Growth and Carcass Characteristics of Feed Efficiency Classified Cattle Fed Corn or Roughage-Based Diets and Finished with Corn or Byproduct-Based Diets

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Summary and Implications

The current study is part of a five-year multidisciplinary grant aiming to identify dietary, genotypic and metabolic factors affecting feed efficiency while additionally analyzing the effects of feed efficiency differences on feedlot performance and carcass characteristics. The current report summarizes the six groups of steers fed over five years. Feed efficiency was relatively repeatable from the growing to the finishing phase as steers classified as highly feed efficient during the growing phase remained more feed efficient than steers previously classified as mid and lowly feed efficient. Marbling differed due to feed efficiency classification but classification effects on other carcass traits were limited. Relative to other diet combinations, steers grown with roughage-based diets and finished with byproduct-based diets excelled in finishing phase growth rate, final bodyweight and hot carcass weight with no differences detected in feed conversion or marbling score.

Introduction

Due to increasing production costs in the beef industry as well the inherent feed conversion disadvantage relative to other meat-producing species, it is important that the beef industry continuously strive to improve efficiency. Because individual feed efficiency measurement is expensive and generally only determined once it is important to determine the repeatability of feed efficiency from one production stage to the next. Previous reports note that cattle within a contemporary group maintained feed efficiency rank as little as 33% or as much as 62% of the time. Feedlot animals are typically grown on roughage-based diets and finished on corn-based diets; diets greatly differing in energy, fiber and other nutritional components. This transition in diet type during the feedlot phase further complicates the evaluation of feed efficiency across feeding phases. Although feed conversion is a predominant profitability determinant, it is also important to evaluate the effect of improved feed efficiency on other economically relevant growth and carcass traits. The objective of the current study was to determine the influence of growing phase feed efficiency classification and diet type on feed efficiency, growth performance, and carcass traits of steers finished on corn or byproduct-based diets.

Materials and Methods

Nine-hundred eighty-five crossbred steers were grown and performance tested at the University of Missouri (Columbia, MO) to determine feed efficiency and relative feed efficiency ranking compared to contemporaries fed the same diet during the same time period. Growing phase diets were composed primarily of roughage and soybean hulls (G-Rough) or whole-shell corn (G-Corn). The steers were housed in dirt lots equipped with GrowSafe feed bunks that measure individual feed intake. Two-day initial and final bodyweights (BW) were measured as well as intermediate BW every 14-28 days. Steers were on the growing phase test for 69-89 days following a receiving period. Steers were then trucked to Iowa State University for finishing.

Following transport to Iowa State University, steers were blocked to pens of six by growing phase feed efficiency rank (lower, mid, or upper one-third) within growing phase diet. Finishing phase pens were concrete, provided partial shelter, and feed intake was measured on a pen basis. Steers were fed a receiving diet for 5-17 days, and transitioned over 14-21 days to finishing phase cracked corn (F-Corn) or grain byproduct-based diets (F-Byp; Table 1). Finishing phase days on test (55-155 days) varied between steer groups due to finishing phase initial BW and days necessary to reach an average 0.5 inch backfat depth; Optaflexx (200mg/steer/day, Elanco, Indianapolis, IN) was fed for the final 26-32 days of the finishing phase prior to harvest. Two-day initial and final BW were gathered for the finishing phase with intermediate BW every 28 days.

Data were analyzed using the MIXED procedure of SAS (SAS Institute Inc., Cary, NC). Once all all six groups were complete, growing phase feed efficiency classifications were determined by calculating average growing phase gain:feed (G:F) for each finishing phase pen (n = 168 pens) using growing phase initial BW as a covariate. Pens were classified by growing phase G:F (G-Corn: 0.207 ± 0.038, SD; G-Rough: 0.185 ± 0.036, SD) as lowly (LFE; < 0.5 SD from the G:F mean), mid (MFE; ± 0.5 SD from the G:F mean), or highly feed efficient (HFE; > 0.5 SD from the G:F mean) within growing phase diet. Finishing phase performance and carcass traits were analyzed using the fixed effect interactions of growing diet, finishing diet, and feed efficiency classification. Group (1-6) was applied as a fixed effect and finishing phase initial BW was applied as a covariate for final BW, average daily gain (ADG), dry matter intake (DMI), G:F, and hot carcass weight (HCW). Pen was the experimental unit and lsmeans were compared using the pdiff command.

Results and Discussion

Growing phase feed efficiency classifications. Feed efficiency classifications had markedly different average G:F among the corn-grown steers (HFE = 0.258, MFE = 0.218, LFE = 0.180 G:F) and the roughage-grown steers (HFE = 0.228, MFE = 0.196, LFE = 0.169 G:F).

Finishing phase performance. There were no growing phase diet × FE classification × finishing phase diet effects ($P \geq 0.2$) on finishing phase growth or carcass traits. Finishing phase G:F was unaffected ($P \geq 0.5$) by any interaction but was greater ($P \leq 0.03$; Table 2) for HFE steers than MFE or LFE steers; MFE steers had greater ($P = 0.02$) finishing phase G:F than LFE steers. Marbling score was unaffected ($P \geq 0.2$; data not shown) by any diet or interaction effects but HFE steers had lesser ($P \leq 0.01$; Table 2) marbling score than MFE and LFE steers; marbling score did not differ ($P = 0.4$) between MFE and LFE steers.

There were growing × finishing diet interactions ($P \leq 0.02$; Table 3) for finishing phase final BW, ADG, and DMI. The G-Rough/F-Byp steers had greater ($P \leq 0.04$) final BW and DMI than other growing × finishing diet combinations. The G-Rough/F-Byp steers had greater ($P \leq 0.05$) ADG than the corn-finished steers. Growing phase diet × feed efficiency classification effects were detected ($P \leq 0.005$; Table 4) for finishing phase FBW, ADG, and DMI. Among roughage-grown steers, HFE and MFE had heavier ($P \leq 0.04$) final BW than the LFE but among the corn-grown steers, LFE had heavier ($P = 0.03$) final BW than HFE. Among the roughage-grown steers, HFE and MFE also had ($P \leq 0.01$) greater ADG than LFE but among the corn-grown steers, ADG was unaffected ($P \geq 0.2$) by feed efficiency classification. Dry matter intake was unaffected ($P \geq 0.3$) by feed efficiency classification among the roughage-grown steers but among corn-grown steers, LFE had greater ($P \leq 0.003$) DMI than MFE and HFE.

Carcass traits were affected by growing phase and finishing phase diets. There tended ($P = 0.06$; Table 3) to be a growing × finishing diet interaction for hot carcass weight (HCW); among the byproduct-finished steers, roughage-grown steers had heavier HCW than corn-grown steers and there no differences among the corn-finished steers. There was a growing phase × finishing diet interaction ($P = 0.003$) for backfat in which the G-Rough/F-Byp steers had greater ($P \leq 0.002$) backfat than other growing × finishing diet combinations. There was a growing × finishing diet interaction ($P = 0.006$) for yield grade in which the G-Rough/F-Byp steers had greater ($P \leq 0.01$) calculated yield grades than other growing × finishing diet combinations. Effects of growing phase diet × feed efficiency classification were limited. There were no differences ($P \geq 0.1$) in HCW among the roughage-grown steers due to feed efficiency classification but among the corn-grown steers, HFE had lighter ($P \leq 0.01$) HCW than LFE and MFE. Roughage-grown HFE steers had larger ($P \leq 0.04$) REA than any other growing phase diet × FE classification combination.

Feed efficiency was repeatable from the growing phase to the finishing phase, independent of any diet interaction. Steers classified as HFE during the growing phase had greater finishing phase G:F than MFE and LFE steers; MFE had greater G:F than LFE steers. Interestingly, DMI drove differences in finishing phase G:F between feed efficiency classifications among the corn-grown steers but ADG drove finishing phase G:F differences among the roughage-grown steers. The improved ADG was likely due, in part, to greater fiber digestibility previously noted in roughage-grown HFE versus LFE steers. The roughage-growing, byproduct-finishing diet combination was most advantageous for growth and carcass yield with no decrease in marbling score or feed conversion relative to other diet combinations.

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Table 1. Finishing phase diets

Ingredients, % DM	F-Corn	F-Byp
Cracked corn	75	30
DDGS	14.99	39.99
Hay	8	8
Soybean hulls	-	20
Limestone	1.54	1.54
Sodium chloride	0.31	0.31
Vitamin A premix[1]	0.11	0.11
Trace mineral premix[2]	0.035	0.035
Rumensin 90[3]	0.013	0.013

[1] Vitamin A premix contained 2,000,000 IU/lb.
[2] Provided to achieve dietary concentrations of: 30 ppm Zn, 20 ppm Mn, 0.5 ppm I, 0.1 ppm Se, 10 ppm Cu, 0.1 ppm Co.
[3] Provided 200 mg/steer/d Monensin; donated by Elanco Animal Health, Indianapolis, IN.

Table 2. Finishing phase G:F and carcass marbling score as affected by feed efficiency classification

Item	LFE	MFE	HFE	Error	P-value
G:F	0.160[c]	0.165[b]	0.169[a]	0.0015	0.002
MS[1]	439[a]	433[a]	417[b]	5.0	0.01

[a, b, c] = Least squares means in a row without common superscript differ ($P < 0.05$).
[1] Marbling score (300 = slight, 400 = small, 500 = modest).

Table 3. Finishing phase growth and carcass traits as affected by growing phase and finishing phase diets

	G-Corn		G-Rough			P-values[1]		
Live performance	F-Corn	F-Byp	F-Corn	F-Byp	Error	G Diet	F Diet	G*F Diet
Initial BW, lb	996	1004	1022	1028	-	-	-	-
Final BW, lb	1340[b]	1344[b]	1334[b]	1357[a]	4.2	0.4	0.001	0.02
ADG, lb/d	3.96[bc]	3.99[ab]	3.85[c]	4.09[a]	0.048	1.0	0.003	0.02
DMI, lb/d	23.7[b]	24.1[b]	23.6[b]	25.3[a]	0.20	0.02	<0.001	0.002
G:F	0.167	0.166	0.163	0.164	0.0015	0.04	0.7	0.5
Carcass traits[2]								
HCW, lb	840[z]	855[y]	840[z]	866[x]	3.2	0.14	<0.001	0.06
DP, %	62.7	63.7	63.0	63.8	0.14	0.1	<0.001	0.6
BF, in	0.52[bc]	0.55[b]	0.50[c]	0.60[a]	0.012	0.12	<0.001	0.003
KPH, %	2.29	2.33	2.31	2.38	0.025	0.2	0.03	0.6
REA, in^2	13.5	13.8	13.8	14.0	0.09	0.02	0.01	0.5
YG	3.08[b]	3.13[b]	3.01[b]	3.32[a]	0.049	0.3	<0.001	0.006

[a, b, c] Least squares means in a row without common superscript differ ($P < 0.05$).
[x, y, z] Least squares means in a row without common superscript tend to differ ($P < 0.1$).
[1] P-values: G Diet = main effect of growing phase diet; F Diet = main effect of finishing phase diet; G*F Diet = interaction effect of growing and finishing phase diets.
[2] HCW = hot carcass weight; DP = dressing percent; KPH = kidney, pelvic, heart fat; BF = 12th rib backfat; REA = ribeye area; YG = yield grade (1-5).

Table 4. Finishing phase growth and carcass traits as affected by growing phase diet × feed efficiency classification

	G-Corn			G-Rough				
Live performance	LFE	MFE	HFE	LFE	MFE	HFE	Error	P-value[1]
Initial BW, lb	986	1004	1010	1012	1016	1046	-	-
Final BW, lb	1354[ab]	1340[bc]	1332[c]	1331[c]	1347[ab]	1359[a]	5.8	0.001
ADG, lb/d	4.06[ab]	3.93[bc]	3.92[bc]	3.79[c]	4.00[ab]	4.11[a]	0.064	0.005
DMI, lb/d	24.9[a]	23.6[bc]	23.2[c]	24.2[ab]	24.5[a]	24.6[a]	0.26	0.002
Carcass traits[2]								
HCW, lb	856[a]	850[a]	837[b]	847[ab]	852[a]	859[a]	4.2	0.003
REA, in^2	13.4[c]	13.9[b]	13.6[bc]	13.6[bc]	13.8[b]	14.2[a]	0.12	0.01

[a, b, c] Least squares means without common superscript differ ($P < 0.05$).
[1] Interaction effect of growing phase diet and feed efficiency classification.
[2] HCW = hot carcass weight, REA = ribeye area.