

## Influence of Feed Efficiency on Meat Tenderness Attributes of Beef Steers

### A.S. Leaflet R3137

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### Summary and Implications

Meat tenderness was assessed on steaks from steers considered highly or lowly feed efficient (FE). Overall, minimal differences were noted for tenderness attributes. There was a tendency for greater calpastatin activity in steaks from steers classified as highly feed efficient (HFE). Despite a tendency for increased calpastatin activity in steaks from HFE steers, there were no differences in calpain 1 autolysis or d 2, or d 14 troponin-T degradation due to feed efficiency (FE) classification. Analysis of d 2 troponin-T degradation indicated no differences due to diet type; however, d 14 troponin-T degradation was greater in steaks from steers finished on a corn-based diet, suggesting finishing diet affected extent of protein degradation. Warner-Bratzler shear force (WBSF) was affected by dietary treatment with steaks from roughage grown steers having a greater WBSF than those grown on corn. Based on this study cattle with high FE don't appear to produce less tender steak; however, further research is needed to evaluate feed efficiency and meat tenderness.

### Introduction

Beef is a highly preferred protein source; however, perceptions of the quality of beef by consumers are driven in part by tenderness. A major player in the tenderness of beef is the Ca-dependent proteolytic calpain system, which consists of calpain 1, and 2 and their potent endogenous inhibitor calpastatin. Increased calpastatin activity in relationship to calpain activity is indicative of reduced protein degradation and the production of a less tender steak. Reduced protein degradation post mortem results in beef that is less tender, and less desirable by consumers. Therefore the objective of this study was to evaluate the effect feed efficiency has on meat tenderness attributes of steers.

### Materials and Methods

*Experimental design.* One hundred and eighty-one British × Continental crossbred steers were grown at the University of Missouri on either a roughage-based diet (**MU-Rough**,  $n = 91$ ) or whole shell corn-based (**MU-Corn**,  $n = 90$ ) diet for 76 d (**Table 1**). All steers were RFI phenotyped at the end of the growing period and then transported to the Iowa State University Beef Nutrition Farm. Forty-eight phenotypic extreme steers approximately 1.40 SD or greater from the

mean of the larger population were then selected for further analysis, including the twelve greatest (highly FE, **HFE**, negative RFI) and least efficient (lowly FE, **LFE**, positive RFI) steers from their respective growing phase diets. Within growing phase diet type steers were assigned equally to a byproduct-based finishing diet (**ISU-Byp**) or a cracked corn-based finishing diet (**ISU-Corn**) for 87 d (**Table 2**;  $n = 6$  per treatment combination). Steers were harvested at a commercial abattoir at termination of the study and carcass data were collected.

*Sample Collection.* Rib sections, approximately 6.35-cm thick, were removed from the right side of each carcass at the 12<sup>th</sup> rib between 21-24 hours post-exsanguination, and transported on ice to the Iowa State University Meat Laboratory for further processing. One, 2.54-cm thick steak was removed from each section, vacuum packed and aged 14 d in a standard display cooler at 2° C for analysis of WBSF. Remaining sample was minced, mixed for homogeneity, divided into two approximately 10 g samples and packaged. One sample was stored at -20°C for d 2 analyses, with the second being vacuum packaged, aged for 14 d in a standard cooler at 2° C, and then frozen at -20° C for d 14 analyses. Steaks were analyzed for calpastatin activity (d 2), calpain 1 autolysis (d 2), and troponin-T degradation (d 2, 14).

*Statistical Analysis.* Data were analyzed using the MIXED procedure of SAS version 9.4 (SAS Inst. Inc., Cary NC) as a 2×2×2 factorial with steer as the experimental unit ( $n = 6$  per treatment combination). The model included the fixed effects of MU diet (MU-Rough and MU-Corn), ISU diet (ISU-Byp and ISU-Corn), FE classification (HFE or LFE), and the interactions.

### Results

Protein expression, WBSF, and calpastatin data are presented in **Table 3**. The two and three-way interactions between MU diet, ISU diet and FE were not significant for any variable ( $P \geq 0.12$ ). Calpastatin activity, measured 2-d post mortem was not different due to growing or finishing diet type ( $P \geq 0.18$ ). However, a tendency was observed due to FE classification, with steaks from HFE steers having greater ( $P = 0.10$ ) activity of calpastatin than steaks from LFE steers. There was no difference in calpain 1 autolysis or troponin-T degradation ( $P \geq 0.15$ ) due to diet type or FE classification, measured 2-d post mortem. However, d 14 troponin-T degradation indicates that steaks from steers finished on ISU-Corn diet had a greater ( $P = 0.005$ ) extent of degradation than steaks from ISU-Byp finished steers ( $P = 0.005$ ) despite no differences observed in d 2 troponin-T.

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No difference was observed in d 14 troponin-T due to MU diet ( $P = 0.12$ ) or FE classification ( $P = 0.13$ ). The WBSF of steaks measured after 14 d of aging was not different to ISU diet ( $P = 0.24$ ) or FE classification ( $P = 0.74$ ); interestingly though, MU diet had an effect on WBSF with steers grown on MU-Rough diet producing steaks that had a greater ( $P = 0.05$ ) WBSF than steaks from steers grown on MU-Corn.

Under the conditions of this study, minimal differences in meat tenderness were observed among steers identified as

phenotypic extremes for feed efficiency, suggesting that cattle producers can continue to select for improved feed efficiency with minimal concerns for ultimate meat tenderness.

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**Table 1.** Ingredient and nutrient composition of growing period diets fed to steers (76 d).

Ingredient, % DM	MU-Rough <sup>1,2</sup>	MU-Corn <sup>1,2</sup>	ISU-Corn <sup>3,4</sup>	ISU-Byp. <sup>3,4</sup>
Whole shell corn	-	64.26	-	-
Cracked Corn	-	-	75	30
Soybean hull pellets	36.84	-	-	20
Sudan baleage	36.25	-	-	-
Bromegrass hay	-	-	8	8
DDGS <sup>5</sup>	22.70	26.07	14.99	39.99
Soyplus <sup>6</sup>	1.75	4.96	-	-
Porcine blood meal	1.65	2.52	-	-
Limestone	0.35	1.09	1.54	1.54
Urea	-	0.19	-	-
Salt	0.18	0.22	0.31	0.31
Vitamin premix	0.18	0.23	0.11	0.11
Trace mineral premix <sup>7</sup>	0.07	-	0.035	0.035
MFP <sup>8</sup>	0.03	-	-	-
Pellet binder	-	0.19	-	-
Rumensin 90	0.01	0.01	0.013	0.013
Nutritional analysis <sup>9</sup>				
DM, % as-fed basis	66.8	85.1	84.5	84.1
NDF, % DM	57.5	26.4	24.4	42.7
ADF, % DM	31.5	6.5	8.0	18.7
CP, % DM	20.8	20.5	11.2	18.4

<sup>1</sup> Vitamin premix contains 2,200 IU vitamin A, 275 IU vitamin D, 100 IU vitamin E per kg of diet

<sup>2</sup> Provided Monensin at 150 mg·steer<sup>-1</sup>·d<sup>-1</sup>, Elanco Animal Health, Indianapolis, IN

<sup>3</sup> Vitamin A premix contained 4,400,000 IU/kg

<sup>4</sup> Provided Monensin at 200 mg·steer<sup>-1</sup>·d<sup>-1</sup>, Elanco Animal Health, Indianapolis, IN

<sup>5</sup> DDGS: Dried distillers grains plus solubles

<sup>6</sup> Soyplus (West Central Cooperative, Ralston, IA)

<sup>7</sup> Trace mineral premix offered 10 mg Cu, 50 mg Fe, 20 mg Mn, 30 mg Zn, 0.1 mg Co, 0.1 mg Se, 0.5 mg I per kg diet

<sup>8</sup> DL-methionine hydroxyanalogue calcium (84% methionine, Novus International, Saint Charles, MO)

<sup>9</sup> Determined from analysis of total mixed rations

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**Table 2.** Evaluation of growing and finishing phase diet types and feed efficiency classification on calpastatin activity, protein expression, and WBSF of steaks.

Item <sup>4</sup>	MU diet <sup>1</sup>		ISU diet <sup>2</sup>		FE <sup>3</sup>			P values <sup>1</sup>		
	Corn	Rough	Corn	Byp	High	Low	SEM	MU Diet	ISU Diet	FE
Calpastatin	11.1	11.9	11.6	11.4	12.0	11.0	0.432	0.18	0.81	0.10
Calpain 1 <sup>5</sup>	77.2	75.2	77.1	75.3	74.1	78.2	2.00	0.48	0.53	0.15
D 2 troponin-T <sup>6</sup>	39.9	32.5	39.7	32.7	30.0	42.4	6.79	0.44	0.47	0.20
D 14 troponin-T <sup>6</sup>	73.5	84.9	89.9	68.4	73.4	84.7	7.26	0.12	0.005	0.13
WBSF, kg	3.43	4.01	3.55	3.89	3.67	3.77	0.202	0.05	0.24	0.74

<sup>1</sup> MU Diet: MU-Corn vs. MU-Rough

<sup>2</sup> ISU Diet: ISU-Byp. vs. ISU-Corn

<sup>3</sup> FE Classification: Highly efficient vs Lowly efficient

<sup>4</sup> No three-way interaction  $P \geq 0.12$ ; two-way interaction  $P \geq 0.19$

<sup>5</sup> Calpain 1: reported as the percentage of completely autolyzed calpain 1 (76 kDa) measured on samples aged 2 d

<sup>6</sup> Troponin-T: ratio of abundance of 30 kDa band to the ratio of the reference sample from each respective day (d2, d14) ran on every gel