



Use of NutriDense Corn Variety for Corn Silage: Forage for Lactating Dairy Cows.

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ABSTRACT

The objective of this study was to evaluate a hybrid corn variety for corn silage and corn grain fed to high producing dairy cattle. Sixty-three lactating Holsteins were paired based on parity, stage of lactation, milk production, and body weight and randomly assigned to one of three dietary treatments. Control (CC) cows received total mixed ration (TMR) containing control corn silage (CS) and control corn grain. Group NDC received TMR containing NutriDense (ND) CS and control corn grain. Group NDND received TMR containing ND CS and ND corn grain. All three dietary treatments were formulated to meet NRC requirements for a 636 kg cow producing 41 kg milk/day at 3.75% fat. All cows were housed in the same free stall barn with ad lib access to feed and water. Cows were fed and milked twice daily with weights and feed refusals recorded. All Cows were fed CC and adapted to individual electronic feeding gates (Calan Gates, American Calan, Inc.) during a 10d training period. CC diet was fed for another 10d to collect baseline data and then assigned diets were fed exclusively for 50d. Dietary ingredients and TMR samples were taken daily and composited by week for nutrient analysis. Milk samples were taken weekly and submitted for analysis of milk fat, protein, urea nitrogen (MUN) and somatic cells (SCC). Weekly body weights and body conditions were recorded and weekly blood samples were collected to evaluate plasma glucose and urea nitrogen (PUN). A second experiment was conducted to evaluate ruminal fermentation of dietary treatments using standard in situ and in vitro techniques. Data collected were ruminal pH, optical density, and NH₃-N concentrations as well as dry matter and nitrogen disappearance. Data were analyzed by Proc Mixed procedures of SAS. Dry matter intake was different (P=0.05) with LSMeans of 22.03, 21.02, and 20.22 kg for CC, NDC, and NDND, respectively. Weekly fat corrected milk, milk fat, protein and SCC were not different (P=0.36, P=0.70, P=0.26, P=0.40, respectively). MUN and PUN were different by treatment (P=0.01, P<0.05, respectively) and by treatment over time (P=0.1, P<0.05, respectively). In situ Nitrogen disappearance was different due to treatment (P=0.0383), with higher values for NDND than CC or NDC (73.26%, 71.44%, and 71.90%, respectively). Ruminal NH₃ concentrations were higher (P=0.02) for NDND than CC or NDC with values of 6.61, 5.90, and 6.16, respectively.

INTRODUCTION

- > Corn silage is a key forage used in dairy cow diets in the United States.
- > According to a nationwide survey of dairy nutritionists from 28 land grant universities (Mowrey and Spain, 1999)
 - > Corn silage use ranges from 40% in the southwestern U.S. to 82.9% in the northeast.
 - > Maximum inclusion rates ranged from 23 to 58% of the diet.
 - > The mean maximum inclusion rate (n=22) was 45.6% of the diet dry matter.

OBJECTIVE

- > Evaluate a hybrid corn variety for use as corn silage and corn grain fed to lactating dairy cattle, using NutriDense™ variety corn hybrid (BASF, Inc.) characterized as a high oil, high protein corn hybrid.

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MATERIALS AND METHODS: PRODUCTION STUDY

- > 63 Holstein cows (n=3 per block)
 - > Lactation number (X=1.9)
 - > Stage of lactation (X=127 days in milk)
 - > Milk production (X=31.8 kg/day)
 - > Body weight (X=631 kg)
 - > Randomly assigned to one of three dietary treatments
- > Dietary Treatments
 - > Control (CC) - Fed standard yellow dent corn silage and yellow dent corn grain.
 - > NDC - Fed NutriDense corn silage and yellow dent corn grain.
 - > NDND - Fed NutriDense corn silage and NutriDense corn grain.
- > Cows were housed in a freestall barn at the University of Missouri Dairy Farm and Research Center.
- > Cows were fed a Total Mixed Ration (TMR) ad libitum to ensure a 10% refusal rate, 2X at 0700 and 1500h
 - > Refusals removed and weighed prior to 1500 feeding
 - > Individual electronic feeding gates (Calan Gates)
 - > Adaptation period of 10 days
 - > 7 day baseline period (all cows fed CC diet)
 - > Fed experimental diet for 50 days.
 - > TMR sampled daily, composited by week
 - > analyzed for DM, CP, ADF, NDF, and EE.
- > Cows were milked 2x at 0400 and 1600h
 - > Electronic records of individual cow production recorded at each milking.
 - > Weekly milk samples from two consecutive milkings.
 - > Analyzed for milk fat, true protein, milk urea nitrogen (MUN), and somatic cell count (SCC) (Mid-South Dairy Records, Springfield, MO).
 - > Weekly blood samples collected via coccygeal venipuncture into vacutainers.
 - > Plasma was analyzed for glucose (Glc) and urea nitrogen (PUN).

Table 1. Ingredient composition (DM basis) of treatment diets, formulated to provide 17% CP, 0.76Mcal/lb DM, and 4% crude fat

Ingredient	CC	NDC	NDND
Alfalfa hay – mid bloom	4.93	5.13	4.92
Alfalfa silage	1.78	1.71	1.71
Yellow dent corn silage	5.96	0	0
ND corn silage	0	6.07	6.15
Corn, cracked	6.19	6.19	0
ND Corn	0	0	6.60
Soybean Meal 48%	1.42	1.42	1.01
Whole cottonseeds, fuzzy	2.51	2.09	2.3
Soybean Hulls	0.82	1.02	1.02
Soy Plus	0.81	0.81	0.61
Lactation Premix	0.85	0.85	0.85

Table 2. Nutrient composition (DM basis) of treatment diets and corn silage varieties.

Nutrient	CC	NDC	NDND	Control corn silage	ND corn silage
DM	59.2	59.4	59.5	36.4	36.6
Neutral Detergent Fiber (NDF)	42.5	43.4	45.8	55.0	51.5
Acid Detergent Fiber (ADF)	27.5	29.2	27.5	28.8	27.6
Crude Protein (CP)	17.7	17.6	17.9	9.0	9.6
Crude Fat (CF)	4.0	3.9	4.2	2.1	3.0

MATERIALS AND METHODS: IN VITRO STUDY

- > Rumen fluid was collected and prepared according to methods by Tilley and Terry using a 4:1 McDougall's buffer solution.
- > Dietary treatment (CC, NDC, NDND)
 - > 3g (n=6 per treatment) placed into a 250ml flask
 - > Inoculated with 150ml of rumen/buffer mixture
 - > Sealed flask with one way stopper
 - > Incubated in a shaking water bath at 39C.
 - > Samples (5ml)
 - > Collected at 0, 6, 12, 18, 24, and 36h of incubation
 - > Analysis
 - > pH
 - > Optical density (OD) measured at 600nm
 - > Ammonia (NH₃)
 - > Volatile fatty acids (VFA), (Nukol 30m GLC column, Supelco, Bellefonte, PA)

MATERIALS AND METHODS: IN SITU STUDY

- > TMR samples from the Production Study were compiled for each dietary treatment, dried and ground (2mm)
 - > 5g sample placed in 10cm x 20cm Dacron polyester bags and heat sealed.
 - > Placed into ruminally fistulated dairy cows.
- > Fistulated cows were fed a standard lactation diet similar to CC
- > In situ bags were incubated at 0, 6, 12, 24, and 36 h
 - > Bags were rinsed with cold tap water upon removal until effluent ran clear and then further rinsed using a commercial washing machine.
 - > Bags were dried (55C) and weighed to determine dry matter disappearance (DMD).
 - > In situ residues were analyzed for N content using the LECO system to determine N disappearance (ND).

RESULTS AND DISCUSSION: PRODUCTION STUDY

Table 3. LS Means values in response to dietary treatment

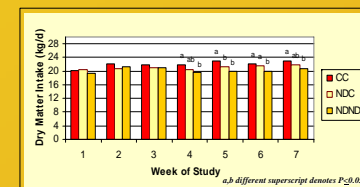
Variable	Trt			SE	P
	CC	NDC	NDND		
Dry Matter Intake (kg/d)	22.03 ^a	21.02 ^{ab}	20.22 ^b	0.70	0.05
Dry Matter Intake (% of Body weight)	3.69 ^a	3.37 ^b	3.30 ^b	0.11	0.04
Milk Yield (kg/d)	32.19	32.23	30.53	1.43	0.45
Fat Corrected Milk (kg/d)	32.46	32.61	30.61	1.36	0.36
Milk fat (%)	4.03	4.08	4.02	0.06	0.70
Milk protein (%)	3.02	3.02	3.09	0.04	0.26
Somatic Cell Count Score (SCC)	2.70	2.43	2.85	0.24	0.40
Milk Urea Nitrogen (MUN)	15.67 ^a	16.31 ^b	15.36 ^b	0.22	0.01
Plasma Urea Nitrogen (PUN)	14.49 ^a	16.65 ^b	15.14 ^b	0.48	0.0009
Plasma Glucose (Glc)	65.11	64.47	65.03	1.03	0.77

^{a,b,c} different superscript denotes P<0.05

Dry matter intake as a % of body weight decreased significantly with the inclusion of Nutridense in the diet. However, milk production was the same for all dietary treatments. Suggesting a greater efficiency of feed to milk conversion with the inclusion on ND corn variety.

RESULTS AND DISCUSSION: PRODUCTION STUDY (Cont.)

Figure 1. LS means dry matter intake (kg/d) (Treatment*Time; P=0.02).



DMI was significantly lower for cows fed NDND diet with differences observed over the last 4 weeks of the trial.

RESULTS AND DISCUSSION: In vitro and In situ studies

Table 4. LS Means values of in situ and in vitro experiments in response to dietary treatment

Variable (in situ)	Trt			SE	P
	CC	NDC	NDND		
Dry Matter Disappearance	61.02	60.20	60.40	0.53	0.29
Nitrogen Disappearance	71.90 ^a	71.44 ^a	73.26 ^b	0.44	0.04
Variable (in vitro)	Trt			SE	P
	CC	NDC	NDND		
Total VFA mM	54.46 ^a	61.58 ^b	61.72 ^b	1.38	0.003
Optical Density	1.57	1.58	1.56	0.07	0.97
In vitro pH	6.75	6.78	6.72	0.02	0.058
Ammonia	5.90 ^a	6.16 ^b	6.62 ^b	0.16	0.02

^{a,b} different superscript denotes P<0.05

Table 5. LS Means values of in vitro VFA production in response to dietary treatment

Volatile Fatty Acid (mM)	Trt			SE	P
	CC	NDC	NDND		
Acetic acid	34.61 ^a	39.20 ^b	39.22 ^b	0.91	0.003
Butyric acid	5.76 ^a	6.90 ^b	6.89 ^b	0.24	0.006
Isobutyric acid	0.29 ^a	0.39 ^b	0.38 ^b	0.02	0.01
Isovaleric acid	0.70 ^a	0.91 ^b	0.95 ^b	0.06	0.014
Propionic acid	12.22 ^a	13.08 ^b	13.14 ^b	0.25	0.04
Valeric acid	0.98 ^a	1.09 ^b	1.14 ^b	0.03	0.008
Total VFA production	54.46 ^a	61.58 ^b	61.72 ^b	1.38	0.003

^{a,b} different superscript denotes P<0.05

In situ Nitrogen disappearance was significantly higher for NDND diet (P=0.04) and was mirrored by an increased in vitro Ammonia production (P=0.02).

Total VFA production greatly increased with the inclusion of ND corn variety (P=0.003). All six VFAs tested were significantly higher for diets containing ND.

CONCLUSIONS

- > Nutridense corn variety maintained milk production with lower DMI and improved production efficiency.
- > VFA production measured in the in vitro study explains the improved production efficiency measured in vivo.