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Science and Technology

GUIDE

Published by the University of Missouri - Columbia Extension Division

Minerals for Dairy Cattle

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Supplying minerals for all dairy cattle is common practice. However, the kind of minerals used and the method of feeding varies from one farm to another. The purpose of this guide is to present requirements, deficiency signs, supplements and methods of feeding.

Requirements

According to the National Research Council (NRC), dairy cattle require 15 minerals: calcium, phosphorus, magnesium, potassium, sodium, chloride, sulfur, iodine, iron, copper, cobalt, manganese, zinc, selenium, and molybdenum.

The NRC has set specific required levels for only calcium and phosphorus out of the 15 required minerals. Table 1 is a summary of NRC levels for selected kinds of dairy cattle.

Requirement values for the other essential minerals are less clear-cut. The antagonistic interaction between minerals in the animal body is worth considering when determining dietary levels. For example, a high level of zinc can interfere with copper and produce anemia.

The following discussion of essential minerals includes brief comments on their functions in the body, deficiency signs, approximate percentages needed in the ration and supplemental sources.

Calcium and Phosphorus. For many years calcium and phosphorus have been recognized as critical nutrients in dairy cattle rations. We will discuss them together since they are closely associated with each other in metabolism. We have listed some of the basic requirements for these minerals in Table 1. The ratio of calcium to phosphorus is important as well as the minimum levels listed. For lactating cows, a range from 1.2:1 to 2:1 is ideal.

These two minerals are essential for normal bone development, clotting of blood and maintenance of acid base equilibrium. A lack of available calcium in a cow system during periods of high calcium drain, as in early lactation, may result in "milk fever." This is not necessarily a lack of calcium in the diet, but more likely a failure of the animal to get enough calcium from bone reserves. Vitamin D is essential for absorbing calcium and phosphorus from the gut as well as for depositing the minerals in the bone. Cattle with access to sunlight are usually able to synthesize sufficient vitamin D.

Table 1. Calcium and Phosphorus Requirements For Large Breeds

Growth of Heifers Body Weight, Lbs.	*Pounds Calcium*	*Pounds Phosphorus*
100	.024	.015
200	.038	.020
400	.045	.030
800	.056	.041
Maintenance of Cows Body Weight, Lbs.	*Pounds Calcium*	*Pounds Phosphorus*
1000	.038	.030
1400	.048	.039
Maintenance and Reproduction		
1430	.085	.060
Milk Production	*Lbs. Per Lb. Milk*	
3.5% B.F.	.0026	.0018

Table 2. Supplemental Sources of Calcium

Supplement	*% Calcium*	*% Phosphorus*	*Calcium Phosphorus Ratio*
Steamed Bone Meal	29.0	14.0	2.14:1.0
Dicalcium Phosphate	22.7	18.0	1.26:1.0
Ground Limestone	34.0	—	

Three supplements are the primary sources used for calcium. These are steamed bone meal, dicalcium phosphate and limestone (calcium carbonate). Calcium is relatively inexpensive. You can buy it according to the approximate composition values listed in Table 2.

Supplements for phosphorus are usually more expensive

Table 3. Calcium and Phosphorus Sources

	Dry Matter (%)	*Crude Protein (%)*	*Estimated Net Energy (Therms/ lb.)*	*Ca (%)*	*Phos. (%)*	*Biological Value of Phosphorus*
Mineral Sources						
Ammonium Poly Phosphate (2)	95				14.0	
	100				14.7	95-110
Bone Meal Steamed	95	12.1	.11	28.9	13.6	
	100	12.7	.12	30.5	14.31	90-100
Curacao Rock Phosphate (4)	100			32.3	14.3	
	95			34.0	15.0	55-70
Defluorinated Rock Phosphate (3)	95			30.0	13.0	
	100			31.7	13.7	65-105
Diammonium Phosphate (1)	95				20.0	
	100				21.0	110-115
Dicalcium Phosphate	96			22.8	18.0	
	100			23.7	18.8	95-105
Monoammonium Phosphate (Monofos) (2)	95	68.7			24.0	
	100	72.8			25.3	110-115
Monocalcium Phosphate	95			14.2	22.8	
	100			15.0	24	120-130
Monosodium Phosphate	87				22.4	
	100				25.8	115-125
Sodium Tripoly Phosphate	96				24.9	
	100				26.0	100-105

(1) Contains 18-21% Nitrogen
(2) Contains 10-12% Nitrogen
(3) Must not contain more than one part fluorine to 100 parts of phosphorus; or not more than 0.18 percent fluorine.
(4) May be used only in such amounts that it will not raise the fluorine concentration of the total grain ration above 0.009%.
(Animal Nutrition and Health - September 1967)

than calcium sources. Several supplements are available and can be selected according to the percent of phosphorus and biological availability. Biological availability refers to that part of the phosphorus in the supplement which can be absorbed from the feed and used to satisfy the animal's requirements. Table 3 gives the composition and relative biological availability for several supplements.

Palatability studies of phosphorus supplements have shown a preference for acidic supplements. Dicalcium phosphate, monocalcium phosphate and monosodium phosphate are acidic.

Magnesium. Magnesium is an essential constituent of bones and teeth and is also required for various body processes, notably as an activator of various enzymes. The suggested magnesium requirement is 0.20 percent of the diet for lactating cows.

Early symptoms of magnesium deficiency in the calf are anorexia, irritability and greatly increased excitability. The calf becomes susceptible to convulsions, which cause it to fall on its side with its legs alternately rigidly extended and contracted. This disorder is most commonly known as grass tetany.

Lactating cows exhibit similar symptoms when suffering from grass tetany. The cows generally have convulsions and fall into a coma before dying six to 10 hours after the disorder appears.

The occurrence of grass tetany is most common when cattle are pastured on lush spring and fall pastures low in magnesium. Pastures are especially susceptible to low magnesium levels when fertilized highly with nitrogen. Under these conditions of potential grass tetany (lush, highly fertilized pastures in cool seasons), we suggest 0.25 percent magnesium for the high-producing lactating cows.

You can use dolomitic limestone, which contains magnesium, as a preventative measure when liming fields. We also recommend the addition of 0.2 to 0.3 percent magnesium oxide in the milking ration as a preventative measure.

Potassium. Limited research data indicate that the dietary potassium requirement for dairy cattle is between 0.5 and 0.8 percent. Most rations which contain a large percentage of forages are likely to be adequate in potassium, but there is a possibility of potassium deficiency in cattle fed high-concentrate diets.

Potassium is primarily a cellular constituent in the body, playing a vital role in muscle tissue where its content is six times that of sodium. The most notable potassium deficiency

signs are decrease in feed intake, pica, loss of hair glossiness, and decreased pliability of hides. Potassium chloride, containing 50 percent potassium, is a good source of the mineral. Each pound of potassium chloride added per ton of grain will increase potassium by 0.025 percent.

Salt (Soldium Chloride). The total requirement for sodium for lactating cows appears to be approximately 18 grams per cow daily. A level of 0.5 percent in the milking ration for lactating cows, along with supplemental free-choice salt, will usually meet the requirement. Salt stimulates salivary secretion and promotes the action of enzymes. There is no evidence of a specific lack of chlorine in dairy rations.

Symptoms of salt deficiency are an intense craving for salt, lack of appetite, haggard appearance, lusterless eyes and rough hair coat. Lactating cows show rapid loss of weight, failure of appetite, and a decline in milk production. Cows recover quickly and completely when rations again are supplemented adequately with salt. Sodium and chloride (salt) are the two generally accepted minerals which can be fed free-choice and animals will consume enough to meet requirements.

Sulfur. Sulfur, a long-neglected element, is receiving renewed attention in dairy rations. The dairy cow daily secretes large amounts of sulfur in her milk, so rations should include at least 0.20 percent sulfur. Recent research indicates greater nitrogen retention in the ruminant animal when sulfur is adequately supplied.

Sulfur deficiency may reduce fiber digestion, limit feed intake, and inhibit proper rumination. You can add sulfur in the form of a potassium-magnesium sulfate (Dyna-Mate) to a dairy ration at the rate of 0.4 percent.

Iodine. The only known function of iodine is as a component of the hormone thyroxine, which controls the rate of oxidation of all cells in the animal body. The production of dead calves with large goiters is an indication of iodine deficiency in the ration of pregnant cows. We recommend including 0.01 percent potassium iodide or its equivalent in salt. This should be adequate to meet the requirements.

Iron. Iron deficiency seldom occurs in dairy cattle under natural conditions except in young animals fed only milk or where there is a severe loss of blood because of parasitic infestations or disease. The NRC has not set a definite iron requirement for mature cattle. But, iron is essential for normal blood and enzymes, and a general anemic condition indicates deficient iron levels.

Copper. Ruminants need a small amount of copper along with iron for normal hemoglobin formation in the blood. A lack of copper causes severe diarrhea; rapid loss of weight; and rough, coarse, bleached hair coat. We recommend adding 0.5 percent copper sulfate to salt in copper-deficient areas.

Cobalt. The most conspicuous symptom of a cobalt deficiency is failure of appetite. This results from a decreased microbial synthesis of the cobalt-containing vitamin B_{12} in the rumen. A slight deficiency may result in below-normal production and may be difficult to diagnose. Adding 0.06 percent cobalt sulfate to the salt in a dairy ration is an effective means of supplementation in most areas.

Manganese. The dietary requirement for manganese is low (0.002 percent of dry ration), but high intakes of calcium and phosphorus increase the requirement. Heifers fed manganese-deficient diets are slower to exhibit estrus and slower to conceive. Trace mineralized salt containing at least 0.157 percent manganese is a satisfactory source for this element. You can use Manganous oxide for manganese supplementation.

Zinc. Zinc is essential in the diet of dairy cattle, although there is no set daily dietary requirement. Cattle deprived of zinc lose weight and develop swollen feet with open, scaly lesions. Wounds often fail to heal normally.

The estimated zinc requirement for dairy cattle is 0.004 percent of the ration. Trace mineralized salt containing a minimum of 0.254 percent zinc is a satisfactory means of supplementation. Zinc oxide is a common source for zinc supplementation.

Selenium. Researchers have shown that in cows fed diets deficient in selenium, the inclusion of adequate selenium decreases the incidence of retained placentas. However, an excessive amount of selenium is toxic, causing alkali disease. The lowest toxic levels appear to be three to five ppm.

Early in 1979 the FDA approved the use of selenium for dairy cattle. You can use it for complete feed (total ration) at levels not to exceed 0.1 ppm. You can incorporate it into feed as follows:

1. Into each ton of complete feed for dairy cattle by a premix containing no more than 90.8mg of added selenium and weighing not less than 1 pound.
2. Into salt mineral mixtures for dairy cattle by a premix containing no more than 18g added selenium in not less than 4 pounds premix.

Molybdenum. The discovery of molybdenum as an important constituent of xanthine oxidase, which is found in animal tissues and milk, generated new interest in the need for this mineral element. Copper and molybdenum are antagonistic to each other in the animal's body, and a low level of copper in the diet may allow molybdenum to build up toxic levels. Common ration ingredients usually contain adequate levels of molybdenum.

Balancing Minerals in a Ration

Select mineral supplements to balance the total feed program. Consider the total feed intake when selecting the mineral supplement. Table 4 illustrates the mineral requirements for a 1,400-pound cow producing 65 pounds of 3.5 percent milk, as calculated from UMC Guide 3104.

Calculating Rations for Dairy Cattle

We listed three different forage programs with the mineral intake provided by each. These forage intake levels are based on research data indicating that a dairy cow will eat about 1.5 percent of her body weight in the form of average-quality forage dry matter.

Values under the heading "Pounds Minerals Needed" in Table 4 represent the difference between the mineral levels in the forages and the requirement. The percentage of each mineral still needed in the grain mix is listed in the last column. To determine percentages of minerals needed in a grain ration, divide pounds of each mineral needed by pounds of milking ration to be fed, and multiply by 100. (Refer to UMC Guides 3104 and 3108.)

Notice that phosphorus is deficient in all three examples in Table 4. Therefore, phosphorus should be added to the milking ration.

When the calcium supplied by an all legume (alfalfa hay) greatly exceeds the requirement (creates a wider Ca: P ratio than 2.0:1), it may be necessary to raise the phosphorus level to maintain a desirable calcium to phosphorus ratio. When this situation occurs, assume a level of about .10 percent calcium in the average grain mix when figuring total calcium intake.

Using an amount of 20 pounds of grain fed, the calculations are as follows: (20 x .10 ÷ 100) = .020 pound of calcium provided in the milking ration before minerals are added. This must be added to the .40 pound calcium provided by the alfalfa for a total intake of .42 pound calcium. This means that to

Table 4. Determining Percent Calcium and Phosphorus in Grain Mix To Meet Requirements.

Requirements Lbs.		Forage Intake Lbs.	Pounds Minerals Supplied		Pounds Minerals Needed		% Needed in Grain Mix*	
Calcium	*Phosphorus*		*Calcium*	*Phosphorus*	*Calcium*	*Phosphorus*	*Calcium*	*Phosphorus*
.22	.16	Alfalfa hay, 24 1/10 bloom	.40	.06	+.18	−.10	—	0.75
		Alfalfa hay, 12 Corn silage, 30	.23	.05	+.01	−.11	—	0.55
		Alfalfa hay, 5 Corn silage, 50	.13	.05	−.09	−.11	0.45	0.55

*Assume 20 pounds grain mix daily

maintain a calcium to phosphorus ratio of approximately 2:1, the level of phosphorus must be raised above the required levels in the grain mix.

In the all-alfalfa example, determine the amount of phosphorus needed to maintain the 2.0:1 ratio (calcium to phosphorus) as follows: .42 pound calcium ÷ 2.0 = .21 pound of phosphorus.

Table 4 indicates that .06 pound of phosphorus is already being supplied by the alfalfa. Therefore, .15 pound (.21 - .06) of phosphorus is needed in the milking ration. Assuming a grain intake of 20 pounds per day, divide .15 pound by 20 pounds x 100 to get a .75 percent phosphorus level needed to meet phosphorus requirements and to correct the calcium to phosphorus ratio in the milking ration. (Where legumes do not provide excessive calcium, follow guideline in Guide Sheet 3104.)

Mineral mixtures chosen for free-choice feeding should contain a calcium to phosphorus ratio between 1:1 and 2:1. A good choice for this purpose is dicalcium phosphate.

Commercial mineral mixtures with a phosphorus content of 12 percent or above usually are superior.

You can meet trace element requirements by adding trace mineralized salt at the rate of 0.5 percent in the milking ration. You can feed trace mineralized salt free-choice with a mineral mixture. One source of trace minerals should be adequate.

Ration Balancing Service

Proper mineral supplementation is important to insure high production and healthy animals. The UMC dairy department offers a computerized least-cost dairy ration program that takes the guesswork out of balancing rations. You can use the program to balance rations for the milking herd, dry cows, heifers or calves. For more information concerning computer rations, contact your area dairy specialist or the Dairy Department, 126 Eckles Hall, University of Missouri-Columbia, Columbia, Missouri 65211.

■ Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 1914 in cooperation with the United States Department of Agriculture. Leonard C. Douglas, Acting Director, Cooperative Extension Service, University of Missouri and Lincoln University, Columbia, Missouri 65211. ■ An equal opportunity institution.