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Vitamins for Beef Cattle

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Vitamin needs of beef cattle can be confined largely to A, D and E. This is because bacteria in the rumen of cattle are considered to have the ability to synthesize vitamin K and the B vitamins in sufficient quantities to meet the animal's requirement.

Vitamin A

Vitamin A needs special attention in beef cattle rations. This vitamin is found only in animals. Plants, however, are the natural source of vitamin A activity for animals. Green and yellow plants contain carotene, a pigment which animals convert to vitamin A. The wall of the small intestine is the principal site for conversion of carotene to vitamin A.

In recent years, many cases of vitamin A deficiency have been reported for beef cattle receiving rations considered to be adequate or high in vitamin A activity. This increased incidence of vitamin A deficiency in beef cattle has been attributed to:

- Greater use of milo and barley to replace yellow corn and the emphasis on high-grain rations with less roughage, all of which lower the carotene level of rations.
- Large destruction of carotene in the components of cattle rations because of longer storage and heat treatments for drying and processing feeds.
- Use of younger calves by feedlots. Young animals have lower body stores of vitamin A and are fed longer than older animals.
- Stress of feeder cattle from hauling, handling, disease and parasites.
- Larger daily gains as a result of nutritional and genetic improvement. Vitamin A requirements are greater per unit of body weight.
- Higher nitrate content of forages, especially when grown under adverse weather conditions, with high nitrogen fertilizer applications.
- Higher nitrite and nitrate levels in livestock water.
- Reduced vitamin E intake because of lower roughage rations, heat treatment of feeds, etc.

Function of vitamin A

Some metabolic functions of vitamin A are not yet known. A chief role is maintenance of epithelial tissue (skin and lining of respiratory, digestive

and reproductive tract) in a healthy condition. It also functions in visual purple, a compound in the eye needed for sight when an animal adapts from light to dark. Vitamin A is essential for proper kidney function and normal development of bones, teeth and nerve tissue.

Symptoms of vitamin A deficiency

One of the first easily detected signs of vitamin A deficiency in cattle is night blindness. An easy way to check for this condition is to place an obstacle in the pathway of cattle and notice if they stumble over it at twilight. Other early signs are loss of appetite, rough hair coat, dull eyes, slowed gains and reduced feed efficiency. Diarrhea and pneumonia may be the first indicators, especially in young animals. Later developments include excessive watering of the eyes, staggering gait, lameness or stiffness in knee and hock joints, and swelling of the legs and brisket (and sometimes in the abdominal region). Feedlot cattle with advanced vitamin A deficiency often pant excessively at high temperatures and go into convulsions when excited.

Signs of vitamin A deficiency in breeding herds include lowered fertility and calving percentage. Cows abort, drop dead or weak calves, and are difficult to settle.

Vitamin A stored in liver

Cattle have from 70 to 90 percent of their total vitamin A stores in the liver. The remainder is deposited in fat and other organs. Carotene that escapes conversion to vitamin A is stored mostly in the liver. It is, however, distributed more evenly in the body than vitamin A, since it is more prevalent in fat. Yellow fat and yellow milk are due to the inability to convert all the carotene in the diet to vitamin A. Carotene has no known physiological function in the body aside from its role as a source of vitamin A. It is questionable if a significant amount of body carotene stores is converted to vitamin A. No appreciable storage of vitamin A takes place in the liver until the vitamin A activity of the diet is much higher than the normal body requirement. Daily vitamin A intake needs to be three to five times the normal requirement (carotene, five to 10 times) for appreciable liver deposit of vitamin A.

Body deposits of vitamin A are low at birth and young animals have smaller reserves than older animals that have consumed diets high in vitamin A activity. Young animals fed vitamin A-deficient rations usually show deficiency symptoms sooner than older animals. This faster depletion rate was shown in a California study (Table 1).

Table 1
Depletion of liver stores of vitamin A

Light feeder steers

- 40 to 80 days

Heavy feeder steers

- 80 to 140 days

Yearling steers

- 100 to 150 days

Cows

- 120 to 180 days

It is risky to depend upon liver stores of vitamin A to protect animals fed vitamin A-deficient rations. The amount of vitamin A storage by cattle cannot be predicted accurately on the basis of prior intake of carotene. In some research trials, cattle have been known to lose vitamin A from their livers even when grazing green pasture or consuming high-silage or haylage rations.

Factors that affect requirements

Species

Rats are much more efficient than farm animals in converting carotene to vitamin A. One milligram of beta-carotene is considered to have 1,667 IU of vitamin A value for the rat, 400 IU for cattle, 400 to 500 IU for sheep, and 500 IU for hogs. Some research has shown carotene to have even lower vitamin A activity levels than these for livestock. Many feed analysis tables list the vitamin A value of feeds on a rat basis, which is four times the vitamin A activity of these feeds for beef cattle.

Breed

Some dairy breeds are more efficient than others at converting carotene to vitamin A. The yellow milk and carcass fat of Guernseys and Jerseys indicate their poor utilization of carotene for vitamin A. Some studies indicated Holsteins were twice as efficient as Guernseys in changing carotene to vitamin A. There does not appear to be any difference among beef breeds in ability to convert carotene to vitamin A.

Carotene

Beta-carotene makes up a larger percent of the total carotene in some plants than in others. Other carotenes yield less vitamin A activity than beta-carotene.

Depletion

Cattle depleted of vitamin A are less efficient in converting carotene to vitamin A. This supports the practice of administering pre-formed vitamin A in the diet or by injection instead of depending upon carotene in the feed to replenish cattle severely deficient of vitamin A.

High-carotene feeds

Cattle maintained on high-carotene diets convert carotene less efficiently to vitamin A. This condition could accelerate the depletion of liver stores of vitamin A when cattle are abruptly changed to diets with less carotene.

Thyroid depression

Hot weather or components in the diet may cause thyroid depression, which is thought to decrease conversion of carotene to vitamin A.

Stresses

Hot weather, disease, parasites and other stresses are believed to interfere with the animal's ability to convert carotene to vitamin A and to depress the efficiency with which vitamin A can be used to meet needs. Also, these and other factors may increase the animal's requirements for vitamin A. Inflammation and damage of the intestinal wall by diarrhea or parasites undoubtedly interfere with the absorption of carotene and vitamin A and the conversion of carotene to vitamin A.

Silages, haylage, pasture

Cattle consuming rations high in corn silage, sorghum or oat silage and grass-legume haylage have been found to deplete normal stores of vitamin A in the liver, even though these feeds contained medium to high levels of what was thought to be beta-carotene. Cattle full-fed grain on pasture have benefited from vitamin A supplementation in some trials.

Vitamin E

This vitamin appears to increase the efficiency of vitamin A and carotene utilization by reducing their oxidation before and after absorption from the digestive tract.

Nitrate

High levels of nitrate or nitrite nitrogen in the ration or water have been found to cause a vitamin A deficiency syndrome in cattle and hogs in some cases. These compounds may have this effect by causing a greater destruction of vitamin A and carotene in the digestive tract, decreasing their absorption and interfering with the conversion of carotene to vitamin A, depression of the thyroid gland and increasing the requirement for vitamin A. Cattle used carotene less effectively when grazing orchard grass fertilized with nitrogen than when grazing unfertilized pastures in an Illinois trial.

Phosphorus

Low levels of phosphorus in the diets of range cattle appeared to lower conversion of carotene to vitamin A. Plasma-carotene levels tended to rise when phosphorus intake was inadequate.

Diethylstilbestrol

Carotene or vitamin A use by cattle does not seem to be affected by diethylstilbestrol in the ration.

Losses

Carotene and vitamin A are easily oxidized and destroyed in feeds by weather damage, exposure to air in lengthy storage, heat, and contact with minerals. Stemmy hay is low in carotene because most of the carotene is in the leaves of the plant.

Requirements for vitamin A

The amount of vitamin A to use in the cattle ration depends upon the level of carotene in the feed, liver stores of vitamin A, and length of feeding period, among other factors.

New feeders

It is advisable to supply incoming feeders or other cattle under extreme stress conditions with 500,000 to 1 million IU of vitamin A. This amount may be given by injection in the muscle or rumen, or by putting 50,000 IU of vitamin A per head daily in the feed or drinking water for two to three weeks. Toxicity from administration of high levels of vitamin A has not been a problem in beef cattle. However, repeated dosing of cattle at short intervals with high injections of vitamin A should be avoided.

Feedlot cattle

The vitamin A requirements of feedlot cattle can be met by feeding around 6 milligrams of carotene or 2,500 IU of vitamin A for each 100 pounds of body weight; or by supplying 1,000 to 1,500 IU of vitamin A per pound of feed. See Table 2 for guides to use in feeding vitamin A to cattle.

Table 2

Standards for adding vitamin A to beef cattle rations

	Units of vitamin A per head daily
Steers and heifers	
Wintered on corn silage	15,000
Full-fed during winter	20,000
Full-fed grain on pasture	20,000
Fed in drylot in summer	30,000
Pastured with no grain, or wintered on rations 50 percent high-quality legume hay	No extra vitamin A
Beef cows	
On rations that contain 5 to 6 pounds green legume hay	No extra vitamin A
Pregnant cows	30,000
Lactating cows	45,000

Supplying vitamin A

- Vitamin A can be purchased in dry or liquid protein supplements or in mixed feeds.
- A vitamin A concentrate can be bought for addition to farm-mixed supplements or rations.
- Mix vitamin A with salt. Adding 500,000 IU of stabilized vitamin A per pound of salt should be adequate. The mixture must be kept dry to

prevent destruction of the vitamin A. Mixing one-fourth pound of calcium stearate, a drying agent, in each 100 pounds of salt-vitamin A mixture will help maintain the vitamin A potency of the mixture. A fresh mixture should be supplied every 10 to 14 days. In a Missouri trial, a salt-vitamin A mixture containing 0.25 percent calcium stearate retained 73 percent of its vitamin A value after one week, and 52 percent after two weeks.

Intramuscular injection of vitamin A

Vitamin A injected in the muscle is used more efficiently to increase liver stores than that given in the feed. This method is often used to supply vitamin A to new feeder cattle. The length of time that injections provide protection is not well established.

Factors involved in the use of a single massive dose of vitamin A to increase liver stores of vitamin A for future use are:

- Vitamin A-deficient animals have decreased ability to store vitamin A in the liver.
- High concentrations of vitamin A in the liver are held less securely than lower levels.

It was necessary to repeat an intramuscular injection of 1 million IU of vitamin A every 28 days to maintain safe vitamin A liver stores for cattle fed corn silage in an Illinois trial. Purdue scientists found an injection of 4 or 6 million IU maintained adequate liver stores of vitamin A after cattle had been fed yellow corn, soybean meal and minerals for 210 days. Conversely, cattle injected with 1 million IU of vitamin A were critically low in vitamin A reserves at the close of the trial.

The intramuscular injection of 500,000 to 6 million IU of vitamin A in cows two months before calving has been used in numerous experiments with range and farm herds. There has been no benefit in many cases in respect to fertility, calving percentage or weaning weights. The results would not support this as a routine recommendation for cow herds. Nevertheless, this would be an effective way of supplying vitamin A to herds that have a history of vitamin deficiency. Injections could be used in years when drought or other causes have increased the hazard of vitamin A deficiency in a cow herd.

Vitamin D

Vitamin D is formed by the action of sunlight or other sources of ultraviolet light rays upon certain sterols. A sterol in the skin of animals, 7-dehydrocholesterol, is converted to vitamin D₃ by ultraviolet rays of sunlight. Glass filters ultraviolet rays from sunlight, so animals kept indoors do not form vitamin D. Ergosterol, a sterol in green plants, is converted to D₂ when the plant is harvested and cured in sunlight. Many commercial products of vitamin D are sold in concentrated form. Irradiated yeast has a high potency of vitamin D₂. Both vitamin D₂ and D₃ are biologically active for cattle and other four-footed animals. Vitamin D₃ is about 100 times as active as D₂ for poultry.

Young, growing animals have a greater requirement for vitamin D than mature animals. Under normal conditions, cattle receive adequate vitamin D from exposure to direct sunlight or from consumption of three to four pounds of sun-cured forages daily. Experiments with calves indicate a requirement of approximately 300 IU of vitamin D per 100 pounds of body weight.

Function of Vitamin D

Vitamin D increases the absorption from the digestive tract and metabolic use of calcium and phosphorus. It helps regulate blood calcium levels and the conversion of inorganic to organic phosphorus. Vitamin D aids in the formation of sound bones and teeth. Its specific role in the prevention of rickets in young animals or osteomalacia in mature animals is associated with its involvement in the metabolism of calcium and phosphorus.

Deficiency signs

Rickets is characterized by soft, porous, poorly developed bones. Early signs of vitamin D deficiency in calves are poor appetite, decreased growth, stiff gait, weakness and labored breathing. Later signs include swollen joints, slight arching of back, bowed legs and bent knees. Bones that are easily broken are a sign in all ages of animals. A deficiency in pregnant animals may result in dead, weak or deformed calves.

Vitamin E

Most rations fed to beef cattle in Missouri are adequate in vitamin E. Adding two to five IU of vitamin E per pound to high-grain rations devoid of leafy roughages has increased feedlot cattle performance in a few Corn Belt trials, but not in others. Injecting new feeder cattle with Vitamin E may reduce the incidence and severity of sickness in the starting phase.

Function of Vitamin E

The specific physiological function of vitamin E is not clear. Its principal role may be as a chemical antioxidant to reduce the destruction of other vitamins and essential fatty acids both in the digestive tract and after their absorption. A vitamin E deficiency impairs reproduction in rats and other laboratory animals, but this effect has not been confirmed in farm animals. Stiff-lamb disease and white-muscle disease in calves have been prevented and cured by use of vitamin E. Selenium, a trace mineral, spares or replaces vitamin E in the prevention or curing of these two diseases. A close relationship exists between selenium and vitamin E, but each is thought to be irreplaceable on a total basis for normal body metabolism.

Source

Vitamin E activity is present in several tocopherols that occur in nature as high molecular weight alcohols, but alpha-tocopherol is the principal one with any significant biological value. One IU of vitamin E is defined as the activity of 1.0 milligram of dl-alpha-tocopherol acetate. Other tocopherols vary from one-third to one-hundredth the biological potency of the alpha form. Common assay methods do not distinguish between these forms, resulting in the vitamin E potency of feeds being overestimated in many cases (Table 3). Alfalfa meal contains a high percent of alpha-tocopherol. Green leafy forages and whole grains are sources of vitamin E. Much of the vitamin E is in the oil of the seed.

Table 3

Tocopherol content of feedstuffs.¹

	Total tocopherol	Alpha-tocopherol	
Alfalfa meal	105 mg per pound	100 mg per pound	95 percent of total
Alfalfa hay	54 mg per pound	24 mg per pound	45 percent of total
Mixed hay	9 mg per pound	5 mg per pound	55 percent of total
Corn silage	0.42 mg per pound	0.38 mg per pound	90 percent of total
Corn	20 mg per pound	2 mg per pound	10 percent of total
Barley	21 mg per pound	3 mg per pound	15 percent of total
Oats	12 mg per pound	4 mg per pound	35 percent of total
Wheat	16 mg per pound	8 mg per pound	50 percent of total
Wheat middlings	45 mg per pound	10 mg per pound	20 percent of total
Cottonseed meal	19 mg per pound	9 mg per pound	45 percent of total
Soybean meal	14 mg per pound	2 mg per pound	15 percent of total

¹C.R. Adams, Hoffman La Roche Co., 19th Montana Nutrition Conference

Problem conditions

The need for vitamin E in beef cattle rations in Missouri has not been clearly demonstrated. Until we know more about this vitamin, however, the following conditions might be suspected as causing a deficiency:

- High-grain rations with limited or no roughage, especially high-moisture harvested grains
- Feeding grains or roughages that are low in selenium
- High fat levels in ration
- Lengthy storage of feeds
- High drying temperatures for feeds
- Feeds that have a small portion of their vitamin E assay value from alpha-tocopherol.

Use about 50 IU per animal daily if vitamin E supplementation of feedlot rations is deemed advisable.

Vitamin K

Rumen bacteria make vitamin K in quantities to meet the needs of cattle under most conditions. One exception is death loss from internal hemorrhage or surgery that may occur when cattle are fed moldy sweet clover hay or silage. Other moldy legumes can possibly cause a similar problem. Vitamin K is essential in the liver for the production of prothrombin. Low levels of prothrombin in the blood lengthen blood clotting time and cause internal bleeding. Dicumarol is the substance in moldy sweet clover hay that interferes with the function of vitamin K in the production of prothrombin by the liver. Vitamin K administration and removal of the moldy feed are the most effective ways to overcome this condition.

B vitamins

Included in the B-vitamin complex are thiamin, biotin, riboflavin, niacin, pantothenic acid, pyridoxine, folic acid, vitamin B₁₂ and choline. Once the rumen becomes functional, bacterial synthesis is considered to supply the normal requirement of cattle for B-vitamins. Milk is a source of B-vitamins for the calf.

The lack of a trace mineral, cobalt, can result in a vitamin B₁₂ deficiency in cattle. This is because cobalt is a part of the vitamin B₁₂ compound and is essential for rumen bacteria to manufacture this vitamin.

Choline supplementation of rations for fattening cattle has appeared to increase performance in Washington State trials, but has not been effective in most other areas of the United States.

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Related MU Extension publications

- CB10, Beef Cow/Calf Series
<http://extension.missouri.edu/publications/DisplayPub.aspx?P=CB10>
- G2066, Rations for Growing and Finishing Beef Cattle
<http://extension.missouri.edu/publications/DisplayPub.aspx?P=G2066>
- G2071, Urea Supplements for Beef Cattle
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