Effects of Varying Levels of Silage Inclusion and Brown Midrib Corn Silage on Finishing Performance of Steers

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Summary with Implications

A 2 × 3 factorial finishing study evaluated traditional or brown midrib corn silage fed at three inclusions in finishing diets. Silage inclusion was 15%, 45%, or 75% inclusion (DM basis) for 70 days followed by 15% inclusion for the remainder of the finishing phase. Cattle were ultrasounded twice to calculate backfat deposition rate for a target backfat of 0.55 inches, as cattle were fed longer if silage inclusion was 45 or 75/15%. Cattle fed 45% or 75/15% silage inclusion had greater final body weight (BW) and days on feed, but higher feed:gain (F:G) than cattle fed 15% silage. Daily gain was greatest for cattle fed 15% silage, but not different between cattle fed 45% and 75/15% treatments. Cattle fed 45% and 75/15% silage had greater final hot carcass weight (HCW) and longissimus muscle (LM) area than 15% but fed for 28 additional days. Dry matter intake was greater for cattle fed brown midrib (bm3) silage but gain or F:G were not affected. Backgrounding cattle on a low energy diet followed by a high energy diet resulted in similar growth performance and carcass endpoint as cattle fed a consistent inclusion of silage throughout the entirety of the feeding period. Feeding cattle 45% or 75/15% silage resulted in larger carcass weights and more days on feed (DOF) than cattle fed 15% silage for the finishing period. This resulted in greater returns for cattle fed 45% and 75/15% silage diet as compared to cattle fed a high energy 15% silage diet throughout the feeding period.

Introduction

Cattle feeders typically feed higher inclusions of corn silage in the growing phase in the feedlot, while decreasing to a low inclusion for the finishing phase. Increasing corn silage inclusion in the diet has been evaluated and showed economic benefit, despite lower average daily gain (ADG), specifically when distillers grains were included in the diet (*2015 Nebraska Beef Cattle Report*, pp. 66–67). Brown midrib hybrids of corn silage have a lower lignin concentration resulting in improvement of fiber digestibility (*2019 Nebraska Beef Cattle Report*, pp. 72–75; *2018 Nebraska Beef Cattle Report*, pp. 89–91). Feeding brown midrib corn silage hybrids at 40% in feedlot finishing diets resulted in greater ADG and HCW compared to corn silage hybrids without a brown midrib trait *(2018 Nebraska Beef Cattle Report*, pp. 89–91). The objective of this study was to determine if including brown midrib or conventional corn silage at greater than typical inclusion of 15% in the feedlot diet affected growth and economic performance as compared to cattle fed a typical backgrounding then finishing diet.

Procedure

Corn silage was harvested at the Eastern Nebraska Research and Education Center (ENREC) near Mead, Nebraska, between September 2 and 12, 2016. Corn silage harvest was targeted to be initiated when the field was approximately ¾ milkline and 37% DM. The two corn silage hybrids (Mycogen® seeds) utilized were a standard control (CON; hybrid TMF2H708), and a brown midrib hybrid (*bm3*; hybrid F27F627). Corn silage was kernel processed at harvest with an onboard kernel processor set at 2mm and a 0.75-inch length of cut. Dry matter samples were taken from each truckload of corn silage and dried in a 60°C (140°F) forced-air oven for 48h to determine dry matter (DM) of the silage at harvest. Silages were stored in bunker silos and opened at the initiation of the trial in February of 2017 and were sampled for fermentation analysis of acid and pH profile and DM (forced air oven at 60°C for 48 hours). All feeds were sampled weekly for DM, and monthly composites were analyzed for nutrient composition.

Crossbred steers (n=288; initial BW 700 ± 6.6 lb) were sorted into 2 BW blocks and assigned randomly to one of 36 pens (8 steers/pen; 1 replication heavy block, 5 replications light block). All steers were limit-fed a common diet of 50% alfalfa hay and 50% SweetBran® (DM basis) at 2% of BW for 5 days before initiation of the trial to minimize gastrointestinal fill. Initial BW was measured on two consecutive days (d0 and d1) and averaged. Steers fed the 15% corn silage inclusion were stepped down from a high forage diet over 24 days and four steps, beginning with 30% inclusion of alfalfa and stepping down to 0% alfalfa while increasing corn grain inclusion. Steers fed 45% inclusion were stepped down to 45% inclusion of silage over 10 days and three steps. Cattle fed 75/15% treatment were stepped down to 15% silage on d70 using the same adaptation steps as used with the 15% silage treatment. Treatments were arranged as a 2×3 factorial, that consisted of corn silage hybrid (*bm3* or CON) and varying inclusions in the final diet, 15%, 45% or 75/15% (Table 1). All steers were fed Rumensin® (Elanco Animal Health) at 30 g/ton of DM and Tylan® (Elanco Animal Health) at 8.8 g/ton of DM. Steers were initially implanted with Synovex Choice® (Zoetis) on d1, and reimplanted with Synovex Choice® (Zoetis) on d70. All diets were fed once daily, and refusals were assessed at approximately 0530 each morning aiming for a small scattering of feed left in the bunk each morning. Feed refusals were subsampled and dried for 48 hrs in a 60°C oven to calculate for DM refused. Steers were ultrasounded for backfat thickness on d70 and d126/127. Backfat deposition rate was calculated from these values to determine slaughter dates at a target backfat thickness of 0.55 inches. Cattle were slaughtered at

Table 1. Diet composition (DM Basis) for beef cattle fed two corn silage hybrids at three different levels of inclusion in the feedlot diet

	15		45		75/15	
Item[1]	*bm3*	Control	*bm3*	Control	*bm3*	Control
CON Corn Silage		15.0		45.0		75.0
bm3 Corn Silage	15.0		45.0		75.0	
Dry-rolled corn	30.0	30.0	15.0	15.0	-	-
High Moisture Corn	30.0	30.0	15.0	15.0	-	-
WDGS	21.0	21.0	21.0	21.0	21.0	21.0
Supplement[2]	4.0	4.0	4.0	4.0	4.0	4.0

[1]Treatments were control (CON; hybrid TMF2H708), and a brown midrib hybrid (*bm3*; hybrid-F27F627), cattle fed 75/15 treatment were fed 75% corn silage diet for the initial 70 days on feed, followed by 15% for the remainder of the feeding period.

[2]Supplement formulated to be fed at 4% of diet DM, Supplement consisted of 1.1% fine ground corn, 1.64% limestone, 0.10% tallow, 0.75% urea, 0.30% salt, 0.05% trace mineral package, 0.015% Vitamin A-D-E package as a percentage of the final diet. It was also formulated for 30 g/ton Rumensin® (Elanco Animal Health, DM Basis) and 8.8 g/ton Tylan® (Elanco Animal Health, DM basis).

Table 2. Nutrient and fermentation analysis of silage hybrids[1]

Item	*bm3*	Control
DM, %[2]	33.23	30.67
CP, %	6.27	7.87
NDF, %	33.3	38.4
ADF, %	22.2	24.6
Starch, %	38.3	37.9
pH	4.33	4.90
Lactic acid, %	2.69	2.93
Acetic acid, %	3.38	4.29
Propionic acid, %	0.54	0.69
Butyric acid, %	0.11	0.11
Total Acids, %	6.85	6.38

[1]Treatments were control (CON; hybrid-TMF2H707, a brown midrib hybrid (*bm3*; hybrid-F27F627),

[2]DM was calculated using weekly samples and oven dried for 48 h at 60°C.

Note: Fermentation analysis was conducted on bi-monthly composite silage samples and analyzed at Dairyland Labs (St. Cloud, MN).

a commercial abattoir (Greater Omaha, Omaha, NE). Steers on the 15% silage inclusion were fed for 153 days before harvest, while steers fed 45 and 75/15% inclusion diets were fed for 181 days before harvest. On the day of harvest, liver scores and HCW were recorded. Carcass-adjusted final body weight (using a 63% dressing percentage) from the HCW were used to determine ADG and feed conversion. Carcass characteristics included marbling score, 12th rib fat thickness and LM area, which were recorded after a 48-h chill.

Economics were evaluated using a corn silage pricing application from Iowa State University accounting for silage shrink (15% DM basis), manure value of spreading the manure 1 year in four to replace the silage removal of phosphorus, incurring one fourth the credit for manure and one fourth hauling expenses, and the opportunity cost of corn grain and stover removal. Manure value was calculated using BFNMP$ system for cattle fed a 45% silage-based diet with 21% WDGS. Initial purchase price was calculated using the average initial purchase weight of a pen multiplied by the average price/lb to get a net return of $0/head for cattle on the 15% silage treatment. Cattle interest charges were 7.5%, with a $200 down deposit on cattle over their feeding period (DOF/365). Corn was priced on market prices for September, with an additional $2.17/ton DM for processing costs. Feed interest costs were 7.5%. Supplement including monensin and tyolosin was $300/ton (DM basis) with 1% shrink applied, WDGS was 90% the price of corn (DM basis) with a 5% shrink applied. Medicinal and processing charges were $20/head and yardage was charged to $0.50/hd/day.

Data were analyzed using the PROC MIXED procedures of SAS (SAS Institute, Inc., Cary, N.C.) as a randomized block design with pen as the experimental unit and block as a fixed effect. Liver scores were analyzed as a binomial distribution using PROC GLIMMIX procedures of SAS. The treatment design was a 2 × 3 factorial, and data were analyzed for an interaction to determine simple effects of inclusion of corn silage and corn silage hybrid, and main effects of each factor were analyzed if there were no significant interactions reported.

Results

Fermentation analyses (Table 2) show the 6 silage samples had a pH at or below 4.9 and lignin at 2.6% for control and 2.4% for *bm3*. Acid detergent fiber, the cellulose and lignin portion of the plant, was numerically lower for *bm3* silages compared to the CON. Neutral detergent fiber was greater for CON silage samples as compared to *bm3*. Crude protein was lower 6.27% for *bm3* silage as compared to CON at 7.87%.

Corn Silage Level

There were no interactions between corn hybrid and corn silage inclusion for growth performance and carcass characteristics evaluated ($P \geq 0.26$). There were no interactions ($P > 0.08$) were observed for carcass characteristics measured. For the main effects of corn silage inclusion (Table 3), cattle fed silage at 45 and 75/15% inclusion had greater final BW and HCW ($P < 0.01$), with no differences between 45 and 75/15% inclusion treatments ($P > 0.06$). The cattle fed 45% and 75/15% corn silage were fed for 28 additional days than those fed 15%. Cattle fed 15% corn silage inclusion had greater ADG ($P < 0.01$) than cattle fed the 45% and 75/15% treatments ($P = 0.09$). Feed conversion was lowest for 15% corn silage inclusion ($P < 0.01$) compared to both 45% and 75/15% silage inclusion, which were not different ($P = 0.84$). Backfat thickness was greatest for 45% inclusion silage (0.60 in), lowest for 15% inclusion (0.53 in; $P < 0.05$), with 75/15% inclusion being intermediate (0.55 inches; $P = 0.13$). Dry matter intake was greater ($P = 0.01$) for 15% and 45% silage inclusion (23.7 and 23.6 lb/day, respectively) versus 23.0 lb/day in the 75/15% inclusion. The lack of statistical difference between the 45% and 75/15% silage fed groups in terms of growth performance or carcass characteristics suggests cattle fed for a short backgrounding phase followed by a typical finishing phase were similar in growth to cattle fed a consistent diet throughout the feeding period.

When the 15% treatment was equal to a net return of $0.00, cattle fed the 45% corn silage treatment had an overall profit of $43.41/hd ($P < 0.01$) over the cattle fed 15% silage diets for 153 days. The cattle fed 75/15% had a tendency to have a greater

Table 3. Main effect of corn silage inclusion on cattle performance and carcass characteristics.

	Treatment[1]				
Item	15	45	75/15	SEM	*P*-Value[2]
Pens	12	12	12		
Days on Feed	153	181	181		
Performance					
Initial BW, lb	700	700	699	1.2	0.61
Carcass Adjust BW, lb[3]	1315[a]	1393[b]	1374[b]	7.3	<0.01
Final Shrunk BW, lb[4]	1321[a]	1423[b]	1402[b]	6.8	<0.01
DMI, lb/day	23.7	23.6	23.0	0.22	0.01
ADG, lb[3]	4.02[a]	3.82[b]	3.73[b]	0.17	<0.01
Feed:Gain[3]	5.88[a]	6.18[b]	6.17[b]	-	<0.01
Returns, $/hd	0.03[a]	43.41[b]	27.06[b]	7.18	<0.01
Carcass Characteristics					
HCW, lb	829[a]	877[b]	866[b]	6.2	<0.01
Dressing Percentage	62.73[a]	61.65[b]	61.75[b]	0.242	<0.01
LM Area, in[2]	13.13[a]	13.51[ab]	13.64[b]	0.16	0.05
Marbling Score[5]	460	480	473	10.5	0.33
Backfat Thickness, in	0.53[a]	0.60[b]	0.55[ab]	0.02	0.06
Liver Abscesses, %[6]	6.25	2.08	3.13	-	-

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

[1] Treatments were 15% silage inclusion, 45% silage inclusion, and 75 to 15% silage inclusion

[2]*P*-value for the main effect of corn silage inclusion

[3]Calculated from hot carcass weight, adjusted to a common 63% dressing percentage

[4]Final shrunk body weight calculated from pen weights taken before transport to slaughter plant, with 4% pencil shrink applied

[5]Marbling Score 400-Small[00], 500 = Modest[00]

[6]Liver abscess data did not converge

Table 4. Main effect of corn silage hybrid on growth performance and carcass characteristics

	Treatment[1]			
Item	*bm3*	Control	SEM	*P*-value[2]
Pens, n	18	18		
Performance				
Initial BW, lb	700	699	1.0	0.39
Carcass Adjust BW, lb[3]	1366	1355	6.3	0.16
Final Shrunk BW, lb[4]	1384	1380	5.9	0.58
DMI, lb/day	23.7	23.1	0.15	<0.01
ADG, lb[3]	3.89	3.83	0.04	0.18
Feed:Gain[3]	6.10	6.02	-	0.23
Returns, $/hd	25.64	21.36	6.16	0.57
Carcass Characteristics				
HCW, lb	861	854	4.0	0.16
Dressing Percentage	62.19	61.89	0.21	0.24
LM Area, in[2]	13.36	13.50	0.14	0.39
Marbling Score[5]	477	466	9.0	0.34
Backfat Thickness, in	0.58	0.54	0.02	0.05
Liver Abscesses, %[6]	2.78	4.86	-	-

[1]Treatments were brown midrib corn silage (*bm3*-Hybrid-F27F627) or Control corn silage (CON; hybrid-TMF2H708)

[2]*P*-Value for the main effect of corn silage hybrid

[3]Calculated from hot carcass weight, adjusted to a common 63% dressing percentage

[4] Final shrunk body weight calculated from pen weights taken before transport to slaughter plant, with 4% pencil shrink applied

[5]Marbling Score 400 = Small[00], 500 = Modest[00]

[6]Liver abscess data did not converge

($P < 0.01$) net profit of $27.06/hd over 15% silage fed cattle. No difference in profitability was observed ($P = 0.08$) between the 45% and 75/15% fed cattle.

Corn Silage Hybrid

There were no differences in growth performance between the two hybrids of corn silage used in this trial (Table 4). Daily dry matter intake was greater ($P = 0.01$) for *bm3* fed steers compared to control steers. This did not translate into improvements for ADG or F:G ($P = 0.18$). Backfat thickness was greater for steers fed *bm3* silage over control as well (0.58 inches vs. 0.54 inches; $P = 0.05$), but no other carcass characteristics were affected by corn silage hybrid. Corn silage hybrid did not affect ($P = 0.57$) the average returns per animal, which averaged $25.64/hd for *bm3* and $21.36/hd for CON as compared to 15% silage inclusion.

Conclusion

Cattle fed 45% silage inclusion throughout the feedlot finishing phase performed similar to cattle fed 75 then 15% corn silage throughout the finishing phase. Increasing corn silage in the diet from 15 to 45% resulted in poorer growth performance but larger carcass size when finished to a common endpoint. Additionally, backgrounding cattle for a period then following with a high energy diet resulted in similar performance and carcass endpoint to cattle fed a consistent level of corn silage throughout the entirety of the feeding period. A consistently high silage finishing diet of 45% appears to be profitable for producers even when considering the extra days on feed as compared to cattle fed a low silage diet (15%). Utilizing a 45% silage diet appears to be as economical as backgrounding then finishing cattle to a common carcass endpoint. Feeding silage with the *bm3* trait did not affect ADG, feed conversion or carcass characteristics in this study.

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