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TRACE MINERAL UTILIZATION IN BEEF CATTLE

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There has been much discussion over the years relating to trace mineral levels for beef animals, as well as which sources are better; inorganic vs. organic. Dr. Jerry Spears, professor emeritus with North Carolina State University, recently (Feedstuffs, May 4, 2015) reviewed advances in trace mineral absorption and homeostasis (how they are regulated internally). Dr. Spears is considered to be one of the top mineral experts in the country. For the purpose of this Nutrition Notes article, the discussion will center on zinc, manganese, iron and copper and their absorption in the small intestine and transportation across the cell wall.

The requirements for these trace minerals (TM) have been established by the National Research Council Requirements for Beef Cattle (1996). Changes do occur from publication to publication but in general they are not major deviations. Data from scientific studies indicate that there are differences in mineral bioavailability within inorganic and organic sources. Typically, oxide sources of TM are poorly available where sulfates and chlorides are more biologically available. Organic sources of trace minerals are complexed or chelated to organic ligands such as amino acids, peptides or polysaccharides. Thoughts in the past have indicated that these organics may be absorbed differently than inorganic forms, thus the better availability. Spears (1989) had thought that these organics were absorbed in this ligand form and transported into the circulatory system as such. However, more recent data indicate that these organics are not absorbed in this form but rather as the metal ion, e.g., zinc or manganese or copper ions, not the complexes. The differences in animal response to form (inorganic vs. organic) is thus not the site of absorption but perhaps antagonists affecting the availability of the inorganics in the rumen and small intestine. Such antagonists may be phytate and/or sulfide that would tie up the metal ions.

What regulates the amount of TM that are absorbed and stored within cattle? It is not the case that we feed cattle and if they have more than they need that's great. The body has an ability to regulate, to an extent, how much of a trace mineral is absorbed and/or excreted. Obviously, if cattle are not allowed access to feed that contains the required TM the animal will become deficient and show symptoms. However, under this scenario, the animal can compensate for the low level and become more efficient in the absorption and utilization of those deficient TM. On the other hand, when TMs are well in excess of needs, the retention within the body is reduced.

There is additional homeostatic regulation at the cellular level in case the whole body mechanism is overwhelmed by a deficient or toxic situation. These sites can additionally enhance the efficiency of utilization of the TM during a deficiency or actually bind them (Cu and Fe) to proteins in order that they cannot cause toxicity concerns. Zinc deficiency and toxicity is regulated within the cell by metallothionein through controlling the storage and release of the Zn ions within the cells. Little is currently know about the transport mechanics of manganese regulation within the cell.

Even with all of these TM regulations within the body, it is not a perfect system as we all know deficiencies and toxicities occur. We see this in sheep when diets are consumed that contain high concentrations of copper regardless of ingredient source. The system can be overloaded or deficiencies occur in extreme cases. However, with these regulations in place and proper diet supplementation, issues with cattle TM status are usually limited.