RESTRICTING VITAMIN A IN CATTLE DIETS IMPROVES BEEF CARCASS MARBLING AND USDA QUALITY AND YIELD GRADES

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Introduction

Marbling continues to be a major factor affecting profitability for beef producers, processors, retailers, and restaurateurs. However, feeding animals to 'fatten' is quite inefficient, requiring about 2.25 times more energy than is needed for producing lean muscle. For the cattle feeding industry to be sustainable in the future, increases in marbling must be accomplished without increasing days on feed, slaughter age carcass weight, and fatness and without sacrificing feed efficiency and carcass cutability.

A 2002 survey of feedlot nutritionists revealed that most recommended supplementation of vitamin A to feedlot cattle at levels exceeding the guidelines of the National Research Council (NRC) by three to five times. Because vitamin A fortification of cattle diets is an inexpensive method used to improve the immune response of receiving cattle, it is likely that few have considered the negative consequences of over-supplementing vitamin A on marbling and carcass quality grades of feedlot cattle. The objective of our research was to evaluate the effects of supplementing vitamin A at either zero (NA) or seven times (HA) the NRC-recommended level in feedlot diets and age at weaning on carcass marbling development and USDA quality grade of crossbred beef steers.

Experimental Procedures

Genetically uniform Angus crossbred steers (n = 48) were either early-weaned (EW) at 137 ± 26 days of age or traditionally-weaned (TW) at 199 ± 26 days of age. The experimental feeding period consisted of a growing and a finishing phase for EW calves and finishing only for TW calves. The HA diet provided 42,180 IU vitamin A per head per day and was initiated upon arrival at the Kansas State University Agricultural Research Center located at Hays, KS, following a 14-day preconditioning period in Manhattan, KS. The finishing diet consisted of sorghum silage, ground sorghum, and supplement (Table 1). The vitamin A treatments were fed until steers were harvested. Steers were weighed, and blood was sampled every 60 days throughout the finishing period to monitor growth performance and level of vitamin A in circulation. No animals exhibited symptoms of vitamin A deficiency during our study.

Table 1. Average Composition (Dry matter basis) of the Finishing Diet

Ingredient	Percent (DM basis)
Ground sorghum grain	48.2
Corn gluten feed	24.2
Tallgrass prairie hay (chopped)	14.8
Whole soybeans (raw)	9.6
Supplement[1]	3.2
Total	100.0

[1]Provided NRC (1996) recommended levels of salt, trace minerals, and vitamin A. Bovatec 91 (Alpharma, Fort Lee, NJ) was included at 1.2% (DM) of the diet.

Steers were harvested at Tyson Fresh Meats® at Emporia, KS, when average 12th-rib fat thickness, determined by periodic ultrasound, reached 0.40 inches. To minimize variation in body composition, steers were harvested in two groups, 35 days apart. Detailed carcass data were collected along with liver, muscle, and fat samples.

Results and Discussion

Concentrations of serum retinol on three sampling days are presented in Figure 1. Serum levels were initially similar ($P>0.10$). On the second sampling day, steers had consumed vitamin A treatments for either 105 (EW) or 45 (TW) days. On the last sampling day, steers had consumed treatment diets for either 210 (EW) or 150 (TW) days and serum retinol levels had diverged significantly ($P<0.05$). Weaning age did not affect serum retinol content on the last sampling day ($P>0.10$).

Weights at the beginning of the finishing period were similar for EW and TW steers (Table 2). The TW steers tended ($P = 0.11$) to have higher ADG than EW steers during the finishing period. This can most likely be attributed to compensatory gain early in the finishing period in TW steers.

There were no differences ($P>0.10$) in mean dressing percent ($62.5 \pm 1.28\%$) or hot carcass weight due to either dietary vitamin A level or weaning age.

Feeding NA increased ($P<0.05$) marbling scores compared with feeding HA, suggesting that feeding NA for at least 150 days increases marbling scores. This difference seemed to be enhanced with EW; the EW-NA steers produced carcasses that tended to have higher marbling scores (480) than the other treatments (430, 440, and 450), but this difference was not statistically different. This research confirms that high degrees of marbling can be attained in cattle 12 to 13 months of age without sacrificing cutability when steers of relatively high genetic potential for marbling are managed on a high plane of nutrition. The percentage of intramuscular fat (IMF), determined by gas chromatography, supported the marbling scores (Table 3). Steers fed NA had 17% more ($P<0.05$) IMF than HA steers. Carcasses from EW-NA steers tended to have 30% more IMF than TW-HA-steers, but the interaction was not statistically significant. The percentage of carcasses that qualified for "Premium Choice" brands (cattle with marbling scores of Modest^{00} or higher) was doubled in carcasses from steers fed NA, regardless of age at weaning. Based on current market premiums, the effect of reduced dietary vitamin A might have important economic benefits for producers.

Carcass yield grades ranged from 1.6 to 3.7 and were excellent relative to the carcass marbling scores. Although not statistically significant ($P>0.10$), the combination of smaller ribeyes in the fattest carcasses caused yield grades to be numerically higher (less desirable) in EW-HA carcasses (Table 3).

The ratio of marbling deposition per USDA Yield Grade is a very useful measure of overall efficiency of marbling deposition (Figure 2). Based on traditional logic, the EW-NA steers might have been expected to produce fatter, lower yielding carcasses associated with higher amounts of marbling. However, EW-NA steers were the most efficient producers of marbling per yield grade (Figure 2) and per day in the feedlot (data not shown). The EW-NA steers also produced the most ($P<0.05$) marbling relative to carcass weight, and EW-HA steers produced the least (data not presented). The TW steers were intermediate in marbling deposited per USDA Yield Grade, regardless of vitamin A level.

Implications

Feeding diets with no supplemental vitamin A to market cattle for at least 150 days is a safe and effective method of improving carcass marbling and USDA quality grades without increasing external fat. These benefits appear to be enhanced with EW and(or) restricting vitamin A for up to 210 days.

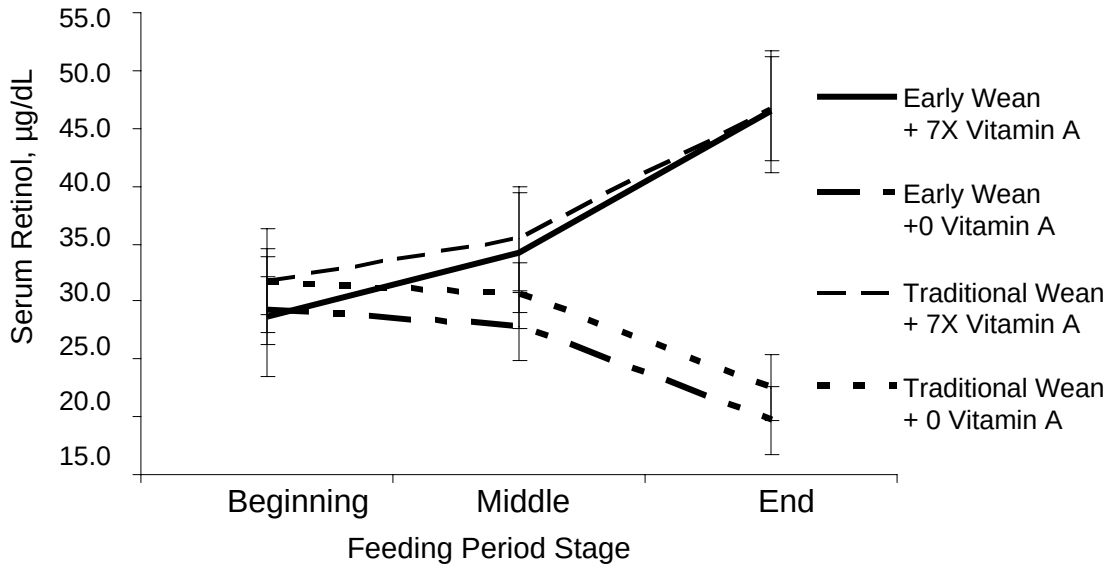

Figure 1. Serum Retinol (vitamin A) Concentration on Three Sampling Days Representing the Beginning, Middle, and End of the Feeding Period. Beginning = before vitamin A supplementation for early- and traditionally-weaned steers; middle = after 105 days for early-weaned and 45 days for traditionally-weaned steers; and end = after 210 days for early-weaned and 150 days for traditionally-weaned steers.

Table 2. Growth Performance of Steers Weaned at Either Early or Traditional Ages Fed Diets with Either Very High or No Supplemental Vitamin A

	High Vitamin A		No Vitamin A					
	Weaning age		Weaning age			P value		
Item	Early	Traditional	Early	Traditional	SEM	Vit. A	Wean	Vit. A × Wean
Grower								
Initial weight, lbs	425.0	NA	414.0	NA				
Final weight, lbs	566.5	NA	573.5	NA				
Weight gain, lbs/day	2.42	NA	2.62	NA				
Finishing								
Initial weight, lbs	566.5	521.4	573.5	506.4	70.2	0.96	0.43	0.87
Final weight, lbs	1078	1074	1061	1055	79.6	0.83	0.96	0.97
Weight gain, lbs/day	2.97	3.26	2.77	3.23	0.24	0.63	0.11	0.67

Table 3. Carcass Traits of Steers Weaned at Either Early or Traditional Ages Fed Diets with Either Very High or No Supplemental Vitamin A

	High vitamin A		No vitamin A					
	Weaning age		Weaning age			P value		
Item	Early	Traditional	Early	Traditional	SEM	Vit. A	Wean	Vit. A × Wean
Hot carcass weight, lbs	700	700	691	686	16.1	0.84	0.96	0.97
Ribeye area, sq. in.	11.3	12.1	11.9	11.7	0.8	0.88	0.69	0.50
12th rib fat, in.	0.46	0.43	0.36	0.33	0.08	0.33	0.74	0.98
KPH, %	2.3	2.2	2.2	2.2	0.2	0.79	0.79	0.62
USDA Yield Grade	3.2	2.8	2.7	2.7	0.4	0.40	0.57	0.64
Marbling score[1]	430	440	480	450	34.9	0.03	0.04	0.77
Intramuscular fat, %	4.8	4.8	6.2	5.3	0.8	0.01	0.03	0.73
Premium Choice and Prime, %	17	18	36	36	NA	NA	NA	NA

[1]Marbling score: 400 = Small^{00}, 410 = Small^{10}, 500=Modest^{00}, etc.

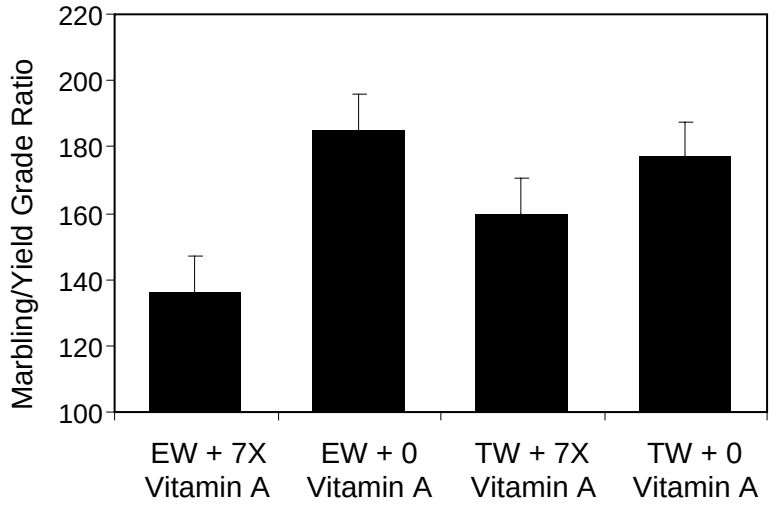

Figure 2. Ratio of Marbling produced per USDA Yield Grade in Steers Weaned at Either Early (EW) or Traditional (TW) Ages Fed Diets with Either Very High or No Supplemental Vitamin A.

0 = No vitamin A supplementation.
7x = 7 times the NRC recommended vitamin A level.
Bars indicate standard error.