TECH TALK

Mineral Nutrition is Instrumental to Animal Health and Performance

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From source and quality to concentration and bioavailability, trace minerals offer many characteristics – and each can affect animal health and nutrition outcomes. A better understanding of trace mineral characteristics is instrumental in improving animal performance, reducing environmental impact, and improving return on investment – all of which will improve health outcomes in your animals.

What should I understand about minerals before formulating an animal diet?

Mineral Hierarchy
It is important to understand the mineral hierarchy and how it applies to feeding trace minerals. If clinical signs of mineral deficiency are observed in your animals, the animal's growth, fertility and immunity have already been negatively impacted as well.

s we formulate animal diets, it is important to ensure trace mineral requirements and needs are adequately met for all parameters of the mineral hierarchy.

Required versus Response Microminerals
Required trace minerals are considered essential nutrients we formulate into animal diets. For example, Zinc (Zn) is supplemented to enable the animal's reproductive success, and manganese is implemented to ensure proper bone development

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Whereas response trace minerals are considered additive ingredients not required by the animal. Unlike required trace minerals, response trace minerals usually help elicit a performance response when added to the diet. Chromium (Cr) is an example of a response trace mineral. When Cr is added to the animal's diet it may cause an increase in performance parameters such as milk yield in dairy cattle and breast yield in poultry.

Figure 1. Mineral Hierarchy

Table 1. Benefits and Deficiencies of Feeding Trace Minerals

Element	Benefit(s)	Deficiencies
Zinc (Zn)	• Protein synthesis • Vitamin A utilization • Immune and reproduction support	• Fertility issues • Poor wound healing • Bone and joint problems
Manganese (Mn)	• Bone growth • Cartilage synthesis • Reproduction support	• Abnormal bone and joint development • Impaired ability to repair joints • Abnormal skin, hair and hooves
Copper (Cu)	• Red blood cell production • Enzyme function • Antimicrobial effects (foot baths)	• Bone and joint disease • Tendon and ligament problems • Embryonic death
Iron (Fe)	• Oxygen transport • Energy metabolism	• Anemia • Poor growth • Loss of appetite
Selenium (Se)	• Antioxidant • Immune and reproduction support	• Muscle dystrophy • Weakened immune system • Skeletal and muscle weakening • White muscle disease (mostly seen in calves)

It is important to also understand the characteristics of each trace mineral being fed.

Both required and response trace minerals are often supplemented using trace mineral premixes (TMP) or vitamin/trace mineral premixes (VTM) as part of the total diet.

How does mineral source impact the animal and their diet?

Organic versus Inorganic Mineral Sources
Trace minerals are involved in numerous biological functions. The type of trace mineral source being fed is impacted differently by the antagonistic properties of other compounds within the diet. The varying degree in which different trace mineral sources react in the presence of antagonists can significantly impact the bioavailability of the mineral. Bioavailability of trace minerals is highly dependent on the trace mineral source. The figure below illustrates a bioavailability scale for the major trace mineral sources.

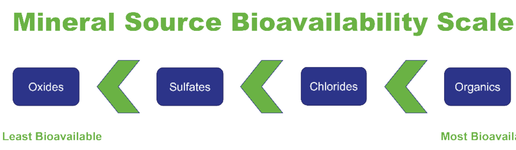


Figure 2. Trace Mineral Bioavailability Scale

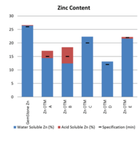
In general, it is important to understand the following regarding trace mineral source:

Inorganic mineral sources are less bioavailable than organic mineral sources. Inorganic mineral sources include oxide, sulfate, carbonate and hydroxychloride. Hydroxychloride minerals are classified as inorganic, but perform as a hybrid between the inorganic and organic classes of trace minerals.

Organic mineral sources are more bioavailable, but are not all created equal. There are currently seven approved definitions for organic minerals, as outlined by The Association of American Feed Control Officials (AAFCO). Those include metal (specific amino acid) complex, metal amino acid complex, metal proteinate, metal amino acid chelate, metal methionine hydroxy analogue chelate, metal polysaccharide complex, and zinc propionate.

Mineral Properties
Manufacturing of inorganic and organic trace minerals requires a high level of expertise to ensure a quality product is produced. However, the industry tends to view trace minerals as a commodity resource because they are readily available. The commodity buying mindset often suggests: "Consider list price and go with the least expensive." Instead, nutritionists and buyers should be focusing on bioavailability, mineral concentration, and cost per unit of metal. Higher concentrated mineral products typically offer lower prices per unit of metal and lower inclusion rates; meaning you pay less for the metal content and the trace minerals take up less space in the animal's diet. This is an especially strong point of differentiation among several organic trace minerals options available to the market today.

The table below demonstrates metal concentration differences and impurities among several organic zinc products.



GemStone Zn	A	B	C	D	E
Ca (%)	0.1098	0.2424	0.6951	0.0761	**5.56**	0.1240
K (%)	0.2647	**1.42**	0.2088	0.1717	0.3256	0.1060
Mg (%)	0.0882	0.2541	0.0711	0.0928	0.1406	0.1030
Na (%)	0.4197	0.7330	0.1431	0.6958	0.1248	**1.20**
P (%)	0.0020	0.3466	0.2667	0.0938	0.0834	0.0350
S (%)	**11.7**	**7.32**	**5.02**	**9.61**	0.7159	**11.0**
Zn (%)	26.6	17.1	18.4	21.9	12.4	22.2
Co (%)	0.0165	0.0005	0.0018	<0.0005	0.0049	<0.0005
Fe (%)	0.0144	0.0244	0.0151	0.2913	0.2782	0.0150
Mn (%)	0.0878	0.2148	0.0447	0.0429	0.0248	0.1000
Cl (%)	0.2564	**1.23**	0.3219	0.8219	**14.5**	0.9371
Cu (ppm)	5.0	8.0	7.0	6.0	8.0	5.0
Se (ppm)	0.4	0.5	1.0	0.2	1.1	0.3

Figure 3: GemStone Zn 260 elemental analysis vs. competitor Zn products

How does organic trace mineral chemistry drive biological action?

Understanding Trace Mineral Utilization & Mineral Interactions
There is a physiological process for how trace minerals are utilized and absorbed throughout an animal's biological system. However, trace minerals often interact with antagonists and other elements prior to being absorbed by the animal. The "Ball of Yarn" in Figure 4 depicts some of the interactions occurring among the trace mineral elements prior to absorption.

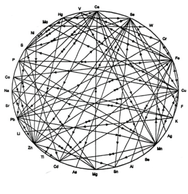


Figure 4. Mineral Interactions

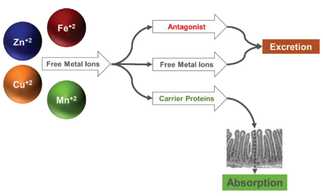


Figure 5. Micromineral Absorption pathways

Mineral Absorption Pathways
For the animal to absorb the trace mineral elements, the mineral must first be solubilized and remain in solution until it can attach to a carrier protein. The trace mineral element must then stay bound to the carrier protein until it reaches the small intestine, where it can then be transported for absorption by the animal. This biological pathway is depicted in Figure 5.

Though most minerals follow the same absorption pathway, all organic mineral sources are not the same; and the minerals therefore may not be absorbed at the same rate as one another.
GemStone® glycine-bound organic trace mineral products and Vistore® hydroxychloride trace mineral products bypass the excretion process because they are already bound to their carrier protein. This allows for better transportation through the animal's digestive system for absorption.

- GemStone: Zinc (26%), copper (24%), manganese (21%) and iron (20%)
- Vistore: Zinc (59%), copper (58%) and manganese (54%).

Through decades of manufacturing expertise, Phibro has worked hard to optimize product safety, quality and stability so that nutritionists and buyers alike can be assured in sourcing Phibro trace minerals

Minerals Can Drive Results

With a better understanding of trace mineral properties and parameters, the industry can make more informed decisions regarding formulations of the trace minerals used in animal diets. Optimizing the trace minerals added to the total diet can help improve animal performance, reduce environmental impact, and may improve your return on investment..

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