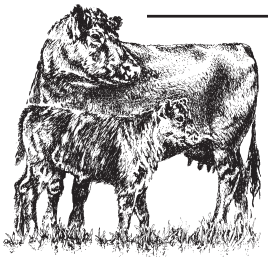

Western Beef Resource Committee

Cattle Producer's Library

Nutrition Section CL381

Vitamin Nutrition of Cattle Consuming Forages: Is There a Need for Supplementation?

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Suboptimal animal performance with adequate supply of protein and energy has been observed when cattle are consuming forage-based diets. Under this condition, insufficient supply of micronutrients may be involved because ruminants, like nonruminants, must receive all the essential nutrients in proper quantities to maintain good health, grow, and reproduce at their maximum potential. This section will focus on the vitamins that may impact production of cattle consuming forages.

Vitamin A—Functions and Utilization

Dietary vitamin A, and perhaps β-carotene, enhance host defense mechanisms toward infections, decrease the incidence of certain reproductive disorders, and serve as effective antioxidants. Because of the aforementioned effects, in addition to vitamin A's role in maintaining epithelial integrity, supplementation of vitamin A to cattle may be advisable when forage is likely to be low in carotene.

Vitamin A Levels in Plant Matter

The biologically active form of vitamin A (all-*trans*-retinol) is present in plants as precursors known as carotenoids. The precursor with greatest biological activity is β-carotene, which constitutes 75 to 95 percent of the total carotenoids in forages.

Consumption of plant species and(or) specific plant parts, as well as mature forage, could greatly impact vitamin A status of cattle. Browse plants, such as sagebrush, rabbitbrush, and winter fat, generally have greater levels of carotene than grasses (Table 1).

The carotene content of plants with dry leaves or stems will decrease 30 to 50 percent from early to late maturity. Conversely, the presence of green basal leaves and(or) regrowth may increase the carotene content.

The amount of carotene in forages may also vary according to harvesting, processing, and storage conditions. Wilted forage retains 75 percent of its carotene content from harvesting to storage, whereas sun-cured forage only retains 35 percent of its initial carotene level. The carotene content of stored forage will drop approximately 50 percent every 6 months. Increasing storage temperature will accelerate carotene loss.

Vitamin A Supplementation

It is not uncommon for liver stores of vitamin A to be reduced when cattle are consuming a diet of low-quality, mature forage. Increasing dietary vitamin A 5,000 IU per day can double the amount of vitamin A stored in the liver. Supplementing brood cows with vitamin A before (16,000 IU/d) and after (40,000 IU/d) calving season can increase conception rates 10 percent and decrease calf morbidity by as much as 50 percent. The beneficial response noted for the calf is most likely associated with vitamin A being concentrated in colostrum and milk.

Supplemental vitamin A may not always be necessary when cattle are grazing rangelands during suspected dormancy or when cattle are fed properly cured and stored hay. This is especially the case if cattle consume reasonably green forage for at least 8 months out of the year.

Portions of this article were obtained from data compiled by the Western Region Coordinating Committee on improvement of forage utilization by ruminants in sustainable production systems in the western region.

Table 1. Vitamin A concentrations and quantity of forage needed daily to meet a 1,200-pound cow's vitamin A requirement during various stages of production.*

Stage of production	Requirement	Forage type	Forage concentration	Quantity of forage required
Middle 3rd of pregnancy	26,000 IU/d	Native browse plants of the Red	34,400 IU/lb	0.8 lb/d
Last 3rd of pregnancy	32,000 IU/d	Desert, WY, from November to April		0.9 lb/d
Lactation	45,000 IU/d			1.3 lb/d
Middle 3rd of pregnancy	26,000 IU/d	Native range grasses of the Red	11,200 IU/lb	2.3 lb/d
Last 3rd of pregnancy	32,000 IU/d	Desert, WY, from November to April		2.9 lb/d
Lactation	45,000 IU/d			4.0 lb/d
Middle 3rd of pregnancy	26,000 IU/d	Newly cured native meadow hay	29,800 IU/lb	0.9 lb/d
Last 3rd of pregnancy	32,000 IU/d			1.1 lb/d
Lactation	45,000 IU/d			1.5 lb/d
Middle 3rd of pregnancy	26,000 IU/d	One-year-old native meadow hay	11,900 IU/lb	2.2 lb/d
Last 3rd of pregnancy	32,000 IU/d			2.7 lb/d
Lactation	45,000 IU/d			3.8 lb/d
Middle 3rd of pregnancy	26,000 IU/d	Two-year-old native meadow hay	3,000 IU/lb	8.7 lb/d
Last 3rd of pregnancy	32,000 IU/d			10.7 lb/d
Lactation	45,000 IU/d			15.0 lb/d
Middle 3rd of pregnancy	26,000 IU/d	Severely bleached native meadow	1,300 IU/lb	20.0 lb/d
Last 3rd of pregnancy	32,000 IU/d	hay		24.6 lb/d
Lactation	45,000 IU/d			34.6 lb/d

*Requirements were from NRC (1996) and data were summarized by Hess (1999) for a publication produced by the Western Coordinating Committee on improvement of forage utilization by ruminants in sustainable production systems in the western region.

The presence of green leaves presumably increased carotene levels of grass samples collected on the Red Desert of Wyoming from November to April (Table 1).

A 1,200-pound cow would only need to eat 0.8 to 4.0 pounds per day of these native range plants to meet her vitamin A requirements during mid-pregnancy to lactation. A 1,200-pound cow would also meet her vitamin A requirement for mid-pregnancy and lactation by consuming 8.7 and 15.0 pounds per day, respectively, of 2-year-old native meadow hay. This cow, however, would need to consume 20.0 to 34.6 pounds per day of severely bleached native meadow hay to meet her vitamin A requirement.

In all practicality, liver vitamin A stores can sustain the animal for only 2 to 4 months. Therefore, supplemental vitamin A is recommended to prevent potential problems with productive efficiency of cattle when feed sources are most apt to be low in carotene.

Vitamin E—Functions and Utilization

Vitamin E functions as an antioxidative component of cell membranes. The antioxidant helps control radical oxygen molecules that may cause cellular damage during normal metabolism. Inadequate levels of α-tocopherol may lead to nutritional muscular dystrophy and impaired immune and reproductive functions.

Vitamin E Levels in Forages

Vitamin E is a generic term used for tocopherol compounds. The biological reference for vitamin E activity is also the predominant form found in forages, α-tocopherol.

Cattle consuming forages below 15 ppm α-tocopherol are not likely to maintain blood α-tocopherol levels above, which is considered marginal (2 to 3 mg/mL). The level of α-tocopherol in forage decreases 35 to 90 percent as the plant matures. The concentration of α-tocopherol is 50 to 80 percent higher in fresh grass than in harvested and processed forages.

Losses are heightened by exposure to heat and prolonged storage. The level of α-tocopherol in many forages stored as hay ranges from 8 to 15 ppm. Thus, supplementing vitamin E to cattle consuming low-quality range or harvested forages as a precautionary measure may be warranted.

Vitamin E Supplementation

The liver is the major storage organ for α-tocopherol and helps maintain plasma α-tocopherol levels under short-term inadequate intake of vitamin E. This mechanism appears to be superseded, however, during the late stages of pregnancy when vitamin E concentration in the blood tends to decrease below marginal levels.

Injectable forms of vitamin E may be used to increase levels of α-tocopherol in the blood, but biweekly injections are necessary to maintain blood vitamin E at desirable levels. Feeding supplemental vitamin E is an effective alternative to the injectable route. Minimal serum α-tocopherol concentrations can be achieved within 14 days after supplementation with 500 IU of vitamin E per day, however, serum α-tocopherol will drop below the marginal level within 28 days if supplementation is discontinued.

Neonatal calves must receive dietary vitamin E because placental transfer of α-tocopherol is very limited. However, supplying supplemental vitamin E to the calf directly may not be necessary. Feeding an additional 1,000 IU of α-tocopherol to cattle during the last trimester of pregnancy can increase antibody production and sequestration in the colostrum and increase vitamin E concentration in the colostrum up to 30 percent.

Plasma concentrations of vitamin E in the calf can be maintained above the minimal level if maternal supplementation continues into the early stages of lactation. Therefore, vitamin E supplementation is recommended for brood cows consuming poor-quality forage during late pregnancy through early lactation.

Vitamin D—Functions and Utilization

Vitamin D is a pro-hormone formed by ultraviolet irradation of skin (D_3) or plant material (D_2). Vitamin D enters the blood from the gut or the skin, accumulates in the liver, and is converted to its most biologically active form in the kidney. This active form helps maintain normal blood Ca and P concentrations by facilitating Ca and P absorption from the intestine and enhancing bone resorption.

Vitamin D Levels in Forages

Vitamin D_2 in irradiated feedstuffs is the dietary source of vitamin D for cattle. Forages that are not allowed to sun-cure may have 60 percent less vitamin D_2, but cattle housed outside are not expected to be deficient in vitamin D.

Vitamin D Supplementation

Sunlight typically stimulates sufficient endogenous production of vitamin D_3 in grazing cattle. Vitamin D status is improved more effectively by increasing the animal's exposure to sunlight than by dietary supplementation.

Vitamin K

The ruminal microorganisms generally synthesize and supply vitamin K in amounts sufficient to meet the ruminant animal's requirements. Supplemental vitamin K is usually only justified when cattle are suspected to have consumed sufficient quantities of vitamin K antagonists.

Consumption of a natural vitamin K antagonist (dicumarol) can be a problem if cattle have injested moldy sweetclover forage. Because dicumarol antagonizes vitamin K, an essential component of the blood clotting process, feeding moldy sweetclover hay to cattle may cause hemorrhage and uncontrollable bleeding.

Responses to vitamin K therapy have been somewhat dependent on differences in dicumarol source and dosages. Therefore, prevention (avoid feeding moldy sweetclover hay) is perhaps a better alternative to supplemental treatments.

B Vitamins

Microbial synthesis of the B vitamins in the rumen is thought to satisfy the ruminant's requirements. Supplementation with B vitamins is not necessary under normal production situations, especially if cattle are consuming high-quality forage or supplements that improve ruminal digestibility and subsequent microbial synthesis. Injections of the B vitamins appear to be beneficial only to combat overt stress and disease.

Conclusions

As a result of the availability of low cost sources of vitamins A and E, regular supplementation to cattle fed low-quality forage should be considered. The benefits of advocating such programs will be realized as production efficiency is expected to increase. Aside from direct effects on reproduction, producers should benefit from cattle in better health. Supplementing other vitamins would not be recommended, except under special circumstances.

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