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Altering Dietary Calcium Does Not Influence Tenderness in Cattle Fed Zilmax

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Introduction

Tenderness is a key contributor to the sensory attributes of beef, and production practices that decrease tenderness are generally viewed as unfavorable. Zilmax (Merck Animal Health, Summit, NJ) is a potent beta-adrenergic agonist that results in dramatic improvements in carcass weight when fed to cattle, normally for a period of 20 days prior to harvest. Zilmax increases muscle mass at the expense of body fat, and these changes can have favorable effects on retail yield and overall value of beef carcasses. One of the unfavorable side effects of Zilmax is a decrease in meat tenderness. Aging of beef is one means of improving tenderness. During the aging process, proteolytic enzymes degrade the myofibrillar proteins that contribute to the perceptions of tough meat. Activity of these enzymes is stimulated by the presence of calcium ions, and various strategies aimed at increasing intracellular concentrations of calcium have been investigated as a means of improving beef tenderness.

The purpose of this experiment was to determine if dietary calcium could be manipulated during the period of Zilmax supplementation as a means of improving meat tenderness. To do this, we eliminated supplemental calcium from the diet in hopes of inducing the secretion of parathyroid hormone. Parathyroid hormone stimulates the mobilization of calcium deposited in skeletal tissue, and we hypothesized that by decreasing dietary calcium we could potentially increase bone mobilization, and in so doing increase the supply of calcium available to proteolytic enzymes within skeletal muscle to enhance activity of these enzymes post-mortem.

Experimental Procedures

Heifers (n = 96) were stratified by initial body weight and randomly sorted into two treatment groups. Cattle were allotted to feeding pens equipped with concrete floors, fence-line feed bunks, and automatic water fountains with 8 animals per pen (6 pens per treatment). A common finishing diet was fed to all cattle until the final 24 days before harvest. Treatments consisted of: (1) a diet containing supplemental calcium (Calcium) in the form of limestone, and (2) a diet in which the limestone had been removed (No Calcium). Prior to Zilmax supplementation, all cattle were fed the control diet (Table 1). The experimental diets were fed for a period of 21 days in conjunction Zilmax. After 21 days, Zilmax was removed, and cattle were placed back onto a common diet containing limestone for 3 days before harvest.

On the day of harvest, cattle were weighed, loaded onto trucks, and transported 280 miles to a commercial abattoir, where incidence of liver abscesses and hot carcass weight were recorded. Forty-eight hours later, carcass data were collected, including marbling score; 12th-rib fat thickness; ribeye area; percentage kidney, pelvic, and heart fat; USDA yield grade, and USDA quality grade. A 2-inch section was removed from the loin of each carcass, weighed, placed into a plastic bag, vacuum-sealed, and allowed to age under refrigeration for 10 days. After aging, loin sections were removed from the

bags, patted dry with absorbent towels, and weighed to determine purge loss during wet aging. A single 1-inch steak was removed from the 12th-rib face, weighed, cooked to an internal temperature, and re-weighed to determine drip loss during cooking. Tenderness of steaks was evaluated by Warner-Bratzler shear force.

Results and Discussion

We speculated that the elimination of supplemental calcium from the diets of feedlot cattle during the period of Zilmax supplementation would stimulate mobilization of calcium from bone. By abruptly switching back to calcium-enriched diets during the post-Zilmax withdrawal period, we believed it might be feasible to achieve a temporary increase in skeletal muscle intracellular calcium concentrations. If calcium concentrations were to increase, it might be possible to stimulate post-mortem activity of calcium-dependant proteases to improve muscle tenderness. Removing calcium from the diet of feedlot heifers during the 21-day period of Zilmax supplementation had no effects on final body weight, average daily gain, or efficiency of feed utilization (Table 2; $P > 0.20$). Similarly, carcass yield and quality attributes (Table 3) did not change in response to altering calcium content of the diet ($P > 0.20$). Shear force values averaged just over 10 lb of force for both treatments, and thus fell within the "acceptable" range of tenderness (Table 4). Altering calcium content had no discernible impact on measures of tenderness in loin steaks.

Implications

Removal of calcium from the diet during the period of Zilmax supplementation had no effect on feedlot performance, carcass characteristics, or beef tenderness.

Table 1. Composition of diets on a 100% dry matter basis

Ingredients	Calcium	No Calcium
Dry-rolled corn	30.97	32.40
Wet corn gluten feed	35.00	35.00
Corn silage	10.00	10.00
Soybean hull pellets	20.00	20.00
Supplement[1,2,3]	4.03	2.6[a]
Analyzed composition, %		
Crude protein	14.8	14.9
Calcium	0.74	0.19
Phosphorus	0.51	0.51
Potassium	0.88	0.89
Neutral detergent fiber	30.4	30.5

[1] Formulated to provide 300 mg Rumensin and 90 mg Tylan (Elanco Animal Health; Greenfield, IN) and 0.4 mg melengestrol acetate (Pfizer Animal Health; Whitehouse Station, NJ) per animal daily, as well as 1,000 IU/lb vitamin A, 10 IU/lb vitamin E, 0.15 ppm cobalt, 10 ppm copper, 0.5 ppm iodine, 60 ppm manganese, 0.25 ppm selenium, and 60 ppm zinc in the total diet on a 100% dry matter basis.
[2] Zilmax (Merck Animal Health, Millsboro, DE) was included in experimental diets for 21 days prior to harvest to provide 8.33 ppm zilpaterol hydrochloride in the total diet dry matter.
[3] Limestone was removed from the supplement fed to the No Calcium treatment throughout the time Zilmax was added to the diet.

Table 2. Feedlot performance of heifers fed diets with or without added calcium during the 21-day period of Zilmax[1] supplementation

Item	Calcium	No Calcium	SEM	*P*-value
Initial body weight, lb	859	868	6.96	0.24
Final body weight, lb	1330	1340	9.69	0.35
Average daily gain, lb	4.06	4.07	0.08	0.91
Dry matter intake, lb	29.57	29.74	0.77	0.84
Gain:feed, lb/lb	0.138	0.137	0.003	0.87

[1] Merck Animal Health, Summit, NJ.

Table 3. Carcass characteristics of heifers fed diets with or without added calcium during the 21-day period of Zilmax[1] supplementation

Item	Calcium	No Calcium	SEM	*P*-value
Hot carcass weight, lb	820	825	8.30	0.57
Dressed yield, %	64.17	64.10	0.36	0.85
Liver abscesses, %	2.1	8.3	4.27	0.20
Ribeye area, sq. in.	14.6	14.9	0.25	0.27
12th-rib fat thickness, in.	0.55	0.59	0.06	0.55
Kidney, pelvic, and heart fat, %	3.14	3.13	0.10	0.89
Yield grade	2.57	2.42	0.12	0.23
Marbling score[2]	496	501	14.6	0.73
Prime, %	2.4	2.1	3.16	0.93
Choice, %	82.7	87.5	6.37	0.49
Select, %	10.7	6.3	5.77	0.47

[1] Merck Animal Health, Summit, NJ.
[2] Marbling scores were determined by a USDA grader: Slight = 300 to 399; Small = 400 to 499; Modest = 500 to 599.

Table 4. Purge loss, drip loss, and tenderness of steaks from heifers fed diets with or without added calcium during the 21-day period of Zilmax supplementation

Item	Calcium	No Calcium	SEM	*P*-value
Purge loss during wet aging, %	1.6	2.0	0.002	0.18
Drip loss during oven cooking, %	19.5	19.3	0.01	0.83
Warner-Bratzler shear force, lb	10.2	10.1	0.26	0.64