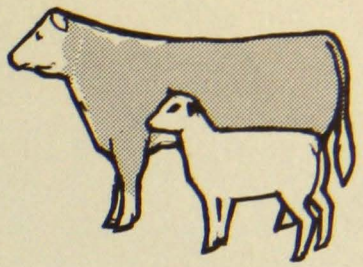
Extension Bulletin 334
Revised 1976

# VITAMIN A AND CAROTENE FOR CATTLE AND SHEEP



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The increased number of reported vitamin A deficiencies in the last decade has stimulated much interest in the vitamin A requirements of cattle and sheep. The recent reevaluation of vitamin A requirements was necessary because of changes in feeding practices and, to some extent, faster growing animals. The use of high concentrate rations usually reduces carotene intake, since grains contain little carotene and total feed consumption is reduced.

The net effect of a reduced carotene intake is a need for preformed vitamin A in the ration, even though the total amount required by the animal has not changed. Other reasons for occasionally observing vitamin A-deficient animals in feedlots is that today's animals are gaining faster than in the past, and the stress imposed by confinement feeding may actually increase vitamin A requirements.

## Relationship of Carotene and Vitamin A

The carotenes are a group of yellow compounds produced only by plants. Beta carotene is the predominant carotene in forages, whereas cryptoxanthin is the one found in corn grain. Animals convert these compounds to vitamin A.

Animals do not require carotene as such, but they do need the vitamin A they derive from it. Plants do not contain vitamin A, although the vitamin A value or potency of plant materials is often reported and is based on known conversions of carotene to vitamin A. According to the National Research Council, a rat converts 1 milligram (mg.) of carotene to 1,667 international units (I.U.) of vitamin A, whereas 1 mg. of carotene equals 500 I.U. of vitamin A for pigs and 400 I.U. of vitamin A for ruminants.

Since the color of the carotenes is masked by the green pigment (chlorophyll) found in plants, it is difficult to estimate carotene contents visually. However, since the green color of plants and harvested forages is lost at a rate similar to the rate of carotene loss, the degree of green is often used as an indicator of carotene content (dark green indicates high carotene). Carotene is unstable; factors such as heat and sunlight contribute to its destruction. During hay making, field losses of carotene due to rain and bleaching by the sun are often extensive. A loss of carotene also occurs during the ensiling process, but silages generally contain more carotene than does dried forage.

## Functions of Vitamin A

Vitamin A is required for the proper maintenance and function of the epithelial tissues of the body. These tissues cover the exterior surface of the body and form a covering for nearly all free surfaces within. The alimentary canal, respiratory tract, urogenital tract, heart, lungs, and abdominal organs are all covered with epithelial tissue. Many of the symptoms of vitamin A deficiency result from a malfunction in areas covered with epithelial tissue.

Vitamin A is required for the formation of rhodopsin (visual purple), a compound in the retina of the eye that enables animals to see in dim light. It is also required for bone growth and for normal weight gains. Also, tear, salivary, and mucus-secreting glands may not function properly during vitamin A deficiency.

## Vitamin A Deficiency

Animals protect themselves, to some extent, against a deficiency of vitamin A by storing large quantities in the liver during periods of high intake. Small amounts are also stored in body fat. This storage is often sufficient to last through the winter, when carotene intakes are low. Under some circumstances, however, liver stores of vitamin A become depleted and deficiency symptoms appear.

Early signs of vitamin A deficiency include reduction of feed intake, watering eyes, and swelling of the joints above the hoof. Night blindness, muscular incoordination and weakness, rough hair coat, diarrhea, respiratory infections, and reproductive disorders are often observed in vitamin A-deficient animals.

In the feedlot, vitamin A-deficient cattle may pant excessively as a result of high temperatures, faint or go into convulsions when excited, develop edema of the brisket and forelegs, and exhibit excessive watering of the eyes and a white or cloudy appearance of the cornea.

Vitamin A deficiency in bulls is characterized by a decline in sexual activity and a decrease in spermatozoa numbers. In cows, poor conception rates and retained placentae are often noted. Calves born to deficient cows may be blind or have cloudy, watering eyes; are weak and susceptible to pneumonia; and die shortly after birth. Recovery from some symptoms of vitamin A deficiency is a slow process, even when the deficient animal is injected with massive doses of vitamin A.

## Factors Affecting Vitamin A Metabolism and Storage

Several factors have been implicated as important in vitamin A and/or carotene utilization. It is not apparent whether dietary nitrates are detrimental to the utilization of vitamin A, but they probably present more of a problem from the standpoint of nitrate toxicity. High protein and energy levels seem to favor increased depletion of vitamin A from the liver. In some cases, this can be attributed to faster rates of gain. There is also evidence that vitamin A requirements are increased by high environmental temperatures and other stresses.

The liver contains most of the vitamin A stored in the body. During periods of high carotene intake, the liver stores vitamin A to meet body needs during periods of dietary inade-

quacy. In animals with low carotene or vitamin A intakes, blood levels of vitamin A remain normal until the liver is depleted. It is therefore, not possible to estimate liver stores from plasma analyses before a deficiency occurs. Plasma vitamin A concentrations of 18-25 micrograms (mcg.) per 100 milliliters (ml.) are considered normal; concentrations of 6-10 mcg. per 100 ml. indicate a deficiency.

**Table 1. Estimated carotene content and vitamin A value of feeds***

| Feed | Carotene as-fed basis† | Vitamin A value for cattle and sheep‡ |
|---|---|---|
| | mg./lb. | I.U./lb. |
| Alfalfa hay, one-tenth to one-half bloom | 20.3 | 8,120 |
| Alfalfa hay, three-fourths to full bloom | 8.5 | 3,400 |
| Alfalfa hay, past bloom | 3.3 | 1,320 |
| Alfalfa hay, cured in rainy weather | 2.7 | 1,080 |
| Alfalfa-bromegrass hay | 6.7 | 2,680 |
| Clover hay, red, average analyses | 7.3 | 2,920 |
| Clover hay, red, cured in rainy weather | 1.8 | 720 |
| Mixed hay, first cutting | 6.4 | 2,560 |
| Mixed hay, second cutting | 15.3 | 6,120 |
| Timothy hay | 4.4 | 1,760 |
| Alfalfa, green chop | 28.3 | 11,320 |
| Bromegrass, green chop | 31.6 | 12,640 |
| Clover, red, green chop | 20.9 | 8,360 |
| Alfalfa silage, wilted | 11.4 | 4,560 |
| Corn silage | 5.8 | 2,320 |
| Oat silage | 17.7 | 7,080 |
| Barley | 0.2 | 80 |
| Corn, dent, Grade No. 2 | 1.3 | 520 |
| Linseed meal, solvent process | 0.1 | 40 |
| Oats grain | 0.05 | 20 |
| Soybean meal, solvent process | 0.1 | 40 |
| Wheat bran | 1.2 | 480 |

*Values taken by permission of the Morrison Publishing Co., Clinton, Iowa, from the 22nd edition, 3rd printing, 1959, of Feeds and Feeding, by F.B. Morrison and Associates.

†These are average values; producers may wish to have their feeds analyzed to determine actual carotene content.

‡Calculated using conversion of 1 mg. of carotene equal to 400 I.U. of vitamin A. In ration formulation, consider no vitamin A activity from cereal grains.

## Carotene Content of Feeds

The carotene contents of some common feeds are shown in table 1. Vitamin A values have been calculated using the conversion that assumes 1 mg. of carotene equals 400 I.U. of vitamin A. Forages harvested during the growing stage with minimum exposure to rain or sunlight and stored for less than 6 months have a high vitamin A potency. The carotene content of forages decreases as plants mature, when exposure time to rain and sunlight is increased, and with long storage periods. Yellow corn is the only grain with any appreciable amount of vitamin A potency. Silage, properly preserved, holds its vitamin A potency for long periods.

## Carotene and Vitamin A Requirements

Recommended carotene and vitamin A allowances for beef cattle and sheep are presented in table 2. The levels shown in this table are high enough to allow for some storage of vitamin A and to give an added level of intake to overcome increased needs such as those encountered during periods of stress. The vitamin A allowances presented in this table are calculated from the conversion that assumes 1 mg. of carotene equals 400 I.U. of vitamin A.

**Table 2. Estimated daily carotene and vitamin A requirements**

| | Carotene per 100 lb. body wt. | Vitamin A per 100 lb. body wt. |
|---|---|---|
| | mg. | I.U. |
| Growing beef cattle and lambs | 6.0 | 2,400 |
| Wintering cattle and sheep | 6.0 | 2,400 |
| Fattening beef cattle and lambs | 6.0 | 2,400 |
| Pregnant beef cows and ewes | 6.0 | 2,400 |
| Lactating beef cows and ewes | 10.0 | 4,000 |

The daily allowance listed in table 2 for normal growth of cattle and sheep is 6.0 mg. of carotene per 100 pounds of body weight. Expressed in terms of vitamin A, this is 2,400 I.U. per 100 pounds of weight. The vitamin A requirements for animals of both species are increased to 4,000 I.U. per 100 pounds of body weight during lactation. The recommended allowances of carotene for cattle are taken from Morrison's Feeds and Feeding;[1] those for sheep are slightly higher than recommended in Morrison's book.

There are several periods during which a vitamin A deficiency is likely to occur in beef cattle. These are:

1. Young calves nursing cows during a dry summer, since under these conditions there is not enough vitamin A in the milk to meet requirements.
2. Calves born to cows wintered on poor quality forage.
3. Feeder cattle from dry range areas.
4. Cows fed poor quality, sun-bleached forages.
5. Finishing cattle fed over 100 days in drylot on high concentrate rations.

Rations composed entirely of grain and protein supplement furnish little, if any, vitamin A potency and must be supplemented, especially during the hot summer months. To protect cattle under these conditions (or sheep under similar situations), vitamin A should be included in the supplement at the desired level. Upon arrival at the feedlot, it is a common practice to feed beef cattle high levels (up to 200,000 I.U. per head daily) of vitamin A for a 1-week period to prevent deficiencies caused by the stress of movement and the new environment.

## General Recommendations

Table 3 shows suggested rates of vitamin A supplementation to rations composed of various amounts and qualities of forage. In this table, high quality forage is considered to contain about 8 mg. of carotene per pound, medium quality to contain 4-6 mg., and low quality to contain 2-3 mg. No vitamin A activity is considered to be furnished by the grain portion of the ration.

Rations composed of 75-100 percent forage need vitamin A supplementation only if the forage is poor quality. Rations with average quality forage need vitamin A supplementation if the ration contains less than 50 percent forage. Those with less than 25 percent high quality forage need vitamin A supplementation.

[1]Taken by permission of the Morrison Publishing Co., Clinton, Iowa, from the 22nd edition, 3rd printing, 1959, of Feeds and Feeding, by F.B. Morrison and Associates.

**Table 3. Suggested rates of supplementing growing-finishing rations for cattle and sheep**

| Forage in total ration | Forage quality | Rate of vitamin A supplementation per 100 lb. body wt. |
|---|---|---|
| percent | | I.U. |
| 100 | high | none |
| 100 | average | none |
| 100 | poor | 500 |
| 75 | high | none |
| 75 | average | none |
| 75 | poor | 1,000 |
| 50 | high | none |
| 50 | average | 500 |
| 50 | poor | 1,500 |
| 25 | high | 500 |
| 25 | average | 1,000 |
| 25 | poor | 2,000 |
| 0 | — | 2,400 |

Table 3 is a useful guide for determining the rate of vitamin A supplementation, since the vitamin A activity values given in table 1 represent averages and may deviate considerably from the feeds being fed. If needs for vitamin A must be estimated, use average values and amounts of ration ingredients to arrive at the intake of vitamin A activity.

For example: A ration composed of 80 percent corn grain and 20 percent late-cut alfalfa hay fed to 1,000 pound beef steers at a rate of 20 pounds per day furnishes 13,600 I.U. of vitamin A potency.

16 lb. corn x 0 I.U./lb. = 0 I.U.
4 lb. hay x 3,400 I.U./lb. = 13,600 I.U.
Total 13,600 I.U.

The vitamin A requirement of a 1,000-pound fattening beef animal is about 24,000 I.U. (table 2). The above ration would therefore need to be supplemented with an additional 10,400 I.U. of vitamin A per animal daily.

Low cost vitamin A concentrates can be purchased from local feed stores and mixed with the supplement to supply required amounts. Commercial supplements usually contain vitamin A.

## Summary


1. Vitamin A deficiency is likely to occur when cattle and sheep are fed poor quality forage that has been sun bleached, rained on, or cut when overripe. Cattle and sheep grazing pastures during drought conditions also need vitamin A supplementation.

2. Vitamin A supplementation is needed for finishing animals fed rations composed largely of grains.

3. Vitamin A requirements of cattle and sheep will be met by feeding 6.0 mg. of carotene or 2,400 I.U. of vitamin A per 100 pounds of body weight.

4. Three factors should guide cattle and sheep feeders in determining the amount of vitamin A to supplement: (1) the amount of previous vitamin A storage, (2) the quality of the forage fed, and (3) the amount of forage fed.



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