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Effect of corn snaplage on lactation performance by dairy cows

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ABSTRACT

The objective of this study was to determine lactation performance by dairy cows fed corn snaplage either alone (SNAP) or in combination with ground dry shelled corn (SPDC) versus rolled high-moisture shelled corn (RHMC). Dry-matter content was greater for RHMC (78.2%) than SNAP (68.5%). The starch content of SNAP was approximately 10%-units lower than RHMC. Sixty Holstein cows (30 primiparous and 30 multiparous; 100 ± 23 DIM and 626 ± 44 kg of BW at trial initiation) were used in a randomized, complete-block, continuous-lactation trial: 2-wk covariate adjustment period with all cows fed a 50:50 mixture (DM basis) of SNAP and RHMC in TMR followed by an 8-wk experimental period with cows fed their assigned treatment corn grain (RHMC, SNAP, or SPDC) in TMR. Intake of DM was reduced by 2.6 kg/d per cow, on average, for SNAP and SPDC compared with RHMC. Milk yield averaged 39.4 kg/d per cow and was unaffected by treatment as were all measures of component-corrected milk yield. Actual milk, FCM, solids-corrected milk, and energy-corrected milk feed efficiencies (kg/kg) were greater, on average, for SNAP and SPDC compared with RHMC by 7 to 9%. Milk fat percentage was reduced by 0.27% units, and milk-urea-nitrogen concentration was greatest, for SNAP compared with RHMC. These changes in milk composition along with reduced DMI were likely related to greater ruminal starch digestibility for SNAP. Milk fat and milk-urea-nitrogen concentrations were improved by the partial replacement of SNAP with ground dry shelled corn in the SPDC treatment.

Key words: corn snaplage, high-moisture corn, dairy cow, starch

INTRODUCTION

Corn harvested as grain for feeding to dairy cattle can be dry or ensiled and most commonly is harvested, stored, and fed as ground dry shelled corn (**GDSC**) or rolled high-moisture shelled corn (**RHMC**), respectively. Shelled corn is harvested with a combine, which dictates the dry down to about 30% kernel moisture before harvest (Mader and Erickson, 2006).

Another option for harvesting high-moisture corn is snaplage (**SNAP**), which can be harvested using a self-propelled forage harvester (**SPFH**) fitted with a corn head (Mahanna, 2008; Lardy and Anderson, 2010). Use of a SPFH for production of SNAP allows the corn harvest to be initiated earlier (greater than 33% kernel moisture) and proceed more rapidly with kernel processing done immediately during the harvest process by way of the SPFH on-board roller mill rather than later at the silo as done with RHMC (Mahanna, 2008; Lardy and Anderson, 2010). Therefore, there is considerable interest in SNAP for dairy-cattle feeding from the corn-production side (Mahanna, 2008).

Nutritionists, however, may be concerned about a reduced energy content of SNAP, because it is composed of kernels, cob, husk, and shank from the ear and possibly some leaf material from above the ear, which serve to dilute its starch content with fiber compared with RHMC or GDSC (Mahanna, 2008). Also, harvest of corn as SNAP with its increased moisture content may increase rate and extent of ruminal starch digestibility (Mahanna, 2008) through breakdown of the starch–protein matrix in the kernel endosperm resulting from more extensive protease activity during the ensiling process (Hoffman et al., 2011; Hoffman et al., 2012). This could contribute to reduced milk-fat content (Oba and Allen, 2003a; Ferraretto et al., 2013a) when SNAP is fed to lactating dairy cows. Because of concerns over starch, energy content, or ruminal starch digestibility, SNAP is often fed in combination with GDSC rather than alone as the sole of grain in dairy-cattle diets.

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Controlled research on feeding SNAP to dairy cattle is lacking. Thus, the objective of this study was to determine lactation performance effects in dairy cows from feeding SNAP either alone or in combination with GDSC compared with RHMC.

MATERIALS AND METHODS

Corn hybrid P35F44 (DuPont Pioneer, Johnston, IA) was planted in a University of Wisconsin Arlington Agricultural Research Station (Arlington, WI) field (16 ha; 84,000 seeds/ha; 76-cm row spacing) on April 22, 2010. Half of the field was harvested as SNAP, and half was harvested as RHMC on September 22 and 29, 2010, respectively. The SNAP and RHMC were stored in separate side-by-side, 2.5-m-diameter × 61-m-long silo bags until the feeding trial was initiated on April 28, 2011. Harvest of SNAP was done using a SPFH (Claas Jaguar Model 860; Claas of America Inc., Omaha, NE) fitted with a 6-row corn head (John Deere Model 643; Deere & Co., Moline, IL) and Kooima (Kooima Co., Rock Valley, IA) header adapter by a custom operator (Bach Farms, Dorchester, WI). The SPFH was set for a 9-mm theoretical length of cut with 1-mm processor gap spacing. Harvest of RHMC was done using a combine (John Deere Model 9400; Deere & Co.) and a roller mill mounted on the silo bagger (Renn Mill Model 36; Renn Mill Center Inc., Lacombe, AB, Canada) set to 1-mm processor gap spacing. A *Lactobacillus buchneri* inoculant (Biotal Buchneri 40788; 600,000 cfu/g; Lallemand Animal Nutrition, Milwaukee, WI) was applied as a liquid to both treatments at the silo bagger. Targeted kernel moisture contents at harvest were 28 to 30% and 32 to 35% for RHMC and SNAP, respectively.

The animal research was conducted under an approved protocol by the Institutional Animal Care and Use Committee of the College of Agricultural and Life Sciences. Sixty Holstein cows (30 primiparous and 30 multiparous; 100 ± 23 DIM and 626 ± 44 kg of BW at trial initiation) were used in the study. Thirty electronic gate feeders (RIC system, Insentec, Marknesse, the Netherlands) in the University of Wisconsin–Madison sand-bedded, freestall barn (Blaine Dairy Research Center, Arlington, WI) were randomly allocated to 6 groups each with 5 gates. Cows were blocked by parity (primiparous or multiparous) and randomly assigned to a group of gates with the 10 cows able to access all 5 gate feeders within the group. The gate feeders (1.40 m deep, 0.80 m wide, and 0.75 m high) were situated on weigh cells, and each cow was fitted with an identification transponder to record consumption of each individual cow meal. This electronic feeding system was described by Chapinal et al. (2007). The groups of 5 gates were then randomly assigned to 1 of 3 treatments in a randomized complete-block design in a continuous-lactation trial: 1 wk for adaptation of cows to gates, a 2-wk covariate adjustment period with all cows fed a 50:50 mixture (DM basis) of SNAP and RHMC in TMR, and an 8-wk treatment period with cows fed their assigned treatment corn grain in TMR: 1) RHMC, 2) SNAP, and 3) SNAP plus GDSC (**SPDC**). Ingredient composition of the experimental diets is provided in Table 1. Ground, pelleted soy hulls partially replaced RHMC in that treatment (70:30 ratio of RHMC to soy hulls on DM basis) to induce more similar total NDF and starch concentrations for the RHMC and SNAP treatments. The ratio of SNAP to GDSC was 69:31 (DM basis) to induce more similar total NDF and starch concentrations for the GDSC and SNAP treatments. Respective concentrate mixtures, which did not include the ensiled corns, were prepared at the University of Wisconsin Feed Mill (Arlington, WI). The covariate and treatment-period TMR were mixed once daily at 1000 h and fed twice daily at 1200 and 1600 h.

All cows were injected with bovine somatotropin (Posilac, Elanco Animal Health, Greenfield, IN) every 14 d commencing on d 1 of the covariate period. The gate feeders were supplied with TMR to allow for 5% refusals, with daily DMI determined

Table 1. Ingredient composition of the experimental diets[1]

Ingredient	RHMC	SNAP	SPDC
Corn silage	21.8	21.8	21.8
Alfalfa silage	32.7	32.7	32.7
High-moisture rolled shelled corn	21.5	—	—
High-moisture rolled corn snaplage	—	29.2	20.0
Dry ground shelled corn	—	—	9.2
Ground, pelleted soy hulls	9.0	—	—
Soybean meal, 48% solvent	8.6	9.7	9.7
Distillers dried grains	3.6	3.6	3.6
Energy Booster 100[2]	0.91	0.91	0.91
Calcium carbonate	0.84	1.04	1.04
Monocalcium phosphate	0.15	0.15	0.15
Magnesium oxide	0.18	0.18	0.18
Mg-K-S[3]	0.09	0.09	0.09
Trace mineral salt[4]	0.45	0.45	0.45
Vitamin premix[5]	0.18	0.18	0.18

[1]RHMC = diet containing high-moisture corn; SNAP = diet containing corn snaplage; SPDC = diet containing corn snaplage and dry ground shelled corn.

[2]Minimum 98% total fatty acids (MSC Company, Dundee, IL).

[3]Dynamate (11% Mg, 18% K, 22% S; The Mosaic Co., Plymouth, MN).

[4]Contained 88% NaCl; 0.002% Co; 0.2% Cu; 0.012% I; 0.18% Fe; 0.8% Mn; 0.006% Se; 1.4% Zn.

[5]Vitamin A, 3,300,000 IU/kg; vitamin D, 1,100,000 IU/kg; vitamin E, 11,000 IU/kg.

on individual cows throughout the 10-wk trial. Body weight and BCS (1 to 5 in 0.25 increments; Wildman et al., 1982) were recorded on individual cows on the same day of the week at 1000 h every other week. Daily body weight change (**BWC**) for individual cows was calculated by linear regression of BW measurements over time. Milk yield was recorded daily (DairyComp305, Valley Agricultural Software, Tulare, CA) on individual cows milked twice daily in a double-16 parlor (Metatron P21, GEA Farm Technologies, Bakel, the Netherlands) throughout the 10-wk trial. Milk samples were obtained from all cows every-other week on the same 2 consecutive days from the a.m. and p.m. milkings throughout the 10-wk trial and composited by cow by week. Composites were analyzed for fat, true protein, lactose, and milk-urea-nitrogen concentrations and SCC by infrared analysis (AgSource Milk Analysis Laboratory, Menomonie, WI) using a Foss FT6000 (Foss Electric, Hillerød, Denmark) with average daily yields of fat and protein calculated from these data for each sampling week. Yields of FCM, solids-corrected milk, and energy-corrected milk (**ECM**) were calculated according to NRC (2001) equations for each sampling week. Actual milk, FCM, solids-corrected milk, and ECM feed conversions were calculated for each milk sampling week using average daily yield and DMI data. Estimated diet energy concentrations (Mcal/kg of DMI) were calculated by summing the megacalories of NE_L from milk production, required for maintenance and in BW change (NRC, 2001), and then dividing the sum by DMI.

Samples of corn silage, alfalfa silage, concentrate mixes, and treatment corns were obtained every other week throughout the trial for nutrient analysis. All samples were dried at 60°C for 48 h in a forced-air oven to determine DM content and ground to pass a 1-mm Wiley mill (Arthur H. Thomas, Philadelphia, PA) screen before sending to Dairyland Laboratories Inc. (Arcadia, WI) for analysis as described by Ferraretto et al. (2012). Samples taken during the treatment period were composited by 4-wk periods before sending to the commercial laboratory. Samples of TMR were obtained every other week during the trial and analyzed for DM content as described previously. Nutrient composition of the TMR was calculated using feed-ingredient analyses and diet-ingredient composition. Particle-size distribution of TMR, corn silage, alfalfa silage, and SNAP samples was determined as described by Kononoff et al. (2003). Geometric mean particle size (**GMPS**) of the RHMC, SNAP and GDSC corns after drying (60°C for 48 h in a forced-air oven) was determined by dry sieving as described by Ferraretto et al. (2012). For SNAP, the GMPS was determined on the complete sample and also on particles that had passed through the 4.75-mm screen to exclude coarse fibrous material, thereby resulting in a sample more similar to the RHMC for comparison. Ruminal in vitro 7-h starch digestibility was determined on RHMC and SNAP corns by Dairyland Laboratories Inc. as described by Ferraretto et al. (2012). Undried, unground samples of RHMC and SNAP corns were sent to Dairyland Laboratories Inc. for determination of fermentation profile (Muck and Dickerson, 1988).

Data were analyzed as a randomized complete-block design with the data from the preliminary period as a covariate using PROC MIXED (version 9.1, SAS Institute Inc., Cary, NC), with week of treatment as repeated measures using the first-order autoregressive covariance structure, which provided the best fit according to Sawa's Bayesian information criterion. The model included parity, treatment, week, and the interactions as fixed effects and cow within treatment as a random effect. There were no covariate or repeated-measures effects included in the analysis of BWC or estimated diet energy concentration data. Data from 2 multiparous SPDC cows had truncated records because of being removed for filching at wk 6 of the experimental period. Filching was defined as a cow consuming another treatment's diet by extending their head over the top of the gate barrier. Filching cows remained on the study, with their intake recorded by the monitoring system, until the proportion of intake from nonassigned treatment diets was more than 15% of their DMI. Degrees of freedom were calculated using the Kenward-Rogers option. Means were determined using the least squares means statement, and treatment means were compared using the PDIFF option. Interaction effects were partitioned using the SLICE option. Statistical significance and trends were considered at $P \leq 0.05$ and $P \geq 0.06$ to $P < 0.10$, respectively.

RESULTS AND DISCUSSION

Nutrient composition and particle size of corn silage, alfalfa silage, RHMC, and SNAP, as measured on feed-out samples, are in Table 2. Corn and alfalfa silages were of high quality as assessed by NDF and starch or CP and NDF concentrations, respectively. Both RHMC and SNAP were drier than targeted, because of a precipitous kernel dry down as kernels approached the black-layer stage of maturity and a brief delay in arrival of the custom operator for harvest of SNAP; RHMC was then harvested 1 wk later. Dry-matter content of RHMC was approximately 9%-units greater than SNAP, which could partially be accounted for by the moisture from the cob, husk, shank, and leaf material present in SNAP (Mahanna, 2008; Lardy and Anderson, 2010) but not RHMC. The starch content of SNAP was approximately 10%-units lower than RHMC. For RHMC, the GMPS (1335 μ) was typical of that found on commercial Wisconsin dairy farms (Tassoul et al., 2007), and similar to SNAP particles that had passed through the 4.75-mm screen to exclude coarse fibrous material (1457 μ); the GMPS of the complete SNAP product was, however, greater (1764 μ). Particle size, measured using the Penn State sieves, was finer for SNAP than corn silage (13 vs. 78%, respectively, of as-fed

Table 2. Nutrient composition and particle size of forages, high-moisture corn, and corn snaplage measured on feed-out samples

Item	Corn silage	Alfalfa silage	High-moisture corn	Corn snaplage
Nutrient, % of DM unless otherwise noted				
DM, % as fed	37.0 ± 2.7	41.9 ± 6.5	78.2 ± 0.2	68.5 ± 0.6
CP	7.7 ± 0.1	20.8 ± 1.0	8.2 ± 0.1	7.7 ± 0.2
Ether extract	3.0 ± 0.1	3.0 ± 0.2	3.9 ± 0.2	3.8 ± 0.2
Ash	4.7 ± 0.2	10.1 ± 0.7	1.6 ± <0.1	1.8 ± 0.1
NDF	39.3 ± 0.6	40.6 ± 1.7	5.8 ± <0.1	15.6 ± 2.0
NFC[1]	45.8 ± 0.5	26.5 ± 1.1	80.6 ± 0.1	71.1 ± 1.9
Starch	33.4 ± 1.0	1.4 ± 0.3	71.2 ± 1.2	61.0 ± 0.8
Particle size				
Tyler sieves GMPS,[2,3] μm	—	—	1,335 ± 78	1,764[4] ± 96 1,457[5] ± 57
Penn State sieves,[6] % as fed retained				
19 mm	4.4 ± 1.4	22.8 ± 8.0	—	1.6 ± 0.9
8 mm	73.6 ± 3.5	57.4 ± 11.2	—	11.3 ± 2.1
1.18 mm	21.4 ± 3.4	18.3 ± 4.5	—	73.0 ± 1.6
Bottom pan	0.6 ± 0.8	1.4 ± 1.2	—	14.1 ± 2.0

[1]Nonfiber carbohydrate = 100 − (NDF + CP + ether extract + ash).

[2]Geometric mean particle size determined on dried samples using Tyler sieves.

[3]GMPS of ground dry shelled corn was 825 ± 113 μm.

[4]Complete product sieved.

[5]Particles that passed a 4.75-mm sieve or corn kernels were sieved.

[6]Particle size was measured as described by Kononoff et al. (2003).

material retained on the ≥8-mm sieves). The high starch content for SNAP compared with RHMC and corn silage and low percentage of coarse material on the coarse sieves for SNAP compared with corn silage suggests that a high-quality SNAP was used in the feeding trial.

Silage fermentation profile and ruminal in vitro starch digestibility for RHMC and SNAP, as measured on feed-out samples, are in Table 3. Numerically, pH was lower and lactic acid greater for SNAP, which may be indicative of a slightly more extensive fermentation for the wetter ensiled material (Kung and Shaver, 2000). Ammonia-N was 2.7-fold higher for SNAP than RHMC, which may be indicative of greater breakdown of the starch–protein in the kernel endosperm resulting from more extensive protease activity during the ensiling process and thought to be related to an increased starch digestibility (Hoffman et al., 2011; Hoffman, et al., 2012; Ferraretto et al., 2013b). Numerically, ruminal in vitro starch digestibility was 9%-units greater for SNAP than RHMC.

Table 3. Fermentation profile and ruminal in vitro starch digestibility for high-moisture corn and corn snaplage

Item	High-moisture corn	Corn snaplage
pH	4.4 ± <0.1	4.0 ± 0.1
Lactic acid		
% of DM	0.6 ± <0.1	1.3 ± 0.1
% of Total acids	72.1 ± 1.3	72.7 ± 4.0
Acetic acid, % of DM	0.2 ± <0.1	0.5 ± 0.1
Ammonia-N, % of CP	1.9 ± 0.1	5.1 ± 0.7
IVStarchD,[1] % of starch	60.7 ± 3.9	70.0 ± 4.8

[1]Ruminal in vitro starch digestibility at 7 h.

Nutrient composition and particle size of TMR, as calculated using analysis on feed-out samples, are in Table 4. As expected, the DM contents of treatment TMR containing SNAP were reduced but only by 3% units, on average, compared with the RHMC treatment TMR. Nutrient composition was similar among the 3 treatment TMR except for NFC and starch concentrations, which were 2.8 and 3.1%-units, respectively, greater, on average, for treatment TMR containing SNAP compared with the RHMC treatment TMR. This occurred because the starch content for SNAP used in diet formulation was lower than what was actually observed in this study (52 vs. 61% on DM basis). The forage NDF content

Table 4. Nutrient composition and particle size of experimental TMR[1]

Item	RHMC	SNAP	SPDC
Nutrient, % DM unless otherwise noted			
DM, % as fed	52.9 ± 1.0	49.8 ± 0.5	49.5 ± 1.5
CP	17.1 ± 0.1	16.8 ± 0.1	16.7 ± 0.8
Ether extract	3.7 ± <0.1	3.5 ± 0.2	3.8 ± 0.4
Ash	7.7 ± 0.4	7.7 ± 0.9	8.1 ± 0.2
NDF	30.2 ± 0.3	28.2 ± 0.5	27.5 ± 0.9
NFC[2]	41.6 ± 0.1	44.3 ± 0.3	44.4 ± 0.3
Starch	23.9 ± 0.4	26.4 ± 0.1	27.5 ± 0.3
TDN_{1x}[3]	72.8 ± 0.2	74.3 ± 0.9	73.4 ± 0.3
Penn State Separator sieves,[4] % as fed retained			
19 mm	5.1 ± 0.8	7.8 ± 2.2	7.7 ± 2.9
8 mm	42.7 ± 5.3	47.1 ± 1.3	46.0 ± 4.2
1.18 mm	41.5 ± 3.8	35.7 ± 2.7	37.0 ± 5.7
Bottom pan	10.7 ± 2.7	9.4 ± 0.6	9.4 ± 1.0

[1]RHMC = diet containing high-moisture corn; SNAP = diet containing corn snaplage; SPDC = diet containing corn snaplage and dry ground shelled corn.

[2]Nonfiber carbohydrate = 100 − (NDF + CP + ether extract + ash).

[3]Calculated using NRC (2001) summative energy equation with assumed NFC processing adjustment factors of 1.0, 0.95, and 0.90 for corn snaplage, high-moisture corn, and dry corn, respectively.

[4]Particle size was measured as described by Kononoff et al. (2003).

was 21.8% of DM (data not provided in table), and the particle size was similar, for the 3 treatment TMR.

Treatment effects on covariate-adjusted least squares means for DMI and lactation performance measurements are in Table 5. Because no ($P > 0.10$) parity × treatment interactions were observed, results are presented as treatment means over the 2 parity groups. Intake of DM was reduced ($P < 0.001$) by 2.6 kg/d per cow, on average, for SNAP and SPDC compared with RHMC, which could be explained by greater ruminal starch digestibility for SNAP (Oba and Allen, 2003a; Allen et al., 2009). Milk yield averaged 39.4 kg/d per cow and was unaffected ($P > 0.10$) by treatment as were all measures of component-corrected milk yield. Thus, actual milk, FCM, solids-corrected milk, and ECM feed efficiencies (kg/kg of DMI) were greater ($P < 0.001$, $P < 0.05$, $P < 0.01$, and $P < 0.05$, respectively), on average, for SNAP and SPDC compared with RHMC by 7 to 9%.

Milk-fat percentage was reduced ($P < 0.05$) by 0.27% units for SNAP compared with RHMC, presumably related to greater ruminal starch digestibility for SNAP (Oba and Allen, 2003a; Ferraretto et al., 2013a). Partial replacement of SNAP with GDSC only partially alleviated the depression in milk fat percentage; SPDC was 0.12%-units greater than SNAP but still 0.15%-units lower than RHMC. A week × treatment interaction was detected ($P < 0.05$) for milk-fat percentage (Figure 1); milk-fat percentage was similar among the 3 treatments through 4 wk of the experimental period, was reduced for SNAP versus RHMC and SPDC at wk 6, and was reduced for SNAP versus RHMC at wk 8. Ammonia-N averaged 4.5, 5.0, and 6.1% of CP for covariate period, wk 1 to 4, and wk 5 to 8 samples of SNAP, whereas for RHMC ammonia-N was 1.9, 2.1, and 1.9% of CP across the 3 sampling periods (data not provided in table or figure). It is possible that these differences between SNAP and RHMC over time may be related to greater ruminal starch digestibility (Hoffman, et al., 2012; Ferraretto et al., 2013b), and thus reduced milk-fat percentage (Oba and Allen, 2003a; Ferraretto et al., 2013a), for SNAP as the study progressed. Ruminal in vitro starch digestibility measurements on samples obtained during the aforementioned time periods, however, did not support this premise. Milk fat yield, protein percentage and yield, and lactose percentage were unaffected ($P > 0.10$) by treatment. The milk-urea-nitrogen concentration was greatest ($P < 0.001$) for SNAP, which could be explained by greater ruminal starch digestibility for SNAP (Oba and Allen, 2003b) and coincident with DMI and milk-fat percentage responses.

Body weight, BWC and BCS measurements were unaffected ($P > 0.10$) by treatment. Estimated diet energy content (Mcal of NE_l/kg of DM), calculated ECM, BW, BWC, and DMI data, was increased ($P < 0.001$) by 9.1%, on average, for SNAP and SPDC compared with RHMC.

IMPLICATIONS

Harvest of SNAP using modern SPFH equipment can result in a corn product with relatively high starch and low NDF concentrations compared with RHMC and whole-plant corn silage. Under the conditions of

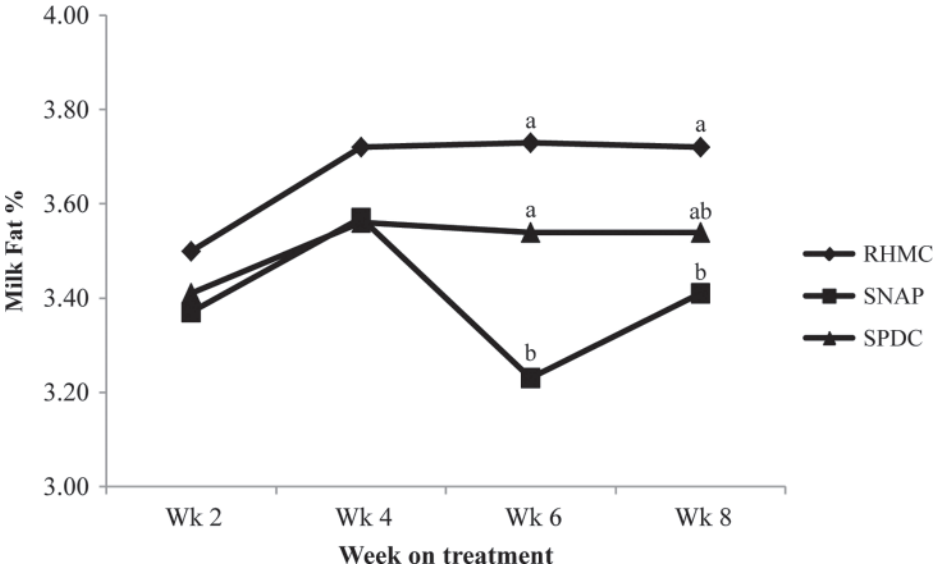

Figure 1. Effect of treatment on covariate-adjusted least squares means for milk fat percentage by week on treatment. Treatments were diets containing rolled high-moisture shelled corn (RHMC), corn snaplage (SNAP), or a mixture of SNAP and dry ground shelled corn (SPDC). Week and week × treatment interaction effects ($P < 0.001$ and $P < 0.05$, respectively); SEM = 0.11. Means within the same week with different letters (a and b) differ ($P < 0.05$).

this study, actual and component-corrected feed efficiencies were greater for cows fed SNAP either alone or in combination GDSC compared with cows fed RHMC. The lowest milk fat and highest milk-urea-nitrogen concentrations were observed, however, for cows fed the SNAP treatment. These changes in milk composition were likely related to greater ruminal starch digestibility for SNAP and were partially alleviated by the partial replacement of SNAP with GDSC in the SPDC treatment. Ammonia-N concentration was greater for SNAP than RHMC and appeared to be related to the observed lactation performance differences between SNAP and RHMC. Further translational research on the utility of ammonia-N as a diagnostic tool for assessing ruminal starch digestibility of ensiled starch sources and the potential for ration interventions to improve lactation performance is warranted.

Table 5. Effect of treatment on covariate adjusted least squares means for DMI and lactation performance[1]

Item	RHMC	SNAP	SPDC	SEM	Treatment *P*-value
DMI, kg/d	27.1[a]	24.9[b]	24.2[b]	0.5	<0.001
Milk, kg/d	39.5	39.4	39.4	0.9	0.98
Milk/DMI, kg/kg	1.46[b]	1.57[a]	1.62[a]	0.03	<0.001
3.5% FCM, kg/d	40.4	38.7	39.6	1.2	0.35
FCM/DMI, kg/kg	1.49[b]	1.57[a]	1.62[a]	0.03	0.05
SCM, kg/d	37.1	35.6	36.4	1.1	0.38
SCM/DMI, kg/kg	1.36[b]	1.44[ab]	1.49[a]	0.03	0.01
ECM, kg/d	39.5	38.1	38.8	1.1	0.40
ECM/DMI, kg/kg	1.45[b]	1.54[a]	1.59[a]	0.03	0.05
Fat					
%	3.67[a]	3.40[b]	3.52[ab]	0.11	0.05
kg/d	1.44	1.33	1.38	0.06	0.14
Protein					
%	2.97	2.93	2.94	0.03	0.35
kg/d	1.17	1.16	1.16	0.03	0.89
Lactose, %	4.99	4.96	4.99	0.03	0.42
Milk urea N, mg/dL	11.4[b]	14.0[a]	10.3[b]	0.3	<0.001
BW, kg	631	635	647	14	0.78
BCS	3.01	2.93	3.10	0.09	0.22
BWC, kg/d	0.18	0.10	0.22	0.10	0.48
Diet NE_l,[2] Mcal/kg of DM	1.43[b]	1.54[a]	1.58[a]	0.02	<0.001

[a,b]Means within a row with different superscripts differ ($P < 0.05$).

[1]RHMC = diet containing high-moisture corn; SNAP = diet containing corn snaplage; SPDC = diet containing corn snaplage and dry ground shelled corn; SCM = solids-corrected milk; ECM = energy-corrected milk; BWC = BW change.

[2]Calculated from BW, BCS, BWC, and DMI data using NRC (2001) equations.

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