The role of nutrition as a defence against dairy cow mastitis

Using nutrition to increase a cow's defence against mastitis has been an important area of research. Minerals, such as selenium (Se), copper (Cu) and zinc (Zn), when properly supplemented, can support the immune response to pathogens. Increased susceptibility to infection through malnutrition has been a recognised issue in livestock for many years.

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The potential to influence immune function by nutritional supplementation has gained interest, especially because of the drive to decrease antibiotic use and minimise the development of resistance to medical and veterinary antimicrobials.

A cow's requirements for minerals are influenced by several factors, including age, stage of pregnancy and stage of lactation. Fig. 1 shows that, for some nutrients, the requirement for optimum immune response is greater than for growth and reproduction. Cattle can have sufficient mineral intake for adequate growth and reproductive performance but may not have optimal immune performance. By the time clinical signs of deficiency become apparent, immunity, growth and fertility have already been compromised.

Mastitis is a costly disease in the dairy industry, and occurrence can be used to indicate disease resistance or immune status of cows.

Nutritional supplementation is one tool that can aid a decrease in mastitis incidence rates, but good management practices must be followed as well. Examples of such practices include pre- and post-milking teat dipping, dry cow therapy and providing cows with a clean, dry environment.

Even with a somatic cell count (SCC) of 200,000 cells/ml, 6% of the quarters are still likely to be infected in the herd.

This SCC level results in a loss of around 400lb of milk over the production period for second and higher lactation cows in a typical herd.

Farms with lower SCC usually follow proper management practices, and supplemental nutrients complement such practices.

With current economic trends in the dairy industry, the producer needs to ensure efficiency in all aspects of milk production. Controlling mastitis is just one area that contributes to overall profitability.

Reproductive performance dictates daily milk production, number of replacements available and selective culling opportunities within the herd. There are many factors influencing dairy infertility, and the adequacy of trace mineral supplementation is one of them.

The role of trace minerals

Selenium and vitamin E have a critical role in the protection of the body from infection. Vitamin E is important in protecting membranes of cells from oxidative damage by free radicals, and selenium is a component in glutathione peroxidase.

Glutathione peroxidase is an enzyme within cells that limits internal oxidative damage by free radicals. Deficiencies of these nutrients can decrease the phagocytic ability of cells in the mammary gland, which is needed to destroy ingested bacteria and reduce mastitis incidence and severity.

Copper has an important role in the immune system, where its compounds are involved in reducing infections and diseases. Copper deficiencies have also

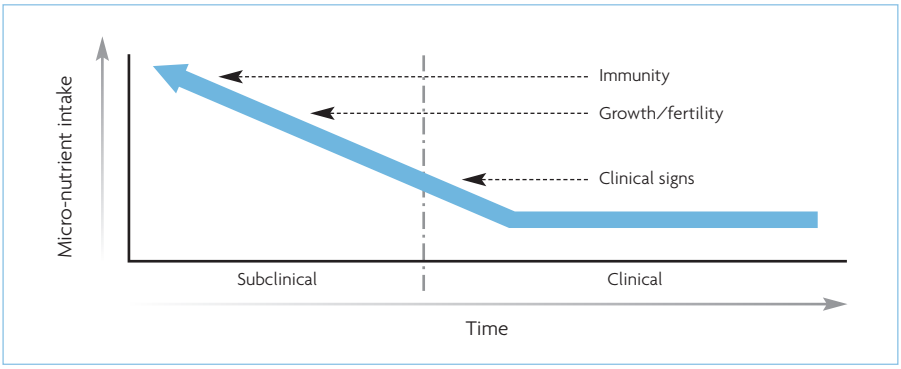

Fig. 1. Vitamin and trace mineral function (Wiske, 1992, Texas A&M University, Veterinary Beef Cattle Short Course).

been associated with retained placenta, embryonic death and decreased conception rates. Inadequate Cu status may be related to an increased incidence of infections at calving, increased severity of infections and a higher SCC than that seen in Cu-adequate cattle.

Copper is also a component of enzymes, such as cytochrome oxidase, necessary for electron transport during aerobic respiration; lysyl oxidase for strong bone and connective tissues; ceruloplasmin, which is essential for haemoglobin synthesis, and superoxide dismutase, which protects cells from the toxic effects of oxygen metabolites.

Manganese is a co-factor for enzymes in the metabolism of carbohydrates, fats, proteins and nucleic acids. It is essential for normal brain function and is important for proper immune function and wound healing. Manganese is involved in collagen formation, bone growth, urea formation, fatty acid synthesis, cholesterol synthesis and protein digestion.

Zinc is an integral part of immunity as a key element of superoxide dismutase. It is also important in other enzyme systems that affect the metabolism of carbohydrates, proteins, lipids and nucleic acids. Zinc is essential in wound healing, epithelial tissue repair and maintenance of cellular integrity.

Keratin, the substance that lines the inside of the teat duct and helps protect against pathogens entering the udder by functioning as a physical and chemical barrier against pathogens, requires zinc for its formation. Zinc deficiencies delay sexual maturity, can cause foetal abnormalities and alter prostaglandin synthesis.

Mineral sources

In the last decade, the form of minerals supplied in feed has been the focus of much research. Concerns regarding pollution and animal production have led to the development of minerals chelated with an organic ligand. This makes them similar to the form of minerals found in animal and plant material and allows for improved absorption and utilisation when supplied in feed, compared to inorganic mineral sources (sulphates, oxides and selenite).

Mineral proteinates (such as Bioplex trace minerals) have been developed as a source of organic zinc, copper, manganese and cobalt. Proteinated minerals are a blend of single amino acid chelates and short-chain peptide chelates. Certain minerals cannot be naturally chelated due to their electro-chemical properties. One such example is selenium. In order to produce an organic form of selenium, it is necessary to supply it as a substrate for yeast fermentation. The mineral is metabolised into seleno-amino acids within the yeast (Sel-Plex).

Why not just supplement with more inorganic mineral sources?

Due to their lower bioavailability, various issues can arise when using inorganic minerals, including associated environmental concerns. Studies have demonstrated that over-fortification of trace minerals can elevate antibiotic resistance in swine operations, as bacteria like salmonella develop tolerance to high copper and zinc levels. Inorganic minerals can have various mineral and vitamin interactions, and they can serve as antagonists, interfering with normal biological processes.

The benefits of feeding organic mineral forms

Peer-reviewed research has demonstrated advantages to dairy cows when only supplementing with organic trace minerals. Kinal et al. showed greater milk production over the first two months of lactation when using only proteinate forms of minerals compared to inorganic sources (sulphate). Additionally, somatic cell count was also lower in cows supplemented with organic minerals compared to cows supplemented with inorganic minerals.

Research conducted by Scaletti and Harmon showed decreased bacteria count in milk and increased milk production in response to an intramammary challenge, with E. coli in one-quarter of each cow when cows were supplemented with copper proteinate compared to the same amount of copper from copper sulphate.

Boland et al. conducted three trials in which organic minerals were supplemented in dairy diets. The control diets had similar mineral concentrations as the organic mineral treatments but without mineral proteinates or selenium yeast. Cows supplemented with organic minerals in the three trials showed 52%, 45% and 35% reductions, respectively, in SCC when compared to controls.

Logic dictates that the best results will be achieved when all trace minerals are supplied to the cow at appropriate levels. Local circumstances often dictate which minerals are more limiting and, thus, need particular emphasis. Reducing mastitis and lowering somatic cell count will result in economic benefits and improved health and welfare of dairy cattle. These nutritional approaches for improving milk quality must be implemented along with proper mastitis management practices that reduce cattle's exposure to pathogens.

Summary

Trace minerals in dairy cow diets are important for optimising health and performance. Supplementing dairy cows with mineral proteinates and organic selenium (Bioplex and Sel-Plex) has improved udder health.

Reducing mastitis and lowering SCC will result in economic benefits and improved health and welfare of dairy cattle.

Nutritional approaches for supporting immune function and reducing mastitis must be implemented, along with proper mastitis management practices that reduce exposure of cattle to pathogens. ■