Understanding and Utilizing Feed Tags for Effective Mineral Supplementation

Feed tags on mineral supplements, unlike other types of commercial feeds, can be very useful in evaluating the relative value of mineral supplements if one has a basic understanding of what to look for and how to use the information. One thing to evaluate is how much of an animal's requirement is supplied by the supplement in question. To accomplish this, the animal's nutrient requirements must be known. Determining an animal's requirements can be difficult depending on the nutrient in question. For example, the major nutrients such as energy, protein, calcium, and phosphorous are dependent on type or class of animal and stage of production (i.e. gestation vs. lactation). Trace mineral requirements, as reported by the 1996 NRC, indicate little variation due to class of animal or stage of production with the possible exception of stressed animals (Table 1). To further complicate these issues, forage is constantly changing due to forage type and stage of maturity. While these difficulties cannot be eliminated, a few steps can be taken to significantly simplify the process.

Evaluation of Grazing Brood Cow Mineral Supplementation

An AMPT™ mineral tag is shown in Figure 1 and will be referred to in this discussion. The tag shown is an actual tag from AMPT-T. The first thing to consider in making a purchasing decision is the number of guarantees available on a tag. From a nutritionist point of view, more guarantees allow for better decision making about product purchases. If no nutrient guarantee is given there is no assurance of what level, if any, is actually present in the supplement. It is not uncommon for a particular mineral source (i.e. zinc sulfate) to show up in the ingredient list, but the nutrient it is supplying, in this case zinc, is not guaranteed. One should not assume that just because a particular ingredient shows up in the ingredient list

Table 1 Trace Mineral Requirements and Maximum Tolerable Levels for Cattle (NRC 1996)

Trace Mineral	Stressed Cattle	All Other Classes of Cattle	Maximum Tolerable
Cobalt, ppm	0.1-0.2	0.1	10
Copper, ppm	10-15	10	100
Iodine, ppm	0.3-0.6	0.5	50
Iron, ppm	100-200	50	1000
Manganese, ppm	40-70	40	1000
Selenium, ppm	0.1-0.2	0.1	2
Zinc, ppm	75-100	30-40	500

Figure One

AMPT™-T 54232AAA

A Mineral Supplement for Beef Cattle on Pasture or Range

GUARANTEED ANALYSIS

Calcium	(Min)	10.75	(Max)	12.75 %
Phosphorus			(Min)	7.00 %
Salt	(Min)	18.20	(Max)	21.80 %
Magnesium			(Min)	3.00 %
Potassium			(Min)	0.10 %
Cobalt			(Min)	200 ppm
Copper			(Min)	1,200 ppm
Iodine			(Min)	100 ppm
Manganese			(Min)	3,600 ppm
Selenium			(Min)	25.00 ppm
Zinc			(Min)	4,200 ppm
Vitamin A			(Min)	250,000 IU/lb
Vitamin D_3			(Min)	5,000 IU/lb
Vitamin E			(Min)	250 IU/lb

INGREDIENTS

Dicalcium Phosphate, Magnesium Carbonate, Salt, Processed Grain By-Products, Calcium Carbonate, Magnesium-Mica, Vegetable Oil, Molasses Products, Manganese Hydroxychloride, Zinc Hydroxychloride, Iron Oxide, Magnesium Oxide, Sodium Selenite, Vitamin A Supplement, Basic Copper Chloride, Ethylenediamine Dihydroiodide, Hydrated Sodium Calcium Aluminosilicate, Natural and Artificial Flavors, Manganous Oxide, Cobalt Carbonate, Lactic Acid, Zinc Oxide, d-alpha Tocopheryl Acetate, dl-alpha Tocopheryl Acetate, Vitamin D_3 Supplement. Artificial Flavor.

FEEDING DIRECTIONS

This product is formulated for grazing beef cattle on pasture or range. When starting to feed, remove salt and self-feed this mineral. Feed continuously near the cattle's source of water. Recommended consumption is 4 ounces per head per day. If consumption is more than recommended, feed salt in addition to this product. If consumption is less than recommended, make sure no other source of salt is available and increase the number of feeding stations, or relocate to areas more frequented by cattle.

that the nutrient it is supplying is present in any significant amount. However, there is important information provided in the ingredient profile that should be considered.

The law requires every ingredient or class of ingredients (as in "collective terms") present in a formula to be listed on the tag, but not all nutrients are required to be guaranteed. For some feeds, the information supplied in the ingredient profile provides little value. However, for mineral supplements it is particularly important to know what source(s) is being used to supply a particular mineral. Some mineral sources are very available to the animal; whereas, other sources offer little bioavailability. For example, if a tag guarantees 1200 ppm copper, but because the only source of copper found in the ingredient list is copper oxide, then little, if any, value could be derived by the animal because copper oxide is not available to the cow. So in effect, the tag might as well read 0 ppm copper. Relative bioavailability of different mineral sources will be discussed in more detail later.

Trace mineral requirements are generally reported in terms of parts per million (ppm) of the total diet. To determine how much of a particular mineral is supplied relative to the animal's requirement one must know four things. Two of these items are supplied on the tag — the guaranteed analysis and the expected or recommended intake of the supplement. The other two items needed are the animal's nutrient requirements (Table 1) and total dietary intake, or in this case forage intake. Total forage intake for a cow is seldom accurately known, but a common number to use for comparison purposes is 24-28 lb, which is simply 2% of body weight for a 1200-1400 lb cow. Before any calculations can be done, all amounts must be expressed using the same unit of measurement. When mineral intake is listed in terms of ounces, divide by 16 to convert to pounds to match with forage intake, which is typically expressed in pounds. While trace mineral requirements are most commonly given in ppm, they may be listed as a percentage. It is easy to convert percentage to ppm, which is done by simply moving the decimal four places to the right.

Table 2 Determining Nutrient Amounts Supplied to the Animal from the Mineral Supplement

Formula: Mineral content in ppm from tag guarantee X Recommended supplement intake in lb from tag ÷ Total dietary intake in lb = Amount of nutrient supplied by the supplement

Example calculation based on mineral guarantees noted in Figure 1:
Mineral supplement intake (recommended consumption from tag) is 4 oz
4 oz ÷ 16 ounces per lb = 0.25 lb daily intake of mineral supplement
Assume forage intake is 28 lb

Mineral	Tag Guarantee (ppm)	Supplement Intake (lb)	Forage Intake (lb)	Amount of Nutrient Supplied by Supplement (ppm)	Cow's Requirement (ppm)
Cobalt	200	0.25	28	1.78	0.1
	200 ppm X 0.25 lb ÷ 28 lb = 1.78 ppm				
Copper	1200	0.25	28	10.7	10
	1200 ppm X 0.25 lb ÷ 28 lb = 10.7 ppm				
Manganese	3600	0.25	28	32.1	40
	3600 ppm X 0.25 lb ÷ 28 lb = 32.1 ppm				
Selenium	25	0.25	28	0.22	0.1
	25 ppm X 0.25 lb ÷ 28 lb = 0.22 ppm				
Iodine	0.01%	0.25	28	0.89	0.5
	Convert percentage to ppm by moving decimal four places to the right (0.01% = 100 ppm) 100 ppm X 0.25 lb ÷ 28 lb = 0.89 ppm				

For example, 0.01% is equivalent to 100 ppm.

Table 2 provides an example of how to determine amounts of minerals supplied by a supplement. Based on tag attributes, the mineral supplies 100% of the cow's copper requirement; however, if copper oxide is the only source of copper in the supplement, the amount of copper credited for meeting needs would have to be discounted to zero because copper oxide is not readily available to the cow for absorption. If zinc was not guaranteed on the tag, even though zinc hydroxy chloride and zinc oxide are listed in the ingredient list, no value can be assigned to zinc. (This scenario is just to make a point as zinc is guaranteed on AMPT tags). Manganese is supplied at 32 ppm relative to a 40 ppm requirement, so it is a little short of the requirement; however, forage manganese levels are seldom very deficient so this amount is acceptable. Selenium and iodine are all supplied at or above the animal's requirements and are all supplied by acceptable sources. Selenium is often supplied close to the FDA legal limit which is well above the stated requirement. Cobalt in AMPT is well above the NRC requirement, due to recent data showing enhanced production by using a more soluble cobalt source. It should be noted the cobalt requirement was determined based on B_{12} production in the ruminant and not based on maximizing microbial activity. This is a key difference with AMPT compared to most minerals on the market.

Trace Mineral Recommendations

How much of a particular trace mineral should be supplied from supplemental sources is a matter of debate. Obviously, the exact amount of supplemental trace minerals needed to meet an animal's requirements is dependent on amount supplied by the basal diet. In reality, the exact trace mineral amounts provided by the basal diet (forage for grazing cattle) are not easily determined. Seldom are trace mineral amounts supplied by the basal diet truly known because forages are rarely analyzed for trace mineral content. And, even if some historical or average type values were available, the accuracy of the values would be questionable. Unfortunately, good information indicating the amounts and availability of trace minerals supplied from forages is not available. Also, trace mineral amounts are most likely dependent on forage species and maturity level. To complicate the issue further, even the animal's requirements are not fully understood and may be somewhat variable. Evidence exists indicating there are some variations in requirements due to breed type and production level. Additionally, requirements are generally based on growth parameters.

Because trace minerals are very important in enzyme and other cofactor functions, the requirements for reproduction or immune function may actually be greater at times than those needed for basic functions related to maintenance or growth. Because of potential variation in supply and demand for trace minerals and because of their importance to the animal, one theory or recommendation would be to simply supply supplemental trace minerals at or very close to the animal's requirements. The other argument that could be made would be to supply trace minerals at levels above the animal's reported requirements. It might be necessary to supply some specific minerals in excess of the reported requirements due to the following situations:

- Excessively low basal levels of minerals
- Higher production levels
- The presence of interfering agents referred to as antagonists in the basal diet

If it is believed, or better yet actually known, that the cattle's basal diet supplied a high percentage of trace minerals to the animal, then maybe only 50% of the requirements would need to come from a supplemental source. However, when one evaluates the risk to reward it seems logical to supply greater amounts of minerals because this can be accomplished relatively cheaply. To put this concept in perspective, under normal situations, it is realistic to supplement a cow on an AMPT mineral program for about $45-50/cow/year. Of this total cost, less than

Table 3 Trace Mineral Guarantee Amounts Needed to Supply 100% of the Cow's Requirements

Trace Mineral	100% of Requirements (ppm)
Copper	1120
Zinc	3920
Manganese	4480
Cobalt	11.2
Iodine	56
Selenium	13

Note: These numbers are based on a 4-oz mineral intake and dry matter intake of 28 lb.

$10 will be attributed to trace minerals. Basically, it is a very cost-effective insurance program that will help ensure lifetime productivity of the cow herd. Table 3 shows the trace mineral guaranteed levels needed to supply 100% of the cow's reported trace mineral requirements. Note these values are based on a four-ounce mineral supplement intake and 28 lb dry matter intake. The needed trace mineral supplementation may differ if dry matter intake varies.

Quality and Availability of Different Trace Mineral Sources

As a general rule, sulfate and carbonate forms of trace minerals are more available compared with oxide forms. However, there are some exceptions to this as in the case of zinc oxide and magnesium oxide, which have availabilities of 80-90% of their sulfate counterparts. While most supplementation concerns center on copper and zinc, other trace minerals are also important. Selenium is usually supplied by sodium selenite and is highly regulated in terms of the maximum amount that can be supplemented (3 mg/hd/day or 0.3 ppm in the total diet). Selenium is almost always added to supplements at the maximum allowable amount and, therefore, is seldom a concern. Iodine can be supplied by several different sources. The most commonly used iodine source is ethylenediamine dihydriodide (EDDI), which is a very available organic iodine source. The FDA limits the amount of iodine that can be supplied by EDDI to less than 50 mg per head daily. There are no restrictions on the amount of iodine supplied from other sources, such as potassium iodate or calcium iodate, both of which have good availabilities.

In some instances the actual level of a supplemental trace mineral needed may be well above the reported requirements due to the presence of other compounds in the feed or water. Because minerals carry charges, they are constantly trying to bind or join with other elements. This is necessary because minerals need to be coupled with something else to carry them through the intestinal wall and into the bloodstream. Copper in particular is very susceptible to binding with certain elements, which effectively renders it unavailable to the animal. Elements which are commonly found to cause absorption interferences are referred to as antagonists. The three primary antagonists are sulfur, molybdenum and iron.

Sulfur is usually present in the sulfate form and found in water although some by-product feeds, such as corn gluten feed, can contain significant amounts of sulfur. Anytime total dietary sulfur exceeds 0.3% caution should be exercised and trace mineral programs should be closely evaluated. Most commonly, sulfur is found in the water supply in the form of sulfates. Sulfates in excess of 800-1000 ppm in the water can cause problems in cattle such as diarrhea and lowered performance, not to mention causing problems related to trace mineral absorption. However, water sulfate levels greater than 500 ppm may also cause problems with trace mineral absorption, especially if it is the only water source available or if other antagonists are simultaneously present.

Iron and molybdenum are also common antagonists typically found in forages. Whenever molybdenum and sulfur are both present, they act together by forming thiomolybdates, which effectively ties up copper and renders it unavailable to the animal. Iron can also interfere with trace mineral absorption when levels are greater than 500 ppm. More important than just the mere molybdenum level is the ratio of copper to molybdenum. Whenever the copper to molybdenum ratio is less than 4.5 to 1, copper supplementation needs to be reevaluated. If only one antagonist is present, and it is not in excessive proportions, then simply increasing the amount of copper from available inorganic sources is probably the most cost-effective means of overcoming the problem. However, in some cases when more than one antagonist is present, or when very high levels of one particular antagonist is present, alternative means of supplementation may need to be pursued. One way to overcome these problems is to supply the trace mineral of concern in an already bound and available source to the animal. This is where the use of organic forms of trace minerals can be very effective.

Because of the reactive nature of trace minerals it is important to maintain good ratios between the individual trace minerals. Figure 2 shows the change in liver copper status by providing copper and zinc from different sources with different supplementation regimes. It is obvious from Figure 2 that simply changing one trace mineral without respect to the others can have potentially negative effects. While it is possible to overcome some copper antagonisms by increasing the level of copper in the supplement, caution should be exercised in setting trace mineral ratios too far out of alignment. Ideally, it is beneficial to maintain a zinc to copper ratio between 3-4 to 1

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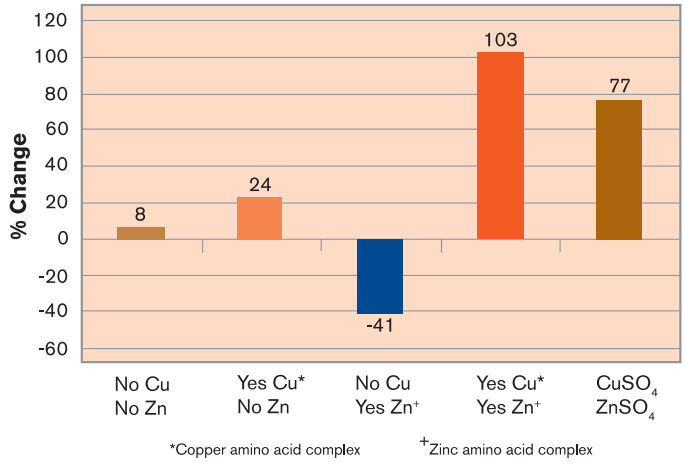
to help prevent negative interactions.

If potential copper deficiencies cannot be overcome by supplying reasonable levels from inorganic supplemental sources, then simply providing higher and higher levels of copper is probably not going to help and may actually have a negative effect probably due to inhibiting microbial production in the rumen. One must always keep in mind the delicate balance between optimum animal performance and optimal rumen performance. It is well known that at some levels trace minerals, particularly copper, exert antimicrobial properties (think foot bath). In this situation, covalently bonded trace mineral forms are very beneficial because these mineral forms are not affected by dietary antagonists.

Figure Two

Change in Liver Copper Status by Copper and/or Zinc Supplementation



*Copper amino acid complex

+Zinc amino acid complex

Wellington et al., 1998

Dietary antagonists do not affect organic forms of trace minerals because they are already bound. Organic trace minerals can come in various forms: chelates, proteinates, polysaccharides, and amino acid complexes. Another class of trace minerals are hydroxy chlorides which are also rumen bypass and covalently bonded like organics, but are technically still classified as inorganic because they are bonded to an inorganic chloride molecule. One additional advantage of hydroxy chloride trace mineral sources is that they are much more economical compared with organics. It is beyond the scope of this article to discuss the basic chemistry that differentiates each of these products from one another. The point is that there are forms of trace minerals available that are already bound to other compounds, which allows them to avoid antagonistic situations and binding, creating greater biological value to the animal.

The ability to optimize animal efficacy while minimizing negative effects on ruminal microorganisms is just one advantage of AMPT Minerals.

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