



Vitamin Supplementation for Beef Cattle

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Beef cattle have defined requirements for vitamins. In some instances, vitamin supplementation may be necessary to avoid deficiencies. Vitamins are classified into two categories: water-soluble and fat-soluble. Water-soluble vitamins include the B vitamins, such as riboflavin, thiamin, and niacin, as well as vitamin C. Fat-soluble vitamins include vitamins A, D, E, and K. Supplementation for beef cattle generally focuses on vitamins A and E. This is because the rumen microbes synthesize the water-soluble vitamins and vitamin K in sufficient quantities to avoid deficiencies. Vitamin D requirements can often be met by exposure to the sun and would therefore only be of concern for cattle in confinement housing.

Rarely are vitamin deficiencies observed in today's beef production systems. This is partially because vitamins are often included with minerals in a free-choice supplement or mixed into complete diets. Over time, the activity of vitamins can decrease, so vitamin and mineral supplements should be purchased in quantities that can be fed within a few months and stored in a cool, dry place.

Fat-Soluble Vitamins

Vitamin A

Vitamin A is important for growth, reproduction, immune-system function, vision, skin and hoof tissue maintenance, and energy metabolism. Vitamin A is the most common vitamin deficiency observed in beef cattle. Symptoms of vitamin A deficiency include:

- night blindness;
- skin lesions;
- decreased growth and feed efficiency;
- staggering gait, lameness, and joint stiffness; and
- fetal resorption and abortion.

Dietary Sources of Vitamin A

The active form of vitamin A is only found in animal sources. However, leafy green forages, silages, alfalfa meal, and whole milk are good sources of the provi-



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tamin carotene, which is readily converted to the active form of vitamin A by ruminant animals. The most abundant form of carotene in plant sources is β -carotene. Most of the carotene in forages is found in the leaves. As forages mature and the leaf-to-stem ratio decreases, carotene concentration also decreases. Additionally, some breeds of cattle have a lower ability to convert β -carotene to the active form of vitamin A.

Storage of Vitamin A

Vitamin A is stored in the liver, and these stores can be utilized to meet vitamin A requirements when dietary supplies are marginal. However, liver stores can be rapidly depleted when dietary carotene concentrations are low, a situation that can result from:

- feeds that have been heavily processed by heat or mixed with oxidizing materials such as minerals;
- forages that have been stored for long periods of time;
- dormant pastures;

- high-grain diets;
- forages with extensive sun-bleaching; or
- feeds low in β -carotene (e.g., white corn or wheat straw).

Supplementation of Vitamin A

Due to the variation in dietary carotene concentrations, it is important to provide supplemental vitamin A. Commonly, supplemental vitamin A is provided in the mineral mix. The current University of Kentucky Beef IRM mineral recommendations for vitamin A are listed in Table 1.

Supplement type	Vitamin A, IU/lb.
Basic cow-calf	150,000
High-magnesium mineral	100,000
Stocker mineral with monensin	150,000

Table 1. Recommended vitamin A concentrations to be included in beef cattle mineral supplements, according to UK Beef IRM mineral recommendations.

In recent years, global supply chain issues have at times led to dramatic increases in vitamin A source prices and decreases of vitamin A in vitamin and mineral mixes. Always consult with your nutritionist or an extension specialist before changing the inclusion of any vitamin or mineral in the supplement, as this can result in deficiencies or toxicities that ultimately impact cattle performance.

Concerns about potential decreases in marbling score have been raised when considering the supplementation of vitamin A for feedlot cattle. However, decreases in marbling score have only been shown when vitamin A was provided at supplementation concentrations that were well above the established concentrations to prevent deficiency, and reductions in intramuscular fat were minimal. Therefore, it is generally recommended that finishing cattle consume vitamin A at the rate of 1,000 IU/pound of dry matter intake. For a 1,200-pound finishing steer consuming 2.25 percent of its body weight in dry matter, or 27 pounds, this would be approximately 27,000 IU of vitamin A per day. Assuming a target intake of three ounces per day, a free-choice mineral containing 150,000 IU of vitamin A would provide approximately 28,000 IU of vitamin A per day, thus meeting the needs of the finishing animal without over supplementation.

Vitamin E

The primary role of vitamin E, as an antioxidant, is to protect against oxidative damage in cells throughout the body. Vitamin E is found in feeds as α -tocopherol. Good sources of vitamin E are green leafy forages, in which the vitamin is found within chloroplasts, and whole grains such as corn or soybeans, in which much of the vitamin E is in the oil.

Vitamin E can be stored in the liver and fat, but it is an essential nutrient, which means it must be consumed in the diet. Vitamin E deficiency typically results in muscle weakness or white muscle disease. Vitamin E is typically supplemented in the diet; however, injectable sources are also available for treatment of white muscle disease.

Current supplemental vitamin E concentrations in the UK Beef IRM mineral

guidelines are included in Table 2. The differences in concentrations reflect differences in target intakes for each supplement.

Supplement type	Vitamin E, IU/lb.
Basic cow-calf	150
High-magnesium mineral	100
Stocker mineral with monensin	150

Table 2. Recommended vitamin E concentrations to be included in beef cattle mineral supplements, according to UK Beef IRM mineral recommendations.

Vitamin D

Vitamin D, in the form of vitamin D3, is synthesized when ultraviolet light, such as that provided from sunlight, interacts with a sterol, 7-dehydrocholesterol, that is in the skin of animals. A second form of vitamin D, vitamin D2, is created in plants from a sterol called ergosterol when plants are harvested and cured in sunlight. Cattle can meet their vitamin D requirement as vitamin D2 by consuming three to four pounds of sun-cured forage daily. Vitamin D supplementation is not required for most cattle. Cattle housed in confinement may require supplementation due to the inability to synthesize vitamin D3; however, cattle in confinement can utilize vitamin D2 from consumption of sun-cured forages.

Vitamin K

Vitamin K is synthesized by the rumen microbes; thus, supplementation of the diet is not required for animals with normal intakes and a healthy rumen. Vitamin K is essential for the production of prothrombin in the liver, which is required for adequate blood clotting. A compound known as dicumarol in moldy clover hay or silage is known to interact with vitamin K and negatively impact blood clotting. Supplementation of vitamin K can overcome this interaction. Vitamin K may be administered as a treatment for internal hemorrhaging caused by consumption of moldy sweet-clover hay or silage.

Water-Soluble Vitamins

Water-soluble vitamins include the B vitamins, such as thiamin, biotin, ribofla-

vin, niacin, pantothenic acid, pyridoxine, folic acid, cobalamin, and choline, as well as vitamin C. Although beef cattle have requirements for water-soluble vitamins, there is typically no need to supplement them to beef cattle with functional rumens, because they are synthesized by the rumen microbes. However, the mineral cobalt must be provided in the diet, as cobalt is critical for the synthesis of the vitamin cobalamin. For young calves without a functioning rumen, the cow's milk contains an adequate supply of these vitamins.

One case where additional B-vitamin supplementation might be required is when cattle are consuming diets with high co-product inclusions. Co-products tend to have high sulfur concentrations. Thiamin works to combat the neurological symptoms resulting from a condition known as polioencephalomalacia (polio) caused by sulfur toxicity. Thiamin may be added to co-product balancer mineral products and injectable thiamin can be administered by veterinarians when treating suspected cases of sulfur toxicity.

Research has investigated performance effects to supplementing ruminally protected water-soluble vitamins. However, research has not shown performance improvements in beef cattle to justify the additional cost of supplementation. Other alternatives for supplementation of water-soluble vitamins include injectable products; however, more research is needed to assess the potential performance advantages to this practice.

Summary

Vitamins are essential nutrients for beef cattle. Supplementation of vitamin A and vitamin E is often included with the mineral supplement and should be considered when selecting a mineral supplement for the herd. Cattle with a functioning rumen can synthesize other required vitamins, thus vitamin deficiencies are rare in cattle. Always consult with a nutritionist before making changes to vitamin inclusions in the mineral supplement to prevent potential deficiencies. For more information about vitamin supplementation for beef cattle, contact your nutritionist or county Extension office.