Beef Day 2020

Feedlot

Effect of Inclusion Rate of Silage With or Without the Presence of Alpha-Amylase on Feedlot Performance, Carcass Characteristics, and Efficiency Measures

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Objective

The experimental objective was to determine the interactions of silage variety and inclusion level in cattle finishing diets on cattle performance and agronomic returns to cropland when fed to beef cattle.

Study Description

One hundred ninety-two Continental × British steers (initial BW 926 lb. [SD 54.5]) were used in a randomized complete block design finishing study with a 2 × 2 factorial arrangement of treatments to evaluate the effects of feeding either a conventional (CON) hybrid or one with increased expressed of alpha-amylase (Enogen, Syngenta Seeds, LLC, ENO) fed at either 12% (12SIL) or (24SIL) of diet DM. Steers were blocked by source and weight (n = 5) and assigned randomly within block to treatments, resulting in five pens and 48 steers per treatment. Steers were stepped up to their final diet over a 21 d period. The steers were fed for either 126 d (12SIL) or 140 d (24SIL) until harvest at Tyson Fresh Meats in Dakota City, NE. Beef produced per acre was determined using actual intake of corn silage and corn for each treatment. Actual corn yield for CON and ENO were used (20.4 and 18.8 T/acre, respectively) and corn grain yield was estimated by assuming that each ton of corn silage contained 8 bushels of dry corn.

Take home points

Silage type had no effect on cattle performance or feed efficiency. Feeding increased amounts of corn silage resulted in reduced ADG and poorer feed conversion on a live animal basis. Due to greater yield, more beef was produced per acre with conventional silage. Feeding 24% silage increased beef produced per acre compared to feeding 12% silage on a DM basis.

Keywords: corn silage, feed efficiency, feedlot, growth performance

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Abstract
One hundred ninety-two Continental × British steers (initial BW 926 lb [SD 54.5]) were used in a randomized complete block design finishing study to evaluate the effects of feeding two types of silage germplasm at two inclusion rates. A 2 × 2 factorial arrangement of treatments was used with either a conventional (CON) or increased expression of alpha-amylase (Enogen, Syngenta Seeds, LLC; ENO) hybrid fed at either 12% (12SIL) or 24% (24SIL) of diet DM. Steers were blocked (n = 5) and assigned randomly within block to treatments, resulting in five pens and 48 steers per treatment. Steers were harvested after 126 (12SIL) or 140 (24SIL) days on feed. There were no silage source by inclusion rate interactions detected for live growth performance. Silage source did not affect live based average daily gain (ADG), feed to gain ratio (F:G), or final BW (FBW; $P \geq 0.35$). Feeding 24% silage reduced ADG ($P = 0.04$) and increased F:G ($P = 0.01$) but increased FBW ($P = 0.02$) compared to 12SIL. A source by inclusion rate interaction was detected ($P = 0.04$) for calculated yield grade (YG) with steers fed 24% silage having increased YG within CON but not ENO. Hot carcass weight and backfat were unaffected by silage source ($P \geq 0.81$), but were increased by feeding 24% silage ($P = 0.03$ and $P = 0.02$, respectively). Feeding increased amounts of silage increased beef produced per acre ($P = 0.05$). Conventional silage produced more beef per acre ($P < 0.01$) due to differences in silage yield, but source of silage did not affect feedlot performance independent of silage yield. Feeding increased amounts of silage reduced DM efficiency on a live animal and carcass basis but increased beef produced per acre, which is of major value to cattle feeders who produce the majority of their own feedstuffs.

Introduction
Corn silage is a cornerstone feed ingredient for beef production in the Midwest. It is a versatile source of readily digestible energy and NDF and can be an effective option for marketing home-raised feedstuffs through cattle. Conventional wisdom has long held that the most effective use of corn silage has been in growing cattle, and that in finishing diets corn silage inclusion should be limited to no more than what is necessary to provide sufficient fiber to maintain rumen health. However, farmer feeders may desire to increase the utilization of silage for several factors including weather conditions, workload demands, or market signals. Few studies have evaluated silage usage in terms of amount of beef produced per unit of cropland.

Hybrid selection also affects the amount of beef produced per acre of cropland as a result of yield but also due to potential variety differences in feed efficiency. Recently, corn hybrids with an increased expression of alpha-amylase enzyme have been marketed as a method to enhance starch digestion either when fed as grain or as corn silage. Silage from these hybrids has shown some promise in finishing diets utilizing steam-flaked corn (Baker et al., 2019), but there is little information regarding effects on performance and feed efficiency in diets typical for the Upper Midwest.

Experimental Procedures

A total of 192 steers were used in this study. Steers were sourced from two different consignments at one South Dakota sale barn and delivered to the Southeast Research Farm facilities in Beresford, SD. Source 1 steers (n=150 steers with a payweight of 919 lbs; first 3 pen replicates, n = 10 steers/pen with a fourth pen replicate of six steers per pen) and Source 2 steers (n = 55 steers with a payweight of 970 pounds; pen replicate 5; 12 steers/pen) were received on March 25, 2019. Cattle were processed on March 28, 2019, where steers were weighed, a unique identification tag was applied to each steer, and vaccinated against respiratory diseases (Bovi-Shield Gold 5, Zoetis, Parsippany, NJ) and clostridial species (Ultrabac 7/Somubac, Zoetis). On April 2, 2019, steers were administered pour-on moxidectin (Cydectin, Bayer, Shawnee Mission, KS), administered a steroidal implant (200 mg trenbolone acetate and 28 mg estradiol benzoate; Synovex Plus, Zoetis) and the study initiated.

Steers were fed once daily in the morning. Bunks were managed to be slick at 0800h most mornings. Steers were stepped up to their final diet over a 21 d period with three step-up diets utilized. Feed intake and diet formulations were summarized at weekly intervals. Steers that died during the trial or that were removed from the study were assumed to have consumed feed equal to the pen mean DMI up to the point of removal or death.

Diets fed are shown in Table 1. Actual inclusion of silage (DM basis) in the test diets was 11.48 and 23.26% for CON and 11.65 and 23.56% for ENO treatment, respectively, as determined by weekly DM analyses of diet ingredient samples and corresponding feed batching records. Diets presented in Table 1 are actual DM diet formulations for the diets fed along with tabular nutrient and energy values (NASEM, 2016).

Any steers pulled from their home pen for health evaluation or treatment were then monitored in individual hospital pens prior to being returned to their home pens. When a steer was removed to a hospital pen, the appropriate amount of feed from the home pen was removed and transferred to the hospital pen. If the steer returned to their home pen, this feed remained credited to the home pen. If the steer did not return to their home pen, all feed that was delivered to the hospital pen was deducted from the feed intake record for that particular pen back to the date the steer was hospitalized.

Steer BW was recorded for each animal at the time of study initiation (individual BW), d 28 (pen BW), d 63 (individual BW), and morning of shipment on d 126 or d 140 (individual BW) for the calculation of live growth performance. Body weights were measured prior to the morning feeding; a 3% pencil shrink was applied to final BW, carcass adjusted performance was calculated using HCW adjusted to a common 62.5% dressing percentage.

Cattle were shipped when they were visually appraised to have 0.50 in of backfat (BF). Cattle were shipped on two different dates; August 6, 2019 (12SIL) after 126 DOF and on August 20, 2019 (24SIL) after 140 DOF and harvested the following day at Tyson Fresh Meats in Dakota City, NE. Individual steer identity was tracked through the harvest facility. Hot carcass weight was recorded at the hot scale during the tag transfer procedure. Video image data was obtained from the plant for ribeye area (REA), BF, calculated USDA Yield Grade (YG) and USDA marbling scores. Dressing percentage was calculated as HCW/(final BW × 0.97). Carcass measurements were used to calculate empty body fat percentage (EBF; Guiroy et al., 2002) and proportion of closely trimmed boneless retail cuts from carcass round, loin, rib, and chuck (Retail Yield; Murphy et al., 1960).

Performance adjusted NE (paNE) was calculated from daily energy gain (EG; Mcal/d): EG = $ADG^{1.097}0.0557W^{0.75}$, where W is the mean shrunk BW [kg; (NRC, 1984)]. Maintenance energy required (EM; Mcal/d) was calculated by the following equation: EM = $0.0077W^{0.75}$ (Lofgren and Garrett, 1968). Dry matter intake required to support gain is related to energy requirements and dietary NEm by the equation DMI_{REQ} = EG/(0.877NEm – 0.41). Dietary NEm was estimated by solving the following quadratic equation:
$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2c}$ where a = -0.41EM, b = 0.877EM + 0.41DMI + EG, and c = -0.877DMI (Zinn and Shen, 1998). Dietary NEg was derived from NEm by the following equation: NEg = 0.877NEm – 0.41 (Zinn, 1987).

Beef production per acre of cropland was calculated from actual intake of corn silage and dry rolled corn for each pen using the weekly diet compositions and DMI records. Actual corn silage yield observed at the Southeast Research Farm in September 2018 was 20.4 and 18.8 T/acre for CON and ENO, respectively. Corn yield (bu/acre) was estimated using the formula: Corn yield (bu/acre) = Silage yield (wet) × 8. Cropland required was the sum of pounds consumed/yield for both corn and corn silage. Beef production per acre was then calculated as: (carcass adjusted final BW – Initial BW)/acres.

Growth performance was calculated on a deads and removals-excluded basis. Growth performance and carcass traits were analyzed as a randomized complete block design using the GLIMMIX procedure of SAS 9.4 (SAS Inst. Inc., Cary, NC) with pen as the experimental unit. The model included fixed effects of block, silage variety, inclusion rate and their interaction. Least squares means were generated using the LSMEANS statement of SAS. Data means were separated and denoted to be different using the pairwise comparisons PDIFF and LINES option of SAS when a significant preliminary F-test was detected. An α of 0.05 determined significance and tendencies are discussed from 0.05 to 0.10.

Results and Discussion

There were no silage × inclusion interaction ($P \geq 0.15$) detected for any live or carcass adjusted growth performance traits. Silage variety did not affect final live or carcass adjusted BW ($P \geq 0.54$; Table 2), ADG ($P \geq 0.35$), DMI ($P \geq 0.54$), or F:G ($P \geq 0.65$). Silage variety had no influence on paNE values ($P \geq 0.55$) or observed/expected NE values ($P \geq 0.53$). Steers fed 24% silage had greater final live and carcass adjusted BW ($P \leq 0.03$), however, steers fed 24% silage required an additional 14 d on feed to reach a similar compositional endpoint as the 12SIL steers translating into a poorer ($P = 0.04$) live basis ADG for the 24SIL steers. Daily DMI did not differ ($P = 0.86$) due to silage inclusion level. Steers fed 12% silage had improved live ($P = 0.01$) and carcass adjusted ($P = 0.04$) F:G compared to the 24SIL steers. Steers fed 24% silage tended to have lower ($P \leq 0.07$) paNE values compared to 12SIL steers, and observed/expected NE values did not differ ($P \geq 0.52$) due to silage inclusion level.

There were no silage × inclusion interactions detected for carcass traits except for YG (Table 3). Silage variety did not affect ($P \geq 0.19$) dressing percentage, HCW, REA, BF, marbling scores, KPH percentage, estimated EBF, final BW at 28% EBF, YG, or retail yield. No differences ($P \geq 0.06$) were detected for dressing percentage, REA, marbling score, KPH percentage, estimated EBF, or final BW at 28% EBF due to silage inclusion level. Silage source interacted with inclusion rate (P =0.04) with steers fed 24% silage having increased YG within the CON but not ENO treatments (Figure 1). Feeding 24% silage did increase ($P \leq 0.04$) HCW, BF, YG, and retail yield compared to 12SIL.

There was no silage × inclusion rate interaction for beef production per acre of cropland (Table 3). Due to the actual silage and estimated corn yield differences observed between CON and ENO, conventional silage did produce ($P = 0.01$) more beef per acre compared to ENO (1892 vs. 1765 ± 33 lbs beef/acre, respectively). Feeding increased amounts of corn silage also resulted in greater production of beef per acre compared to 12SIL ($P = 0.04$, 1866 vs. 1791 ± 33 lbs beef/acre cropland, respectively).

Implications

These data indicate that silage variety had no effect on animal growth performance or carcass traits, but that choosing silage hybrids with greater yield does result in increased beef produced per acre. Feeding increased amounts of silage resulted in reduced ADG and feed efficiency on an individual animal basis, but increased HCW and beef produced per acre compared to a lower silage inclusion rate. Cattle feeders that raise their own feed may be able to increase the amount of beef produced from a fixed land base by increasing the inclusion rate of corn silage in cattle finishing diets.

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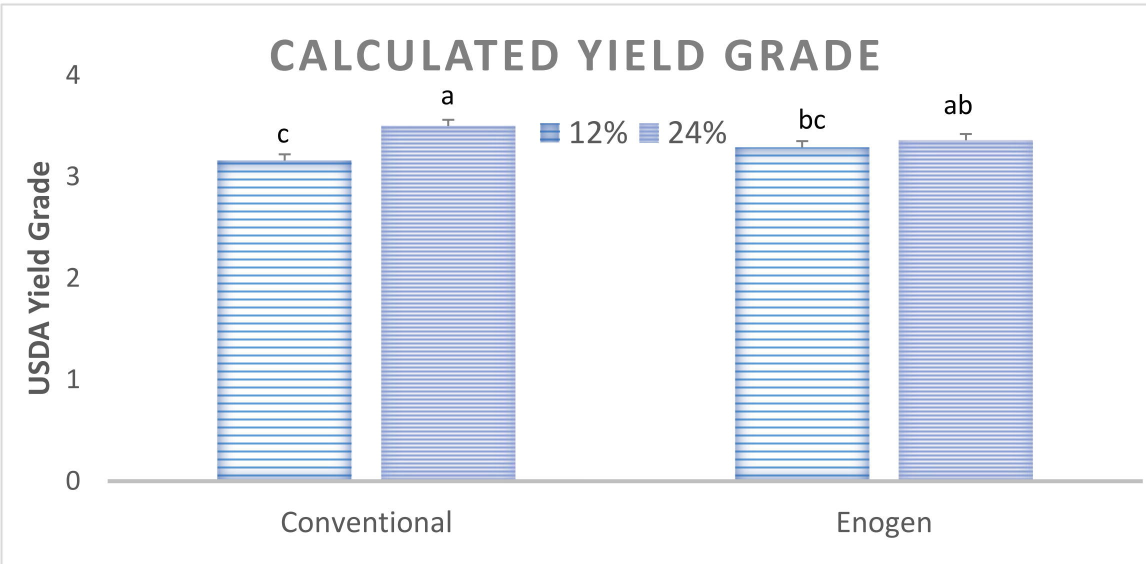

[abc]Means with different superscripts differ $P < 0.05$

Figure 1. Calculated USDA Yield Grade responses for simple means.

Table 1. Actual diet formulations fed[a]

	Step 1 (d 1 to 7)				Step 2 (d 8 to 14)				Step 3 (d 15 to 21)				Finisher (d 22 to harvest)			
	CON		ENO		CON		ENO		CON		ENO		CON		ENO	
	12	24	12	24	12	24	12	24	12	24	12	24	12	24	12	24
Dry rolled corn, %	35.33	27.60	34.56	27.22	44.01	37.12	43.37	36.12	51.87	44.97	51.99	45.17	65.15	52.89	65.02	52.69
Modified distillers grains with solubles, %	15.11	15.29	14.79	14.55	15.18	15.18	14.92	14.82	20.43	20.46	20.47	20.56	19.29	19.66	19.26	19.58
Silage, %	11.24	22.75	13.36	26.38	11.77	23.54	13.03	25.71	11.77	23.59	11.57	23.24	11.48	23.26	11.65	23.56
Hay, %	34.31	30.35	33.46	28.12	25.12	20.17	24.81	19.56	11.98	7.01	12.00	7.05	--	--	--	--
Liquid Supplement, %[b]	4.01	4.01	3.83	3.73	3.92	3.99	3.87	3.79	3.95	3.97	3.97	3.98	4.08	4.19	4.07	4.17
DM, %	67.80	61.05	69.28	63.81	67.63	61.33	68.46	62.80	65.69	59.66	65.65	59.58	65.82	58.98	67.10	60.31
CP, %	13.49	13.45	13.34	13.14	13.29	13.22	13.21	13.05	14.20	14.11	14.21	14.14	13.75	13.88	13.74	13.85
NDF, %	36.61	38.80	36.84	38.71	31.88	33.55	32.09	33.92	26.62	28.32	26.57	28.24	19.63	24.11	19.68	24.20
ADF, %	20.58	21.86	20.73	21.80	17.22	18.17	17.38	18.42	12.92	13.87	12.88	13.81	8.14	11.01	8.18	11.07
Ash, %	6.53	6.68	6.45	6.51	5.91	6.04	5.90	5.96	5.20	5.30	5.20	5.30	4.45	4.92	4.45	4.92
EE, %	4.12	4.05	4.10	4.00	4.23	4.16	4.21	4.14	4.59	4.52	4.59	4.53	4.69	4.57	4.68	4.56
NEm, Mcal/cwt	82.40	81.03	82.29	81.10	85.81	84.71	85.63	84.50	90.94	89.87	90.98	89.94	95.46	92.47	95.43	92.40
Neg, Mcal/cwt	51.94	51.00	51.88	51.14	55.27	54.61	55.13	54.44	60.33	59.68	60.36	59.74	64.73	62.23	64.70	62.17

[a] All values except DM on a DM basis.
[b] Provided 30 g/ton of monensin as well as vitamins and minerals to exceed requirements (NASEM, 2016).

Table 2. Feedlot Performance, Carcass Characteristics, and Efficiency Measures								
	Silage Type (S)		Inclusion Rate (I)			*P* -Values		
	CON	ENO	12%	24%	SEM	S	I	S × I
Live Basis[a]								
Initial BW, lb	928	926	927	927	1.8	0.24	0.80	0.49
Final BW, lb	1350	1355	1340	1365	9.0	0.54	0.02	0.24
ADG, lb	3.17	3.24	3.28	3.13	0.065	0.35	0.04	0.17
DMI, lb	22.6	22.8	22.7	22.4	0.22	0.54	0.86	0.59
F:G	7.16	7.11	6.96	7.31	0.117	0.65	0.01	0.15
Carcass Basis[b]								
Final BW, lb	1397	1396	1383	1410	11.1	0.99	0.03	0.37
ADG, lb	3.52	3.54	3.61	3.45	0.078	0.80	0.06	0.27
F:G	6.44	6.48	6.31	6.61	0.129	0.74	0.04	0.32
paNE, Mcal/cwt[c]								
Maintenance	88.77	89.34	89.99	88.13	0.944	0.55	0.07	0.21
Gain	59.25	59.76	60.32	58.69	0.829	0.55	0.07	0.22
Actual trial NE, Mcal/cwt								
Maintenance	92.87	92.80	94.23	91.44	--	--	--	--
Gain	62.14	61.97	63.19	60.92	--	--	--	--
Observed/Expected NE[d]								
Maintenance	0.96	0.96	0.95	0.96	0.010	0.49	0.37	0.25
Gain	0.95	0.96	0.95	0.96	0.013	0.55	0.53	0.20

[a]Final BW shrunk 3% to account for digestive tract fill.
[b]Calculated from HCW/0.625.
[c]pa = performance adjusted.
[d]paNE/tabular NE.

Table 3. Carcass traits and beef production per acre of cropland								
	Silage Type (S)		Inclusion Rate (I)			*P* -Values		
	CON	ENO	12%	24%	SEM	S	I	S × I
Dress, %[a]	64.7	64.4	64.5	64.6	0.27	0.30	0.70	0.83
HCW, lb	873	873	864	882	6.9	0.99	0.03	0.37
REA, in^2	13.1	13.2	13.2	13.1	0.16	0.86	0.57	0.22
BF, in	0.54	0.55	0.52	0.57	0.017	0.81	0.02	0.25
KPH, %	1.8	1.76	1.79	1.77	0.025	0.19	0.56	0.91
YG	3.33	3.33	3.23	3.43	0.062	0.94	0.01	0.04
Retail Yield, %[b]	49.82	49.86	50.04	49.63	0.098	0.80	0.01	0.06
EBF, %	30.87	30.90	30.53	31.25	0.250	0.93	0.06	0.55
Marbling score[c]	532	510	519	522	18.0	0.25	0.85	0.39
Beef/acre	1892	1765	1791	1866	32.6	0.01	0.04	0.40

[a]HCW/final BW shrunk 3%
[b]As a percentage of HCW
[c]USDA Marbling Score 400 = $Small^0$ = Low Choice; 500 = $Modest^0$ = Average Choice