Comparison of Corn Silage and Earlage in Finishing Diets when fed as a Roughage on a Neutral Detergent Fiber Basis

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Summary with Implications

This finishing trial was conducted to evaluate the ability of earlage to serve as a roughage source compared to corn silage when both sources were balanced on an NDF basis. Steers were fed in a randomized block design with a 2×2 treatment arrangement, with one factor being NDF source (corn silage or earlage) and the other factor being inclusion ("normal" amount of roughage provided by corn silage or earlage as the only grain source and roughage source). No significant interactions were observed between roughage source and inclusion level on steer performance. Steers fed corn silage and grain had greater intakes and gains than steers fed earlage. Steers fed less NDF had more efficient feed conversion, and greater gain with heavier hot carcass weights.

Introduction

An ear of corn consists of approximately 80% grain with the remainder being comprised of the cob and husk. Earlage is a feedstuff made of these parts of the corn plant to produce a product that contains both roughage and a concentrate and harvested at high moisture to ensile. Roughage in a finishing diet is fed to help maintain rumen health and prevent acidotic upsets. Inclusion of roughage in the diet can increase dry matter intake (DMI) and average daily gain (ADG). More specifically, balancing a ration based on percentage of roughage in the diet can yield differences in performance when using different roughage sources at the same inclusion. Different roughages contain different proportions of neutral detergent fiber (NDF). Previous research shows that balancing roughage inclusion on an NDF basis in the diet can yield similar performance for cattle fed different roughage sources. Previous literature also indicates dietary NDF inclusion of 8–10% yields optimal gain and efficiency. The objective of this study was to determine the effects on performance and carcass characteristics of cattle fed earlage or corn silage as the source of roughage in the diet while balancing these on an equal NDF basis at two inclusion levels.

Procedure

A finishing trial was conducted at the Panhandle Research, Education, and Extension Center (PREEC) research feedlot near Scottsbluff, NE. Crossbred yearling steers (n=216; initial BW = 1037 lb ± 69 lb) were fed one of 4 experimental diets in a 2×2 factorial treatment arrangement. This trial was designed as a randomized block design with pen as the experimental unit. In the current experiment, NDF inclusion rates were obtained with corn silage representing "normal" dietary roughage inclusion (i.e., corn silage at 15% to supply 7.5% forage in the diet) and then earlage to match that amount of forage NDF provided by corn silage. The other inclusion of roughage was based on the amount of roughage supplied if earlage was the only grain source in the diet. As a result, forage NDF was approximately doubled (14.8% using that approach (74% earlage compared to 30% corn silage). Treatments were designed to evaluate the feeding performance (ADG, DMI, and feed efficiency) and carcass characteristics of cattle fed corn silage or earlage as the sole roughage source, with diets matched in NDF content. Treatments included corn silage at normal NDF inclusion, corn silage at 2X normal NDF inclusion, earlage at normal NDF inclusion DM, and earlage at 2X normal NDF inclusion (Table 1). The forage percentage of each diet was calculated assuming earlage was 20% forage from cob and husk, and silage was 50% forage and 50% grain. The normal inclusion treatment used these forage percentages to provide 7.5% roughage from silage and then matched the inclusion based on equal dietary forage contributed by either roughage source. The 2X normal inclusion of forage was formulated by using earlage as the only grain and roughage source and was 74% of the diet. This diet provided 14.8% forage, so 29.6% silage was included to equalize forage to 74% earlage. Subsequently, based on the initial two formulations, diets were formulated to compare corn silage and earlage when balanced for dietary forage content at two different inclusion levels. Corn silage was harvested, packed, and stored in an uncovered bunker prior to the initiation of the experiment, and contained an average starch content of 34% and averaged 38.0% NDF. Earlage was purchased and delivered to the feedlot as needed throughout the trial. The earlage was stored unpacked and uncovered in a bunker and had an average starch content of 55%, and averaged 20.2% NDF. High moisture corn was stored in an uncovered bunker, and dry rolled corn was supplied in both corn silage diets and the low inclusion (7.5%) earlage diet as a 50:50 blend on a DM basis. Wet distillers grains plus solubles were included at 20% (DM basis), reflecting the most commonly used diet inclusion levels in the industry. A liquid supplement was included at 6% and was formulated to provide 360 mg/steer of monensin (Rumensin, Elanco Animal Health) and 90 mg/steer of tylosin (Tylan Elanco Animal Health) daily. Feed was offered once a day to target ad libitum intake. A Revalor-200 (Merck Animal Health) implant was administered to all animals on day 0 Initial BW was determined by an average of weights collected on day 0 and 1 while consuming a corn silage diet targeting 2.2% of BW for 30+ days prior to trial initiation to equalize gut fill. Twenty-four pens with 9 steers/pen were used in this trial. Cattle were stratified by weight from day 0 and were subjected to blocking

Table 1. Diet composition of steers fed either earlage or silage at different NDF inclusion levels (% diet DM)

	Treatments[1]			
	Corn Silage		Earlage	
Ingredient	Normal (7.5%)	2X (14.8%)	Normal (7.5%)	2X (14.8%)
Earlage	0	0	37.5	74
Corn silage	15	29.6	0	0
High-moisture corn	29.5	22.2	18.5	0
Dry-rolled corn	29.5	22.2	18.5	0
Wet distiller's grains	20	20	20	20
Supplement[2]	6	6	6	6
Nutrient Analysis				
%NDF from roughage, DM basis[3]	5.7	11.2	7.5	14.8
%Total NDF	19.2	23.2	18.9	22.7
%Total Starch	47.1	41.8	46.8	41.2
%CP, DM basis[4]	12.3	12.2	12.6	12.6

[1]Normal = 7.5% NDF, 2X = 14.8% forage inclusion on DM basis

[2]Supplement (Midwest PMS LLC.) was formulated to meet requirements of vitamins and minerals, and approximately 0.92% of the diet as urea on a DM basis

[3]NDF percentage in the diet is calculated from NDF supplied by roughage in the diet

[4]Values presented for CP include values from all feeds given in the diet except the supplement

criteria based on initial body weight and to reduce BW variation. All blocks started on the same day and were fed for 120 days. Three body weight blocks were used (light, medium, and heavy), with 2 treatment repetitions within each block. Live body weights were collected 1 day prior to cattle shipment to a commercial abattoir. Upon harvest, hot carcass weights (HCW), and liver abscess scores were recorded. Carcass adjusted final body weights were calculated using a common 63% dressing percentage. Following a 48-hr chill, *Longissimus* muscle (LM) area, 12th rib fat thickness, marbling score, and USDA quality and Yield grades were collected. Net energy values were calculated using DMI and ADG data with the heaviest pen average as the target end weight for each block and choice as the target finishing quality grade.

Data were analyzed using the Mixed procedure of SAS. Pen was the experimental unit and treatment and block were fixed effects. Interactions between roughage source and inclusion were tested. When interactions were not significant, main effects for either roughage source or inclusion were evaluated. Liver abscess incidence data were analyzed using the GLIMMIX procedure of SAS as a binomial distribution.

Results

Upon lab analysis for NDF content of earlage and corn silage, NDF content of corn silage was 38.0%, which is on the lower end of NDF values presented in the NRC (43 ± 5.50). This provided 5.3% NDF from corn silage at the normal inclusion and 10.4% NDF at the matched 2X normal inclusion of forage. Earlage was 20.2% NDF which reflects NRC values for earlage NDF (21 ± 5.6) and provided 7.5% NDF at the matched normal inclusion of forage and 14.9% NDF at the 2X normal inclusion. Differences in NDF content of these two roughage sources led to greater differences in forage NDF at both inclusions.

When evaluating the interaction between roughage source and inclusion (Table 2), no interaction was observed for gain, intake, feed conversion, or carcass characteristics ($P \geq 0.13$) except for a tendency present with marbling score ($P = 0.08$). Cattle fed corn silage at 15 or 30% of the diet had equal ($P > 0.33$) marbling scores (526) which was equal to the lower inclusion of earlage (529). When the only grain source was earlage, marbling was lowest (493; $P < 0.09$). A tendency for an interaction was also observed for percentage of animals with liver abscesses ($P = 0.09$). When examining forage type, liver abscess percentage did not differ ($P = 0.27$) among inclusion levels of dietary NDF. Liver abscess prevalence was greater (P = 0.09) for cattle fed earlage compared to corn silage when fed at the normal inclusion of NDF, but was not different between roughage sources at the 2X normal NDF inclusion. The prevalence of A+ liver abscesses among all animals was 8%, and of animals with a liver abscess, A+ liver abscess accounted for 15% of those. No other interactions were observed so the main effects of roughage type and inclusion level will be discussed.

When analyzing main effects for roughage source, greater intakes were observed in cattle fed corn silage which led to those cattle also having greater ADG ($P \leq 0.01$) than those fed earlage. The steers fed corn silage consumed more which allowed them to gain more, resulting in similar F:G ($P = 0.36$) between the two roughage sources. Hot carcass weights were significantly greater when cattle were fed corn silage as the roughage source ($P = 0.02$).

Feed conversion was impacted by NDF inclusion from roughage. Cattle that were fed the 7.5% roughage were 6% more efficient ($P < 0.01$) when compared to the 14.8% forage and tended to have greater ADG ($P = 0.10$) treatments while DMI between inclusion was similar ($P = 0.11$). Hot carcass weight was also greater in steers fed the normal inclusion of dietary NDF (P = 0.03). No other significant differences were observed for the main effects of roughage type or NDF inclusion.

Net energy utilization for maintenance (NEm), gain (NEg), and metabolizable energy were also analyzed using calculations with values derived from the NRC. Significant differences were present for all net energy calculations ($P < 0.01$). The normal forage inclusion (7.5%) for both roughages showed greater energy concentrations for NEm, NEg, and ME compared to 2X inclusion. However, these calculations that are based on feed conversion are not good reflections of intake and gain responses, and usually favor lower intakes. Cattle fed less roughage had greater calculated energy concentrations, similar to the F:G response. Cattle fed silage were equivalent to cattle fed earlage for calculated energy concentration, which also is similar to the F:G responses observed. Using net energy

Table 2. Carcass adjusted performance of cattle fed corn silage or earlage at equal NDF inclusions

	Treatments					*P*-values		
	Corn Silage		Earlage					
Item	Normal (7.5%)	2X (14.8%)	Normal (7.5%)	2X (14.8%)	SEM	Roughage* Inclusion[1]	Roughage source	Inclusion
Performance								
Initial BW, lb	1038	1036	1037	1038	1.4	0.26	0.73	0.73
Final BW, lb[2]	1456	1423	1420	1394	12.5	0.80	0.02	0.03
DMI, lb/d	29.8	31.0	29.0	29.0	0.39	0.13	<0.01	0.11
ADG, lb	3.99	3.79	3.70	3.58	0.092	0.65	0.01	0.10
F:G	7.45	8.18	7.82	8.11	—	0.18	0.35	<0.01
Net Energy Utilization[3]								
NEm, Mcal/lb	0.74	0.69	0.73	0.69	0.012	0.33	0.46	<0.01
NEg, Mcal/lb	0.47	0.42	0.45	0.42	0.010	0.29	0.39	<0.01
ME, Mcal/lb	1.16	1.09	1.13	1.09	0.014	0.30	0.41	<0.01
Carcass Characteristics								
HCW, lb	917	897	895	878	7.9	0.81	0.02	0.03
Dressing, %	60.1	60.0	60.1	60.0	0.37	0.71	0.20	0.20
LM Area, in[2]	13.4	13.3	13.1	13.5	0.17	0.14	0.82	0.25
Marbling Score[4]	523	527	529	493	11.0	0.05	0.22	0.17
12th rib fat, in	0.66	0.61	0.60	0.60	0.022	0.38	0.15	0.28
Calculated YG[5]	3.53	3.42	3.46	3.48	0.080	0.39	0.96	0.60
Liver Abscess, %[6]	35	46	52	38	—	0.09	0.27	0.86

[1]Interaction between roughage type and inclusion level

[2]Final BW is HCW adjusted to a common dressing percentage of 63%

[3]Calculated using values from the Beef NRC (2016)

[4]Fat marbling is scored as 400+ = slight, 500+ = modest, 600+ = moderate etc.

[5]Calculated yield grade = 2.5 + (2.5*fat thickness)—(0.32*LM area) + (0.2*2.5) + (0.0038*HCW)

[6]Liver abscess data was analyzed as a binomial distribution

calculations from performance illustrates that the responses are similar to F:G observations. Cattle fed silage as a roughage source consumed more and gained more than cattle fed earlage, which is not accounted for in these calculations of energy concentration.

Conclusion

Feeding earlage as the sole roughage and grain source or at approximately half of the grain and normal inclusion of roughage in a finishing diet resulted in lower intake and gain but did not impact feed conversion compared to feeding silage and grain. Feeding 2X the normal amount of NDF used in these diets did not significantly affect ADG but feed conversion was negatively impacted with more roughage.

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