1999 Animal Science Research Report

# EFFECTS OF SUPPLEMENTAL VITAMIN D ON BLOOD PARAMETERS, CALPASTATIN ACTIVITY AND PH OF STEER CARCASSES

Pages 143-146

*Authors:*

**K. Karges, J.B. Morgan, F.N. Owens and D.R. Gill**

## Story in Brief

Effects of supplemental vitamin D on plasma blood parameters, pH (0, 3, 12, and 24 h postmortem) and calpastatin activity (0 and 24 h postmortem) of three different muscles (Strip Loin, Top Sirloin and Inside Round) were measured. Treatments included no vitamin D supplementation or 6 million IU daily for either 4 or 6 d pre-harvest. Utilizing a completely randomized design, 24 steers (1200 lb) were allocated to three treatments (eight pens) and fed a 90% concentrate ration twice daily with vitamin D added as a pellet that was fed as a percentage of the total ration. Plasma blood samples obtained at harvest during exsanguination were analyzed for total calcium, phosphorus, and magnesium concentrations. Plasma calcium concentration was increased by vitamin D supplementation and was increased more by feeding vitamin D for 6 d than for 4 d. Muscle pH was greater at 0, 3 and 12 h after harvest for steers fed vitamin D for 6 days than for steers fed vitamin D for 4 d. Calpastatin activity at 0 or 24 h was not affected by vitamin D supplementation. These data indicate that vitamin D can increase blood plasma calcium concentrations and longer intakes may increase pH of various beef muscles postmortem.

Key Words: Vitamin D, Carcass, Beef, pH, Calcium, Calpastatin

## Introduction

Consumers today consider tenderness to be the single most important component in meat quality. However, the beef industry is plagued by inconsistency, which has long been identified as one of the major problems that the industry needs to overcome (Morgan et al., 1991). It is estimated that the problem of lack of tenderness in beef costs the industry $250 million annually (Smith et al., 1995). Because consumers consider tenderness to be the major factor determining the quality of meat there, is an economic incentive for producing meat with improved tenderness. Research has demonstrated (Koohmaraie, 1992) that calcium levels postmortem play a critical role in the postmortem tenderization process involving the calcium dependent proteases m-calpain and μ -calpain. One means to improve tenderness of beef cuts is to provide supplemental vitamin D (VITD). Previously Swanek et al. (1997) showed that supplemental VITD would increase plasma blood calcium and decrease magnesium concentrations. With elevated calcium levels to activate the proteases, it is speculated that this could possibly be one of the metabolic mechanisms by which VITD improves tenderness. Therefore, our objective in this trial was to evaluate

the effects of VITD fed for different time intervals on blood parameters, muscle pH and calpastatin activity in beef carcasses.

## Materials and Methods

The feeding regime and allotment for these cattle utilized the same procedures as described by Karges et al. (1999a). All steers were harvested using an approved humane technique at the Food and Agricultural Products Research and Technology Center at Oklahoma State University over a period of 4 d. At the time of exsanguination, plasma blood samples were obtained to be analyzed for total blood calcium (Ca), phosphorus (P), and magnesium (Mg) concentrations using a Vitros 750 x RC. Measurements of pH were performed at 0, 3, 12 and 24 h postmortem by sampling 5 g of muscle tissue from the left side of the carcass at the Strip Loin (SL), Top Butt (TB) and Inside Round (IR) locations. These samples were homogenized with 50 ml of distilled $H_2O$ and pH was measured. Calpastatin activity was determined at 0 and 24 h postmortem on Strip Loin and Top Sirloin muscles according to the procedures of Shackelford et al. (1994).

***Statistical Analysis.*** Blood plasma measurements, pH values, and calpastatin activity were analyzed statistically using the General Linear Model procedure SAS (1985) for a completely randomized design. Treatment means were separated using orthogonal contrasts that compared control vs VITD fed animals and duration of feeding of VITD (4 vs 6 d).

## Results and Discussion

No differences were detected ($P<.05$) in calpastatin activity between tissue samples of carcasses from control vs VITD-supplemented cattle (Table 1). However, blood plasma (Table 2) Ca concentrations were significantly greater ($P<.03$) for animals supplemented with VITD and for those supplemented for 6 vs 4 d prior to harvest, which supports Karges et al. (1999b) findings. Concentrations of Mg were decreased numerically with the lowest concentration occurring with 6 MIU VITD for 6 d. This trended towards significance for a feeding effect ($P<.09$) but no duration of feeding VITD effect was detected ($P>.05$). Plasma P concentrations tended to increase slightly with VITD supplementation, which supports findings of Karges et al. (1999b) who observed a significant increase in P concentrations by d 2 of supplementation with VITD.

Carcasses from cattle that had not been supplemented with VITD displayed a typical drop in pH over a 24-h period (Table 3), reaching a final pH of 5.28. In contrast, carcasses from cattle that had been supplemented with VITD for 4 d had lower pH values at 3 and 12 h post-harvest. Steers that had been supplemented with VITD for 6 d had carcasses that were consistently higher in pH than those that had been supplemented for only 4

d, although ultimate pH (24 h) was lower.

### Implications

In this investigation, dietary supplementation of feedlot steers with VITD for 4 or 6 d at 6 MIU prior to harvest increased blood Ca and decreased Mg concentrations. Calpastatin activity was not affected by VITD supplementation. Contrary, muscle pH values were significantly increased with the longer duration of VITD supplementation, suggesting that both increased blood Ca and higher pH may be influencing the postmortem tenderization process.

### Literature Cited


Karges, K. et al. 1999a. Okla. Agr. Exp. Sta. Res. Rep. P-973:

Karges, K. et al. 1999b. Okla. Agr. Exp. Sta. Res. Rep. P-973:

Koohmaraie, M. 1992. J. Biochemie. 74:239.

Morgan, J.B. et al. 1991. J. Anim. Sci. 69:3274.

SAS. 1985. SAS User□s Guide: Statistics (Version 5 Ed.). SAS Inst. Inc., Cary, NC.

Shackelford, S.D. et al. 1994. J. Anim. Sci. 72:857.

Smith, G.C. et al. 1995. The final report of the National Beef Quality Audit. National Cattlemen's Beef Association, Englewood, CO.

Swanek, S.S. et al. 1997. Okla. Agr. Exp. Sta. Res. Rep. P-958:79.


**Table 1. Least squares means for calpastatin activity of muscle supplemented with vitamin D for 4 or 6 d with 6 MIU.**

| | Vitamin D, MIU/d | | | Contrasts[a] | |
|---|---|---|---|---|---|
| Item | 0 | 6 for 4 d | 6 for 6 d | C vs D | 4 vs 6 d |
| Strip Loin[b] | 2.91 | 2.18 | 2.74 | .26 | .38 |
| Strip Loin[c] | 2.21 | 2.35 | 1.45 | .48 | .19 |
| Top Sirloin[b] | 2.16 | 1.71 | 2.07 | .31 | .33 |
| Top Sirloin[c] | 1.68 | 1.40 | 1.86 | .87 | .35 |

[a]Contrasts: C vs D = control vs all with vitamin D; 4 vs 6 = duration of

feeding vitamin D for 4 vs 6 d.

[b]Calpastatin activity at 0-h.

[c]Calpastatin activity at 24-h.

**Table 2. Least squares means of blood plasma from steers supplemented with vitamin D for 4 or 6 d with 6 MIU.**

| | Vitamin D, MIU/d | | | | Contrasts[a] | |
|---|---|---|---|---|---|---|
| Item | 0 | 6 for 4 d | 6 for 6 d | SE[b] | C vs D | 4 vs 6 d |
| Ca, mg/dl | 9.91 | 11.33 | 12.16 | .24 | .0001 | .03 |
| P, mg/dl | 7.08 | 7.33 | 8.33 | .56 | .24 | .27 |
| Mg, mg/dl | 2.16 | 2.00 | 1.83 | .12 | .09 | .41 |

[a]Contrasts: C vs D = control vs all with vitamin D; 4 vs 6 = duration of feeding vitamin D for 4 vs 6 d.

[b]Standard error.

**Table 3. Least squares means for pH of carcasses supplemented with vitamin D for 4 or 6 d with 6 MIU.**

| | Vitamin D, MIU/d | | | | Contrasts[a] | |
|---|---|---|---|---|---|---|
| Item | 0 | 6 for 4 d | 6 for 6 d | SE[b] | C vs D | 4 vs 6 d |
| 0 h | 6.18 | 6.12 | 6.34 | .03 | .15 | .0001 |
| 3 h | 5.65 | 5.44 | 5.62 | .03 | .007 | .003 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 h | 5.38 | 5.29 | 5.40 | .01 | .12 | .0008 |
| 24 h | 5.28 | 5.33 | 5.28 | .01 | .25 | .06 |

[a]Contrasts: C vs D = control vs all with vitamin D; 4 vs 6 = duration of feeding vitamin D for 4 vs 6 d.

[b]Standard error.

1999 Research Report - Table of Contents