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EFFECTS OF SUPPLEMENTAL VITAMIN D LEVELS ON FEED INTAKE AND BLOOD MINERALS OF YEARLING STEERS

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Story in Brief

Although supplemental vitamin D can improve tenderness of beef cuts, it may depress feed intake. Two trials were conducted to determine how high dietary concentrations of vitamin D may affect feed intake of an 80% concentrate diet by yearling steers (817 lb). In Trial 1, vitamin D was top-dressed onto the daily ration at rates of 0, 5, 7.5, 15 and 75 million IU per steer daily. Four steers were allocated to each diet and individually fed their diets once daily. Significant depressions in dry matter intake were first observed on d 2 with 75 million IU, d 4 with 15 million IU, d 5 with 7.5 million IU, and d 6 with 5 million IU added vitamin D. The decrease in feed consumed was in response to a dose effect of vitamin D and was significant on d 3. Starting on d 2, the depression in feed intake was linearly related to concentration of vitamin D in the diet. In Trial 2, five steers were allocated to each of four dietary concentrations of vitamin D: 0, 227, 454, and 682 IU/g feed at a daily feed intake of 24 lb, these concentrations would provide 0, 2.5, 5 and 7.5 million IU per steer daily. In this trial, vitamin D was mixed with a corn-based supplement and pelleted with pellets being fed as a percentage of the total ration for 25 d. Significant depressions in dry matter intake were first detected on d 12 with both 5 and 7.5 million IU and at 20 d with 2.5 million IU added vitamin D. The depression in feed intake first became linearly related to dietary vitamin D concentration on d 12. In conclusion, to delay feed intake depression when high concentrations of vitamin D are fed, it should be fed as a percentage of the total ration and incorporated into a pellet.

Key Words: Feedlot, Vitamin D, Steer, Intake

Introduction

Tenderness was ranked by the National Beef Quality Audit in 1995 (NCA, 1996) as the second most important beef quality problem that the cattle industry should be addressing in order to prevent further decline in market share to other food protein sources. Smith et al. (1995) suggested that the problem of beef toughness costs the industry $250 million annually. Swanek et al. (1997) reported that feeding high amounts of vitamin D (VITD) for 5 to 10 d prior to harvest will increase tenderness of beef cuts. The mechanism of action is not clear though elevations in plasma calcium concentrations probably are involved. Our objective in these trials was to evaluate the effects of different levels of VITD on feed intake and blood

mineral concentrations of yearling cattle.

Materials and Methods

Trial 1. Twenty Angus x Hereford crossbred steers (817 lb) were stratified by weight and randomly assigned to one of five treatments: 0, 5, 7.5, 15 and 75 million IU (MIU) of VITD per steer daily. Steers were housed in individual 12 x 12 ft slatted floor, concrete pens equipped with automatic waterers at the Oklahoma State University Nutrition Physiology Barn. The diet was fed individually each morning after orts from the previous feedings were removed and weighed. Dry matter intakes were monitored on a daily basis with the amount of fresh feed added being based on intake of the previous day. Steers were given ad libitum access to an 80% concentrate diet (Table 1) with fresh feed added once per day. Vitamin D, in a powder form and containing 500,000 IU vitamin D_3 per gram, was top-dressed onto the ration and mixed into the diet each day. The amount of VITD fed was held constant throughout the trial for each treatment regardless of fluctuations in intake. Steers were adapted to the diet for 7 d prior to VITD addition. All steers received VITD for a 12-d period. Blood samples from the tail were taken three times each week throughout the trial starting 4 d prior to the beginning of supplementation with VITD. Plasma from the blood samples was obtained and analyzed for total calcium (Ca), phosphorus (P) and magnesium (Mg).

Trial 2. Twenty Angus x Hereford crossbred steers (980 lb) were stratified by weight and randomly assigned to one of four treatments 0, 2.5, 5 and 7.5 MIU of VITD per steer daily with five steers per treatment. Cattle were housed with one or two steers per pen in partially covered 12 x 52 ft pens equipped with automatic waterers and fence-line cement bunks with 38 in of linear bunk space per steer at the Oklahoma State University Nutrition Physiology Barn. The diet (Table 1) was fed twice per day with orts being removed and weighed each morning prior to adding fresh feed. Dry matter intake was monitored each day, with the amount of feed added being adjusted based on the previous day's intake. Steers were adapted to the diet for 8 d prior to VITD addition to the diet. In this trial VITD was included in a pelleted supplement consisting of a corn-based mix plus VITD that was included as a percentage of the total diet each day so that at a 24 lb base line daily feed intake, each steer would receive either 0, 2.5, 5 and 7.5 MIU daily. The amount of pellets carrying VITD was held at a constant each day, but the amount of feed with which the supplement was fed fluctuated with daily intake for the 25-d trial. Blood was taken from the tail of steers at the start and the end of the trial. Plasma from these blood samples was obtained and analyzed for total Ca, P and Mg.

Statistical Analysis. For both trials, the general linear model procedure of SAS (1985) was used to analyze dry matter intake (DMI) and blood parameters within each sampling day. Contrast statements were used to

determine if 1) the mean of all steers receiving VITD was different from steers receiving no supplemental vitamin D, and 2) if the response to VITD concentration in the diet (Trial 1) or vitamin D intake (Trial 2) was linear.

Results and Discussion

Trial 1. Supplemental VITD depressed DMI. Depressions in DMI first became significant (P<.05) after 2 d with 75 MIU, at 4 d with 15 MIU, at 5 d with 7.5 MIU, at 6 d with 5 MIU of added VITD (Figure 1). The DMI difference between cattle fed the control diet and the mean for all cattle receiving VITD supplementation became significant (P<.05) on d 3 and the response to VITD level was first detected as being linear (P<.05) on d 2. Although data are not shown, cattle that stopped receiving supplemental VITD were switched from VITD diets to the control diet on d 13 and continued to have low intakes that increased slowly, only reaching DMI equal to that of control cattle on d 25. Cattle that continued to receive VITD supplemented diets continued to have low DMI intakes for the entire trial. These data indicate that VITD will alter intake patterns and reduce feed intake when the total amount of VITD intake on previous days exceeds approximately 30 MIU. For cattle which have been fed VITD for an extended period, intakes will continue to be low even if supplementation is stopped.

Blood plasma concentrations for Ca (Figure 2) and P (Figure 3) became significantly increased by VITD and became linearly related to VITD levels on d 2 (P<.05). A significant decrease for Mg (Figure 4) due to a dose effect of VITD was first detected on d 2 and became linearly related to VITD dose level on d 4. Blood plasma parameters indicate that Ca and P levels were increased while Mg levels were decreased supporting the concept of Swanek et al. (1997) that supplementation with VITD alters the blood profile allowing more Ca to be available postmortem in the tenderization process.

Trial 2. Significant depressions in DMI (Figure 5) were first detected on d 12 with both 5 and 7.5 MIU and on d 20 with 2.5 MIU added VITD. As compared with results from Trial 1, steers in Trial 2 tolerated higher VITD intakes (50 to 60 MIU compared with approximately 30 MIU) before DMI was depressed. The mean DMI of cattle supplemented with vitamin D became different (P<.05) from the DMI of control cattle on d 12; linearity of the DMI response to VITD intake also became significant on d 12. These results could be interpreted to suggest that one can avoid, or at least postpone, the depression in feed intake noted with supplemental VITD by including VITD into the total diet rather than top-dressing the supplement and incorporating VITD into a pellet.

Blood analysis indicated that Ca levels on d 25 tended to be increased for cattle receiving VITD supplementation (Table 2), however, this difference

was not significant (P=.74) when tested by comparison with control cattle (P=.74) or tested for linearity of response to VITD dosage (P=.3). Plasma concentration of P was not increased in this trial in contrast to results from Trial 1 and results of Swanek et al. (1997) where plasma Mg concentrations were linearly increased (P<.01) with VITD supplementation. Note that these samples were taken 25 d after VITD supplementation began. As noted with dairy cows (Hibbs and Conrad 1983), Ca responses to high doses of VITD are transient and disappear as homeostatic systems readjust their Ca metabolism. If elevated blood Ca concentrations are desired, supplementing with VITD for longer than 8 d would not be desirable due to the probability of depressing DMI and compensatory blood Ca responses. One alternative explanation for these results would be that pelleting decreased the availability or potency of the VITD. However, VITD assays of the supplement fed indicated that VITD concentration of the pellet was within 96.5% of the concentration in the mixture before pelleting.

Implications

Cumulative intake of 25 to 50 MIU of VITD over a period of 15 d will depress dry matter intake by cattle. This intake depression was postponed by feeding VITD as a percentage of the total ration rather than top-dressing it onto the feed and incorporating the VITD into a pellet. Blood plasma concentrations of Ca increased by 2 d and reached a plateau, possibly associated with decreased VITD intake, after about 6 d. However, after prolonged feeding of VITD (26 d), the response in blood calcium was lost. Consequently, feeding low levels of VITD (under 2 MIU) for a long time period to avoid feed intake depressions would not be expected to improve beef tenderness.

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Table 1. Diet and calculated nutrient composition (% of DM).	
Ingredients	% of diet DM
Cracked corn	62.8
Cottonseed hulls	14.3
Alfalfa pellets	6.1
Soybean meal 44%	10.2
Cane molasses	4.25
Dicalcium phosphate	.55
Limestone	.56
Salt	.55
Urea	.11
Potassium chloride	.58
Pellet supplement	
Cracked corn	68.0
Soybean hulls	25.7
Cane molasses	3.0
Vitamin D	3.3
Diet composition, calculated	
NEm, Mcal/cwt	87.06
NEg Mcal/cwt	53.27
Crude protein	12.95
Calcium	.52
Phosphorus	.41
Potassium	1.24
Magnesium	.17
Pellet composition, calculated	
NEm, Mcal/cwt	89.15
NEg, Mcal/cwt	57.06
Crude protein	9.54
Calcium	.17
Phosphorus	.25
Potassium	.71
Magnesium	.10

Table 2. Least squares means for blood plasma samples from steers in Trial 2.				
Item	0	2.5 MIU	5.0 MIU	7.5 MIU
Ca, mg/dl	9.6	9.8	10.25	9.8

P, mg/dl	8.2	8.4	7.25	7.6
Mg[ab], mg/dl	2.0	2.0	2.50	2.6

[a]Linear response (P<.008).

[b]Dose effect (P<.04).

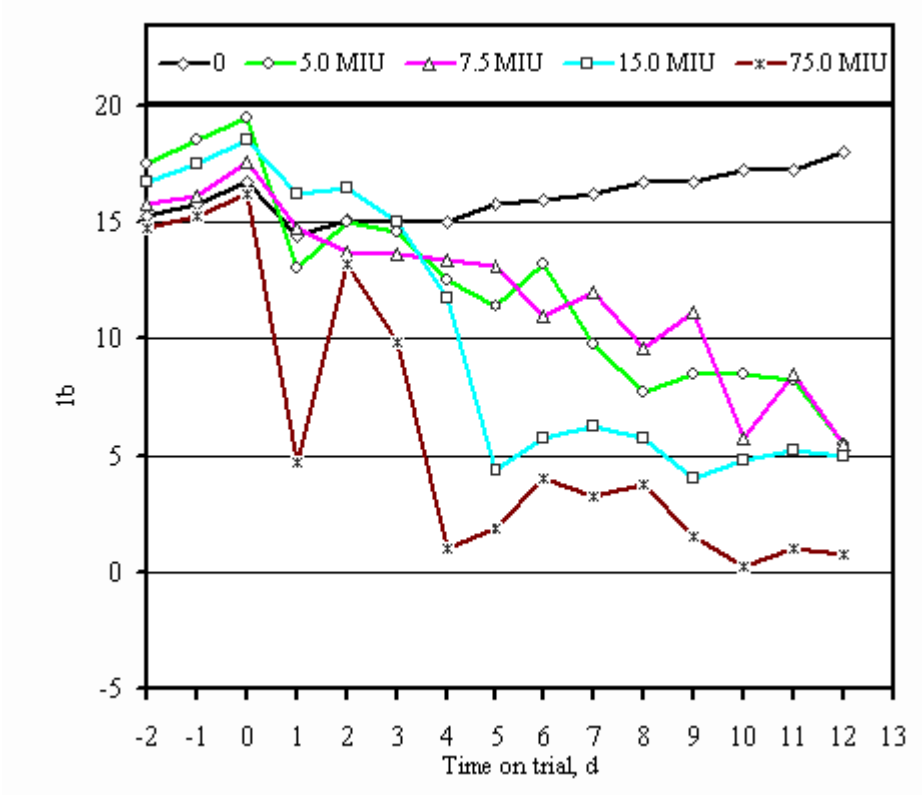

Figure 1. Least squares means for DMI of steers supplemented with different levels of vitamin D (Trial 1).

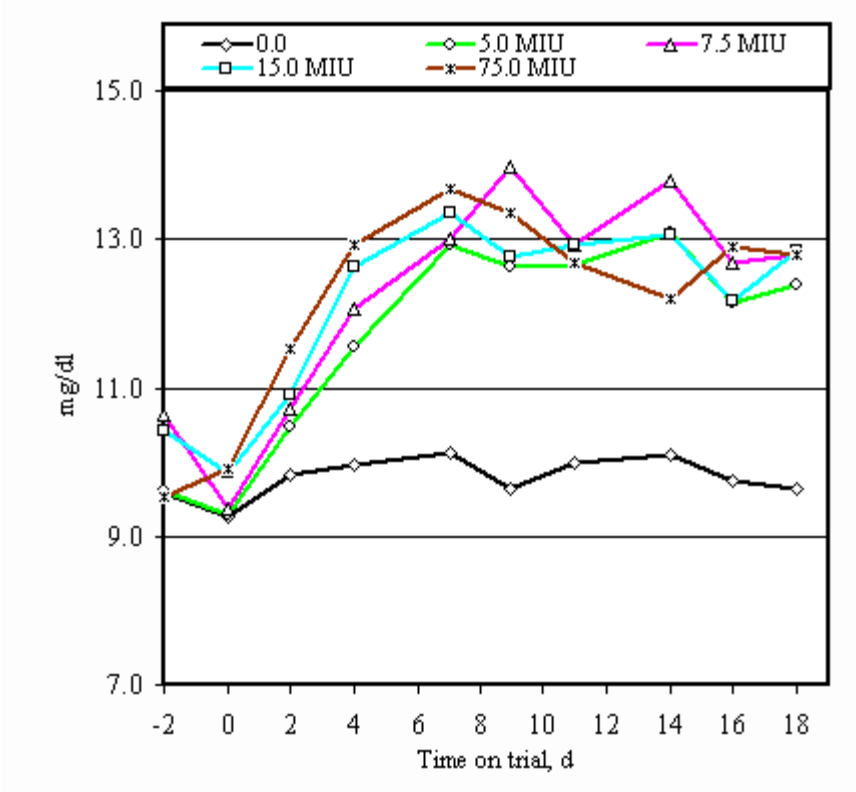

Figure 2. Least squares means of blood plasma calcium concentrations of steers supplemented with different levels of vitamin D.

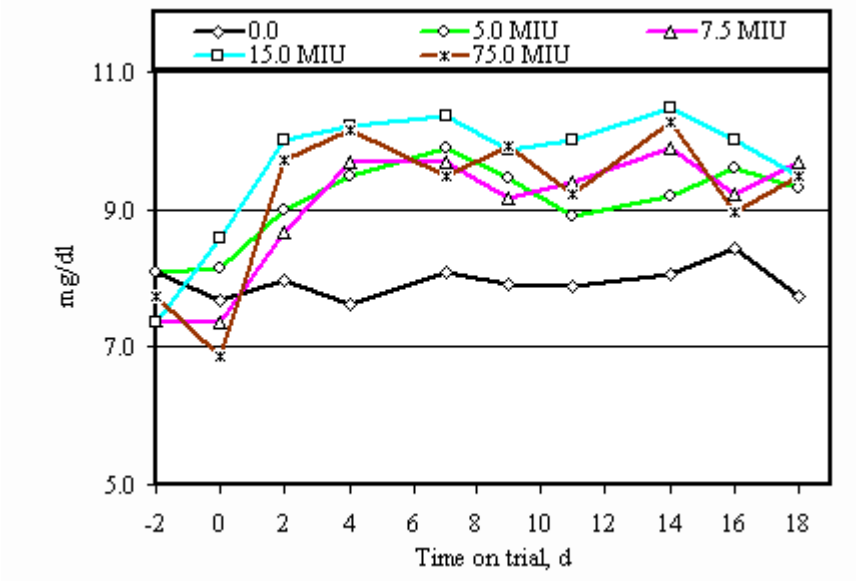

Figure 3. Least squares means of blood plasma phosphorus concentrations of steers supplemented with different levels of vitamin D.

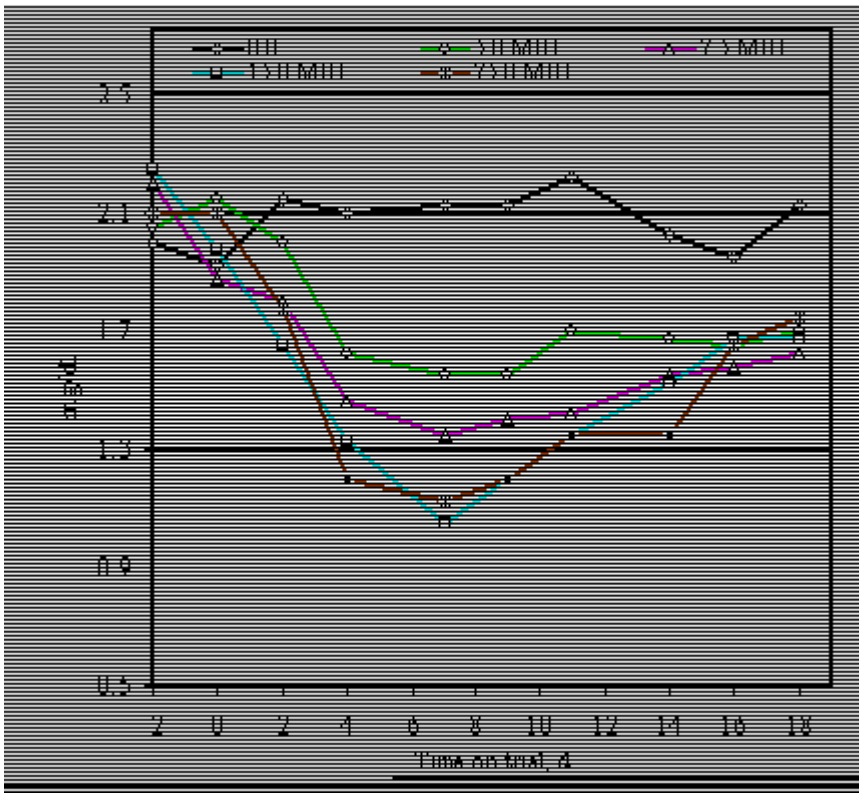

Figure 4. Least squares means of blood plasma magnesium concentrations of steers supplemented with different levels of vitamin D.

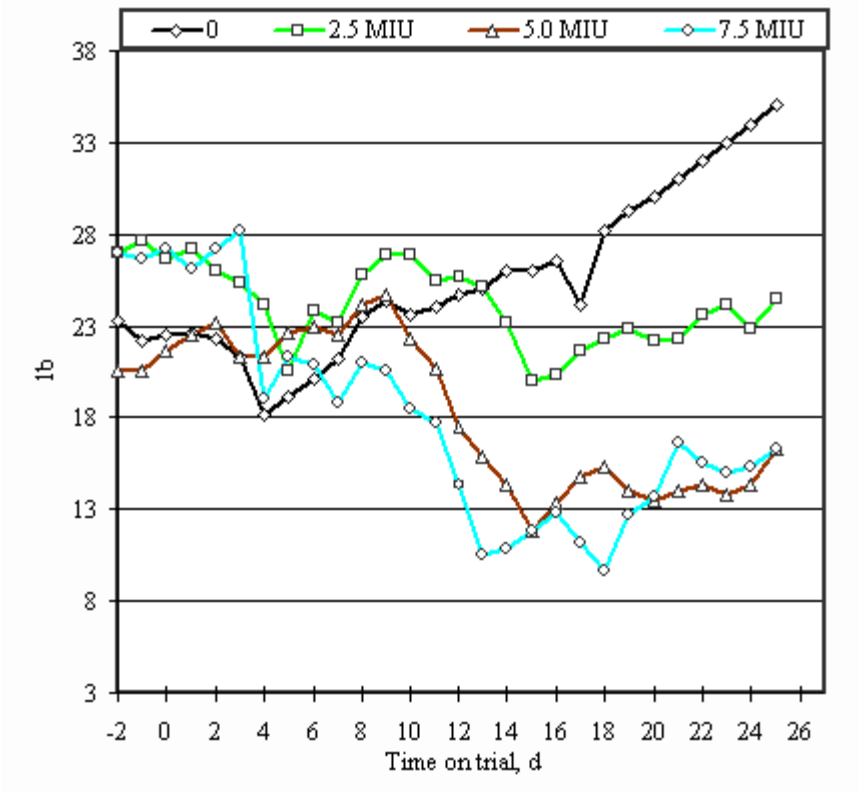

Figure 5. Least squares means for DMI of steers supplemented with different levels of vitamin D (Trial 2).

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