Trace mineral nutrition symposium: 
Exploring recent developments in swine and ruminants

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The Trace Mineral Nutrition Symposium was held at the Joint Annual Meeting of the American Society of Animal Science and the American Dairy Science Association in Indianapolis, IN, July 8 to 11, 2013. The purpose of the symposium was to present recent advances in both basic and applied aspects of trace mineral nutrition in livestock. Fred Steward, President of Micronutrients, opened the symposium with a brief review of major milestones in the development of the science of trace mineral nutrition.

In the first formal presentation, M.D. Lindemann discussed “The role of trace minerals in feed stability and swine production” (Lindemann, 2013). He first discussed the fact that whereas minimum levels of minerals needed to avoid deficiency symptoms have been established, much less research has focused on defining optimized levels for immune function and growth. In addition, certain essential trace minerals act as pro-oxidants when supplemented to diets, can reduce stability of vitamins and enzymes, and can promote oxidation of lipids. Chemical properties of various trace mineral sources are very different and, therefore, can affect the stability of nutrients and enzymes in diets. Sulfate forms of trace minerals are hygroscopic and highly reactive whereas hydroxy and chelated forms of trace minerals are significantly less reactive.

The next presentation, titled “Exploring cellular trace mineral metabolism in bovine and porcine tissues,” was given by R.S. Fry (Fry et al., 2013). He described protein transporters involved in the import and export of copper, iron, and zinc from the small intestine and other tissues. These transporters and small chaperone proteins are critical for cellular trace mineral homeostasis as well as for the whole animal. The initial discussion was focused on the major factors that affect trace mineral absorption. These include solubility and availability at the point of absorption, animal genetics, dietary antagonists, and physiological processes such as those involved with transport or regulation of trace minerals. Competition for certain transporters may explain certain trace mineral interactions that occur. Trial work done with swine by Frye et al. in 2012 was used to illustrate how differing chemical properties of trace mineral forms can result in effects being seen in different sections of the gastrointestinal tract. The lower solubility and reactivity of tribasic copper chloride (TBCC) compared with copper sulfate was evidenced by mRNA analysis of copper transporters and chaperones, revealing TBCC’s greater impact in the lower sections of the intestinal tract.

The third presentation by K.C. Klasing was titled “Relative bioavailability, immune function, and antimicrobial effects of trace minerals” (Klasing and Iseri, 2013). Essential trace minerals are required at nutritional levels for various metabolic functions. In addition to their nutritional role, certain trace minerals can also modulate the immune response and/or act as a bacteriostatic agent in the gut. Klasing discussed how bioavailability of different copper sources at relatively low levels would affect their ability to meet nutritional requirements. He also explored how greater levels of copper function in immune modulation or act as antimicrobial agents. Discussion included substrates for the immune system, pathogen requirements for certain nutrients such as iron, and modulating signaling in leukocytes. Finally, the differing chemical properties and structures of trace minerals were proposed as a means to explain differences in bioavailability and effects throughout the gastrointestinal tract.

The symposium concluded with a presentation by T.R. Overton titled “Practical applications of trace minerals in dairy cattle” (Overton and Yasui, 2013). Lactating dairy cows are under considerable oxidative stress and...
their immune system is often challenged. The role of various trace minerals in immunity and control of oxidative stress was discussed. Recent studies examining the effects of level and/or form of copper, zinc, manganese, chromium, and selenium on responses in lactating dairy cows were presented. Overall conclusions by Overton included the statement that our traditional approaches for determining requirements for dairy cattle do not fit well with trace mineral nutrition. He stated that more bioavailable forms generally result in enhanced production, reproduction, and health, with evidence indicating that it is time to move beyond sulfate-based mineral programs in dairy rations.

For many years, nutritional sources of essential trace minerals such as iron, zinc, copper, and manganese have not been the focus of substantial scientific research. However, recent and more intensive studies have shed light on trace mineral function and stability as well as performance differences between alternative sources of minerals. These newer published studies make it clear that the picture is more complex than previously believed. In addition to differences in efficiency of absorption of the target metal into the bloodstream, different sources can affect nutrition and animal performance in at least four other important ways: 1) destruction of nutrients, including vitamins, in a feed mixture, 2) interactions with other nutrients in the digestive tract, 3) direct influence on gut microbial ecology, and 4) effects on the animal’s natural immune functions. The inclusion rates of trace minerals in animal diets may be small but the effects on animal growth and performance are often very substantial.

LITERATURE CITED


