NUTRITION

Organic trace minerals support better bone structure and integrity

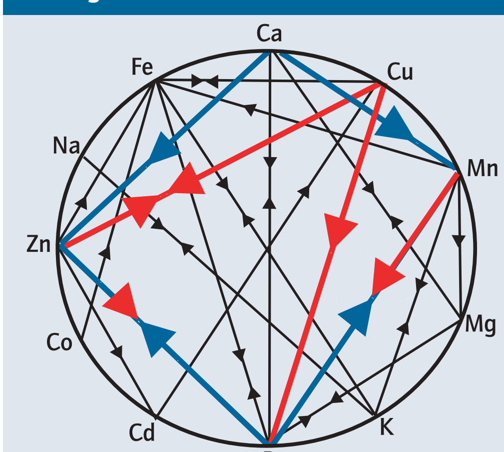
As broilers are grown to increasingly large sizes, a healthy and stable skeletal structure becomes even more important. Well-designed poultry diets, including organic trace minerals, can be used to help achieve this.

The low-intensity lighting in a state-of-the-art broiler house initially limits the vision of visitors who come from outside. What we notice almost immediately is a clean house. Air quality is excellent and the temperature is comfortable. The birds are quiet and less active than in older open-sided, naturally lit houses. But the most striking difference between these birds and those a decade back is that their average weight is greater than ever and increasing all the time.

Driven by processing plant efficiencies and increasing demand for carcass cuts, each year, in every part of the world, broilers are being grown to greater size. In the US, the average weight of all classes now approaches 2.5 kg; this is a full 20% heavier market size than the bird of 10 years ago. The largest of these typically mixed-sex flocks averages more than 3.63 kg, with feed conversion approximating two units of feed per unit gain – rivalling the feed conversion ratios accomplished a decade back on the average 2.0 kg flock.

These animals need optimal nutrition to achieve their full genetic and economic potential. Producers need to do more than optimise the birds' diets for calorie/protein (amino acid) balance and form. In modern livestock production it is fundamental to ensure that the animals achieve normal function, skeletal structure and wellbeing while post-production environmental pollution is minimised. This is not an easy task. Due to the complexities of mineral nutrition, it is relatively common to see birds down on their hocks and walking stiff-legged. This is frequently correlated with observations of curved legs or less-than-perfect footpads. But it can also be due to maladies such as tibial dyschondroplasia, which are only diagnosed via post-mortem exam or costly non-invasive diagnostics.

Figure 1 - Mineral Antagonisms, critical when defining inclusion rates



Copper antagonists: Sulfate, Zinc and Molybdenum
Manganese antagonists: Calcium and Phosphorous

Figure 1 shows the complexities of some of the many mineral actions that nutritionists must consider as they prepare a well-designed diet. Less than ideal mineral balances can precipitate skeletal deformities. Consider the examples of macro minerals calcium (Ca) and phosphorus (P), themselves antagonistic. Consider, too, the examples of excess Ca suppressing zinc (Zn) and manganese (Mn) availability, P and Zn being mutually antagonistic. The end result of these excesses and imbalances is birds whose skeletal structure is so poor that they cannot reach feed and water adequately. These birds achieve less-than-satisfactory condition and are poor performers. Yet such problems are usually minimised or eliminated with only minor amendments to the mineral nutritional package.

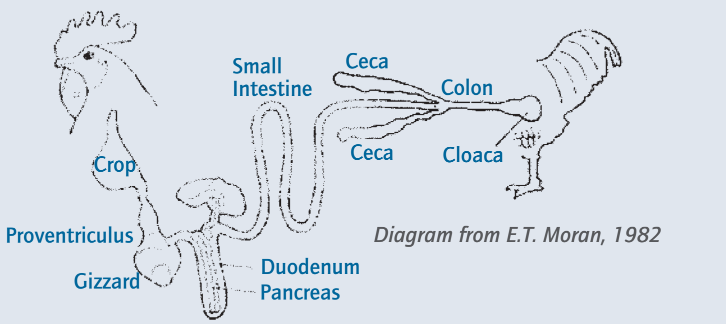
Producers who are accustomed to formulating nutritional packages to put weight on birds or attain superior feed conversion would also see benefits from formulating for optimal mineral nutrition. Minor alterations to the mineral nutrition programme could produce a better, more stable skeletal system. Producers must consider organic trace minerals as a strategic alternative in mineral nutrition in modern poultry production.

The nutritional benefits of the properly balanced feeding of organic trace minerals are many and diverse. Animals are structurally more sound, lost performance associated with the nutritional imbalance improves and economic return is enhanced. An additional benefit is that faecal output of the more environmentally significant minerals is reduced. It is well documented that the macro-mineral P must be effectively managed and its inclusion limited because of its environmental impact, and to comply with government regulations. However, the same is true of Zn. As production increases, populations grow and poultry production units come in more intimate contact with residential communities, the need to minimise nutrients in waste will only increase, not diminish. Incorporation of organic trace minerals in lieu of inorganic trace minerals will help meet those new demands for optimal performance while minimising waste and environment pollution.

Skeletal mineral needs

Let's examine some of the nutritional needs of these large birds that affect bone development. Those needs for optimum bone synthesis, structure and integrity become more urgent as the genetic potential of today's broilers continues to allow production of larger

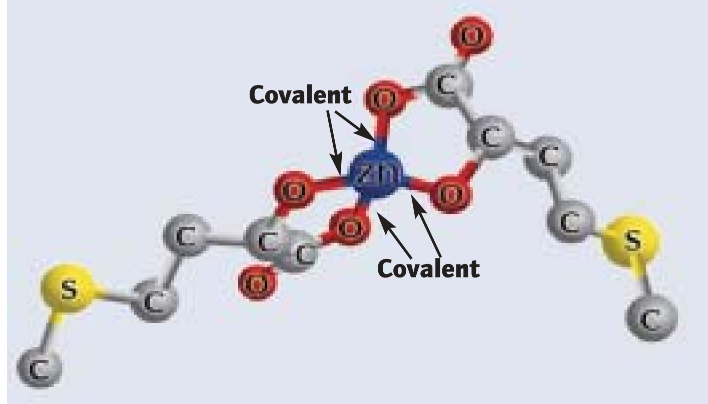
Figure 2 - Poultry Digestive Tract pH



pH:

Crop	Proventriculus	Gizzard	Duodenum	Small Intestine Upper	Small Intestine Lower	Cecum	Colon
4-6	2-5	2-5	5-6.5	6-7	7-7.5	5.5-7	7

Figure 3 - X-ray crystallography



birds in less time each year.

Bone is subject to an array of malformations, deformities and weaknesses, and this is especially true during the active growth or modelling phase of development. These maladies may be brought on by nutritional as well as environmental and managerial factors. Common nutritional causes include mineral deficiencies and imbalances. Macro-mineral deficiencies are well documented and researched; those involving trace minerals are often less evident, but just as harmful to general health and wellbeing. These are the incipient and chronic incidences that can so negatively impact live performance and profit margins.

Necessary macro-minerals for proper bone development are Ca and P, whose roles are well studied and effective ratios established and generally accepted. These macro-minerals account for the vast majority of the bone components and body mineral content; some 99% of body Ca is isolated to the skeletal system. In commercial poultry rations Ca is seldom an issue. It is a low-cost ingredient and is often provided in excess, which leads to imbalance issues. P is also essential to proper bone formation, but is a relatively expensive nutrient. Availability is also impaired due to dietary phytic acid which is present in vegetable proteins. As a result, close attention must be given nutritionally available P rather than to total P in the diet. Meanwhile, nutritionists strive to balance P with Ca and the absolute needs of the animal while minimising waste in response to ever-increasing environmental regulations.

Role of trace minerals

Trace minerals are involved in a series of processes from immune response to skin and gut integrity. They also play a significant role in bone development and bone integrity. However, trace minerals are often overlooked or given too little attention. Copper (Cu), Zn and Mn have been accepted as critical to the normal development and maturation of bone.

Zn plays an essential role in collagen synthesis and turnover. This is important because collagen is one of the major proteins that give tissues and bone their strength. In addition, Zn serves in gene transcription and regulation of chondrocyte and osteocyte cell turnover. Deficiencies inhibit chondrocyte proliferation and induce cell death at the epiphyseal plate in young birds.

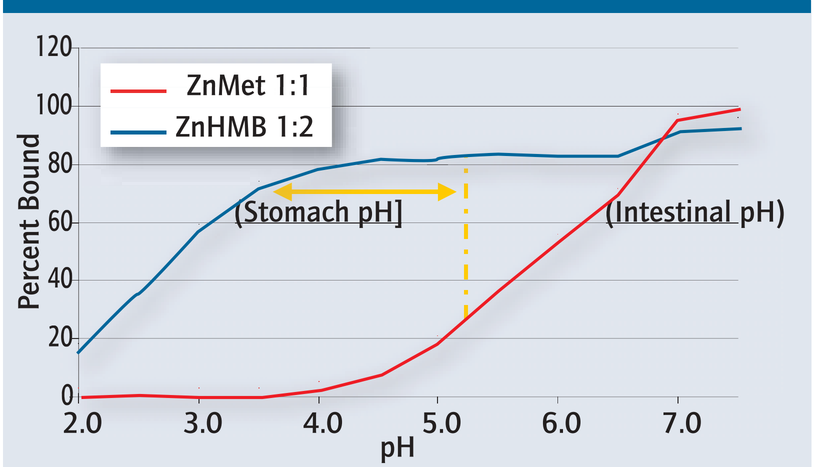
Cu is key to elastin development and function and collagen cross-linking and strength. Collagen cross-linking has been reported to correlate with bone breaking strength, and Cu functions in ligament integrity and facilitates proper tendon insertion into bones. Deficiencies have been associated with decreased mineralisation of bone proper.

Yet another key trace mineral is Mn. Mn functions in proteoglycan synthesis and is a key compound in the development and production of the extracellular ground substance which is the key component of normal bone ossification. Mn is also a critical component of the growth plate cartilage matrix where it supports endochondral ossification.

These trace minerals are available in a variety of forms for inclusion in livestock diets. Most often they are included via the low-cost inorganic forms that have been commercially available and exhaustively studied for many years - although inclusion levels vary significantly among producers. The chelates and proteinates are relatively new entries, but have shown better availability and more efficient utilisation than the inorganic products.

Figure 2 documents the pH environment of chickens' digestive tract. Relative pH varies greatly throughout the tract.

Figure 4 - The real cost of organic trace mineral supplementation



Bone formation basics

The skeletal system is composed of bone, cartilage, tendons and ligaments. Bone alone makes up the greatest proportion of this essential system and has been the focus of extensive study relative to mineral requirements within avian production systems. However, in considering the overall mineral nutrition needed for satisfactory skeletal system development and integrity one must remember that cartilage, tendons and ligaments are also part of the complete system.

The development of this skeletal system is a complex process; bone growth is the process of overall increase in bone mass or the enlargement of specific bones. As a dynamic process, it is constantly ongoing. Bone modelling is the initial development of the bone, incorporating increases in length and width of bone and continuing until closure of the epiphyseal or growth plates. Modelling is the process responsible for basic bone morphology. Subsequent to modelling is the process of bone remodelling or turnover which will occur throughout life.

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Compounds that require uptake in the small intestine must remain in an active and available form through the anterior portion of the tract and its pH extremes.

Proteinated trace minerals are more available due to their ability to survive intact the low pH of the anterior digestive tract, avoiding terminal bonding with phytic acid, fibers, etc., which will negatively impact availability and absorption in the small intestine. The chelated trace minerals offer better stability still, due to a more robust and acid-stable molecule. New compounds are finding their way to the market routinely.

Chemistry yields more available organic trace minerals

Of late, by applying novel approaches of relatively old chemistry, new entries have arrived in the organic trace mineral market via the Mintrex® product line from Novus International. Novus has applied longstanding proven chemistry which has been used to produce dry methionine hydroxy analogue-calcium to the organic trace mineral arena. In this case, liquid methionine hydroxy analogue has been combined not with simply Ca to produce a dry methionine product, but with the essential trace minerals Zn, Cu and Mn. This creates an acid-stable chelated organic trace mineral complex.

Figure 3 shows an X-Ray crystallography structural model of the new product. The chelated complex provides acid stability allowing these organic trace minerals to the reach the distal reaches of the digestive tract intact. These new entries are stable to very low pH, in stark contrast with the more acid labile proteinates and amino acid complexes that preceded them in the marketplace. This stability at low pH is shown in *Figure 4*, which demonstrates how trace minerals complexed to the amino acid methionine dissociate at much higher pH than the new Novus product offering. The amino acid and other similar protein complexes typical dissociate at pH 5-6, this renders them less available since they can now bind with phytic acid, fibre or another minerals. The end result is higher mineral content in the faeces.

Another unique quality of the Mintrex line is its ability to supply methionine as well as the trace mineral. Each trace mineral molecule is accompanied by two methionine hydroxy analogue molecules. Once in the small intestine, this organic trace mineral complex comes into intimate contact with the intestinal cell wall where, due to its low pH, it dissociates, the mineral and subsequently the methionine source are then transported into the animal. It is a novel approach with multiple benefits to the animal and producer. Mineral inclusion can be kept to minimum, reducing the likelihood of interactions, essential methionine is made available and carried safely into the small bowel, and the mineral content of faecal wastes are reduced due the more effective uptake of the organic trace minerals.

In conclusion, the incorporation of more acid-stable organic trace minerals in diets will allow nutritionists to efficiently balance dietary inclusion with the needs of the animal. This will aid in improving bone development and integrity by fulfilling trace mineral needs while minimising mineral antagonisms and reducing waste to the environment. ■

(Source: Novus International)