Experiment 3 vs. 2.18 in Experiment 2), it is possible to compare lactation curves to determine much more precisely whether they are parallel. Cubic polynomial lactation curves were developed by regressing measured response variables on week of lactation, and homogeneity of regression was tested. Model used included diet, previous shade treatment, diet-shade, and cows within diet-shade cells.

No differences were found between cows fed control and enzyme-treated corn silage, but effects of roughages were significant for dry matter intake (Figure 1) and milk yield (Figure 2). Orthogonal contrasts selected did not compare directly SPTB with corn silage diets, but milk yield curves for cottonseed hulls diets differed from corn silage ($P<.01$) but not from SPTB diets.

Analysis of differences with shaded vs. unshaded cows prepartum showed no significant effects for dry matter intake, milk yield, milk fat percent, or fat yield, in overall means or when lactation curves were tested for homogeneity of regression.

The major reason for designing this experiment with cows in early lactation was to test

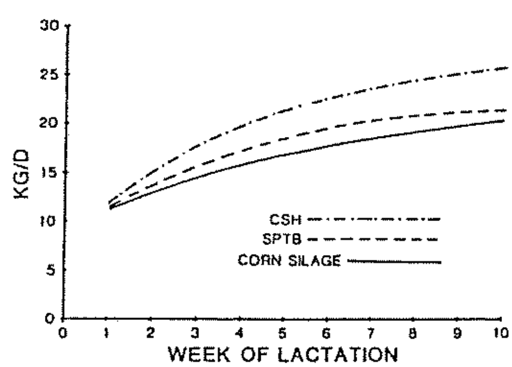

Figure 1. Dry matter intake response from complete rations containing cottonseed hulls (CSH), steam pressure-treated bagasse (SPTB), and corn silage for cows during wk 1 to 10 of lactation.

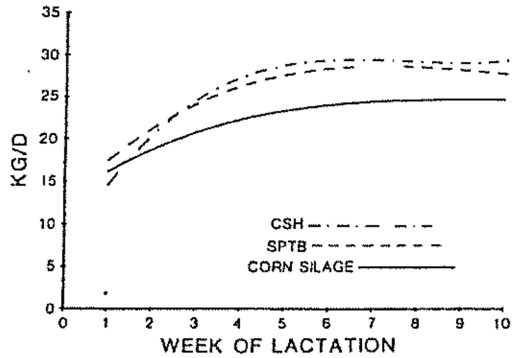

Figure 2. Milk yield response from complete rations containihg cottonseed hulls (CSH), steam pressure-treated bagasse (SPTB), and corn silage during wk 1 to 10 of lactation.

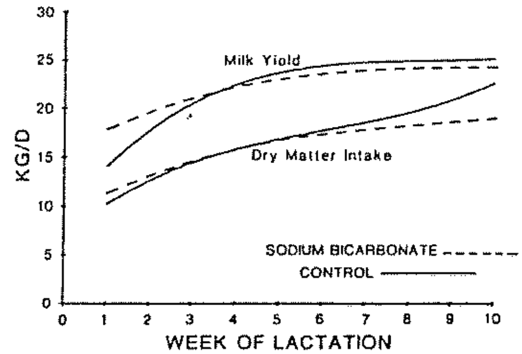

Figure 4. Dry matter intake and milk yield response during wk 1 to 10 of lactation when fed complete rations based on corn silage and added sodium bicarbonate (0 to 170 g/cow daily).

the hypothesis that sodium bicarbonate helps improve feed intake and milk yield in the first few weeks of lactation. No differences were significant in overall means (Table 7) or between milk yield and feed intake curves (Figure 3). However, even though milk yield and feed intake differed little, within corn silage diets differences between curves were significant ($P<.05$) and suggested that cows receiving sodium bicarbonate ate and produced more until wk 3 of lactation (Figure 4).

Experiment 4

This experiment was a continuation of Experiment 3 with two new roughages: 1) pelleted steam pressure-treated bagasse (SPTB) (52% dry matter product used previously, reduced in moisture, dried, and pelleted); and 2) a slightly wetter SPTB (48.9% dry matter). The experimental design utilized a 5 × 2 factorial in a partially balanced incomplete block design and three 28-day periods. Data from the last week of each period were used for statistical analysis. Grain content of corn silage again was assumed to be 38.1% of silage dry matter as measured in Experiment 1. The experimental rations are in Table 8. (Rations 7 to 10 are added to rations similar to those fed in Experiment 3.)

Corn silage was stored in a bunker silo, and STPB was stored on plastic. No spoilage occurred from storage in this way as it was a sterile product. Management of cows was the same as in Experiment 3 except milk samples were obtained from cows on the final day of each period and consisted of combined afternoon and morning samples. Samples were stored at 4°C until Babcock analysis.

Analyses of quantitative data collected during these experiments were analyzed by the mixed model least-squares and maximum likelihood computer program of Harvey (10) and under release 79.3A of SAS by the general linear models procedure (1).

Least squares means for rations are in Table 9. All roughages compared, sodium bicarbonate did not affect dry matter intake, milk yield, milk fat percent, or fat yield. However, there was a significant increase of dry matter intake when sodium bicarbonate was added to corn

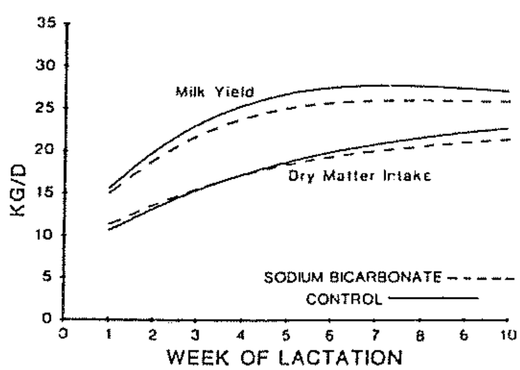

Figure 3. Average dry matter intake and milk yield response from cows during wk 1 to 10 of lactation fed complete rations containing added sodium bicarbonate (0 or 170 g/cow daily).

TABLE 8. Experimental rations for Experiment 4.

Ingredients	Ration number									
	1	2	3	4	5	6	7	8	9	10
	(% of ration dry matter)									
Corn silage[a]	34.0	33.7	....	....	....	....	....	....	....	....
Cottonseed hulls	....	....	40.0	39.7	....	....	....	....	....	....
SPT bagasse[b]	....	....	....	....	25.5	25.3	....	....	....	....
Pelleted SPT bagasse	....	....	....	....	....	....	34.0	33.7	....	....
Wetter SPT bagasse (48% dry matter)	....	....	....	....	....	....	....	....	29.7	29.5
Corn meal	46.9	46.5	41.1	40.7	53.3	52.9	45.1	44.7	50.4	49.9
Soybean meal	16.8	16.7	16.5	16.4	19.2	19.0	18.5	18.4	17.6	17.5
Salt, trace	.8	.8	.8	.8	.6	.6	.7	.7	.8	.8
Calcium carbonate	.9	.9	.7	.7	.6	.6	.8	.8	.9	.9
Dynafos	.6	.6	.9	.9	.8	.8	.9	.9	.6	.6
Sodium bicarbonate[c]	....	.8	....	.8	....	.8	....	.8	....	.8
Roughage	21.0	20.9	40.0	39.1	25.5	25.3	34.0	33.7	29.7	29.5
Concentrate mixture	66.0	66.3	60.0	60.3	74.5	74.7	66.0	66.3	70.3	70.5
Silage grain	13.0	12.8	....	....	....	....	....	....	....	....

[a]Corn silage averaged 23.7% dry matter. Dry basis component percents were: crude protein, 7.2; ether extract, 2.5; crude fiber, 26.6; ash, 4.0; NFE (nitrogen-free extract), 59.7.

[b]SPT = steam pressure treated. SPT bagasse is same product used in Experiment 3.

[c]Cows receiving sodium bicarbonate, consumed 170 g/day hand-mixed with ration at time of feeding. Percent of diet thus varied depending on amount of dry matter consumed, averaging .83%.

silage and cottonseed hull rations compared with the three forms of SPT bagasse rations. Also, a significant difference in milk yield was noted from sodium bicarbonate effect when wet forms of SPT bagasse rations were compared with pelleted SPT bagasse rations. Sodium bicarbonate was particularly detrimental in the diet with pelleted SPTB.

Cottonseed hull rations fed at 40% of ration dry matter gave significantly higher dry matter intakes than the average of other roughages (24.7 vs. 19.0 kg/day), increased milk yields (26.1 vs. 23.8 kg/day), increased milk fat percent (3.27 vs. 2.95%), and increased fat yields (.85 vs. .70 kg/day). Corn silage diets also gave significantly higher dry matter intakes, milk yields, milk fat percent, and fat yields than the SPTB rations but little differences from wet forms of SPTB. Wet forms of SPTB showed significant increases of dry matter intake (18.0 vs. 17.5 kg/day) and milk yield (24.3 vs. 22.5 kg/day) over the pelleted SPTB diets.

Experiment 5

A 30-day field trial was conducted in the four highest production groups of a 1500 cow dairy approximately 65 km from Gainesville, FL, during June, July, and August. Groups averaged 152 cows each. Daily ration per cow averaged 16 kg corn silage (approximately 25% dry matter), 3 kg Bermuda grass hay, and 16 kg concentrates. Cows were fed and housed in a confined shaded area with access to outside lots 2 to 4 h/day. All cows were fed to appetite. About 4 kg of pelleted concentrate was fed daily in the milking parlor. Remaining concentrate and corn silage were mixed and fed with a feeder-mixer wagon, and hay was offered separately in the lots. Two lots of cows were selected randomly to receive about 150 g of sodium bicarbonate per cow daily with silage-concentrate mixture fed free choice in lots. Milk weights were taken in mid-June (DHIA, Milk Only Program) to be used as a covariate to compare production

TABLE 9. Ration least squares means for Experiment 4.[a]

Treatment comparisons	DMI	MY	F	FY
	—— (kg/day)	——	(%)	(kg/day)
Overall effect of $NaHCO_3$				
No $NaHCO_3$	20.1	24.2	2.97	.73
170 g/day $NaHCO_3$	20.2	24.4	3.06	.74
Comparison of roughages and $NaHCO_3$				
Corn silage	19.7	24.0	3.10	.74
Corn silage + $NaHCO_3$	21.6	25.0	3.03	.75
CSH	24.2	25.4	3.33	.85
CSH + $NaHCO_3$	25.2	26.7	3.20	.85
SPTB	18.6	24.7	2.81	.69
SPTB + $NaHCO_3$	18.3	24.9	2.92	.73
Pelleted SPTB	18.4	23.8	2.93	.71
Pelleted SPTB + $NaHCO_3$	16.6	21.1	3.11	.63
Wet SPTB	19.6	22.7	2.68	.63
Wet SPTB + $NaHCO_3$	19.3	24.4	3.04	.73
Significant orthogonal contrasts				
Bicarbonate vs. 0	NS	NS	NS	NS
CSH vs. corn silage diets	$P<.001$	$P<.10$	NS	$P<.05$
All SPTB vs. corn silage diets	$P<.001$	$P<.05$	$P<.05$	$P<.05$
SPTB + wet SPTB vs. pelleted	$P<.05$	$P<.10$	NS	NS
Interaction (contrast 1 × 4) SPTB	$P<.05$	$P<.10$	NS	NS
Error mean squares				
s^2, 61 df	3.94	7.0	.183	.0016

[a]DMI = Dry matter intake, MY = milk yield, F = milk fat, FY = milk fat yield, CSH = cottonseed hulls, SPTB = steam pressure-treated bagasse.

obtained from the next monthly DHI test. Milk fat percents were not available. Sodium bicarbonate was administered following the preliminary milk yield measurement to cows in two of the four groups. A total of 610 cows completed the 30-day feeding trial.

Covariance adjusted milk yields for cows receiving approximately 150 g/day of sodium bicarbonate averaged 22.46 kg/day vs. 22.53 kg for controls. Differences were not significant.

DISCUSSION

Maintaining high feed intake with sugarcane silage in Experiment 2 contrasted to Experiment 1 and other work with ensiled sugarcane (4). De Gonzalez and MacLeod (5) observed decreased intake on sugarcane silage because of high alcohol. High alcohol was due to high soluble sugar content of sugarcane and a tremendous growth of yeast. In Experiment 1, it is possible that volatile substances (presumable acetic acid) were responsible for depression of animal performance on sugarcane silage rations. Sugarcane used in Experiment 2 showed no undesirable properties. One explanation for the difference of the silages may be the method of storage of the silage. Silage in Experiment 1 was stored in smaller quantity in upright silos, whereas silage in Experiment 2 was stored in a compressed bag which probably excluded air at ensiling time more effectively than the procedure in upright silos.

Pelleted SPT bagasse posed several problems. The pellets were processed and delivered at several times, each time with slightly different quality and moisture content. Another problem with bagasse pellets was molding and crumbling, causing varied feed intakes. In spite of some problems of maintaining a uniform supply of SPT bagasse, these experiments show the nonpelleted forms of this product were at least equal to the nongrain portion of corn silage for maintaining milk yield which is our best estimate of the product energy. However, its effective fiber probably was less than corn silage as indicated by lower milk fat percentages in both experiments than from diets based on corn silage.

The corn silage in Experiment 4 was from a bunker silo and was much higher in moisture and quality than that in Experiment 3. It is possible the dryness of silage may have something to do with the lack of response to sodium bicarbonate by cows in early lactation (Experiment 3) as observed by Erdman et al. (7) and Kilmer et al. (11) as the effect in wetter corn silage diets and the wettest SPT bagasse was observed in Experiments 2 and 4.

Cows receiving sodium bicarbonate in cottonseed hull diets in Experiments 2, 3, and 4 did not show benefit from sodium bicarbonate. No benefit was found in diets containing corn silage in Experiments 3 and 5. Thus, sodium bicarbonate seems unlikely to be beneficial except in high moisture diets. It is definitely detrimental in some diets, e.g., with pelleted SPT bagasse. Because feed intake appears to be depressed greatly when sodium bicarbonate is detrimental, it is likely that detriment is associated with poor palatability as found by Stout et al. (17) and that its bad taste is covered in wet and particularly silage diets much better than in other diets.

Cottonseed hull rations produced greater milk yield than corn silage-based rations in these experiments (26.4 kg/day vs. 24.4 from corn silage-based rations). The major reason for this was through effecting greater feed intake (24.4 kg/day vs. 19.9 from corn silage rations). Another reason may be that cottonseed hulls composed slightly less percent of total ration dry matter (average of 36.2% of total ration dry matter vs. 39.7% from corn silage) but estimated percent of nongrain roughage was greater (36.2% vs. 24.6% from corn silage). Fat percents in these four experiments averaged slightly higher for cottonseed hulls (3.44% vs. 3.25% for corn silage) probably because dry matter consumption and nongrain roughage consumption from corn silage were both low. Thus, although cottonseed hulls often are considered to be a low quality roughage, the positive effect on feed intake makes performance from these diets much nearer optimum even though ratios of milk to feed still tend to favor corn silage rations (1.23 from corn silage-based rations vs. 1.08 from cottonseed hulls).

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