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Influence of Feed Efficiency Ranking on Diet Digestibility and Performance of Beef Steers

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Summary and Implications

The current study evaluated diet digestibility and finishing phase growth performance in steers previously evaluated for feed efficiency during the growing phase. Based on growing phase feed efficiency, steers were classified as highly or lowly feed efficient. During the finishing phase, the highly feed efficient steers remained more feed efficient. Steers were fed either corn or roughage-based diets during the growing phase and then transitioned to either corn or byproduct-based diets during the finishing phase. Dry matter digestibility was strongly positively correlated in steers grown/finished on corn or grown/finished on high fiber diets (roughage, byproduct). Conversely, there was a strong negative correlation in G:F between feeding phases when steers were roughage-grown and corn-finished. Overall, the study reinforced the idea that diet digestibility differences may contribute to feed efficiency variability and that cattle should be feed efficiency tested on diets similar to the production environment of interest.

Introduction

After animal acquisition, cost of gain is the greatest contributor to feedlot profitability. Cost of gain is driven largely by feed efficiency but the underlying sources of variation in feed efficiency between individual animals are not well characterized. Along with variation in methane production, activity level, and metabolic efficiency, differences in digestibility have also been attributed to feed efficiency variation. Previous work has shown greater nutrient digestibility in animals identified as more feed efficient versus animals with poorer feed efficiency. In a typical beef system, animals are raised on roughage-based diets and then transitioned to corn-based finishing diets. This raises a question as to repeatability of feed efficiency and digestibility advantages when the diets change, especially as energy, fiber and other nutrient values differ. The objective of the study was to determine effects of growing phase diet, growing phase feed efficiency, and finishing phase diet on diet digestibility and finishing phase feed efficiency.

Materials and Methods

Two groups of steers, totaling 373 head, were grown and performance tested at the University of Missouri (Columbia, MO). Steers were fed one of two growing phase diets, composed primarily of roughage (G-Rough; alfalfa/grass baleage and soybean hull-based) or whole-shell corn (G-Corn). The steers were housed on dirt lots and fed with Growsafe feed bunks that measured individual feed intake. Two-day start and end weights were measured as well as intermediate weights every 28 days. In both groups, steers were on the growing phase test for 70 days following a receiving period. At the completion of the growing phase, feed efficiency was calculated and steers were ranked by feed efficiency within diet. Steers were then trucked to Iowa State University (ISU) for the finishing phase.

Within each group, the 12 greatest and 12 least feed efficient steers from each growing phase diet (n = 96 total across the two groups; 1074±11 lb) were selected for total tract diet digestibility and feedlot growth performance analysis. Upon arrival at ISU, steers were housed in six-head concrete pens under partial roof and fed in Growsafe bunks. Steers were initially fed receiving diets (Table 1) similar to their respective growing phase diets. Titanium dioxide was included in the receiving diets as an indigestible marker at a rate of 10 g per head daily for 14 d, with fecal grab sample collection prior to feeding on days 14 and 15.

After the receiving period and fecal collection, steers were transitioned for 18 days to a finishing diet (Table 1) composed largely of corn (F-Corn) or grain byproducts (F-Byp). Steers were fed finishing diets until an estimated average 0.5 inch backfat depth was reached, receiving Optaflexx (200 mg/steer/day, Elanco, Indianapolis, IN) for the final 27-28 days of the finishing test period followed by harvest. Due to differences in average initial BW (IBW) for the finishing phase, group 1 (1120 ± 16 lb) had a 56 d total finishing phase whereas group 2 (1028 ± 15 lb) had a 97 d total finishing phase. Finishing phase diet digestibility was determined by repeating the 15 d titanium dioxide protocol immediately prior to Optaflexx introduction. Two-day start and end-weights were gathered for the finishing period as well as intermediate weights every 28 days to calculate growth performance.

Feed samples and fecal samples from both periods were dried, ground, and analyzed for DM, OM, NDF, ADF, protein, and titanium dioxide content. Titanium dioxide content was determined colorimetrically.

The 96 steers were ranked by growing phase G:F and categorized as the 24 greatest (HFE) or 24 least (LFE) feed efficient steers from each growing phase diet. Data were analyzed using the MIXED procedure of SAS (SAS Institute Inc., Cary, NC). Fixed effects were growing diet (G-Corn, G-Rough), finishing diet (F-Byp, F-Corn), and feed efficiency grouping (HFE, LFE). Group (1, 2) was applied as a random effect and finishing phase IBW was

applied as a covariate for finishing growth traits. Animal was the experimental unit. Correlations were determined using the CORR procedure of SAS to generate Pearson's correlation coefficients denoted as R.

Results and Discussion

Finishing phase performance. There were no differences ($P > 0.5$) in end weight, ADG, or DMI due to growing phase diet and a tendency for greater ($P = 0.07$) end weight in byproduct-finished versus corn-finished steers (Table 2). Within steers grown on roughage, steers finished on the byproduct diet had greater ($P < 0.05$) end weight, ADG, and DMI than steers finished on the corn diet. There were no differences in G:F due to diet ($P > 0.05$). Steers classified as HFE tended to have lesser ($P = 0.11$) DMI than LFE steers, which contributed to greater ($P = 0.04$) finishing phase G:F in HFE versus LFE steers (Table 3).

Diet digestibility. There were no differences ($P > 0.2$) in growing phase DM digestibility or CP digestibility due to diet or the interaction of diet and feed efficiency ranking (Table 4). The HFE steers tended to have greater ($P = 0.13$) DM digestibility than LFE steers. Steers grown on the high fiber, lower starch roughage-based diet had greater ($P < 0.003$) NDF and ADF digestibility than steers fed the high starch corn-based diet. The HFE steers tended to have greater ($P < 0.09$) NDF and ADF digestibility and ultimately, the roughage-grown HFE steers had the greatest ($P = 0.02$) NDF digestibility. During the finishing phase, corn-grown steers tended ($P < 0.15$) to have greater DM, NDF and ADF digestibility than steers grown on the roughage-based diet (Table 5). Similarly, corn-finished steers had greater ($P = 0.01$) DM digestibility during the finishing phase than byproduct-finished steers; however, steers fed the higher protein, higher fiber byproduct-based diet had greater ($P < 0.002$) NDF, ADF, and CP digestibility.

Correlations. There was a positive correlation between the growing and finishing phases DM digestibilities (R = 0.39, $P < 0.001$; Table 6) that was driven by positive correlations for digestibility between feeding phases in the steers grown and finished on the corn-based diets (R = 0.49, $P = 0.02$) as well as steers grown on the roughage-based diet and finished on the byproduct-based diet (R = 0.68, $P < 0.01$; Table 7). There was no correlation for individual G:F between feeding phases ($P = 0.2$; Table 6) and a negative correlation for G:F between phases in roughage-grown, corn-finished steers (R = -0.57, P =0.003; Table 7) was noted. Growing phase G:F and digestibility tended to be positively correlated (R = 0.2, $P = 0.07$; Table 6); however, finishing G:F and digestibility were negatively correlated (R = -0.35, $P < 0.01$).

Overall, growing phase feed efficiency ranking had limited effects on finishing phase feedlot performance though steers classified as highly feed efficient during the growing phase tended to consume less feed during the finishing phase and had greater gain:feed. Digestibility was positively correlated between feeding phases when steers were grown and finished on similar diets. Feed efficiency was negatively correlated between phases when steers were roughage-grown and corn-finished, reinforcing the idea that cattle should be FE tested using diets similar to the production environment of interest.

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Table 1. Receiving and finishing phase diets.

	G-Corn	G-Roughage	F-Corn	F-Byp
Whole shell corn	69	-	-	-
Soybean hull pellets	11	40	-	20
Corn Silage	-	21	-	-
Hay	10	14	8	8
DDGS	7.75	15.02	14.99	39.99
Cracked corn	-	8	75	30
Limestone	1.54	1.54	1.54	1.54
Sodium choride	0.31	0.31	0.31	0.31
Urea	0.27	-	-	-
Vitamin A premix[x]	0.11	0.11	0.11	0.11
Trace mineral premix[y]	0.024	0.024	0.035	0.035
Rumensin 90[z]	-	-	0.013	0.013

[x] = Vitamin A premix contained 2,000,000 IU/lb

[y] = Provided per 2.2 lb of diet: 30 mg Zn, 20 mg Mn, 0.5 mg I, 0.1 mg Se, 10 mg Cu, 0.1 mg Co

[z] = 200 mg/steer/d Monensin; donated by Elanco Animal Health, Indianapolis, IN

Table 2. Finishing phase performance as affected by growing phase and finishing phase diets.

	G-Corn[t]		G-Rough[u]			*P*-values		
	F-Corn[v]	F-Byp[w]	F-Corn[v]	F-Byp[w]	SEM	G Diet[x]	F Diet[y]	G*F Diet[z]
End wt, lb	1360.9[ab]	1358.3[ab]	1344.6[b]	1380.3[a]	12.76	0.7	0.07	0.03
ADG, lb/d	3.89[ab]	3.83[ab]	3.70[b]	4.11[a]	0.154	0.7	0.13	0.04
DMI, lb/d	25.3[ab]	25.1[ab]	24.6[b]	26.6[a]	0.81	0.5	0.14	0.05
G:F	0.154	0.154	0.150	0.156	0.005	0.7	0.5	0.4

[a, b] = Least squares means in a row without common superscript differ ($P < 0.05$)
[t] = Growing phase, whole shell corn-based diet
[u] = Growing phase, alfalfa/grass baleage and soybean hull-based diet
[v] = Finishing phase, cracked corn-based diet
[w] = Finishing phase, DDGS and soybean hull-based diet
[x] = Main effect of growing phase diet
[y] = Main effect of finishing phase diet
[z] = Interaction effect of growing and finishing phase diets

Table 3. Finishing phase performance as affected by growing phase feed efficiency ranking.

	LFE[y]	HFE[z]	SEM	*P*-value
End wt, lb	1359.4	1362.7	11.08	0.8
ADG, lb/d	3.85	3.92	0.143	0.6
DMI, lb/d	26.0	24.9	0.59	0.11
G:F	0.149	0.158	0.0045	0.04

[y] = Least feed efficient during the growing phase
[z] = Most feed efficient during the growing phase

Table 4. Growing phase digestibility as affected by growing phase feed efficiency ranking and diets.

	G-Corn[t]		G-Rough[u]			*P*-values		
Digestibility, %	LFE[v]	HFE[w]	LFE[v]	HFE[w]	SEM	Diet[x]	FE[y]	Diet*FE[z]
DM	65.4	65.9	65.5	72.4	3.39	0.2	0.13	0.2
NDF	58.8[b]	56.7[b]	60.4[b]	71.7[a]	3.80	0.003	0.09	0.02
ADF	45.7	47.1	58.2	71.3	3.45	<0.001	0.04	0.095
CP	58.9	57.2	60.4	65.4	4.40	0.6	0.6	0.2

[a, b] = Least squares means in a row without common superscript differ ($P < 0.05$)
[t] = Growing phase, whole shell corn-based diet
[u] = Growing phase, alfalfa/grass baleage and soybean hull-based diet
[v] = Least feed efficient during the growing phase
[w] = Most feed efficient during the growing phase
[x] = Main effect of growing phase diet
[y] = Main effect of growing phase feed efficiency ranking
[z] = Interaction effect of growing phase diet and feed efficiency ranking

Table 5. Finishing phase digestibility as affected by growing phase and finishing phase diets.

	G-Corn[t]		G-Rough[u]				*P*-values	
Digestibility, %	F-Corn[v]	F-Byp[w]	F-Corn[v]	F-Byp[w]	SEM	G Diet[x]	F Diet[y]	G*F Diet[z]
DM	73.0	71.9	73.4	67.2	1.48	0.15	0.01	0.09
NDF	60.5	67.9	57.4	63.2	2.04	0.06	0.002	0.7
ADF	52.2	63.1	49.8	57.4	2.53	0.11	<0.001	0.5
CP	65.7	73.9	67.9	71.6	1.17	0.9	<0.001	0.053

[t] = Growing phase, whole shell corn-based diet
[u] = Growing phase, alfalfa/grass baleage and soybean hull-based diet
[v] = Finishing phase, cracked corn-based diet
[w] = Finishing phase, DDGS and soybean hull-based diet
[x] = Main effect of growing phase diet
[y] = Main effect of finishing phase diet
[z] = Interaction effect of growing and finishing phase diets

Table 6. Dry matter digestibility and gain:feed correlations across growing and finishing phases.

Variable 1	Variable 2	R[z]	*P*-value
Growing phase G:F	Growing phase DM digestibility	0.20	0.07
Finishing phase G:F	Finishing phase DM digestibility	-0.34	<0.001
Growing phase G:F	Finishing phase G:F	-0.13	0.2
Growing phase DM digestibility	Finishing phase DM digestibility	0.39	<0.001

[z] = Pearson's Correlation coefficient

Table 7. Dry matter digestibility and gain:feed correlations across growing and finishing phase diets.

		Dry matter Digestibility		Gain:feed	
Growing phase diet[y]	Finishing phase diet[z]	R[z]	*P*-value	R[x]	*P*-value
Corn	Corn	0.49	0.02	0.07	0.7
Corn	Byproduct	0.25	0.3	0.13	0.6
Roughage	Corn	0.21	0.4	-0.57	0.003
Roughage	Byproduct	0.68	<0.001	-0.14	0.5

[x] = Pearson's Correlation coefficient
[y] = Growing phase diets: whole shell corn-based (Corn), alfalfa/grass baleage and soybean hull-based (Roughage)
[z] = Finishing phase diets: cracked corn-based (Corn), DDGS and soybean hull-based (Byproduct)