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Effects of Method of Supplementing Vitamin A on Feedlot Performance and Blood and Liver Vitamin A Levels in Feedlot Cattle

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Rations consisting of corn grain and limited hay appear to be satisfactory for fattening beef cattle from about 700 lb. to slaughter weights without additional protein supplementation. The intake of carotene, a precursor of vitamin A, could be relatively low under these conditions, and, therefore, a vitamin A supplement would likely be needed. In a previous experiment, pronounced signs of vitamin A deficiency became evident after about 6 months in cattle fed corn grain with about 4 lb. of a low-carotene hay and no supplemental vitamin A.

Methods other than through a daily supplement may provide a more practical and economical means of administration. Feeding vitamin A in a high potency supplement at 2- to 3-week intervals, in a free-choice mineral supplement or administering the vitamin as a large one-time injection offer certain convenience and labor saving advantages to the cattle feeder.

The objective of this experiment was to study the effects of method of administering vitamin A on the performance of feedlot cattle. The vitamin A status in terms of blood plasma level and liver storage was determined along with weight gain and feed efficiency in a trial conducted at the James Valley Research and Extension Center near Redfield during the summer and fall of 1975.

Procedure

Sixty-five Hereford steers averaging 735 lb. were purchased through a livestock auction for the experiment. The steers were from one ranch in central South Dakota. Wintering rations indicated liberal intakes of vitamin A and carotene. During a 60-day preliminary period prior to the start of the trial, the cattle were fed whole oats or corn grain with about 2 lb. of low quality, legume-grass hay. This low-carotene ration was expected to result in some depletion of initial body stores of vitamin A and carotene. Following this preliminary period, the cattle were ear tagged, weighed and allotted to 5 pens of 13 steers each. The steers were implanted with 36 mg zeranol at the start of the trial.

Experimental treatments were as follows:

1. Control--no vitamin A, mineral free choice
2. Conventional--daily supplement with vitamin A and mineral
3. Intermittent--vitamin A supplement top-dressed on the ration every 2 weeks, mineral free choice

4. No supplement--vitamin A in mineral free choice

5. No supplement--vitamin A injected at start of trial, mineral free choice

Each pen of cattle was given a full feed of whole shelled corn and 2 lb. of chopped average-to-poor quality alfalfa-bromegrass hay per head daily. The composition of the mineral mixtures and supplements with vitamin A is shown in table 1. The mineral mixtures were composed of ground limestone and trace mineral salt. The conventional supplement and the supplement fed intermittently were made into 1/4 inch pellets. The daily supplement (treatment 2) was fed at the rate of 1 lb. per steer daily. In the case of the top-dressed supplement (treatment 3), the cattle received the 1 lb. rate but with a level of vitamin A equal to 14 days of the daily feeding level at one time at the beginning of each 2-week period. For the injected group, vitamin A was administered by intramuscular injection at the beginning of the feeding period in the amount of 3 million International Units (IU). Free-choice mineral was placed in boxes equipped with a partial cover with vitamin A in the mix for treatment 4.

Table 1. Composition of Mineral and Supplement Mixtures

	Free-choice mineral mixture[a]		Vitamin supplements	
	Without vitamin A	With vitamin A	Conventional	Intermittent
	%	%	%	%
Ground corn	---	---	86.65	97.90
Ground limestone	74.43	74.42	10.00	---
Trace mineral salt	25.57	24.47	3.20	---
Vitamin A premix[b]	---	1.11	0.15	2.10

[a]Formula based on expected mineral consumption of 60 grams/head/day.
[b]Premix contained 15,000 IU vitamin A palmitate/gram by analysis.

The cattle were weighed initially and after 18 hours without feed and water at the start of the 145-day trial. Final weights were taken at slaughter following a 4-hour transit period. Samples of the supplements and feeds were collected periodically during the trial and analyzed for carotene and vitamin A.

Samples of blood were taken initially (July 16) and at 93 days (October 17) from the jugular vein. Blood and liver samples were collected when the cattle were slaughtered on December 9 (145 days). Carotene and vitamin A analyses were performed on all samples.

Average carotene content of the whole corn and feed supplements was 0.66 mg/pound. The poor-quality hay contained 0.70 mg carotene per pound. Vitamin A analyses were performed on the primary premix, supplements and the mineral mix at the State Chemical Laboratory, Vermillion.

The vitamin A primary premix was manufactured in 1974 with a listed concentration of 30,000 IU per gram. Analysis of the product revealed a concentration of about 15,000 IU/g following storage under atmospheric conditions for slightly more than 1 year. The analyzed concentration was used in calculating vitamin A concentration in the free-choice mineral mix and the supplements. Samples of the primary premix, supplements and the mineral mix taken later during the experiment indicated essentially no further loss in vitamin A potency from the initial concentrations. Studies have indicated substantial losses in vitamin A activity in primary premixes and mixed feeds following several months of storage. This would emphasize the importance of relatively fresh sources of feeds or that level of supplementation may need to be increased to take care of possible losses in activity.

Results

Feedlot Performance

Results of feedlot performance are presented in table 2. One pen of 12 steers is of limited value in evaluating effects of the method of vitamin A supplementation on weight gain and feed data. Variation in weight gains of considerable magnitude may exist between pens of this number when treated in the same manner. Other research has shown that weight gains of cattle fed rations low in vitamin A and carotene are not affected to any appreciable extent until body stores are essentially depleted and feed intake decreases.

Steers fed the ration without supplemental vitamin A gained at the lowest rate. They also had lower feed intake and thus the highest feed requirements.

Considerably higher rates of gain and greater feed intake were obtained when the ration was supplemented with a daily level of about 10,200 IU of vitamin A in a feed supplement. Weight gains and feed consumption would indicate no problem from lack of vitamin A even though the level fed was only about one-half of the recommended level for growing and finishing steers within the weight range in this experiment.

Cattle supplemented with vitamin A one time each 2 weeks, but at the same average daily level as those supplemented daily, had a lower rate of gain in comparison to those supplemented daily. Feed intake was also lower resulting in higher feed requirements.

Steers offered vitamin A in the free-choice mineral supplement received only a small amount of the vitamin (average about 1,200 IU daily) because of the low mineral consumption. They gained at a lower rate than steers supplemented daily but more than steers supplemented at 2-week intervals. They also had a lower feed intake than steers supplemented daily.

Steers injected with 3 million IU of vitamin A at the beginning of the experiment had similar performance as those supplemented daily. This amount of injected vitamin A was about twice the total units over the 145 days as for the daily supplemented group.

Table 2. Feedlot Performance and Methods of Vitamin A Supplementation (July 17 to December 8, 1975--145 days)

	Method of vitamin A supplementation				
	Control (None)	Daily supplement	Supplement at 2-week intervals	Free-choice in minerals	Injection 3 million IU
No. steers	13	12[a]	12[a]	12[a]	13
Avg. initial wt., lb.	735	739	738	738	734
Avg. final wt., lb.	1047	1167	1099	1127	1151
Avg. daily gain, lb.	2.16	2.95	2.49	2.68	2.88
Avg. daily ration, lb.					
Whole corn	16.95	19.20	18.25	18.94	19.51
Chopped hay	1.99	1.99	1.99	1.99	1.99
Supplement	---	0.993	0.076	---	---
Minerals	0.036	0.006	0.028	0.016	0.002
Total	18.976	22.189	20.344	20.946	21.502
Feed/100 lb. gain, lb.					
Whole corn	786	651	733	707	679
Chopped hay	92	67	80	74	69
Supplement	---	34	3	---	---
Minerals	2	0	1	1	0
Total	880	752	817	782	748
Avg. daily carotene intake, mg	12.6	14.7	13.5	13.9	14.3

[a]Losses from experiment unrelated to dietary treatments.

Blood and Liver Vitamin A and Carotene

Blood and liver vitamin A and carotene values for each treatment group are shown in table 3. Initial carotene values in blood plasma ranged from 54 to 78 mcg/100 milliliters. At subsequent bleedings, the carotene content of the blood was higher for each treatment group than that observed at the initial sampling. The highest values for plasma carotene were observed at the last sampling after 145 days on the low-carotene rations.

The carotene content of the rations (table 2) resulted in an average daily intake of about 1.5 mg per 100 lb. of average body weight during the experiment. This level represents about 25% of the recommended level to meet needs for vitamin A of growing and finishing cattle. Carotene levels in the blood are affected by dietary intake and values considerably in excess of those observed in this experiment are encountered with high-carotene rations. Liver carotene values obtained at slaughter would indicate low body stores. Initial liver storage was not determined.

Initial plasma vitamin A ranged from about 28 to 39 mcg/100 milliliters. Values of this magnitude are considered to represent adequate vitamin A nutrition. After 93 days, plasma vitamin A had dropped markedly (from 33 to

20 mcg/100 ml) in the control group and remained at this level during the remainder of the experiment. While a value of 20 mcg/100 ml is not generally associated with visible signs of vitamin A deficiency, these cattle had somewhat lower rates of gain and feed intake than those which received supplemental vitamin A. Liver vitamin A at slaughter for the control group indicates body storage was severely depleted.

A marked increase in plasma vitamin A values at 93 days resulted from the daily supplementation of about 10,200 IU. Values had decreased from the 93-day level after 145 days. The final plasma value and liver storage at slaughter would indicate that this level of vitamin A supplementation plus the small amount of ration carotene were sufficient to maintain adequate blood levels and body stores of the vitamin under conditions of the experiment. However, such values do not represent major liver storage of the vitamin.

Supplementing vitamin A at 2-week intervals in amounts to equal the same average daily level as daily supplementation gave similar results as measured by plasma levels and liver stores. Thus, blood and liver data indicated no appreciable difference between the two methods even though weight gains were lower for the cattle supplemented at 2-week intervals.

The low intake of the free-choice mineral supplement resulted in a low level of vitamin A supplementation (about 1,200 IU daily). While the plasma vitamin A level at 93 days was fairly high, there was a marked reduction after 145 days. This reduction along with the lower liver value in comparison to those for other vitamin A supplemented groups indicated the cattle were not receiving adequate amounts of vitamin A to maintain proper levels in the blood and body stores. Variable voluntary intake of free-access minerals would appear to be a serious disadvantage to this method of vitamin A supplementation.

Injection of vitamin A appeared to be an effective way of providing vitamin A. There was no major difference between this method and the daily supplementation as measured by blood values. However, the injected level was about twice the total level supplemented daily over the 145-day experiment. The higher injected level did result in larger liver stores at the end of the experiment.

Table 3. Blood Plasma and Liver Concentrations of Carotene and Vitamin A

Item	Control (None)	Daily supplement	Supplement at 2-week intervals	Free-choice in minerals	Injection 3 million IU
Blood carotene, mcg/100 ml					
July 16, 1975--initial[a]	54.15	57.00	62.58	64.00	77.69
October 17, 1975-- 93 days	87.31	120.92	115.42	136.42	119.08
December 9, 1975-- 145 days	112.31	146.58	113.83	123.50	145.23
Blood vitamin A, mcg/100 ml					
July 16, 1975--initial	33.28	27.78	28.06	30.26	39.28
October 17, 1975-- 93 days[b]	20.38	47.89	44.98	46.02	59.08
December 9, 1975-- 145 days[b]	20.90	35.12	36.12	25.78	39.80
Liver carotene, mcg/g[c]	2.39	2.48	2.10	3.02	2.81
Liver vitamin A, mcg/g[b,c]	0.78	3.43	4.67	1.71	5.63

[a]Significant difference between treatments (P<.05).
[b]Significant difference between treatments (P<.01).
[c]Collected at slaughter.

Summary

Yearling steers were fed a low-carotene ration during a 60-day preliminary period and a 145-day finishing experiment to compare methods of vitamin A supplementation. The experimental ration consisted of whole corn grain and 2 lb. per head daily of a low-carotene hay. The ration furnished an average of about 1.5 mg of carotene per 100 lb. of body weight during the experiment. This level of carotene was not sufficient to support adequate vitamin A nutrition as indicated by lower weight gains, less feed consumption and the plasma and liver vitamin A values at the end of the experiment in the group receiving no vitamin A.

Supplementing the ration with a daily level of 10,200 IU of vitamin A or an equivalent total amount but at 2-week intervals gave similar results as measured by plasma and liver vitamin A values. This level of vitamin A plus the small amount of ration carotene appeared to result in adequate plasma and liver vitamin A values under conditions of the experiment but without major liver stores.

Voluntary intake of a free-choice mineral supplement was quite low and cattle supplemented in this way received a low level of the vitamin. Blood and liver values at the end of the experiment indicated the method was unsatisfactory in comparison to other methods of supplementation. Variable voluntary intake of free-choice minerals would appear to be a serious disadvantage for this method of vitamin A supplementation.

Injection of 3 million IU of vitamin A at the beginning of the experiment maintained similar blood levels of the vitamin as daily supplementation even though the injected level provided about twice as much of the vitamin over the experiment. The higher level of vitamin A by injection did result in larger liver storage.