



DAIRY HUSBANDRY
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Vitamins for Dairy Cattle

Vitamins are classified into two major groups—fat soluble and water soluble. Fat soluble vitamins are stored in the fat or lipid portion of a feed and include vitamins A, D, E, and K. Water soluble vitamins include all the B vitamins and C. Under most conditions, vitamin needs are met through feeding high quality, natural feedstuffs; rumen fermentation; and tissue synthesis. Vitamins A, D, and E usually are found in significant amounts in excellent quality forages. All of the B vitamins and vitamin K are synthesized by rumen microorganisms, while vitamin C is made in the body tissues.

Vitamin D is important in the absorption and subsequent utilization of calcium and phosphorus from the intestinal tract. Deficiencies of vitamin D are exhibited through the effects of reduced calcium and phosphorus availability. The first symptoms of deficiency are decreased blood phosphorus and possibly blood calcium levels. These decreases are associated with swollen joints and fragile, weak bones that break easily. This condition is followed by stiffness, dragging of hind feet, tetany, labored breathing, and weakness. In some instances, silent heats and low fertility problems have been associated with sub-optimal levels of vitamin D.

VITAMIN A

All animals require vitamin A. Vitamin A is not found in feedstuffs as a vitamin but as carotene, a precursor to vitamin A. Carotene is converted to vitamin A within the animal's body—either in the intestinal wall or the liver. One milligram of carotene is equivalent to 400 USP or international units (IU) of vitamin A for cattle.

VITAMIN E

Compounds with vitamin E activity are known as tocopherols. While numerous forms of tocopherol exist and have antioxidant activity, they vary in vitamin E activity. Alpha tocopherol has the most activity. Vitamin E is used in many foods to prevent the oxidation of other vitamins.

Many factors affect the availability and utilization of vitamin A and carotene. Factors either reducing or destroying vitamin A potency are: 1) presence of nitrates in feedstuffs; 2) heating of feeds during storage; 3) long periods of storage; 4) exposure to air and sunlight; 5) oxidation of oils and fats in the ration; and 6) inadequate amounts of protein, phosphorus, and zinc in rations along with other nutrient interrelationships. Stressful conditions such as low environmental temperatures and sickness will increase vitamin A requirements.

Deficiencies of vitamin E are rare. A deficiency of vitamin E in calves is known as white muscle disease, with symptoms including weakening of the leg muscles, impaired tongue muscles preventing suckling, and eventual inability to stand. In older animals, sudden heart failure or heart muscle injuries are associated with chronic deficiencies.

Deficiencies of vitamin A include degeneration of the respiratory tract, mouth, salivary glands, eyes, tear glands, intestinal tract, urethra, kidneys, and vagina. Tissues affected are highly susceptible to infection, with colds and pneumonia often occurring. Diarrhea, loss of appetite, and emaciation are common. Latter stages of deficiency are characterized by changes in the eye—keratitis, inflammation of the eye, cloudiness of the cornea, night blindness, and finally permanent blindness. Pregnant cows exhibit deficiency symptoms through shortened gestation periods; high incidences of retained placentas; and birth of dead, blind, or incoordinated calves.

Off-flavored milk usually is the first deficiency symptom in lactating cows. Feeding high levels of vitamin E (400 to 1,000 milligrams per cow per day) has reduced oxidized flavors in milk; however, the cost is high because less than 2 percent of the feed vitamin E is transferred into the milk.

VITAMIN D

Vitamin D is known as the sunshine vitamin or antirachitic factor. Vitamin D occurs in two forms—D₂ and D₃. Vitamin D₂ most commonly is found in hays, yeast, and other plants, while D₃ is known as the animal form because of its occurrence in fish oils and irradiated milk. Both forms are equal in vitamin D potency and are stable during storage.

Green forages, leafy materials, and various oils (wheat germ and soybean) are good feed sources of vitamin E. Under most conditions, natural feedstuffs supply adequate amounts of vitamin E to dairy cattle. Large amounts of vitamin E can be stored in various body organs and tissues.

Sunshine or ultraviolet light converts certain compounds in the skin into vitamin D. While animals exposed to sunlight will synthesize some vitamin D, sunlight alone should not be depended on for all vitamin D needs. Calves or cows housed inside and not consuming 10 to 12 pounds of sun-cured hay per day should be supplemented with vitamin D. Grains, corn silage, milk, and other feeds not sun-cured are practically devoid of vitamin D.

VITAMIN K

Vitamin K activity is essential for normal blood coagulation. Green leafy materials (fresh or dry) are good sources of vitamin K. Vitamin K also is synthesized in large amounts in the rumen. Feeding moldy sweet clover causes deficiencies to appear. Symptoms of Vitamin K deficiency are hemorrhage or excessive bleeding.

VITAMIN C

Ascorbic acid or vitamin C is not needed in dairy cattle rations because of synthesis within the body. Only man, monkey, and guinea pig require dietary sources of vitamin C.

B VITAMINS

B vitamins are synthesized by rumen microorganisms, and most are abundant in natural feeds. Therefore, there is no evidence of a need for B vitamin supplementation for

animals with a functional rumen (6 weeks of age and older). The vitamins of the B complex are thiamine, riboflavin, pantothenic acid, niacin, biotin, vitamin B₁₂, folic acid, pyridoxine, and choline.

Under disease situations and during periods of stress, B vitamin production may be limited. Deficiencies of cobalt will lead to vitamin B₁₂ deficiencies characterized by anemia.

In calves, B vitamin deficiencies can result in: 1) *thiamine*—polyneuritis (poor coordination of legs, especially forelimbs), loss of appetite, severe diarrhea, dehydration, and death; 2) *riboflavin*—hyperemia (blood congestion) in mucosa of mouth, lesions, loss of hair, excessive salivation; 3) *pantothenic acid*—scaly dermatitis around eyes and muzzle, loss of appetite, diarrhea, convulsions; 4) *niacin*—sudden loss of appetite, severe diarrhea, dehydration, and death; 5) *biotin*—paralysis of hind legs, decreased urinary excretion; 6) *vitamin B₁₂*—poor appetite and growth, muscular weakness, anemia; 7) *pyridoxine*—loss of appetite, poor growth, epileptoid fits, grinding of teeth; 8) *choline*—extreme weakness, labored breathing, inability to stand.

VITAMIN REQUIREMENTS

Vitamin requirements for dairy cattle are related to body size and stage of gestation (table 1). Vitamins A, D, and possibly E should be balanced in adult dairy cattle rations. Calves fed whole milk should be supplemented with A, D, and E; but B vitamins are supplied in the milk. Milk replacers should contain vitamins A, D, E, and all of the B vitamins (table 2).

Table 1. Daily vitamin requirements for dairy cattle

Animal (weight)	Vitamin A (IU)	Vitamin D (IU)
Calves (100 lb)	1,900	300
Heifers (300 lb)	5,800	900
Heifers (600 lb)	11,500	1,800
Heifers (900 lb)	17,300	2,700
Dry cows (1,300 lb)	45,000 (50,000) ^a	---- (15,000) ^a
Lactating cows (1,300 lb)	45,000 (50,000) ^a	---- (15,000) ^a
Mature bulls (2,000 lb)	38,500	----

^aValues in parentheses are general recommendations for all milking and dry cows.

Table 2. Vitamin levels for calf milk replacers

Vitamin	Amount/lb
A	1720 IU
D	270 IU
E	300 IU
Niacin	2.6 ppm
Pantothenic acid	13 ppm
Riboflavin	6.5 ppm
Pyridoxine	6.5 ppm
Thiamine	6.5 ppm
Folic acid	.5 ppm
Biotin	.1 ppm
B ₁₂	.07 ppm
Choline	.26%

VITAMIN SUPPLEMENTATION

There are two methods of providing vitamins for dairy cattle—oral (via feed or water) and injectable.

The most common method is mixing a vitamin premix with the grain. Addition of 2 to 5 pounds of vitamin premix per ton of grain mix to supply 2,000 to 3,000 IU of A and 500 to 1,000 IU of D per pound of grain mix is adequate.

Vitamins A, D, and E can be injected intramuscularly. One dosage usually provides adequate levels of vitamins for up to 3 months, depending upon level and carrier of vitamins. Use of injectables during the dry period and for newborn calves will increase vitamin levels in the blood and tissues.

Vitamin A, D, and E levels of various feeds are listed in table 3.

Table 3. Vitamin A, D, and E level of some feedstuffs

Feed	Vitamin A (IU/lb)	Vitamin D (IU/lb)	Vitamin E (IU/lb)
Alfalfa hay (field dried)	14,000	905	26.0
Alfalfa hay (barn dried)	21,000	215	
Alfalfa hay (rained on)	4,500	---	
Alfalfa silage	7,000	322	
Timothy hay (field dried)	12,800	523	
Corn silage	9,700	54	
Shell corn	2,100	---	13.4
Oats	83	---	13.8
Barley	333	---	11.0
Soybean meal	167	---	2.0
Milk	677	12	

Extreme oversupplementation of vitamins for long periods should be avoided. This is true particularly for vitamin D. Massive doses (20,000,000 IU of vitamin D per day) started 3 days before calving and for a maximum of 7 consecutive days have been helpful in controlling milk fever. This level of vitamin D is toxic if fed longer than 7 days. Continuous year-round feeding of 30,000 IU of vitamin D per pound of grain per day reduces the incidence of milk fever in cows with a previous history of the disease, but increases milk fever incidence in cows that have not had the metabolic disorder.

IN SUMMARY

On most dairy farms, adequate vitamins or vitamin precursors are found in feedstuffs. Situations where additional vitamins are recommended are listed below. The vitamin(s) in parentheses should be supplemented.

- Forages stored for long periods (vitamin A)
- Frost damaged corn silage (vitamin A)
- High grain feeding (vitamins A, D, and E)
- Cattle housed indoors (vitamin D)
- Milk or milk replacer rations (vitamins A, D, and E)
- Residue crops (vitamins A and D)
- Weather damaged forage (vitamins A and D)
- Oxidized flavor in milk (vitamin E)
- Periods of stress (vitamins A, D, and E)
- Heat damaged, caramelized forage (vitamin A)

For further information, see:

- Feeding the Dairy Herd*, Extension Bulletin 218.
- Corn Silage in Dairy Cattle Rations*, Dairy Husbandry Fact Sheet 7.
- Nutritional Management of the Dry Cow*, Extension Folder 437.

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