Evaluating the Benefits of Organic Trace Mineral Supplementation for Improved Dairy Production

Despite advancements in genetics and management practices, today's dairy producers still face problems related to poor reproductive performance and various health issues that can lead to increased costs and loss of revenue. Mastitis, for example, is one of the main health challenges facing the dairy industry.

However, the biggest economic impact is not due to treatment costs but to loss of production (milk yield) and high cull rates. On average, studies showed that mastitis can cost the producer as much as $250 per case (Enting, 2014). Other studies showed that milk yield loss increased as the number of test days with somatic cell counts (SCC) exceeding 100,000 cells/ml increased, with daily losses ranging from $1.20/cow per day to $2.06/cow per day (Hadrich *et al.,* 2018).

How can producers overcome these reproductive and health challenges?

The Nutritional Importance of Trace Minerals

At face value, trace mineral nutrition is a small part of the complete nutritional program, since these minerals are only required in very small amounts. However, even at minute quantities, these trace minerals, especially copper, manganese, zinc and selenium are a core component of the diet, as they are needed daily and are essential for optimum health and performance in dairy cows.

Deficiencies of certain trace minerals can result in reduced growth, fertility and milk production as well as impaired immune function. Deficiency symptoms may even exist without the animal exhibiting any clinical signs; they are often reflected in reduced intakes and poor performance (Enting, 2014).

Primary and Secondary Deficiencies

Trace mineral deficiencies can either be primary or secondary. A low concentration of trace minerals in the diet results in primary deficiencies, while secondary deficiencies are a direct consequence of an excess of other trace minerals, infectious or parasitic disease, or circumstances that reduce the bioavailability of the trace mineral (Smart *et al,* 1981; Spears *et al,* 2011).

What we typically see in the dairy industry are secondary deficiencies, mostly due to antagonistic mineral interactions. Such antagonistic interactions can be the result of suboptimal trace mineral supplementation.

Trace Mineral Supplementation: Inorganic vs. Organic

Trace minerals can be supplemented in either the inorganic or organic form. Inorganic trace minerals (such as oxides, sulfates and chlorides) are metal salts typically derived as byproducts of mining and other industries, while organic trace minerals are bound to an organic material (or carbon structure).

In order to overcome deficiencies, producers and nutritionists tend to over-formulate these essential trace minerals, usually in the inorganic form for economic reasons. This inadvertently creates a situation where these excess trace minerals can interfere with the digestion and absorption of other trace minerals, causing an antagonistic effect and affecting the bioavailability of the trace mineral.

This can easily be overcome by supplementing trace minerals in the more bioavailable organic form instead. Organic trace minerals that can reduce or eliminate interferences from other trace minerals, are more bioavailable to the animal, and can be stored as tissue reserves.

This is especially important to the dairy cow, where dry matter intake may vary and reliance on reserves might be more important to cope with production demands and other stressors. It also affects the health and performance of the cow's offspring. Strong maternal nutrition can boost calf growth and future lactation, while calf morbidity due to poor nutrition can lead to increased costs and reduced milk production.

A Closer Look at Supplementation Levels

The evidence supporting organic trace mineral supplementation over inorganic forms is overwhelming and brings us to the next question: If organic trace minerals are more bioavailable, can they be included at lower levels? The answer is, "It depends." Just as inorganic trace minerals differ from organic trace minerals based on chemical structure, the same holds for the different types of organic trace minerals available on the market.

The Association of American Feed Control Officials (AAFCO) has categorised organic trace minerals in seven different categories (Table 1).

AAFCO	
Metal Proteinate (57.23)	The product resulting from the chelation of a soluble salt with amino acids and/or partially hydrolysed protein.
Metal Amino Acid chelate (57.142)	The product resulting from the reaction of a metal ion from a soluble metal salt with amino acids.
Metal Amino Acid Complex (57.150)	The product resulting from complexing a soluble metal salt with an amino acid(s).
Metal (specific amino acid) Complex (57.151)	The product resulting from complexing a soluble metal salt with a specific amino acid.

Association of American Feed Control Officials (AAFCO, 1998)

Table 1. Official AAFCO terminology for organic trace minerals

Different categories of organic trace minerals have different physical and chemical properties and different bonding strengths. Consequently, they produce different nutritional and production responses. Even within the same

category, the production process, ligands and raw materials used will impact the mineral's properties and, in turn, the animal's response.

This means that when choosing a brand of organic trace minerals, it is important to ask for specific research and the exact recommended inclusion rates for the particular product you're considering. Since organic trace minerals can vary so much, the research behind one product cannot support recommended rates for another.

The Science Behind Bioplex and Sel-Plex

Alltech's ranges of organic proteinated chelated trace minerals (Bioplex®) and organic selenium yeast (Sel-Plex®) address the question of exactly how much less we can supplement when doing so in the organic form.

Bioplex trace minerals are proteinated chelates, produced to contain not only metal salts chelated with amino acids but also di- and tripeptides. This is important because protecting the mineral with multiple amino acids and peptides (as compared to single-amino-acid complexes) prevents it from dissociating, ensuring that it remains stable across the varying range of pH changes that occur in the rumen and during digestion. Sel-Plex, on the other hand, is an organic selenium-enriched yeast, in which selenoamino acid analogues such as selenomethionine predominate and is produced through a multi-stage fermentation process. Similar to Bioplex, Sel-Plex has been specifically formulated for enhanced stability and bioavailability.

Extensive research in both university and commercial dairy farm settings has been done to determine optimal mineral level recommendations (Table 2). Based on this research, Alltech developed Total Replacement Technology™ (TRT), a unique and proven way to address trace mineral supplementation in the dairy industry. TRT involves replacing

Authors	Findings
Pino and Heinrichs (2015)	Diets with Bioplex trace minerals results in lower rumen pH, higher total VFA production, and increased butyrate proportions due to higher bioavailability and faster utilisation by rumen organisms.
Graugnard *et al.* (2015)	Replacing inorganic trace minerals with Bioplex in heifers aged 10-15 months improved reproductive performance, including better regulation of estrus, shorter calving intervals, and improved implantation rates.
Gelsinger *et al.* (2016)	Cows and calves on the Bioplex program had improved health scores, increased plasma Mn and Zn, and better immune efficiency.
AgroParis Tech (2017)	Cows receiving Alltech's Bioplex Cu, Mn, Zn, and Sel-Plex had improved production, energy-corrected milk, better reproduction, and fewer cases of lameness and mastitis.
Pino *et al.* (2018)	Bioplex-supplemented heifers calved earlier, had fewer open days, and greater overall milk yield.

Table 2. Bioplex and Sel-Plex Dairy Research Highlights

all sources of inorganic trace minerals with Bioplex and Sel-Plex minerals at Alltech's recommended – and substantially lower – rates of inclusion. In many cases, these inclusion rates can be 30–50% lower than the industry standards. Alltech has proven that this can be done cost-effectively, with less environmental impact, and without negatively affecting the cow's wellbeing and performance.

The Benefits of Supplementing with Bioplex and Sel-Plex

Investing in a nutritional program such as Alltech's TRT can help producers ensure their herds have optimal trace mineral status, which helps support immune function. Several studies with Bioplex trace minerals have shown that this technology is a viable option to help manage udder health and SCC; also, in many cases, dairy producers noted improvements in milk yield.

Bioplex trace minerals have also been reported to support reproductive performance. Considering the financial investment in replacement heifers, this is a cost-effective nutritional strategy that can pay off significantly in the future.

Conclusion

There is a fine balance between providing trace minerals for adequate health and production, which is necessary and helpful, versus overfeeding, which can be detrimental to the cow's health, increase feed costs and have a negative effect on the environment. In a rapidly evolving industry, dairy producers must be willing to adopt new, proven technologies, especially if these technologies can aid in addressing a known on-farm challenge. As new products and additives enter the market, it is also increasingly important for dairy producers to evaluate these products based on efficacy and the research associated with each product, and to work with reputable companies that invest in research and development and have robust quality control programs in place.

For more information on Alltech's Total Replacement Technology (TRT) and Bioplex proteinated trace minerals, email knowyourminerals@alltech.com or contact your local Alltech representative.

Laurentia van Rensburg

Laurentia van Rensburg, Global Head of Commercial (Nutrition), originally from South Africa, Laurentia van Rensburg received her Master's Degree in Animal Science from the University of Kentucky. With more than 20 years of experience in the livestock and animal science industry, van Rensburg has worked in South Africa, the Netherlands, Latin America and North America. She joined Alltech in 2005 and currently serves as the Commercial Head of Nutrition as part of the Technology Group.