Trace mineral supplementation

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Zinc, copper and manganese play fundamental roles in the biochemistry of a wide variety of cellular functions. As such, deficiencies in these minerals can lead to a number of developmental, immunological, structural and performance deficits.

Most trace minerals are fed as inorganic trace minerals, but these forms are susceptible to losses via dietary antagonisms prior to intestinal absorption.

Organic trace minerals are trace minerals complexed or chelated by an organic ligand(s).

Ligand binding should increase structural stability in the upper gastrointestinal tract, thereby avoiding mineral losses to dietary antagonists and increasing mineral bioavailability.

Indeed, traditional methodologies such as tissue mineral studies have demonstrated enhanced tissue mineral levels with organic trace minerals. However, ligands vary in the extent to which they are able to increase mineral bioavailability.

Recently, metallothionein gene expression assays have been developed to measure intestinal absorption of zinc sources. Some forms of organic zinc, especially zinc chelated by the methionine hydroxy analogue (HMTBa), has been shown by these assays to increase zinc availability compared to inorganic sources.

Given greater mineral bioavailability with organic trace minerals, it should be possible to reduce supplementation levels and reduce mineral excretion.

Accordingly, commercial trials with reduced (50%) mineral inputs via Mintrex organic trace minerals support equal or better live performance, with the opportunity for white meat yield increase.

Furthermore, several trials have demonstrated skeletal developmental and strength improvements, as well as reductions in footpad lesions. Finally, egg mineral levels were increased and eggshell quality was improved in commercial trials.

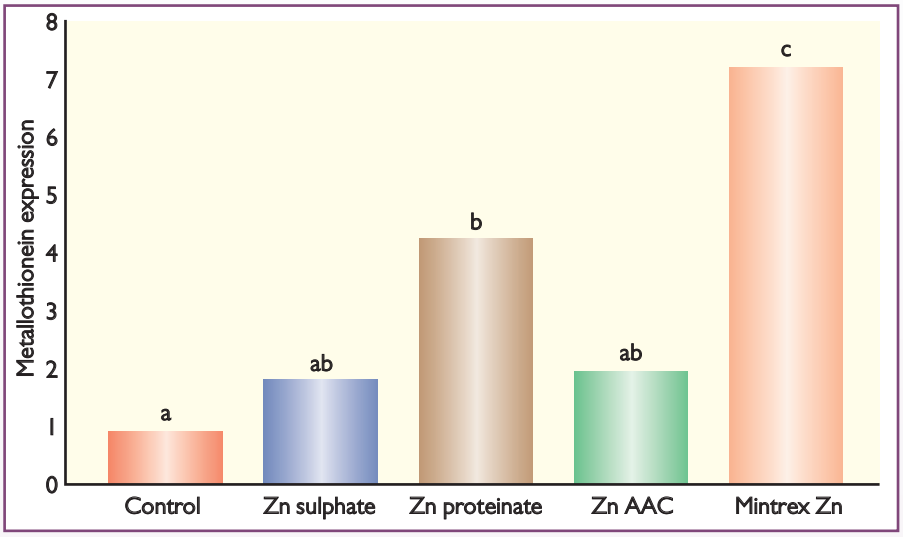

Fig. 1. Metallothionein expression demonstrated greatest bioavailability with Mintrex zinc.

Organic trace minerals

Organic trace minerals can provide a more bioavailable form of trace minerals than inorganic trace minerals. Indeed, tissue mineral and slope-ratio type experiments have demonstrated increased availability of organic trace minerals.

Another potential assay to measure mineral bioavailability is to measure the expression of mineral responsive biomarkers in the animal, preferably in the small intestine where minerals are absorbed.

Metallothionein (MT) is such a biomarker, because its expression is regulated by zinc status. MT mRNA and protein expression increase when more zinc is taken up and decrease when less zinc is taken up.

As such, MT mRNA or protein expression is widely used as an indicator of the zinc status of humans and animals and to evaluate the bioavailability of different zinc sources.

Novus International Inc has developed patent pending, real time polymerase chain reaction (RT-PCR) assays to measure the expression of MT mRNA, as a marker for both zinc status and bioavailability.

In a recent broiler trial, the bioavailability of four zinc sources was compared to each other and to a zinc deficient control diet by measuring small intestinal MT as the marker for bioavailability.

All birds were fed a milo-soy starter diet for 13 days and then switched to corn soy treatment diets which were a zinc deficient control, or the control diet formulated to contain an additional 70ppm zinc from either zinc sulphate, a zinc proteinate, a zinc amino acid complex (ZnAAC) or Mintrex zinc.

MT expression was measured after two days on treatment diets. Zinc sulphate and the ZnAAC only numerically increased MT expression versus the control.

The zinc proteinate induced MT expression greater than the control, but not

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Table 1. Functional effects of mineral bioavailability.

Treatments	Zinc (ppm)	Copper (ppm)
Mintrex*	24.86[a]	5.82[a]
Inorganic	18.85[b]	3.26[b]
Mineral amino acid complex	19.26[b]	1.65[c]
Variance	P<0.0001	P<0.0001

*Mintrex is a trademark of Novus International Inc and is registered in the United States and other countries.

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greater than zinc sulphate or ZnAAC. Mintrex zinc induced MT expression that was significantly greater than all other treatments (Fig. 1). Therefore, more zinc from Mintrex zinc than from the other sources was being absorbed by the small intestine.

These results indicate that Mintrex zinc was more bioavailable than the other zinc sources in this experiment.

Mineral bioavailability

Enhanced mineral bioavailability has also been demonstrated with Mintrex in a commercial broiler breeder trial.

In a recent trial in Brazil, 42,000 Ross broiler breeders were randomly assigned to three treatments (14,000 birds/treatment). Mintrex Poultry (a blend of Mintrex zinc, Mintrex copper and Mintrex manganese) or a mineral AAC blend were supplemented 'on top' of the company's normal inorganic trace minerals inclusion at 0.5kg/ton of feed.

Levels of zinc and copper were measured in the eggs at 33 and 50 weeks of age. The average of these two time points is shown in Table 1.

The mineral AAC blend did not increase egg mineral levels versus the control. Egg mineral levels were highest in the birds fed Mintrex.

This study further demonstrates that organic trace minerals can be more bioavailable than inorganic trace minerals, but that not all organic trace minerals perform equally.

Additional Mintrex trials in broiler breeders are consistent with these data.

Because organic trace minerals should be more bioavailable than their corresponding inorganic forms, it would be predicted that lower mineral inclusion rates could be used without compromising performance.

Two consecutive studies were conducted using four grow out houses with 15,600 birds per house to investigate the benefits of organic trace minerals (Mintrex zinc, copper and manganese) on performance and carcase yield in Cobb 700 (Trial 1) and Ross 708 (Trial 2) birds.

Control birds were raised under a standard grow out programme using 100% inorganic trace minerals to provide 80ppm zinc, 120ppm manganese, and 8ppm copper from sulphates.

The organic trace minerals treatment contained half of the level of zinc and manganese as control (40ppm zinc, 60ppm manganese and 8ppm copper), with 50% of zinc and manganese and 100% of copper from Mintrex.

There was no negative effect of the reduced mineral levels on weight gain, feed efficiency, or tissue mineral levels (tibia zinc, manganese and liver copper) in either trial.

In addition, in Trial 1 organic trace minerals improved final body weight (3.48 vs. 3.60kg for the control and organic trace minerals, respectively, $P = 0.04$), white breast meat yield in males (22.4 vs. 23.0%, $P = 0.09$), and tender percentage in both males (3.77 vs. 3.92%, $P = 0.02$) and females (4.10 vs. 4.20%, $P = 0.02$).

An ROI of 5.8:1 was calculated solely on yield, without considering performance improvements.

No treatment differences were observed in growth performance and meat yield in Trial 2. Thus, Mintrex supported equal or improved performance and white meat yields in these trials, while at the same time allowing for a reduction in total trace mineral inclusion and therefore, the reduction of trace mineral excretion into the environment.

It has been shown that organic trace minerals can benefit laying hens as well.

In recent trials, supplementation with Mintrex Poultry (a blend of zinc, copper and manganese) variously improved keel length, body weight uniformity and bird performance (feed conversion and eggs per hen hatched).

In these same trials, antibody titres to infectious bronchitis and Newcastle disease vaccinations were also increased with Mintrex addition, further supporting the role of these minerals in immune competence.

Other trials demonstrated egg shell strength and elasticity benefits, and significant reductions in cracked eggs with Mintrex. ■