Beef Cattle Mineral Nutrition

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This publication gives a brief overview of minerals that have the greatest impact on livestock productivity

Minerals make up a small portion of an animal's diet; however, they play an important role in health, growth and reproduction. The National Research Council (NRC 1984, 1996) has established mineral requirements for beef cattle. Many variables affect an animal's mineral status, including soil and plant mineral compositions, climate, breed and stage of production. This publication gives a brief overview of minerals that have the greatest impact on livestock productivity. Requirements, deficiency and toxicity levels will be provided with the intent that they be used as a management tool.

Macrominerals

This class of minerals is required in larger amounts than trace minerals, and usually is expressed as a percentage of the diet or grams per day, rather than parts per million (ppm).

Calcium and Phosphorus

Animals' calcium (Ca) requirements cannot be considered independently of phosphorus (P) since these two minerals work hand in hand. Calcium and phosphorus are the major mineral constituents of bone. Calcium also plays an important role in muscle function, whereas phosphorus is key to major metabolic functions throughout the body (carbohydrate, protein and fat metabolism, and nerve and muscle function). For example, when a bag of mineral supplement describes a 12:12 ratio on its feed label, it is referring to the Ca and P concentration in the supplement. In this example, the product ontains 12 percent Ca and 12 percent P (Table 1).

For grazing ruminants, Ca generally is adequate in forages (especially legumes). Phosphorus, however, can be deficient in these forages, and since legumes contain higher levels of Ca, supplemental phosphorus generally is needed in forage-based diets. When feeding or grazing legumes, provide a mineral supplement that is higher in phosphorus than calcium to keep the Ca:P ratio in a desired range. If the Ca:P ratio exceeds 10:1, or phosphorus remains deficient, reduced growth, feed efficiency and reproduction will result. For more information about phosphorus requirements, see the NDSU Extension publication AS-1286, "Phosphorus Supplementation and Requirements in Beef Cows."

For cattle on a high-concentrate diet, the opposite problem exists. Most cereal grains are much higher in P than Ca; therefore, Ca must be added to the ration. When Ca:P approaches 1:1, or P intake exceeds Ca, reduced feed intake and urinary calculi (water belly) can result in steers and bulls.

In addition, if Ca is not supplemented in adequate amounts, Ca deficiencies can result. These deficiencies will not become apparent, however, until broken bones, convulsions and death occur. Based on extensive research on these two minerals, optimal performance occurs when the Ca:P ratio in beef cattle diets ranges from 1.5:1 to 2:1. However, performance typically is not adversely affected unless the dietary Ca:P ratio exceeds 6:1.

Table 1.Brand X mineral supplement[a].

Mineral	Feed Tag Specifications	Will supply to total diet[b]	Percentage of NRC Recommendation	NRC Recommendation[c]
Calcium, %	12.0	0.155	40.63	0.27%
Phosphorus, %	12.0	0.091	46.23	0.23%
Salt, %	10.0	0.086	122.86	0.07%
Magnesium, %	4.0	0.036	36.36	0.10%
Potassium, %	3.0	0.027	4.20	0.65%
Cobalt, ppm	10	0.047	47.00	0.10
Copper, ppm	2,800	6.363	63.63	10.00
Iodine, ppm	70	0.439	87.81	0.50
Manganese, ppm	5,600	18.325	45.81	40.00
Selenium, ppm	0.3	0.073	5.45	0.20
Zinc, ppm	5,500	17.998	59.99	30.00
vit A, IU/lb	300,000	75,000	3.38	2,215,909
vit D, IU/lb	25,000	6,250	181.82	3,438
vit E, IU/lb	400	100	16.00	625

[a] Information provided by the Missouri Ag Beef Focus Team, University of Missouri, Columbia.

[b] Supply to total diet based on 4 oz. intake per day

[c] Requirements are estimated based on dietary and animal factors (age, sex, stage of production) from NRC 2000 Nutrient Requirements of Beef Cattle.

Sulfur

Sulfur (S) is unique in that it is the only trace mineral incorporated into amino acids (specifically, methionine and cystiene). Amino acids are the building blocks for protein. Rumen microorganisms use inorganic sulfur to form their own sulfur-containing amino acids. Sulfur has many dietary sources. Soybean products, alfalfa hay and corn byproducts have relatively high levels of sulfur.

Thiamin and biotin (vitamins), as well as certain enzymes, also are sources of S. Water can contain high levels of sulfur, as well. Cereal grains, such as corn or oats, generally range from 0.14 percent to 0.23 percent S; protein sources, such as soybean meal, can contain as much as 0.5 percent sulfur. Forages tend to be more variable. Alfalfa, for example, typically will range between 0.25 percent and 0.50 percent S, whereas grass hays, such as brome or prairie, contain little or no sulfur. Cattle on pasture require 0.15 percent S in their diet.

Deficiencies in S are not common. However, when a deficiency exists, signs include poor appetite, emaciation and dullness. In addition, low levels of dietary S can result in poor utilization of nonprotein nitrogen (NPN), which in turn reduces microbial growth and fermentation.

The sulfur level is critical in growing and finishing rations. These diets, which typically are high in S and low in fiber, can induce an S toxicity. Sulfur toxicity can interfere with selenium, copper, molybdenum and thiamin metabolism.

South Dakota State University (Patterson, et al., 2003) recently reported data indicating intake and average daily gain decreased in feedlot cattle as sulfate levels in water increased. In addition, cattle developed a disease known as polioencephalomalacia (PEM; commonly referred to as polio), when S levels in the water were greater than 100 milligrams/liter. This disease affects the nervous system. Symptoms include blindness, difficulty walking, muscle tremors, convulsions and ultimately death. Producers concerned about sulfur should have their water tested before they implement a sulfur supplementation program.

Sodium and Chloride

Sodium (Na) and chloride (Cl) work together to maintain cellular volume, pH and osmolarity (water balance) of body fluids, such as blood. Sodium chloride (NaCl) promotes water intake, which will help maintain or improve milk production and overall herd health. Individually, Cl is involved primarily in hydrochloric acid production in the abomasum (stomach) to aid in digestion. Sodium works in conjunction with potassium (K) for nutrient transport into and out of cells. On average, cattle should consume 11 to 15 grams of salt per day to meet nutritional requirements.

Both elements can be consumed, and usually are, in relatively high amounts without negative effects, but dietary levels of NaCl should not exceed 8 percent. Excess dietary salt simply is excreted in the urine. Commercially, salt often is used as an intake limiter for self-fed supplements. However, keep in mind that when salt is used to limit intake, it dilutes remaining nutrients in the feed. Producers also run a risk of overfeeding salt.

When toxicities do occur, symptoms include reduced milk production and weight loss. Adequate water availability and intake can reduce the risk of toxicity. To reduce salt intake, use a salt block rather than a loose granular supplement. Deficiencies in sodium can occur in forages that are high in potassium (K) due to fertilization. Deficiency symptoms of Na include reduced milk production, body condition, intake and growth. Chloride requirements have not been determined fully. Since most forages in the north-central region of the United States are low in sodium and chloride, producers should use a salt supplement (Table 2).

Potassium

Like sodium (Na), cattle need potassium (K) in large amounts to maintain normal body and organ function. Potassium works in conjunction with Na in the body to transport nutrients in and out of cells. It also helps maintain health by maintaining the cellular water balance (osmotic pressure). Increased levels of K in the animal's system will demand an equal increase in Na to maintain homeostasis in the body's cells.

Most forages typically supply adequate amounts of potassium. In fact, K can be so high in some cool-season grasses and legumes that it can accelerate the onset of grass tetany by inhibiting magnesium (Mg) absorption. In this case, producers need to provide magnesium supplementation.

In high-concentrate diets, K levels may become deficient since corn grain and most corn byproducts are low in K. Corn silage, however, is an excellent source of K. Cattle require 0.6 percent to 0.7 percent K in the ration (DM basis). Most forage sources are relatively high in K (1 percent to 2 percent), whereas cereal grains are lower (0.30 percent to 0.36 percent). Deficiencies in K can result in reduced intake, weight loss and stiff joints. Cattle stressed due to long shipping distances may require increased levels of K to replenish lost body reserves.

Producers have reported deficiencies in K in grazing situations during the winter months, particularly for cattle grazing cool-season grass pastures. Potassium can leach out of the plants during dormancy. A mineral supplement containing at least 1 percent K can remedy deficiencies easily.

Table 2. Mineral requirements based on stage of production, maximum tolerable levels and the greatest impact on performance in beef cattle. [a]

Mineral	Growing-Finishing BW 650 lbs	Gestating Dry Cows BW 1,250 lbs	Lactating Cows BW 1,200 lbs	Max. Tolerable	Performance Impacted
Ca, %	0.31	0.18	0.27	1.8	Growth
P, %	0.27	0.18	0.27	0.3	Growth
Na, %	0.07	0.07	0.10	4.0	Milk Prod.
Cl, %	□	□	□	4.0	Milk Prod.
Mg, %	0.10	0.12	0.20	0.40	Growth
S, %	0.15	0.15	0.15	0.40	Growth
K, %	0.60	0.60	0.70	3.0	Reprod.
Co,	0.10	0.10	0.10	10.0	Growth

ppm					
Cu, ppm	10.0	10.0	10.0	100.0	Growth
I, ppm	0.50	0.50	0.50	50.0	Milk Prod.
Mn, pm	20.0	40.0	40.0	1000.0	Reprod.
Se, pm	0.10	0.10	0.10	2.0	Immunity
Zn, ppm	30.0	30.0	30.0	500.0	Immunity

[a] Requirements based on values provided by NRC, 2000, and expressed in concentration (% or ppm).

Trace Minerals

Producers need to pay attention to dietary levels and the animal's requirements to meet their herd's needs cost effectively.

This class of minerals is required in very small amounts. Requirements typically are expressed in feed in parts per million (ppm), or milligrams per kilogram body weight (mg/kg), both of which are concentration units. Although these minerals are required in small amounts, they still play important roles in normal body function (Table 2).

Cobalt

Colbalt's (Co) primary function in the ruminant animal is to provide a substrate for the rumen microbes to produce vitamin B_{12}. Vitamin B_{12} is used in the rumen microbes' metabolic processes to produce proprionate (a volatile fatty acid and an important energy source for the animal). When present in the large intestine, Co also can be a substitute for Zn in the production of specific protein-degrading enzymes. Although the animal doesn't absorb Co readily, the involvement of Co in vitamin B_{12} production makes it an important mineral.

Deficiencies of Co are far more common than toxicities, as cattle can tolerate up to 300 times their requirement (0.10 ppm). When deficiencies occur, signs include depressed appetite, listlessness, decreased growth, reduced milk production and rough hair coat. Fortunately, Co typically is adequate in summer range forages and many silages. However, including this mineral in feeding programs, particularly when feeding dry forage, provides added insurance with little risk. Cobalt is found in most trace mineral supplements. The feed tag may not list its inclusion rate, but Co should be listed under the ingredient portion of the tag (Table 1).

Copper and Molybdenum

Red-blood cell health, collagen development, reproduction and immunity are just a few of the important roles of copper (Cu). Copper also works in conjunction with molybdenum (Mo) and inorganic sulfur to create several important enzymes involved in nucleotide and vitamin metabolism. Consequently, a balance between
Cu and Mo is important. A ratio of 2:1 to 4:1 (Cu:Mo) allows for optimal performance in grazing cattle.

Many soils contain approximately 1.5 ppm Mo, which is adequate in meeting the animal's needs. If a soil is alkaline (> 7.0, pH) or is high in Ca (> 1.5 percent), Cu
availability is reduced. As a result, the Cu:Mo ratio can be altered and Cu supplementation may be needed. Semiarid regions, such as North Dakota, tend to be more alkaline.

In addition, if cattle are exposed to high levels of zinc (Zn), iron (Fe) or phosphorus (P), Cu absorption and function can be reduced. This, in turn, can result in reduced performance; thus producers have an increased need for Cu supplementation.

Typically, primary Cu deficiencies (deficiencies that result from low dietary copper) are rare in the northern United States; however, many forages in North Dakota are low in Cu. As a result, producers commonly supplement the forages. Deficiency signs include lighter or faded hair coats, reduced conception rates, severe diarrhea, brittle bones and reduced immune response.

Because Cu interacts with many other minerals (Fe, Mo, S, Se, Zn), secondary deficiencies can occur, as well. Secondary Cu deficiencies occur when dietary Cu is made unavailable by interactions with antagonists such as Fe, Mo, S, Se or Zn present in the diet or water. For example, dietary levels of Cu (8 to 10 ppm) may be adequate, but deficiency signs still are evident if elevated levels of S (> 0.4 percent), Zn (> 500 ppm) or Mo (> 150 ppm) are in the diet. When these minerals are in excess, they compete with Cu for absorption sites in the intestinal mucosa. They also form thiomolybdate complexes, which renders Cu unavailable to the animal.

Copper toxicities can occur in cattle when dietary levels exceed 100 ppm, although toxicities are much more common in sheep (toxicity occurs at 25 ppm). Chronic exposure to high levels of Cu results in rapid breathing, elevated temperature, anorexia, dehydration and jaundice. When evaluating a mineral supplement package, the source of Cu is as important as the content. Soluble forms of Cu, such as copper sulfate ($CuSO_4$) or copper chloride (CuCl), are absorbed more readily than copper oxide (CuO). In addition, when feeding a high Zn supplement, have adequate levels of Cu to counteract the negative interaction that still exists with Zn.

Iodine

Although required at relatively low levels (0.5 ppm), iodine (I) is key in maintaining a normal metabolic rate through its role in producing the hormone thyroxin (T4) from the thyroid gland. Deficiencies of this mineral are far more prevalent in the northern United States than toxicities. When I is deficient, thyroxin production is reduced because the body attempts to conserve I. Lower levels of thyroxin result in lower metabolic rates, which in turn will affect milk production, weaning weights and overall herd health.

Cows deficient in I may have calves that are born blind, weak, hairless or stillborn. In addition, goiter development is common. A goiter is an enlargement of the thyroid gland. It was a significant problem in humans and livestock for many years, and eventually was linked to high levels of fluoride inhibiting the uptake of I. Once researchers discovered the source of the problem, iodized trace mineral salt supplements were developed.

Magnesium

Grass tetany, a metabolic disease in cattle grazing lush, cool-season grasses, is the primary association with magnesium (Mg). The root of this disease is in magnesium's role in biological function. Magnesium is a key component in the initiation of many metabolic enzymes and pathways, and also is important in neuromuscular function.

Magnesium deficiencies reduce calving rates, calf vigor and rate of gain in calves. Low Mg in the grass doesn't cause poor calf performance directly, but it does reduce the cow's milk production. If the cow's Mg requirements are not met, reduced conception rates would be the primary deficiency symptom.

Grass tetany, also termed hypomagnesemia, simply means a deficiency in Mg. Prolonged Mg deficiency results in excessive urination, erratic and nervous behavior (also called grass staggers), twitching of facial muscles, convulsion and death. While all ruminants are susceptible to the disorder, older lactating cows are at the greatest risk. Grazing lush, rapidly growing, cool-season grasses usually are associated with grass tetany.

In northern regions, where producers feed more harvested forages, winter tetany can be a problem. Many grass hays and cereal grain hays, such as oat hay, typically are low in Mg (< 0.15 percent) and high in K. When Mg levels in hay fall below 0.12 percent, cattle may become vulnerable to Mg deficiency.
In addition, if calcium levels are low and potassium levels are high in these feed sources, winter tetany can result. Legume-based hays, however, generally have adequate (0.27 percent to 0.33 percent) Mg.

Drought conditions often result in increased use of these hays and crop residue alternatives. Drought-stressed annual forages typically are higher in K, which also contributes to the condition. Feeding a mineral supplement high in Mg should prevent problems associated with grass or winter tetany. Magnesium oxide (MgO_2) typically is used as a source of Mg in most supplements. It is not palatable, however, and requires blending with other more palatable ingredients to achieve sufficient intake.

Manganese

Manganese (Mn) plays an important role in growth and reproduction. As dietary levels of Mn increase, concentrations of the mineral increase in reproductive tissues, offering a direct link between Mn and fertility. Manganese is linked to growth through its involvement in specific enzyme functions related to skeletal cartilage. Ironically, Ca and P (which are linked to bone growth) can inhibit Mn absorption when fed in excess.

Requirements may vary depending on the stage of production. For example, growing and finishing

cattle require 20 ppm in the diet (or approximately 200 mg/d),
while pregnant, lactating cows require 40 ppm (or 400 mg/d). As with Co, Mn has a fairly large "safe" feeding range. The maximum tolerance for the mineral can be as high as 1,000 ppm before it causes noticeable negative effects. However, Mn interacts with many different minerals, which can alter the animal's tolerance level for Mn and the minerals with which it interacts.

If Mn requirements are not met, reduced conception rates can occur. Other results include poor growth rates, low birth weights and increased abortions.

Selenium

Selenium (Se), in conjunction with Vitamin E, boosts immune function and the development of antioxidant enzyme systems. Recently, medical research has indicated that Se, in the form of selenomethionine, can reduce rates of certain types of cancers in humans, including skin, lung, prostate and colon cancers.

In the past, producers have had trouble managing problems associated with Se because its tolerance range is quite narrow (< 0.2 ppm is considered deficient and 5 ppm is toxic). The FDA states that no prepared complete feed can contain more than 0.3 ppm of Se in the mix. Mineral supplements for cattle may contain up to 120 ppm of Se, provided the total daily intake does not exceed 3 mg of Se per head per day.

Recent research conducted at NDSU indicates that Se tolerance may be greater than originally thought. The source of Se appears to influence tolerance. When the source of Se is organic (associated with either methionine or cysteine amino acids), Se has a greater impact on the liver and small intestine, compared with
Se from an inorganic source such as selenate ($SeNO_3$). Although the maximum dietary level of Se tolerance in beef cattle has been estimated to be 2 ppm (NRC, 1980), recent evidence suggests dietary levels as high as 3 ppm have no ill effect on performance.

Toxicities and deficiencies are very dependent on soil composition. In the north-central United States, soil Se content is relatively high (> 2 ppm). As with Cu, Se levels in the soils and plants are greater in arid regions with high Ca content in the soil. In some of these regions, toxicities ("blind staggers," sloughing of hooves and hair, anorexia and a wide range of birth defects) can develop.

Deficiencies of Se more commonly are found in the Pacific Northwest, Great Lakes and Atlantic Coastal Range, and are associated with disorders such as white muscle disease (primarily in sheep), retained placentas and reduced reproductive efficiency. If evidence of these symptoms and disorders occur, producers may need to have additional diagnostic work to confirm a Se deficiency.

Zinc

Zinc (Zn) plays a role in immune response, enzyme systems and hoof health. Zinc also plays an important role in DNA, RNA and protein production. Because of this wide scope and the body's demand, it is required at levels of 30 ppm. Forages, grains and proteins all are sources of Zn. Forages average 20 ppm, cereal grains average 35 ppm and protein sources average between 60 and 70 ppm. When cattle are fed forage-based diets or when cattle are stressed, producers may need to provide Zn supplementation.

Signs of deficiency include reduced feed intake and weight gain, excessive salivation, rough hair coat and eventually swelling of the feet and legs. Critical Zn deficiencies result in hair loss, thickening of skin, and lesions around the nose and mouth. Zinc levels should not exceed 1,000 ppm or it will affect performance and toxicity can develop.

Reading a Mineral Tag

With all of the products on the market, deciding on the appropriate supplement can be a daunting task. Table 2 shows a commercial mineral supplement designed to be fed to brood cows on native pasture or being fed grass hay.

This product is considered a complete mineral because it has 10 percent salt in the mix. Therefore, no additional salt needs to be offered.

In evaluating this product, it appears to fall short of all but one mineral component - salt. This supplement, however, is designed to be fed on pasture or with a good quality forage base. Proper intake of quality forage should help meet the cow's mineral requirements adequately.

The appropriate intake for this particular example should average 3 to 4 ounces per head per day. Mineral products that contain less than 5 percent salt are considered mineral concentrates. In this situation, intakes of the product will be less - about 2 ounces per day. In addition, producers must provide free-choice salt to ensure the cow meets its sodium requirement. Producers need to monitor supplement intake to determine if their cattle are eating enough or too much of a mineral supplement. Mineral intake records may help answer questions if performance or reproductive problems arise.

Other things to consider are the source of the minerals on the supplement's ingredient list. In general, most oxide-based minerals (for example, copper oxide) are less available to the animal compared with sulfate, carbonater or chloride forms of minerals.

Sources of Minerals

Chelated Minerals

Chelated minerals are metals bound to an organic compound such as an amino acid. Because chelated minerals are associated with organic compounds, they appear to be absorbed in the small intestine more readily. Inorganic mineral sources generally are associated with oxygen, chloride or other noncarbon-based compounds.

Stress can result in a reduced rate of nutrient absorption. In situations where inorganic mineral sources have not proven effective, feeding a chelated mineral package may prove beneficial.

Chelated minerals generally are more expensive (averaging $1.50/pound) than inorganic minerals (35 cents/pound). Many commercial mineral supplements provide a combination of inorganic and chelated mineral sources.

Table 3 gives the mineral composition and relative bioavailabilities of common ingredients in mineral supplements. Many different mineral sources are available for use in beef cattle diets. Check the mineral tag to be sure the ingredients being used are high in bioavailability.

Table 4 gives the mineral composition of common mineral supplement ingredients. Many mineral ingredients are sources of several minerals. For example, dicalcium phosphate contains calcium and phosphate, as well as several trace minerals. Be sure to select the appropriate ingredient for your application.

Table 3. Source, empirical formulas, mineral concentrations and relative bioavailabilities of common mineral sources.

Mineral	**Supplement**	**Empirical formula**	**Mineral concen-tration (MC, %)**	**Relative bioavail-ability (RV)**	**Mineral avail-ability (MC x RV)**
Calcium	Calcium carbonate	$CaCO_3$	38	100	38.00
	Bone meal	variable	24	110	26.40
	Calcium chloride (dihydrate)	$CaCl_2 (H_2O)$	31	125	38.75
	Dicalcium phosphate	$Ca_2(PO_4)$	20	110	22.00
	Limestone		36	90	32.40
	Monocalcium phosphate	$Ca(PO_4)$	17	130	22.10
Cobalt	Cobaltous sulfate	$CoSO_4 (H_2O)7$	21	100	21.00
	Cobaltic oxide	Co_3O_4	73	20	14.60
	Cobaltous carbonate	$CoCO_3$	47	110	51.70
	Cobaltous oxide	CoO	70	55	38.50
Copper	Cupric sulfate	$CuSO_4 (H_2O)5$	25	100	25.00
	Copper EDTA	variable	variable	95	variable
	Copper lysine	variable	variable	100	variable
	Cupric chloride (tribasic)	$Cu_2(OH)3 Cl$	58	115	66.70
	Cupric oxide	CuO	75	15	11.25
	Cupric sulfide	CuS	66	25	16.50
	Cuprous acetate	$CuC_2O_2H_3$	51	100	51.00
Iodine	Potassium iodide	KI	69	100	69.00

Sodium iodide	NaI	84	100	84.00
Calcium iodate	Ca(IO)3	64	95	60.80
Diiodosalicyclic acid	$C_7H_4I_2O_3$	65	15	9.75
Ethylenediamine dihydriodine	$C_2H_8N_2$ (HI)2	80	105	84.00
Pentacalcium orthoperiodate	$Ca_5(IO_6)_2$	39	100	39.00

Mineral	**Supplement**	**Empirical formula**	**Mineral concen-tration (MC, %)**	**Relative bioavail-ability (RV)**	**Mineral avail-ability (MC x RV)**
Iron	Ferrous sulfate heptahydrate	$FeSO_4(H_2O)_7$	20	100	20.00
	Ferric citrate	variable	variable	110	variable
	Ferric EDTA	variable	variable	95	variable
	Ferric phytate	variable	variable	45	variable
	Ferrous carbonate	$FeCO_3$	38	10	3.80
Magnesium	Magnesium sulfate	$MgSO_4$	20	100	20.00
	Magnesium acetate	$MgC_2O_2H_4$	29	110	31.90
	Magnesium basic carbonate	$MgCO_3$	31	100	31.00
	Magnesium oxide	MgO	55	100	55.00
Manganese	Manganese sulfate	$MnSO_4(H_2O)$	30	100	30.00
	Manganese carbonate	$MnCO_3$	46	30	13.80
	Manganese dioxide	MnO_2	63	35	22.05
	Manganese methionine	variable	variable	125	variable
	Manganese monoxide	MnO	60	60	36.00
Phosphorus	Sodium phosphate	$NaPO_4$	variable		variable
	Bone meal	variable	21	100	21.00
	Defluorinated phosphate	variable	12	80	9.60
	Dicalcium phosphate	$CaHPO_4$	18	85	15.30
Selenium	Sodium selenite	Na_2SeO_3	45	100	45.00
	Cobalt selenite	variable	variable	105	variable
	Selenomethionine	variable	variable	245	variable
	Selenoyeast	variable	variable	290	variable
Sodium	Sodium chloride	NaCl	40	100	40.00

	Sodium bicarbonate	$Na(CO_3)_2$	27	95	25.65
Zinc	Zinc sulfate	$ZnSO_4(H_2O)$	36	100	36.00
	Zinc carbonate	$ZnCO_3$	56	60	33.60
	Zinc oxide	ZnO	72	100	72.00

Adapted from: Ammerman, C.B., D.H. Baker, and A.J. Lewis. 1995.
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Table 4. Composition of common mineral supplement ingredients (DM basis).

Supplement	Calcium %	Phosphorus %	Sodium %	Potassium %	Magnesium %	Manganese ppm	Iron ppm	Copper ppm	Zinc ppm	Selenium ppm
Calcium carbonate	38.00	□	0.06	0.06	0.50	279.00	336.00	24.00	□	0.07
Diamonium phosphate	0.50	20.00	0.04	□	0.45	500.00	15000.00	80.00	300.00	—
Defluorinated phosphate	33.00	18.00	4.50	0.09	□	220.00	9200.00	22.00	44.00	0.60
Dicalcium phosphate	20.00	18.50	0.08	0.07	0.60	300.00	10000.00	80.00	220.00	0.60
Mono-dicalcium phosphate	16.00	21.00	0.05	0.06	0.50	220.00	7000.00	70.00	210.00	0.60
Mono-ammonium phosphate	0.50	24.00	0.06	□	0.45	500.00	12000.00	80.00	300.00	—
Sodium phosphate	□	21.80	32.30	□	□	□	□	□	□	□
Sodium tripolyphosphate	□	25.00	31.00	□	□	□	42.00	□	□	□
Phosphoric acid (75 percent)	□	23.80	□	□	□	□	5.00	□	□	□

Adapted from: Mineral Supplements for Beef Cattle, University of Missouri Extension, Chad Hale and K.C. Olson, and

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Summary

Minerals are very important for normal bodily function and physiological processes such as lactation and reproduction. Producers need to pay attention to dietary levels and the animal's requirements to meet their herd's needs cost effectively. The stage of production and forage quality dictate mineral demand. For the brood cow, overall mineral requirements are greatest during the last trimester of pregnancy through 90 days post-calving.

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