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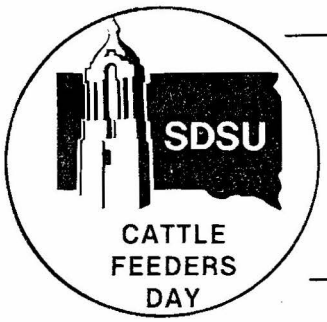

EFFECT OF VITAMIN A INJECTIONS ON BLOOD AND LIVER LEVELS IN CATTLE FED LOW-CAROTENE DIETS

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Summary

Three experiments were conducted with fattening steers to study the effect of 2.5 and 5.0 million International Units (IU) of vitamin A administered as injections on performance and blood and liver levels of vitamin A. Steers in the noninjected groups were not receiving adequate vitamin A nutrition as indicated by lowered blood plasma and/or liver stores of the vitamin. Injection of 2.5 million IU of vitamin A increased both blood plasma and liver levels of vitamin A. The addition of another 2.5 million IU to achieve a higher dosage level increased plasma vitamin A levels in two of three trials. However, this level of injection had only a small additional effect on liver storage of the vitamin. The higher dosage level did not result in a proportional increase in liver vitamin A reserves. Vitamin A injections of 2.5 million IU resulted in adequate vitamin A nutrition as indicated by blood plasma and liver storage values under conditions of these experiments.

Introduction

Previous carotene and vitamin A nutrition and the status of liver stores are not generally known when cattle are placed in the feedlot for fattening. A supplement is commonly provided to insure adequate vitamin A nutrition. Administering vitamin A as a single one time injection when cattle enter the feedlot is a convenient method of supplying the vitamin. Quantity needed may be the amount to provide the requirement for periods of 2 to 3 up to 6 or 8 or more months. Therefore, the effect of dosage level of injected vitamin A on efficiency of utilization to maintain optimum blood levels and adequate liver storage of the vitamin is of major concern where it is desired to provide the daily required amount by injection over periods of several months.

The objectives of these experiments were twofold, first, to study the effects of length of feeding period and dosage level of injected vitamin A on vitamin A status of steers fed a low carotene finishing ration without supplemental vitamin A, and, second, to study the effect of dosage level of injected vitamin A on liver storage of the vitamin following a period of feeding considered to have resulted in major depletion of prior body stores of the vitamin.

Procedures

Experiment 1 - Dosage Level and Length of Feeding

Trial 1 (57 days). Twenty-four yearling steers of Hereford and Hereford crossbreeding were used in the experiment. The cattle were previously used in a growth study to evaluate oat hay and oat haylage. The cattle received a full feed of oat forage without additional grain and were not of desirable market weight or quality at the end of the growth study. The steers averaged 1011 lb. and were allotted to three pens of eight steers each. Initial and final weights were recorded following an overnight stand without feed and water.

A 3-week adjustment period preceded the trial during which time the cattle were fed corn silage (1977 crop) and rolled corn grain and supplement. The silage was gradually reduced to 8 lb. per steer daily, wet basis, and corn increased to a full feed. Shortly after the trial began, mechanical trouble developed in the silo containing corn silage and the cattle were switched to oat haylage and fed 8 lb. per steer daily. Oat haylage supplies became exhausted and the cattle were fed baled oat hay at the same daily rate of dry matter as oat haylage. A protein supplement was fed at a rate of 1 lb. per steer daily. Composition of the supplement was ground shelled corn, 14.1%; soybean oil meal, 69.9%; ground limestone, 10.0%; and trace mineral salt, 6.0%. These rations would not be expected to result in major stores of vitamin A.

Three vitamin A treatments were administered at the initiation of the 57-day experiment. One pen of steers received no supplemental vitamin A. Another pen received 2.5 million IU of vitamin A. A third pen received 5.0 million IU of vitamin A. The vitamin A used was TEVCO A2X water immersible product which was administered intramuscularly as a single dose.

Samples of whole blood were collected initially and at the completion of the experiment. Plasma was obtained and subjected to chemical analyses to determine carotene and vitamin A concentrations. Samples of liver tissue were collected at slaughter and analyzed for carotene and vitamin A.

Trial 2 (112 days). Twenty-three steers of mixed Hereford and Hereford crossbreeding were used in this experiment. The steers averaged 898 lb. at the start of the 112-day feeding trial. The cattle used in this study were fed and managed the same as those used in trial 1 for the time prior to the adjustment period and during the experiment.

The procedures for weighing the cattle, administering the vitamin A treatments, sampling blood and collection of liver samples and analysis of blood and liver samples were essentially the same as outlined for trial 1. Since the experiment was longer (112 days) than the previous trial, a sample of blood was collected midway through the experiment to monitor blood levels of carotene and vitamin A.

Experiment 2 - Vitamin A Depleted Cattle

A total of 36 steers of Angus or Angus x Hereford breeding were used for this experiment. The steers averaged 770 lb. and were allotted to six pens of six steers each. Prior to the start of this experiment, the steers were fed a full feed of corn silage and 2 lb. per head daily of a protein supplement.

The diets fed to the cattle during the trial consisted of either whole or rolled oat grain with three pens of cattle per oat treatment. All cattle received a supplement consisting of 75% ground corn, 15% ground limestone and 10% trace mineral salt. The supplement was made into 3/16-inch pellets and was fed at a rate of 1 lb. per steer daily.

The steers were implanted with Synovex-S at the start of the trial. The steers were fed the oat diets for 120 days and then the vitamin A injection treatments were administered. One pen of steers fed each of the oat treatments received no vitamin A. Another pen received 2.5 million IU of vitamin A and a third pen received 5.0 million IU of vitamin A. The vitamin treatment was given by intramuscular injection as a single dose. The vitamin A used was TEVCO A2X water immersible product containing 1,000,000 IU of vitamin A per cubic centimeter.

Samples of whole blood were taken by jugular venipuncture on the day of injection and 8 days after injection. The cattle were slaughtered 10 days following the injection treatments and samples of liver tissue were collected and frozen for analysis. Blood plasma and liver samples were analyzed for concentrations of carotene and vitamin A.

Initial and final filled and shrunk weights were recorded with the oat treatment study. The shrunk weights were taken after an overnight stand without feed and water. Filled weights were taken periodically during the 120-day study to monitor changes in body weight with low-carotene feeding.

Results

Experiment 1 - Dosage Level and Length of Feeding

Trial 1. Feedlot performance data are presented in table 1. The number of steers used in this trial was small with a relatively short feeding period of 57 days. The cattle weighed over 1000 lb. when the vitamin A treatments were administered. The data provide an indication of rate of gain and the amount of feed the cattle were consuming. The steers injected with 2.5 and 5.0 million IU of vitamin A consumed more feed and gained at a more rapid rate than steers receiving no vitamin A. However, feed required per unit of gain was about the same for the steers receiving no vitamin A as for the steers injected with the vitamin. There was no visual evidence of vitamin A deficiency in the trial.

Blood plasma and liver concentrations of carotene and vitamin A are shown in table 2. Carotene levels in plasma are influenced largely by intake of dietary carotene. The carotene values indicate that the oat haylage and corn grain in the diet were providing some carotene, but that the amount was well below that observed with carotene-rich diets.

Table 1. Feedlot Performance of Steers--Trial 1
(August 25-October 20, 1978--57 days)

	Vitamin A injection treatments		
	No vitamin A	2.5 million IU	5.0 million IU
Number of steers	8	8	8
Avg. initial wt., lb.	1019	1010	1004
Avg. final wt., lb.	1200	1215	1197
Avg. daily gain, lb.	3.18	3.61	3.40
Avg. daily feed, lb. (as fed)			
Corn silage	1.73	2.08	2.38
Oat haylage[a]	3.40	3.60	3.25
Oat hay[a]	3.26	4.06	4.04
Rolled shelled corn	20.14	25.14	22.95
Supplement	0.96	0.98	0.98
Free-choice mineral[b]	--	--	--
Total	29.57	35.86	33.60
Feed/cwt. gain, lb. (as fed)			
Corn silage	54	58	70
Oat haylage	107	100	95
Oat hay	102	112	119
Rolled shelled corn	633	696	674
Supplement	30	27	29
Free-choice mineral	--	--	--
Total	926	993	987

[a] Oat hay or haylage substituted for corn silage when mechanical problems developed in the silo containing corn silage.
[b] Consumption not determined.

Table 2. Concentrations of Carotene and Vitamin A in Blood Plasma and Liver Tissue of Steers--Trial 1
(August 25-October 20, 1978--57 days)

	Vitamin A injection treatments		
	No vitamin A	2.5 million IU	5.0 million IU
Number of steers	8	8	8
Blood plasma carotene, mcg/100 ml			
Initial (8-25-78)	87.01	82.82	117.43
Final (10-20-78)	89.32	82.67	106.37
Blood plasma vitamin A, mcg/100 ml			
Initial (8-25-78)	33.80	25.80	36.89
Final (10-20-78)	26.57	37.09	44.59
Liver tissue carotene, mcg/g			
Final (10-22-78)	2.04	1.96	1.92
Liver tissue vitamin A, mcg/g			
Final (10-22-78)	4.26	11.08	15.97

Final plasma vitamin A levels for steers receiving no vitamin A were lower than the initial values, indicating that the animals were being depleted of the vitamin. Steers that received the 2.5 and 5.0 million IU of vitamin A injections had higher plasma vitamin A levels and greater vitamin A storage in the liver than steers not receiving vitamin A. Both blood and liver values for injected groups are indicative of adequate vitamin A nutrition during the time of the experiment. Higher values resulted from the larger dosage of vitamin A.

Trial 2. The performance of steers used in the 112-day fattening trial are presented in table 3. There were no important differences in rate of gain, feed consumption or feed efficiency with respect to the treatments used over a longer feeding period. Also, there were no visible signs of vitamin A deficiency in the noninjected group.

Blood plasma and liver concentrations of carotene and vitamin A are shown in table 4. Levels of carotene in blood plasma show some variation with no important differences between vitamin A treatments. Final carotene values were higher than at the initial and intermediate sampling times, indicating higher intakes of carotene during the latter part of the experiment. There were no major differences in plasma vitamin A levels with the injection treatments at any of the sampling times.

Liver vitamin A values for the noninjected steers indicate that the livers were essentially depleted. However, blood plasma vitamin A levels would be considered adequate with no signs of vitamin A deficiency. Plasma vitamin A values were lower than for the injected groups. The 2.5 million IU vitamin A treatment resulted in some increase in liver stores and higher plasma vitamin A values. Higher stores of liver vitamin A were observed with the 5.0 million IU injections, but plasma levels of vitamin A were essentially the same. Liver vitamin A reserves were low with all treatments. The 2.5 million IU injection was adequate as indicated by plasma vitamin A levels and the absence of deficiency symptoms.

Experiment 2 - Vitamin A Depleted Cattle

The feedlot performance of steers fed a low-carotene diet of oats grain is presented in table 5. The oat diets without additional vitamin A supplementation would be expected to result in low levels of carotene intake and a lowering of vitamin A body stores during the trial.

Rate of growth and fattening as indicated by gains recorded periodically over the 120-day feeding period show no evidence of vitamin A deficiency. Lowered gains were observed the first 29 days due to the cattle going off feed with development of acute acidosis. The overall average daily gains were somewhat lower with the oat diets than has been observed in experiments where corn grain was the major component of the diet.

Table 3. Feedlot Performance of Steers--Trial 2
(August 15-December 15, 1978--112 days)

	Vitamin A injection treatments		
	No vitamin A	2.5 million IU	5.0 million IU
Number of steers	7	8	7[a]
Avg. initial wt., lb.	898	894	909
Avg. final wt., lb.	1269	1264	1234
Avg. daily gain, lb.	3.31	3.31	2.90
Avg. daily feed, lb. (as fed)			
Corn silage	1.21	0.95	1.21
Oat haylage[b]	7.23	7.30	6.40
Oat hay[b]	1.52	1.52	1.43
Rolled corn	24.96	23.40	24.68
Supplement	1.00	0.98	0.97
Total	35.76	34.15	34.69
Feed/cwt. gain, lb.			
Corn silage	37	29	42
Oat haylage	219	221	221
Oat hay	46	46	49
Rolled corn	754	708	851
Supplement	30	30	34
Total	1086	1034	1197

[a] One steer died of unknown causes.
[b] Oat hay or haylage substituted for corn silage when mechanical problems developed in the silo containing corn silage.

Table 4. Concentrations of Carotene and Vitamin A in Blood Plasma and Liver Tissue of Steers--Trial 2
(August 25-December 15, 1978--112 days)

	Vitamin A injection treatments		
	No vitamin A	2.5 million IU	5.0 million IU
Number of steers	7	8	8[a]
Blood plasma carotene, mcg/100 ml			
Initial (8-25-78)	87.10	110.48	92.69
Intermediate (10-20-78)	94.42	86.12	88.64
Final (12-15-78)	163.96	158.04	132.01
Blood plasma vitamin A, mcg/100 ml			
Initial (8-25-78)	32.22	37.14	37.43
Intermediate (10-20-78)	24.98	37.50	38.99
Final (12-15-78)	26.21	30.03	29.38
Liver tissue carotene, mcg/g			
Final (12-15-78)	2.80	2.75	2.64
Liver tissue vitamin A, mcg/g			
Final (12-18-78)	0.86	1.65	3.18

[a] One steer died October 30, 1978. Analytical values after this date are for 7 steers. Liver values are for 7 steers.

Table 5. Steer Weights and Gains During Feeding Period--Experiment 2 (September 28, 1978-January 25, 1979--120 days)

	Vitamin A injection treatments[a]		
	No vitamin A	2.5 million IU	5.0 million IU
Number of steers	11[b]	12	12
Avg. initial wt., lb. (shrunk)	770	770	770
Avg. final wt., lb. (shrunk)	1041	1037	1038
Avg. total gain, lb.[c]			
0-29 days	12	36	54
29-56 days	96	87	76
56-85 days	80	89	81
85-120 days	74	52	59
0-120 days	262	265	270
Avg. daily gain, lb.[d]	2.26	2.23	2.24

[a] Vitamin A injection treatments administered at completion of 120-day feeding trial.

[b] One steer died of acidosis early in the feeding period.

[c] Filled weight basis.

[d] Adjusted daily gains are based on carcass weight and a dressing percentage of 62%.

Concentrations of carotene and vitamin A in blood plasma and liver tissue are presented in table 6. Initial plasma carotene and vitamin A levels indicate a high vitamin A status for all groups of cattle at the start of the trial. Therefore, the cattle were not depleted to the low levels observed in the previous trials. Final plasma vitamin A for the noninjected steers indicates a borderline level as to deficiency of the vitamin. The 2.5 million IU vitamin A injection increased both plasma and liver concentrations of vitamin A. An additional 2.5 million IU elevated plasma vitamin A levels but increased storage of the vitamin in liver only slightly over the 2.5 million IU level.

The technique employed in this study to measure dose response of vitamin A has been used to measure efficiency of absorption of vitamin A. The small difference in liver storage between the two levels injected in this experiment with cattle might be due to inadequate time allowed between injection and slaughter or storage of the vitamin in other tissues. However, the liver is the major site of storage. The data are not adequate to determine the efficiency of vitamin A storage as related to dosage administered. A true measure would be to follow liver storage and evidence of deficiency signs over extended periods following injection.

Table 6. Concentrations of Carotene and Vitamin A in Blood Plasma and Liver Tissue of Steers Fed Oats Grain--Experiment 2 (September 28, 1978-January 25, 1979--120 days)

	Vitamin A injection treatments[a]		
	No vitamin A	2.5 million IU	5.0 million IU
Number of observations	11[b]	12	12
Blood plasma carotene, mcg/100 ml			
Initial (10-6-78)	261.3	272.0	284.2
Preinjection (1-26-79)	40.82	23.50	26.36
Final (2-2-79)	26.94	17.97	21.63
Blood plasma vitamin A, mcg/100 ml			
Initial (10-6-78)	44.96	41.79	42.56
Preinjection (1-26-79)	23.81	20.44	18.20
Final (2-2-79)**	16.45	31.97	42.71
Liver carotene, mcg/g			
Final	0.85	0.91	0.86
Liver vitamin A, mcg/g			
Final*	5.78	14.23	16.63

[a] Administered intramuscularly as a single dose to steers following oats grain feeding for 120 days.
[b] One steer died of acidosis early in the feeding period.
* Differences between treatments significant at P<.05.
** Differences between treatments significant at P<.01.