

Project Summary

A Novel Approach to Improving Tenderness of Underutilized Muscles from the Round from Pasture-Fed Beef Steers

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Background

Supplementing vitamin D₃ metabolites prior to harvest has the potential to improve beef tenderness because of an increase in calcium, which, in turn, activates the calpain system of proteolysis. One challenge with supplemental vitamin D₃ is that residues in muscle can be high enough to elicit hypervitaminosis D in consumers. Given this, it has been found that 25-hydroxyvitamin D₃ can be used without the residue issues of other vitamin D metabolites.

Interest in pasture-fed beef has grown because it has a greater concentration of conjugated linoleic acid (CLA); however, one of the challenges of pasture-finished beef is decreased tenderness compared to grain-finished beef. Moreover, the ethanol industry is growing rapidly making ethanol co-products readily available for inclusion in cattle diets. Supplementing finishing steers on pasture may prove to be a valuable use of land and distillers co-products; however, it is unknown how supplementation with co-products affects the fatty acid composition of pasture-finished beef. The objective of this project was to determine the effects of dietary treatments intended to enhance tenderness of beef from selected muscles from the round and loin section of feedlot and pasture-fed steers by increasing calcium in muscle at the time of harvest with oral administration of 25-hydroxyvitamin D₃.

Methodology

Forty-eight British-type beef steers were randomly assigned to one of two treatment diets: 0 (control) or 500 mg 25-OH D₃ (VIT D). Steers were fed a typical feedlot diet or grazed pasture with supplementation of a pellet of wheat middlings, distillers grains, and spy hulls for 105, 126, or 147 days. Seven days prior to harvest, steers received gelatin boluses of 500 mg 25-OH D₃ (VIT D steers) or a similar amount of cornstarch (control steers). Also at 7 days prior to harvest, blood samples were collected via jugular venipuncture.

Blood samples were collected at exsanguinations during harvest. Following a 48-hour chill, carcass data was collected along with strip loins (*longissimus* muscle) and inside rounds (*semimembranosus* and *gracilis* muscles). Muscles were dissected, cut into seven 2.54-cm thick steaks, vacuum-packaged, and aged for 3, 7, or 14 days. A sample was also collected for 3-day calpastatin activity determination with a spectrophotometer. Lipid percentage was calculated after extraction with methanol and chloroform and fatty acids were analyzed using gas chromatography. Instrumental color and Warner-Bratzler shear force were analyzed on steaks following their respective aging times. Also, plasma and muscle calcium determination were conducted using atomic absorption spectroscopy and plasma and muscle vitamin A, E and beta-carotene were analyzed by high performance liquid chromatography. Radioimmunoassay was used to evaluate plasma and muscle concentrations of 25-hydroxyvitamin D₃. Sensory analysis of steaks aged 14 days was conducted by a 4-member trained panel.

Findings

Feedlot steers weighed more than pasture-finished steers resulting in a significantly higher average daily gain for the feedlot-finished steers. Pasture-finished cattle had significantly less 12th rib fat than

did feedlot-finished cattle. In addition, pasture-finished steers had lower marbling scores and quality grades than feedlot-finished steers.

Steers receiving an oral bolus of 500 mg of 25-hydroxyvitamin D₃ had much greater plasma concentrations of 25-hydroxyvitamin D₃ at harvest. Steers receiving 25-OH D₃ treatment had decreased plasma magnesium samples on the day of harvest compared with that of controls. Furthermore, control steers had increased plasma magnesium concentrations on the day of harvest compared with 7 days prior to harvest. Pasture-fed steers also had greater concentrations of plasma magnesium on the day of harvest than 7 days prior to harvest and greater concentrations than feedlot steers on the day of harvest. In steers receiving 25-OH D₃, the lack of change in plasma magnesium would indicate that the increase in plasma calcium was derived from intestinal absorption and not from bone. Pasture-finished steers had greater concentrations of beta-carotene in the plasma than feedlot-finished steers. Neither dietary nor 25-hydroxyvitamin D₃ treatments affected plasma retinol (vitamin A) concentrations as the pasture-finished steers. However, pasture-finished steers had greater plasma alpha-tocopherol (vitamin E) concentrations than feedlot-finished steers.

Though treatment with 25-hydroxyvitamin D₃ was able to increase plasma calcium concentrations, muscle calcium was not increased by treatment; however, the *gracilis* muscle had the greatest calcium content among muscles evaluated. Muscle retinol concentrations were not affected by dietary treatment or by 25-OH D₃ treatment. Muscle alpha-tocopherol concentrations were greater in the *longissimus* of steers supplemented with VITD than non-supplemented control steers. In control steers, the *gracilis* muscle had a greater concentration of alpha-tocopherol than either the *longissimus* or *semimembranosus*. Muscle beta-carotene concentrations were greatest in the *gracilis* of pasture-finished steers supplemented with VITD.

Calpastatin activity on day 3 was not affected by dietary treatment or by 25-hydroxyvitamin D₃. However, differences were detected between muscles and the *gracilis* had the most calpastatin activity. Fatty acid analysis showed that CLA concentration was much greater in the *longissimus* and *semimembranosus* muscles of pasture-finished cattle than of feedlot-finished cattle. Concentrations of CLA in the *longissimus* and *gracilis* of pasture-finished cattle were greater than concentrations in the *longissimus* and *gracilis* of feedlot-finished cattle. This result shows that co-product supplementation of pasture-finished steers does not decrease CLA concentrations to concentrations found in feedlot-finished cattle.

Generally, feedlot-finished cattle had greater concentrations of mono-unsaturated fatty acids than pasture-fed cattle, with the exception of *trans*-9 and *trans*-11 isomers of C18:1. Total mono-unsaturated fatty acid content was greater in feedlot-finished steers. In contrast, pasture-finished cattle had greater concentrations of poly-unsaturated fatty acids than feedlot-finished cattle. The most notable difference among the muscles was that the *gracilis* muscle had significantly greater concentrations of linoleic acid. Warner-Bratzler shear force in this study was dependent upon aging period and muscle.

L*, an indicator of lightness, increased with increased aging time indicating steaks were lighter as time progressed. A* values, an indicator of redness, were greater in steaks from feedlot-finished steers than from pasture-finished steers. The a*/b* ration was also measured (increasing values indicate increasing redness). Steaks from feedlot-finished steers had greater a*/b* ratios than those from pasture-finished steers. Instrumental color analysis indicates that steaks from feedlot-finished

steers were redder than those from pasture-finished beef, which would likely translate to improved consumer acceptability.

The *gracilis* muscle had the least lipid of the muscles evaluated. Unexpectedly, steers supplemented with 500 mg of 25-OH D₃ had a lower overall lipid percentage compared to controls. For the *longissimus* muscle, off-flavor scores were greatest in pasture-finished steers receiving 500 mg of supplemental 25-OH D₃. Tenderness scores for the *gracilis* muscle were more desirable for pasture-finished receiving 500 mg 25-OH D₃ than steers receiving no 25-OH D₃, indicating that 25-OH D₃ supplementation improved tenderness of the *gracilis* and it appears to differentially affect the muscles examined in this study. Juiciness for the *gracilis* muscle showed a trend similar to that of tenderness. No sensory traits for the *semimembranosus* muscle were affected by 25-OH D₃ treatment or diet.

Implications

Feedlot-finished steers exhibited greater performance and carcass quality over pasture-fed steers and steaks were redder; however, steaks from pasture-fed steers had increased concentrations of CLA. Instrumental tenderness evaluation showed no improvement in tenderness because of supplementation with vitamin D. However, the tenderness of the *gracilis* muscle from the round was improved in pasture-finished steers supplemented with vitamin D when evaluated by a trained sensory panel. Furthermore, tenderness of beef from pasture-finished and feedlot-finished steers was not different. This study indicates that steers supplemented with distillers co-product on pasture had tenderness, juiciness and flavor attributes similar to those of feedlot-finished steers and higher CLA concentrations compared with feedlot steers.

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