

Effects of 25-Hydroxyvitamin D₃ on Sensory Traits and Color of Beef from Pasture- and Feedlot-Finished Beef Steers

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Summary and Implications

Pasture- and feedlot-finished beef steers (n = 48) were supplemented with 25-hydroxyvitamin D₃ (25-OH D₃) on d 7 prior to harvest. The longissimus (LM), semimembranosus (SM), and gracilis (GR) muscles were collected after harvest for evaluation of effects on sensory traits and fresh beef color. Sensory analysis indicated that supplementation of 25-OH D₃ improved tenderness of GR steaks in pasture finished steers, but not feedlot-finished steers. Tenderness of the SM and LM were not affected by 25-OH D₃ supplementation. This seems to indicate that muscles are differentially affected by 25-OH D₃. Furthermore, as aging time increased, L* values increased, indicating steaks were lighter with increased aging time. Also, results indicated that pasture-finished steers yield steaks that are less red than steaks from feedlot-finished steers. This may have implications for consumers as they generally prefer a bright, cherry-red colored product.

Introduction

A novel method to improve beef tenderness involves the use of 25-hydroxyvitamin D₃ (25-OH D₃). Pre-harvest supplementation with 25-OH D₃ increases calcium absorption from the intestine, increasing plasma calcium concentrations. Increased plasma calcium concentrations may then in turn increase activation of the calpain system of protein breakdown, which requires calcium for activation. Enhanced protein breakdown may lead to improved beef tenderness. Beef tenderness in previous studies has been primarily measured with Warner-Bratzler shear force, though tenderness may also be determined through sensory analysis. It is unclear what effects, if any, this supplementation has on fresh beef color. Therefore, the objective of this research was to evaluate sensory traits, including beef tenderness, and fresh beef color of steaks from pasture- and feedlot-finished beef steers supplemented with 25-OH D₃ prior to harvest.

Materials and Methods

British-breed beef steers (n = 48) averaging 814 lbs. were assigned to one of two diets on April 18th, 2006. A typical feedlot ration containing 10% wet distillers' grain was fed to the steers assigned to the feedlot diet (Table 1). Feedlot steers were housed at the Iowa State University (ISU) Beef Nutrition Farm in Ames, IA in outside lots and fed once daily. The steers assigned to pasture-finishing continuously grazed predominantly bromegrass pasture at the Western Research and Demonstration Farm (Castana, IA). Pasture-finished steers were supplemented once daily, initially with 10 lbs./head daily of a pellet containing dried distillers' grain (Table 2) and then, on July 13, 2006, supplement was increased to 15 lbs./head daily due to deteriorating pasture conditions. Pasture-finished steers also had access to a vitamin/mineral block that supplied Rumensin®. All steers were implanted with Component TE-S prior to beginning the study.

After 12 weeks on the respective feeding regimens, ultrasound image evaluation indicated that a number of steers were nearing 0.5 in. of 12th rib fat. At this time, steers were designated to 1 of 3 harvest dates (3 weeks apart) based on estimated 12th rib fat thickness. On d 7 prior to harvest, steers received a bolus of either 0 or 500 mg of 25-OH D₃. At 48 hours after harvest, strip loins and inside rounds were collected for analysis. Collection of these cuts allowed for analysis of the longissimus, semimembranosus, and gracilis muscles. These muscles were cut into 1-inch steaks and aged for 3, 7, or 14 d and then vacuumed-packaged. Sensory traits were evaluated on steaks aged 14 d by a highly trained panel for tenderness, chewiness, juiciness, beef flavor and off-flavor. Color was measured instrumentally with a Minolta colorimeter on steaks aged 3, 7, or 14 d after allowing 30 min for bloom. Color measures included L*, a*, and b*, in which L* is a measure of lightness, a* is a measure of redness, and b* is a measure of yellowness. Statistical analysis was conducted using PROC MIXED of SAS.

Results and Discussion

Sensory traits. In the longissimus muscle, off-flavor was increased in steaks from pasture-finished steers supplemented with 25-OH D₃ (Table 3). In the gracilis muscle, tenderness of steaks from pasture-finished steers supplemented with 25-OH D₃ was improved as compared to feedlot-finished steers and non-supplemented control steers (Table 4). That this effect was only seen in the gracilis muscle seems to indicate that 25-OH D₃ supplementation may differentially affect muscles. No sensory traits in the semimembranosus muscle were affected by diet or by supplementation with 25-OH D₃ (Table 5). The lack of

differences between pasture- and feedlot-finished steers may indicate that supplementation to the pasture-finished steers helped offset some of the previously reported effects of pasture-finishing including decreased tenderness and strong off-flavor. Nonetheless, further research is needed to conclude the effects of supplementation to pasture-finished on beef sensory traits.

Beef color. Evaluation of beef color a^* values (an indicator of redness) indicated that pasture-finished steers yield steaks that are less red ($P = 0.04$; 22.24) than feedlot-finished steers (22.67). This may have implications for consumer preferences as they typically look for a brighter, cherry-red color. Muscles also differed in a^* values as the GR had the greatest a^* values ($P < 0.0001$; 23.22), followed by the SM and LM (22.25 and 21.90, respectively), which did not differ from each other. Muscle differences may be related to fiber types in the muscles as the GR has a greater proportion of red fibers than the SM and LM. In addition, as aging time increased, steaks had increased L^* values, indicating the steaks got lighter with increased aging time. Yellowness (b^*) did not change over time for the semimembranosus or longissimus muscles, however, the gracilis had the lowest b^* values on d 7 of aging.

Conclusions. Steaks from pasture-finished steers were less red than those from feedlot-finished steers, which may have implications for consumer preferences as a brighter, cherry-red color is commonly preferred. Color of steaks from various muscles may also have different color properties because of differences in fiber composition of that particular muscle. Supplementation of 25-OH D_3 prior to harvest improved tenderness of the gracilis in pasture-finished cattle, but similar results were not seen in other muscles or in feedlot-finished steers.

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Table 1. Composition of feedlot-finishing diet.

Feed Ingredient	% of diet, DMB ^a
Dry rolled corn	72.965%
Wet distillers' grains	10.000%
Corn silage	9.955%
Ground hay – brome	2.500%
Urea	1.474%
Potassium chloride	0.966%
Limestone	0.966%
Salt	0.300%
Vitamin A	0.080%
Trace minerals	0.024%
Rumensin 80	0.020%
Molasses	0.750%
Total	100.000%

^aDMB = Dry Matter Basis

Table 2. Composition and calculated analysis of a by-product feed mix.

Composition	%
Dried distillers' grains with solubles	50.0
Soy hulls	25.0
Wheat middlings	20.9
Molasses	2.5
Calcium carbonate	1.6
Total	100.0
Calculated Analysis	
Dry matter, %	90.1
Crude protein, %	21.8
Calcium, %	0.94
Phosphorus, %	0.67
NE m	0.91
NE g	0.61
TDN, %	85.9

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Table 3. Sensory characteristics of longissimus steaks from pasture- and feedlot-finished steers supplemented with 0 or 500 mg of 25-hydroxyvitamin D₃ on d 7 prior to harvest.

Sensory Trait/Diet	Dose of 25-hydroxyvitamin D ₃ , mg		SEM	P-value ^a
	0	500		
Juiciness ^b				
Pasture	7.73	8.23	0.65	0.14
Feedlot	8.57	7.41		
Tenderness ^b				
Pasture	8.31	8.44	0.55	0.23
Feedlot	8.13	6.88		
Chewiness ^b				
Pasture	4.36	4.65	0.56	0.71
Feedlot	5.00	5.71		
Beef Flavor ^b				
Pasture	5.28	5.21	0.66	0.26
Feedlot	4.46	5.02		
Off Flavor ^b				
Pasture	0.76 ^d	1.60 ^c	0.38	0.0399
Feedlot	1.36 ^c	0.93 ^c		

^aP-value for the interaction.

^bScores determined using a 150-mm unstructured line scale where 0 = a very low degree of the trait given (dry, tough, not chewy, no beef flavor, no off flavor) and 15 = a very high degree of the trait given (juicy, tender, very chewy, intense beef flavor, intense off flavor).

^{cd} Means within a trait lacking a common superscript letter are different ($P < 0.05$).

Table 4. Sensory characteristics of steaks from the gracilis muscle from pasture- and feedlot-finished steers supplemented with 0 or 500 mg of 25-hydroxyvitamin D₃ on d 7 prior to harvest.

Sensory Trait/Diet	Dose of 25-OH D ₃ , mg		SEM	P-value ^a
	0	500		
Juiciness ^b				
Pasture	7.68 ^{d,z}	8.8 ^{c,y}	0.05	0.0149
Feedlot	8.36 ^{c,z}	7.75 ^{c,z}		
Tenderness ^b				
Pasture	6.26 ^{d,z}	8.49 ^{c,y}	0.60	0.0131
Feedlot	7.14 ^{c,z}	6.26 ^{c,z}		
Chewiness ^b				
Pasture	5.39	4.10	0.77	0.09
Feedlot	5.01	5.79		
Beef Flavor ^b				
Pasture	4.78	4.29	0.87	0.07
Feedlot	4.25	4.65		
Off Flavor ^b				
Pasture	0.66	1.51	0.41	0.45
Feedlot	0.88	1.23		

^aP-value for interaction.

^bScores determined using a 150-mm unstructured line scale where 0 = a very low degree of the trait given (dry, tough, not chewy, no beef flavor, no off flavor) and 15 = a very high degree of the trait given (juicy, tender, very chewy, intense beef flavor, intense off flavor).

^{cd} Means within a row lacking a common superscript letter are different ($P < 0.05$).

^{yz} Means within a column, within a muscle and trait, lacking a common superscript are different ($P < 0.05$).

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Table 5. Sensory characteristics of steaks from the semimembranosus muscle from pasture- and feedlot-finished steers supplemented with 0 or 500 mg of 25-hydroxyvitamin D₃ on d 7 prior to harvest.

Sensory Trait/Diet	Dose of 25-hydroxyvitamin D ₃ , mg		SEM	<i>P</i> -value ^a
	0	500		
Juiciness ^b				
Pasture	7.89	7.61	0.72	0.52
Feedlot	7.01	7.36		
Tenderness ^b				
Pasture	6.13	6.41	0.65	0.32
Feedlot	6.80	5.99		
Chewiness ^b				
Pasture	6.27	6.00	1.14	0.72
Feedlot	6.23	6.37		
Beef Flavor ^b				
Pasture	5.23	4.67	0.72	0.67
Feedlot	4.93	4.65		
Off Flavor ^b				
Pasture	1.12	0.89	0.38	0.45
Feedlot	0.72	0.84		

^a*P*-value for interaction.

^bScores determined using a 150-mm unstructured line scale where 0 = a very low degree of the trait given (dry, tough, not chewy, no beef flavor, no off flavor) and 15 = a very high degree of the trait given (juicy, tender, very chewy, intense beef flavor, intense off flavor).