Project Summary

Using a Combination of 25-Hydroxyvitamin D_3 and Vitamin E to Improve Beef Tenderness
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Background

Past research has shown that increasing muscle calcium concentration in beef cattle prior to harvest can result in increased tenderness. Increasing calcium concentration in beef muscles has the potential to increase tenderness as it increases the activity of calpains, which are calcium dependent enzymes that break apart muscle fibers. In this project researchers examined supplementation of 25-hydroxyvitam D_3, a naturally occurring metabolite of vitamin D, as a means to increase calcium concentrations. In the first phase of the project, researchers investigated an optimum dose of 25-hydroxyvitamin D_3 necessary to increase calcium concentrations.

Improvements in beef tenderness from feeding vitamin D3 or 25-hydroxyvitamin D_3, has been inconsistent in past research. Recent data have suggested that the antioxidative characteristics of vitamin E fed at 1,000 international units per day for 125 days prior to harvest may protect the calpains from degradation. Vitamin E has been shown to extend the activity of the calcium dependent enzymes that break down muscle fibers. In order to enhance the effect of the increased calcium concentrations, in the second phase of this project, researchers also investigated supplementing vitamin E in combination with 25-hydroxyvitamin D_3.

Methodology

Phase I

Researchers randomly separated feedlot steers into four treatment groups that received 0, 125, 250 or 500 milligrams (mg) of 25-hydroxyvitamin D_3 (Rovimix ® Hy•D, DSM Vitamins, Ames, IA). Blood samples were drawn every other day for 14 days and feed intake was also measured for each steer. Plasma calcium and plasma 25-hydroxyvitamin D_3 concentrations were measured.

Phase II

Forty-eight heifers were divided and fed one of two dietary vitamin E treatments—0 international units or 1,000 international units of supplemental vitamin E. Baseline blood samples were collected at the initiation of the study. The supplemental vitamin E treatments were fed to the heifers for 104 days. Seven days before transport to the harvest facility, heifers were weighed, blood samples were collected and each heifer was administered the appropriate dosage of 25-hydroxyvitamin D_3 based on their assigned treatment group. In this project, heifers received one of four treatments: 1) control, 2) 500 milligrams of 25-hydroxyvitamin D_3, 3) vitamin E or 4) combination of 500 milligrams of 25-hydroxyvitamin D_3 and vitamin E. After harvest, carcasses were chilled for 48 hours and two steaks were collected. An additional four steaks were collected and left in a cooler to age for either seven or 14 days. After aging, the steaks were frozen until analysis.

Findings

Phase I

An oral bolus of 500 mg of 25-hydroxyvitamin D_3 increased blood calcium concentrations compared to the animals that received no supplement, or 125 and 250 mg of 25-hydroxyvitamin

D_3. The smaller doses did increase plasma calcium concentrations, but not significantly. Supplementing 25-hydroxyvitamin D_3 increased plasma concentrations in all treatment groups, but the plasma calcium of cattle that received the 500 mg dose of 25-hydroxyvitamin D_3 was increased to a greater extent. With this dosage, the concentration of plasma 25-hydroxyvitamin D_3 was increased to 594 nanograms of 25-hydroxyvitamin D_3 per milliliter of plasma, which is about 13 times the normal concentration.

Based on this study, the researchers concluded that the 500 mg dose of 25-hydroxyvitamin D_3 was the most effective dose to increase plasma and ultimately postmortem tissue calcium, and should be fed at seven days pre-harvest.

Phase II
Regardless of whether vitamin E was supplemented or not, oral supplementation with 25-hydroxyvitamin D_3 increased plasma calcium concentration. There were also increases in concentration of two vitamin D_3 metabolites that could be attributed to the supplementation with oral 25-hydroxyvtamin D_3.

In the *longissimus dorsi* muscle, researchers found an increase in 25-hydroxyvitamin D_3 concentration after supplementation with 500 mg. Although statistically significant, this concentration was only about three to four times the concentration in the control samples. From a human safety standpoint, the concentration of vitamin D was well below limits that would be of concern. The current recommended upper limit for vitamin D consumption in humans is five micrograms per day. 25-hydroxyvitamin D_3 has about 1.8 times the activity of vitamin D. Based on the concentrations found in this study, a person would have to consume more than two pounds of meat to reach the upper limits. This information becomes more important as researchers seek to gain approval of supplementing 25-hydroxyvitamin D_3 as a means of increasing beef tenderness.

At the time of this writing, more analyses, including evaluating the steaks for tenderness using Warner-Bratzler shear force, were still yet to be conducted.

Implications
This research helps demonstrate the potential for supplementing feedlot cattle with a combination of vitamin E and 25-hydroxyvitamin D_3, as a method for increasing beef tenderness. Data collected in this project also demonstrate that doing so would not have negative implications for human health, thus making Food and Drug Administration (FDA) approval of 25-hydroxyvitamin D_3, as a feed additive more likely to occur.

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