Lactational performance, chewing behavior, and ruminal fermentation of dairy cows fed diets differing in amount and digestibility of NDF from two sources of corn silage

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INTRODUCTION

- Conventional corn silage (CCS) and brown midrib corn silage (BMR) differ in amount and digestibility of NDF, influencing chewing behavior and performance responses of dairy cows.

OBJECTIVE

- To evaluate the lactational performance, chewing behavior, and ruminal fermentation of early lactation cows fed diets differing in amount and digestibility of corn silage.

MATERIALS & METHODS

Experimental Design

- Replicated 4 x 4 Latin square, 21-d periods
  - 8 ruminally cannulated, multiparous lactating Holstein cows
- Treatments were formulated to contain similar (approximately 25%) NDF from forage:
  - Low forage, conventional corn silage **(Low CCS)**
  - High forage, conventional corn silage **(High CCS)**
  - Low forage, BMR corn silage **(Low BMR)**
  - High forage, BMR corn silage **(High BMR)**

Data Collection & Analysis

- Intake and milk yield recorded d 14 – 21
- Milk composition measured d 17 & 18
- Chewing behavior monitored d 17 – 19
- Rumen pH measured d 17 – 19
- Ruminal NH_3-N and VFA measured at 4 h intervals for 48h, d 17 & 18

Statistics

- Analyzed as a replicated Latin square with the MIXED procedure of SAS using diet, period, and replicate as fixed effects and cow within square as random effect.

Table 1. Ingredients and chemical composition of dietary treatments

	Treatment			
Item	Low CCS	High CCS	Low BMR	High BMR
Ingredient, %DM				
Conventional corn silage	39.3	55.0	-	-
Brown midrib corn silage	-	-	36.1	50.2
Haycrop silage	13.4	13.4	13.3	13.3
Corn meal	17.3	1.6	20.4	6.3
Grain mix	30.1	30.1	30.1	30.1
% Forage	52.7	68.4	49.4	63.5
Chemical composition, %				
DM	52.2 ± 0.8	45.8 ± 0.5	52.8 ± 1.3	47.0 ± 0.8
CP	17.0 ± 0.1	17.0 ± 0.1	16.7 ± 0.3	16.7 ± 0.1
αNDF[1]	32.1 ± 0.4	35.6 ± 0.4	31.5 ± 0.3	35.1 ± 0.2
Starch	28.0 ± 0.9	21.2 ± 0.5	27.8 ± 0.9	23.8 ± 0.7
Fat	4.0 ± 0.1	3.9 ± 0.1	4.4 ± 0.2	4.5 ± 0.2
$\alpha NDFd_{24}$[2], %αNDF	56.3 ± 1.5	54.0 ± 1.4	62.0 ± 1.8	60.3 ± 1.4
peNDF[3]	17.3 ± 0.8	23.1 ± 2.0	18.5 ± 2.0	21.5 ± 1.2

[1]αNDF = αNDF with residual ash using amylase and sodium sulfite
[2]$\alpha NDFd_{24}$ = 24-h in vitro digestibility of NDF
[3]peNDF = physically effective NDF

Table 2. Intake

	Treatment					*P*-value
Item	Low CCS	High CCS	Low BMR	High BMR	SE	Treatment
DMI, kg/d	29.0[a]	26.5[b]	29.3[a]	29.2[a]	0.7	<0.01
DMI, % of BW/d	4.31[a]	3.96[b]	4.37[a]	4.36[a]	0.12	<0.01
NDF intake , kg/d	9.36[b]	9.47[b]	9.32[b]	10.25[a]	0.22	<0.01
NDF intake, % of BW/d	1.39[b]	1.41[b]	1.39[b]	1.53[a]	0.04	<0.01

[ab] Least squares means within a row without a common superscript differ ($P \leq 0.05$).

Table 3. Milk yield and composition

	Treatment					*P*-value
Item	Low CCS	High CCS	Low BMR	High BMR	SE	Treatment
Milk, kg/d	47.0[a]	43.1[b]	48.6[a]	47.2[a]	1.6	<0.01
3.5% Fat-corrected milk (FCM), kg/d	49.3[xy]	46.5[y]	50.3[x]	50.2[x]	1.2	0.06
Solids-corrected milk (SCM), kg/d	45.2[ab]	41.8[b]	46.4[a]	45.7[a]	1.2	0.02
Milk composition						
Fat, %	3.82[ab]	4.02[a]	3.76[b]	3.94[ab]	0.14	0.04
Fat, kg/d	1.83	1.71	1.87	1.85	0.05	0.12
True protein, %	3.06[ab]	2.92[c]	3.10[a]	3.02[b]	0.05	<0.01
True protein, kg/d	1.48[ab]	1.25[c]	1.55[a]	1.43[b]	0.04	<0.01
Efficiency, kg/kg						
Milk/DMI	1.62	1.62	1.66	1.61	0.04	0.46
3.5% FCM/DMI	1.70	1.76	1.72	1.72	0.03	0.28

[ab] Least squares means within a row without a common superscript differ ($P \leq 0.05$).
[xy] Least squares means within a row without a common superscript differ ($P \leq 0.10$).

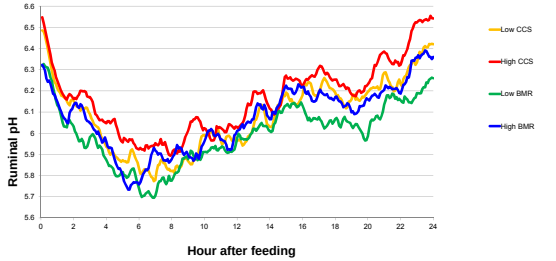
Table 4. Chewing behavior

	Treatment					*P*-value
Item	Low CCS	High CCS	Low BMR	High BMR	SE	Treatment
Eating Behavior						
Eating, min/d	273[ab]	301[a]	250[b]	273[ab]	14	<0.01
Eating, min/kg NDF	29.3[ab]	31.7[a]	27.3[b]	27.1[b]	1.6	<0.01
Ruminating Behavior						
Ruminating, min/d	514[ab]	543[a]	463[b]	536[a]	17	<0.01
Ruminating, min/NDF	55.3[xy]	57.0[x]	50.6[y]	53.4[xy]	2.4	0.09
Total Chewing[2]						
Total chewing, min/d	786[a]	844[a]	713[b]	809[a]	24	<0.01
Total chewing, min/kg NDF	84.6[ab]	88.7[a]	77.9[b]	80.5[b]	3.6	<0.01

[abc] Least squares means within a row without a common superscript differ ($P \leq 0.05$).
[xy] Least squares means within a row without a common superscript differ ($P \leq 0.10$).

RESULTS

Ruminal pH relative to feeding



SE = 0.08; *P*-value (treatment, time, treatment x time): 0.02, <0.001, 0.91
Time (min/d ± SE) below a pH of 5.8 (328 ± 89) or 5.5 (98 ± 43) did not differ ($P > 0.10$) among diets.

Table 5. Ruminal NH_3-N and VFA concentrations

	Treatment					*P*-value		
Item	Low CCS	High CCS	Low BMR	High BMR	SE	Treatment	Time	Treatment x Time
NH_3-N, mg/dL	10.49	11.60	9.88	10.42	0.79	0.43	<0.01	0.61
Total VFA, m*M*	105[ab]	102[b]	110[a]	111[a]	8	0.04	<0.01	0.46
VFA, m*M*								
Acetate (A)	65.2	64.8	65.3	67.0	5.27	0.73	<0.01	0.61
Propionate (P)	26.2[ab]	21.5[c]	29.0[a]	25.7[b]	2.27	0.001	<0.01	0.45
Butyrate (B)	3.0	12.2	13.4	13.1	1.19	0.56	<0.01	0.75
A:P	2.56[bc]	3.08[a]	2.31[c]	2.69[b]	0.15	<0.001	<0.01	0.14
A+B:P	3.08[bc]	3.64[a]	2.79[c]	3.22[b]	0.19	0.002	<0.01	0.15

[abc] Least squares means within a row without a common superscript differ ($P \leq 0.05$).

CONCLUSIONS

- Intake, milk yield, and SCM were lower on the High CCS diet.
- Efficiency of milk production was not affected by treatment.
- Chewing time per kg of NDF intake was greater for CCS diets.
- Mean ruminal pH was lower on the Low BMR diet
- Greater inclusion of highly digestible NDF corn silage (High BMR diet) maintained DMI, milk yield, and chewing behavior without compromising the ruminal environment.
- Greater inclusion of less digestible NDF corn silage (High CCS diet) decreased DMI, milk yield, and total VFA.

IMPLICATIONS

- High forage rations require highly digestible NDF forage to maintain production.
- Highly digestible NDF forage requires greater inclusion in the diet to maintain rumen health.