Impact of Steam-Flaked Rye Fed in Combination with Steam-Flaked Corn on Performance and Carcass Characteristics of Yearling Steers

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Summary with Implications

A finishing study evaluated the effect of feeding steam-flaked rye on performance and carcass characteristics of yearling steers. Treatments consisted of different ratios of steam-flaked rye to steam-flaked corn. The ratios were 0:100, 25:75, 50:50, and 100:0 rye:corn. Increasing inclusions of rye linearly decreased final body weight, dry matter intake, average daily gain, and hot carcass weight. As a result, feed conversion was poorer as rye replaced corn. Carcass characteristics reflected lower gain with linear decreases in marbling score, ribeye area, and backfat thickness. There was no difference in yield grade among treatments. Based on dietary energy calculated from performance, steam-flaked rye has approximately 92% the energy value of steam-flaked corn.

Introduction

Finishing diets in cattle are always changing in reference to availability of ingredients and grain prices. Traditionally, rye grain has not been a common ingredient in finishing diets due to concerns about ergot toxicity, along with high market prices due to low supply. A new hybrid variety of rye has been released with several benefits such as reduced ergot risk and higher yields. With farmers beginning to utilize this new hybrid, and selling the grain into the market, supply may increase causing prices to become competitive relative to corn in the future.

Previous research has suggested a decrease in average daily gain, dry matter intake and poorer feed conversion when dry rolled rye replaced dry rolled corn in the diet. However, there are no data on feeding steam-flaked rye to feedlot cattle. With the possible increase in rye on the market, research is needed to determine the energy content of feeding steam-flaked rye and impact on performance with increasing inclusion of hybrid rye in cattle diets.

The objective of this study was to determine the effects of feeding different inclusions of steam-flaked hybrid rye (SFR) replacing steam-flaked corn (SFC), on the performance and carcass characteristics of yearling steers.

Procedure

All procedures involving animal care and management were approved by the University of Nebraska–Lincoln's Institutional Animal Care and Use Committee.

A 140-day finishing study was conducted in October of 2020 using 400 crossbred yearling steers at the Eastern Nebraska Research and Extension Center (ENREC) near Mead, NE. Half of the steers were purchased in September 2020, received at ENREC and fed in the feedlot until trial initiation (Source 1). The other half of the steers used in the trial were purchased in October 2019 and received at ENREC. These steers were grown on cornstalks, grass, and in the feedlot over the winter, spring, and summer (Source 2).

Steers were limit-fed a diet consisting of 50% Sweet Bran (Cargill Wet Milling; Blair, NE) and 50% alfalfa hay at approximately 2% of body weight for five consecutive days before collecting initial weights in order to minimize variation due to gastrointestinal fill. Steers were weighed on two consecutive days to establish initial weights (856 lb ± 48 for source 1; 903 lb ± 57 for source 2). Cattle were assigned to pens based on the first day's weight and sorted into one of three weight blocks: light (1 replication), medium (3 replications), and heavy (1 replication) within each source. Steers were then stratified by weight and assigned to pens to ensure equal initial pen weights by block. Pens were then assigned randomly to treatment within block with 5 pens per treatment within source. A 21-day adaptation period was used whereby Sweet Bran decreased from 77% to 20% while the grain was increased from 5% to 62%, all other ingredients remained constant. All rye to corn ratios remained constant during the adaption period. The first adaptation diet was fed for 4 days and consisted of 77% Sweet Bran and 5% grain. The second diet was fed for 5 days and consisted of 62% Sweet Bran and 20% grain. The third diet was fed for 6 days and consisted of 47% Sweet Bran and 35% grain. The fourth adaption diet was fed for 6 days and consisted of 32% Sweet Bran and 50% grain. The final finishing diet is presented in Table 1 and consisted of 20% Sweet Bran and 60% grain.

Four treatments were evaluated as a generalized randomized block design. The cattle were bought from two different sources and were blocked within source with three different weight blocks: light (4 pens per source; 8 total pens), medium (12 pens per source; 24 total pens), and heavy (4 pens per source; 8 total pens) for a total of 40 pens with 10 steers per pen. Cattle from source 1 were weighed, implanted, and sorted on day -4 of the trial. Source 2 was weighed, implanted, and sorted on day 0 of the trial. Both groups were started on treatment diets on day 1 of the trial to allow all 10 replications to be stepped together by treatment. Treatments consisted of 0:100, 25:75, 50:50, and 100:0 (SFR:SFC). All diets contained 60% grain, and each treatment differed only in the ratio of SFR to SFC. Treatment diets are provided in Table 1.

Rye grain was cleaned prior to flaking using a two-screen grain shaker with air in order to decrease total ergots. Rye was sampled upon delivery and evaluated for ergot contamination based on sample date. All grain was processed at the same feedyard (Raikes Feedyard, Ashland, NE). Grain was delivered approximately weekly. At time of delivery, SFR was sampled as some

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Table 1. Dietary treatment compositions (DM basis) for finishing steers fed increasing inclusions of steam-flaked rye replacing steam-flaked corn.

Treatments (% Rye)	0%	25%	50%	100%
Steam-Flaked Corn	60.0	44.6	29.2	-
Steam-Flaked Rye[1]	-	15.4	30.8	60.0
Sweet Bran	20.0	20.0	20.0	20.0
Forage Corn Silage	10.0	10.0	10.0	10.0
Corn Stalks	2.0	2.0	2.0	2.0
Corn Oil	3.0	3.0	3.0	3.0
Supplement	5.0	5.0	5.0	5.0
Fine Ground Corn	2.086	2.536	2.986	2.986
Limestone	1.60	1.60	1.50	1.5
Tallow	0.125	0.125	0.125	0.125
Urea	0.80	0.40	0	0
Salt	0.30	0.30	0.30	0.30
Trace Mineral premix	0.05	0.05	0.05	0.05
Vitamin ADE premix	0.015	0.015	0.015	0.015
Rumensin-90 premix[2]	0.0165	0.0165	0.0165	0.0165
Tylan-40 premix[3]	0.0075	0.0075	0.0075	0.0075
Nutrient composition[4]				
CP,%	13.1	12.7	12.3	13.6
NDF,%	19.8	22.9	25.9	31.7
ADF,%	8.5	8.8	9.1	9.6
EE,%	6.2	5.9	5.7	5.2

[1]Rye inclusion was adjusted based on corn contamination on day 22

[2]Supplement formulated to provide 30 g/ton of Rumensin® (Elanco Animal Health, DM Basis)

[3]Supplement formulated to provide 8.8 g/ton Tylan® (Elanco Animal Health, DM Basis)

[4]Based on analyzed nutrients for each ingredient

visual contamination of SFC was observed in the SFR which was corn left in the steam chest at the end of the day before rye was processed. Using sieves, corn was separated in a sample, and quantified as a percentage (Table 2). Early on, SFR contained approximately 8% SFC contamination. After a few weeks, limited corn contamination was observed, averaging less than 2% SFC present. As a result, the proportion of SFR was adjusted on day 22 for the 25:75 and 50:50 proportions in an attempt to account for any SFC contamination, albeit small. After the decrease in SFC contamination was observed, the 25:75 and 50:50 diets were then readjusted on day 69. Due to acidosis concerns based on intake and loose stools, corn stalks were added to all diets at an inclusion of 2% and grain decreased to 60% on day 37 of the trial. Optaflexx was added to the diets on day 110 to target 300 mg/steer daily (Elanco Animal Health) and fed for 28 days then removed 2 days before slaughter.

All steers were implanted with Revalor-IS (Merck Animal Health) as an initial implant. Steers were implanted on day -4 for source 1 and day 0 for source 2 and all cattle started on treatment diets on day 1. Revalor-200 (Merck Animal Health) was administered as the terminal implant on day 54 for source 1 and day 55 for source 2.

Steers were fed trial diets for 140 days. On the day of harvest, kill order, liver abscess scores, and hot carcass weight (HCW) were recorded. Carcass-adjusted final body weight was calculated using a 63% dressing percentage. Marbling score, longissimus muscle area (LM area), and fat

Table 2. Percentage of steam-flaked corn detected in steam-flaked rye samples at delivery.

Sample Date	Corn Contamination (%)
10/12/2020	6.64
10/28/2020	12.97
11/9/2020	4.19
11/19/2020	4.11
11/25/2020	1.15
12/3/2020	2.20
12/11/2020	2.56
12/28/2020	1.68
1/5/2021	0.64
1/12/2021	1.98
1/20/2021	0.14
1/29/2021	1.02
2/10/2021	1.52
2/23/2021	0.84
Average	2.97

depth were collected after a 48-hour chill. Carcass adjusted final body weight was used to calculate ADG and F:G. USDA yield grade was calculated using an assumed 2% KPH (kidney, pelvic, heart fat). Individual carcass data were averaged by pen, then analyzed with pen as the experimental unit. Performance-adjusted net energy values were calculated using average initial weights, carcass-adjusted ADG, DMI, and mean shrunk final body weight.

Data were analyzed using the MIXED procedure of SAS as a generalized randomized block design, with pen as the experimental unit and source and weight block as fixed effects. Effect of increasing the SFR:SFC ratio on performance and carcass characteristics were analyzed using linear and quadratic contrasts. Orthogonal contrast coefficients were calculated with Proc IML to account for unequal spacing.

Results

As the level of rye increased in the diet HCW, carcass-adjusted final body weight, ADG, and DMI decreased linearly ($P < 0.01$; Table 3). Intakes were 27.9 to 30.7 lb/d for these large yearling steers but feeding SFR decreased dry matter intake by 2.7 lb/d as the SFR:SFC ratio increased from 0:100 to 100:0. Gains also decreased 14.5% when grain changed from SFC to SFR. Lower DMI and ADG with increasing SFR may be due to faster ruminal starch digestion and acidosis risk which has been shown to decrease DMI and ADG. A linear increase ($P < 0.01$) in feed conversion (F:G) was observed as ratio of SFR:SFC increased. Calculated NEm and NEg also linearly decreased ($P < 0.01$) with increasing inclusion of SFR. These data suggest no associative effect of blending SFR with SFC as all performance responses were linear. Carcass characteristics were also affected by treatment. With increasing levels of rye, LM area ($P < 0.01$), 12th rib fat ($P = 0.03$), and marbling score ($P < 0.01$) decreased linearly. USDA yield grade did not differ among treatments ($P = 0.16$). The observed impacts on carcass characteristics reflect the decrease in ADG over the 140-day study.

The SFR was composited over the feeding period and analyzed for various nutrients. The rye grain was found to contain approximately 28.4% neutral detergent fiber, 4.3% acid detergent fiber, 12.7% crude protein, 1.8% fat, and 54.7% starch on a dry matter basis. Ergot levels were evaluated by delivery time and averaged 1878 ppb on average (Table 4). Sampled ergot concentrations ranged from 1183 to 2740 ppb. Although ergot toxicity symptoms are often difficult to distinguish from other health concerns, we observed some evidence that foot health may have been compromised in cattle fed rye. Treatments for lameness was 3% for the 0% rye and 11% for the 100% rye treatment, while the 25 and 50% rye cattle had pull rates of 8% and 6%, respectively. Ergot toxicity levels are not well established, but some indications for concern with the ergot contamination in this study/source may be influencing results. More data are needed to establish toxicity thresholds and the effects of ergot on animal health and performance.

Conclusion

Feeding finishing cattle increasing ratios of steam-flaked rye to steam-flaked corn linearly decreased overall gains, intakes, and resulted in poorer feed conversion. Increasing inclusion of steam-flaked rye in the diet also decreased marbling scores, backfat thickness, and LM area due to impacts on performance. Based on dietary energy calculated from performance, steam-flaked rye has approximately 92% the energy value of steam-flaked corn.

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Table 3. Performance and carcass characteristics of finishing yearlings fed increasing inclusions of steam-flaked rye replacing steam-flaked corn.

	% Steam-Flaked Rye					P-value	
Item	0%	25%	50%	100%	SEM	Linear	Quadratic
Performance							
Initial BW, lb	882	880	881	882	1.8	0.66	0.50
Final BW, lb[1]	1528	1493	1478	1434	7.5	<0.01	0.44
DMI, lb/d	30.6	29.7	28.9	27.9	0.24	<0.01	0.22
ADG, lb[1]	4.62	4.39	4.27	3.95	0.051	<0.01	0.55
F:G	6.63	6.76	6.77	7.07	-	<0.01	0.67
NEm, Mcal/lb	0.821	0.809	0.801	0.790	0.0072	<0.01	0.90
NEg, Mcal/lb	0.533	0.523	0.526	0.507	0.0066	<0.01	0.67
Carcass Characteristics							
HCW, lb	963	941	931	903	4.7	<0.01	0.46
Marbling Score[2]	594	566	563	534	12.4	<0.01	0.68
LM Area, in^2	14.1	14.0	13.9	13.5	0.14	<0.01	0.63
Fat Thickness, in	0.66	0.66	0.65	0.62	0.013	0.03	0.57
Calc. USDA YG[3]	3.69	3.66	3.63	3.57	0.067	0.16	0.98
Liver Abscesses, %[4]	9.09	9.00	8.16	6.19	-	-	-

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

[2]Marbling Score 400=Small00, 500=Modest00

[3]Calculated yield grade = [2.5 + (2.5 × fat thickness, in) + (0.2 × 2% KPH) + (0.0038 × HCW, lb)—(0.32 × LM area, in^2)]

[4]Liver scores were evaluated in SAS as a binomial distribution, and was not significant (P = 0.44)

Table 4. Average hybrid rye ergot alkaloid concentration (DM basis)[1,2]

Ergot Alkaloid	Concentration, ppb
Ergosine	95
Ergotamine	109
Ergocornine	95
Ergocryptine	224
Ergocristine	215
Ergosinine	82
Ergotaminine	117
Ergocorinine	187
Ergocryptinine	412
Ergocristinine	342
Total	1878

[1] North Dakota State University Diagnostic Laboratory

[2] Detection limit = 20 ppb