



Availa[®] Mins Improve Broiler Breeder Performance

Introduction

Maintaining high performance of the broiler breeder flock is essential to the profitability of a breeder operation as well as the integrated poultry operations it supplies. Increasing the number of top grade quality chicks is a key objective. This objective is only obtained when all aspects of production are well managed. Flock health, hatchery management and nutrition programs must meet the high standards of the genetic strain. One area of nutrition often overlooked is trace mineral nutrition. Improving zinc, manganese and copper nutrition will have dramatic effects on the performance of the broiler breeder flock. The objectives of this paper are to review the roles of these trace minerals and the effects of these trace minerals on broiler breeder performance.

Trace Mineral Function

Zinc. Zinc is an essential component of over 200 enzyme systems of which the metabolic actions include carbohydrate and energy metabolism, protein synthesis, nucleic acid metabolism, epithelial tissue integrity, cell repair and division, and the absorption and utilization of vitamins A and E (1). In addition zinc plays a major role in the immune system and certain reproductive hormones (1, 2). Adequate zinc nutrition is crucial for normal development, maintenance, and function of the immune system and associated cells, including heterophils, basophils, macrophages, and T-lymphocytes (3). Zinc plays a role as cofactor for the enzyme keratinase in formation of the eggshell membrane and carbonic anhydrase that is involved in the formation of the eggshell.



USDA-ARS Image # K3627-16.
Photo by Keith Weller

Zinc is known to be essential for proper sexual maturity and reproductive capacity. Zinc deficiency has resulted in poor semen quality (4, 9). Improved zinc status also improves fertility by reducing footpad ammonia burns and foot lesions allowing the hens to stand and walk comfortably (6, 7).

Recommended dietary supplementation of zinc for breeder hens is typically 100 to 160 ppm in broiler breeder diets in the USA. Other regions of the world will feed zinc in a range of 60 to 120 ppm mainly in the sulfate and oxide forms.

Manganese. In general, manganese is an activator of enzyme systems in the metabolism of carbohydrates, fats, proteins and nucleic acids (11). It is also essential for normal brain function, and plays a role in collagen formation, bone growth, urea formation, synthesis of fatty acids and cholesterol, protein digestion, eggshell formation, and the function of the immune system (12, 13). Manganese is a cofactor in superoxide dismutase and required for the synthesis of chondroitin-4-sulfate, which is required for proper wound healing (33).

Manganese is typically supplemented at 120 to 180 ppm in the broiler breeder diet in the USA. Other regions will supplement manganese at 60 to 120 ppm in the diet mainly in the form of sulfates or oxides.

Copper. Copper is a necessary component of a number of enzymes. Many of these enzymes play a role in the immune system. These include superoxide dismutase, lysyl oxidase and thiol oxidase (14, 15), which function to eliminate free radicals that increase tissue susceptibility to bacterial infections. These enzymes also are necessary to increase structural strength and elasticity of connective tissue and blood vessels and increase strength of bone. Copper also is involved in the metabolism of iron and the maturation of red blood cells.

The copper requirement provided in the National Research Council (10) nutrient requirements for broilers is 8 ppm; the nutritional requirement of broiler breeders for copper is unknown. Copper typically is supplemented at 8 to 25 ppm in broiler breeder diets, almost exclusively in sulfate form.

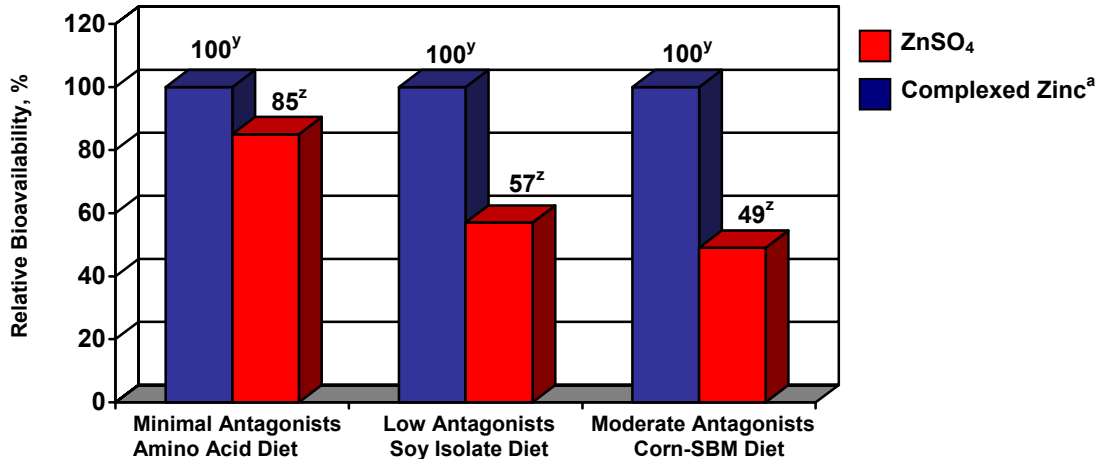
Inorganic vs. Complexed Trace Minerals

Differences in trace mineral forms are well documented. These differences are represented in the degree of bioavailability of the specific trace mineral form. Bioavailability refers to the ability of trace minerals to be absorbed and metabolized in the animal. Oxide trace mineral forms are considered to have the lowest bioavailability, sulfate trace minerals have higher bioavailability, and complexed trace minerals are considered to have the highest bioavailability (17). The bioavailability of trace minerals fed to poultry is dependent not only upon the source of trace minerals but also upon amounts of other trace and macro minerals in the diet, as well as anti-nutritional factors such as phytate. Elements such as calcium, iron and sulfur can reduce the availability of other trace minerals. Some minerals compete for absorption or form insoluble compounds in the digestive system rendering the trace minerals unavailable to the animal. For example, the well-known affect of sulfur and molybdenum combining with copper to form tetrathiomolybdates in ruminants. Zinc and iron also decrease copper availability in livestock and poultry. Complexed trace minerals consistently show an increase in bioavailability over inorganic trace minerals (22, 23) through the ability of this form of trace minerals to avoid interaction with other trace minerals and dietary components in the digestive tract. As dietary antagonist level increases, the bioavailability of inorganic trace minerals diminishes relative to amino acid complexed minerals produced by Zinpro Corporation (Figure 1).

Attempting to increase trace mineral status of the animal by feeding higher levels of specific inorganic trace minerals may decrease the availability of other trace minerals in the diet, increase the toxicity risk, and increase excretion of those trace minerals into the environment. For example, high levels of copper or zinc can inhibit the absorption and utilization of the other trace mineral. Furthermore, trace mineral excretion is becoming a concern. Countries such as Japan and the European Union have passed legislation limiting dietary trace mineral levels. Interest has increased in the feeding of complexed trace minerals to improve trace mineral status, decrease mineral excretion and improve animal performance.

Figure 1.

ANTAGONISTS REDUCE INORGANIC TRACE MINERAL BIOAVAILABILITY



^a ZINPRO[®] zinc methionine

Regression on total tibia Zn in chicks

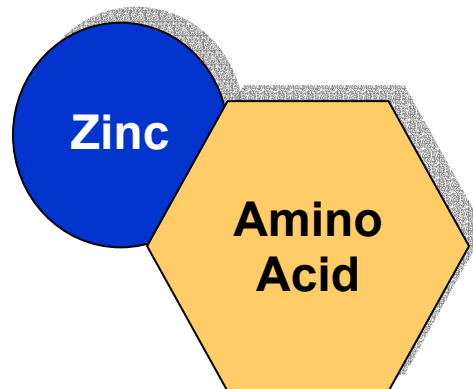
^{yz} Within diet type, means lacking a common superscript letter differ (P<0.01)

Adapted from Wedekind et al., JAS 70:178-187

What are Availa[®] Mins?

AvailaMins are the most recent generation of complexed trace minerals from Zinpro Corporation.

These amino acid complexes are the result of chemically bonding (complexing) a single amino acid to a single metal ion (see illustration opposite), to form the smallest, most stable and most bioavailable organic trace mineral available. Because of AvailaMins size and stability, they are rapidly absorbed through the gut wall in the digestive tract, avoiding negative interactions that commonly antagonize and reduce absorption of other forms of trace minerals. With Zinpro Corporation's recognized commitment to research, new applications for the utilization of AvailaMins in poultry production are regularly being demonstrated and validated, such as their role in immune function, eggshell quality, egg production and feed conversion.



**One metal
(zinc) bonded
to one amino
acid. 1:1 Ratio**

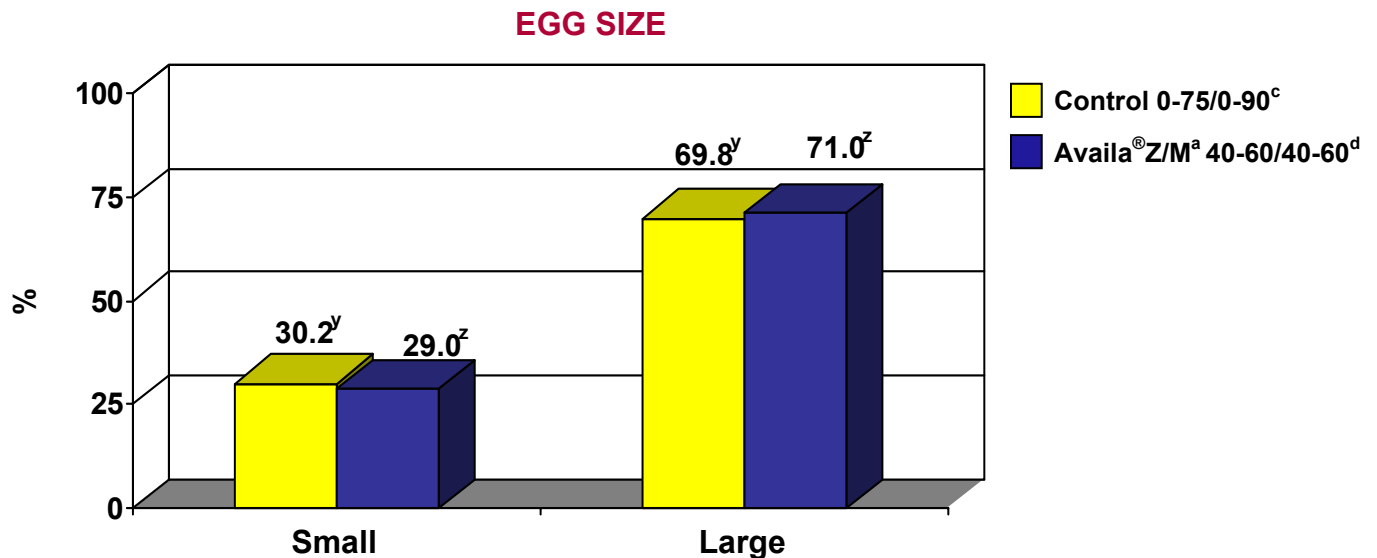
Broiler Breeder Performance

Research has shown that feeding complexed trace minerals to broiler breeders has helped to increase egg production, enhance immunity, reduce mortality, improve fertility, improve eggshell quality, increase livability, and increase the quality and number of saleable chicks produced from the breeder flock. We will review data supporting the use of complexed trace minerals in each aspect of broiler production.

1. Egg Production Complexed trace minerals have shown positive effects on egg production of broiler breeder and laying hens. Egg size, eggshell quality and egg production have all been improved:

- A. **Egg Size** - Egg weight is directly related to the quality of chick produced. A general rule demonstrates the effect of egg weight on the finished broiler; for every 1-gram change in egg weight you will see 7 to 10 grams change in the weight of the 42-day-old broiler. Wide variation in egg size will produce a wide variation in chick size at hatching and affect broiler performance. Large eggs produce large chicks, which will be dominant over smaller chicks. Research on broiler breeders fed complexed zinc and manganese resulted in more large eggs produced compared to hens fed the control diet (Figure 2).
- B. **Eggshell Quality** - Zinc, manganese and copper play roles in the formation of the eggshell. Zinc is a component of keratinase enzyme, which is necessary for the formation of the eggshell membrane. Zinc is also required for carbonic anhydrase enzyme activation, which is required for formation of the calcium carbonate shell. Manganese affects collagen metabolism and the formation of a strong shell matrix. Copper is necessary for eggshell membrane formation via the copper containing enzyme lysyl oxidase. Research feeding complexed zinc and manganese to layers demonstrated an improvement in eggshell weight ($P < 0.05$), eggshell thickness ($P < 0.05$) and specific gravity ($P < 0.05$; 19), indicators of eggshell strength.

Figure 2. Effect of Complexed Zinc and Manganese^a on Broiler Breeder^b Egg Size



^a Availa[®]Zn zinc amino acid complex and Availa[®]Mn manganese amino acid complex

^b Cobb 500 genetic line; treatments applied from hatch

^c 75 ppm Zn from ZnO and 90 ppm Mn from MnSO₄

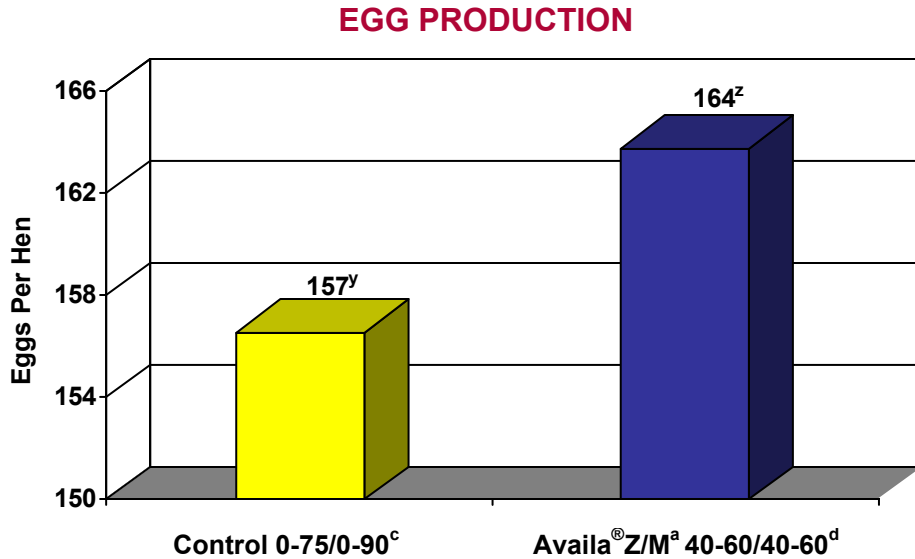
^d 40 ppm Zn from Availa-Zn + 60 ppm Zn from ZnO and 40 ppm Mn from Availa-Mn + 60 ppm Mn from MnSO₄

^{y/z} Within a category, means lacking a common superscript letter differ ($P < 0.12$)

Khajareem et al., 2002. Poultry Sci 81(In press)

- C. **Total Eggs Produced** - Research conducted in the USA demonstrated an increase of 8 eggs (243 vs. 235) produced per hen through sixty-five weeks of age when complexed zinc was added to the basal diet (18). Additional research has shown that complexed zinc and manganese also increased egg production when fed to laying hens (19, 20). A broiler breeder trial using complexed zinc and manganese in the breeder diet from one-day of age to 65 weeks of age increased the number of eggs per hen by 7 eggs ($P < 0.10$; 21). Results are shown in Figure 3.

Figure 3. Effect of Complexed Zinc and Manganese^a on Broiler Breeder^b Egg Production



^a Availa[®]Zn zinc amino acid complex and Availa[®]Mn manganese amino acid complex

^b Cobb 500 genetic line; treatments applied from hatch

^c 75 ppm Zn from ZnO and 90 ppm Mn from MnSO₄

^d 40 ppm Zn from Availa-Zn + 60 ppm Zn from ZnO and 40 ppm Mn from Availa-Mn + 60 ppm Mn from MnSO₄

^{y,z} Means lacking a common superscript letter differ ($P < 0.10$)

Khajareem et al., 2002. Poultry Sci 81(In press)

2. Immunity Minerals play an important role in developing a strong immune defense system. Research on specific areas of the immune system affected by complexed trace minerals are outlined below:

- A. **Epithelial Tissue** Epithelial tissue is the first line of defense. Skin and the lining of the digestive system are the most important epithelial tissues concerning immunity. These are the first line of cells to interact with foreign organisms and disease. One of the roles of epithelial tissue is to prevent foreign organisms from entering the cells where they grow and cause disease. Zinc and manganese play major roles in the development, repair and maintenance of epithelial tissue. By providing adequate zinc, manganese and copper status we assure the strength of this defense system.
- i. **Skin** - Zinc and manganese play an important role in healing process, skin repair and epithelial tissue growth. Research from Parc Institute reported a reduction ($P < 0.05$) in skin tears (6) when broilers were fed complexed zinc. Downs and coworkers (29), found a decrease ($P < 0.10$) of cellulitis incidence and severity when complexed zinc was fed to broilers.

- ii. **Footpads** - Footpad lesions or burns are caused by ammonia accumulating in the litter. Slats or wire cages also can cause foot lesions and joint swelling. Work at Auburn University demonstrated a significant reduction in lesions on footpads of poultry fed complexed zinc (Table 1). Research indicates that feeding poultry complexed zinc will decrease footpad lesions 25 to 30% (7, 24).

Table 1. Effect of Feeding Various Forms of Complexed Zinc to Female Broilers

FOOTPAD RESEARCH

Treatment	Footpad Lesion Score ^a
Control ^b	1.70 ^y
ZnMet ^c	1.26 ^z
ZnLys ^d	1.24 ^z
ZnMet/ZnLys ^e	1.30 ^z



Zinpro Corporation

- ^a Score: 0 = no lesion, 1 = lesions of <7.5mm, 2 = lesions of >7.5mm in diameter
- ^b 55 ppm from ZnO
- ^c Control + 40 ppm Zn from ZINPRO[®] zinc methionine
- ^d Control + 40 ppm Zn from LyZin[®] zinc lysine
- ^e Control + 20 ppm Zn from ZnMet and 20 ppm Zn form ZnLys
- ^{yz} Means lacking a common superscript letter differ (P<0.05)
Hess et al., J Appl. Anim. Res. 19:49-60, 2001

- iii. **Digestion Track** - The epithelial tissue lining the digestive track is affected by the use of complexed zinc in the diet of animals. Researchers at Alberta, Canada, fed high levels of complexed zinc to the sow and found a significant increase in development of gut tissue and gut immune cells in the progeny (25). Disease organisms enter the small intestine and attach themselves to the epithelial lining of the intestinal cell wall. If they penetrate this defense, an infection may occur. Research was conducted at Colorado Quality Research on feeding complexed zinc to broilers and challenging them with coccidiosis. Trial results showed a reduction (P<0.05) of coccidiosis lesions in the treatment groups fed complexed zinc (8).

B. **Cellular Immunity** - Cellular immunity is directed by T- cells. A common test for cellular immunity is cutaneous basophil hypersensitivity (CBH) test. The size of toe web swelling or waddle skin swelling response is measured when phytohemagglutinin-P is injected just under the skin. This response is a measurement of cellular immune response. Generally, the greater the swelling response, the stronger the cellular immune system. The provision of supplemental complexed zinc to broiler breeders consistently increased the phytohemagglutinin-P response in the progeny (27).

C. **Humoral Immunity** - There are two key categories of humoral immunity, Phagocytic cells and B-cells. Both systems are essential defensive mechanisms to prevent disease and infections.

- i. **Phagocytic Cells** – Macrophages are the most prominent members of this immune defense system. Macrophages are the next non-specific defense mechanism after epithelial tissue. Of the three metals (zinc, manganese and copper), zinc plays a direct role in macrophage development and activity. Young turkey poults fed complexed zinc and manganese had statistically enhanced macrophage activity and phagocytic response (26).

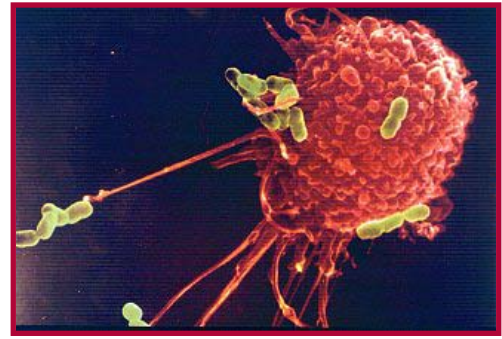
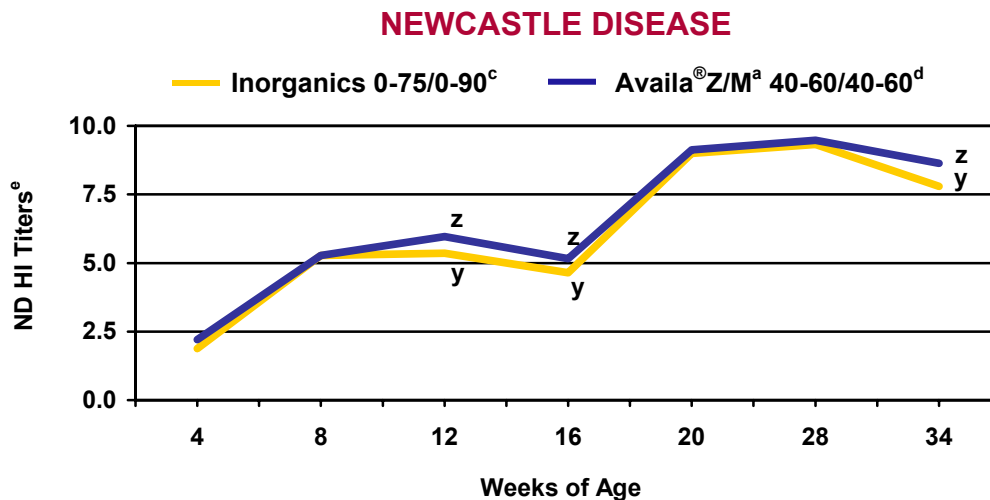


Photo courtesy Dr. Peter Ferket, NCSU

- ii. **B-Cells** - Several research trials have been conducted studying the effects of feeding complexed trace minerals to poultry and measuring titer response. Researchers in the USA and China found increases in titer response to foreign protein (bovine serum albumin) and Salmonella in poultry when feeding complexed trace minerals (26, 27, 28). In a separate trial, complexed zinc and manganese were fed to broiler breeders. Titer response was measured for infectious bronchitis (IB), infectious bursal disease (IBD) and Newcastle disease (ND). Breeders fed complexed trace minerals showed a higher titer response for all three diseases (21). Titer responses are shown in Figures 4-6 below. Internal research in broilers also have shown a higher ND titer response when feeding complexed zinc, manganese and copper (Figure 9).

Figure 4. Effect of Complexed Zinc and Manganese^a on Broiler Breeder^b Humoral Immune Response (antibody titers)



^a Availa[®]Zn zinc amino acid complex and Availa[®]Mn manganese amino acid complex

^b Cobb 500 genetic line; treatments applied from hatch

^c 75 ppm Zn from ZnO and 90 ppm Mn from MnSO₄

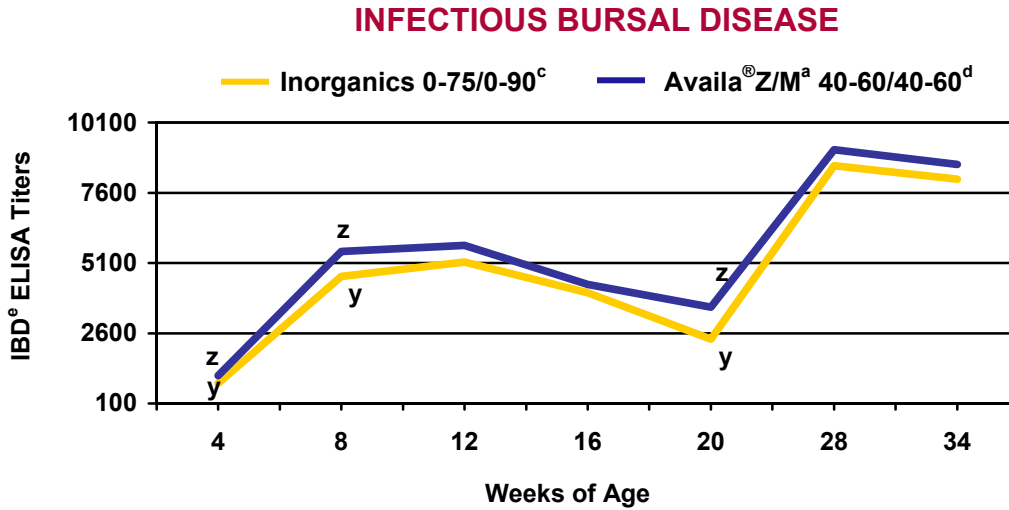
^d 40 ppm Zn from Availa-Zn + 60 ppm Zn from ZnO and 40 ppm Mn from Availa-Mn + 60 ppm Mn from MnSO₄

^e ND = Newcastle disease; HI = hemagglutination inhibition; Vaccination schedule: 7, 24, 56, 84, 106, 140 and 196 days of age and every 56 days thereafter

^{yz} Within a week, means lacking a common superscript letter differ (P<0.05)

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Figure 5. Effect of Complexed Zinc and Manganese^a on Broiler Breeder^b Humoral Immune Response (antibody titers)



^a Availa[®]Zn zinc amino acid complex and Availa[®]Mn manganese amino acid complex

^b Cobb 500 genetic line; treatments applied from hatch

^c 75 ppm Zn from ZnO and 90 ppm Mn from MnSO₄

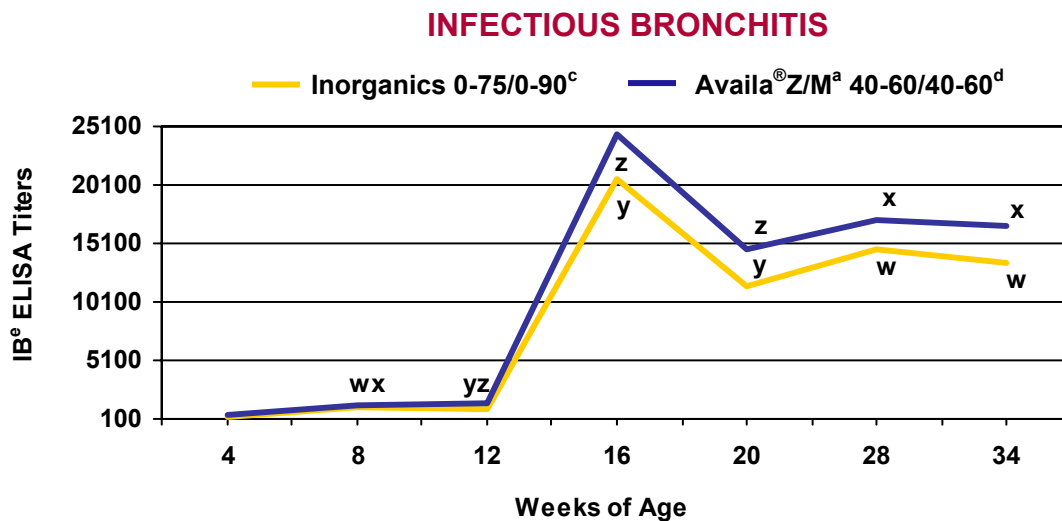
^d 40 ppm Zn from Availa-Zn + 60 ppm Zn from ZnO and 40 ppm Mn from Availa-Mn + 60 ppm Mn from MnSO₄

^e IBD = infectious bursal disease; Vaccination schedule: 18, 28 and 140 days of age

^{yz} Within a week, means lacking a common superscript letter differ (P<0.05)

Khajareem et al., 2002. Poultry Sci 81(In press)

Figure 6. Effect of Complexed Zinc and Manganese^a on Broiler Breeder^b Humoral Immune Response (antibody titers)



^a Availa[®]Zn zinc amino acid complex and Availa[®]Mn manganese amino acid complex

^b Cobb 500 genetic line; treatments applied from hatch

^c 75 ppm Zn from ZnO and 90 ppm Mn from MnSO₄

^d 40 ppm Zn from Availa-Zn + 60 ppm Zn from ZnO and 40 ppm Mn from Availa-Mn + 60 ppm Mn from MnSO₄

^e IB = infectious bronchitis; Vaccination schedule: 7, 24, 56, 84, 106, 140 and 196 days of age and every 56 days thereafter

^{wx} Within a week, means lacking a common superscript letter differ (P<0.10)

^{yz} Within a week, means lacking a common superscript letter differ (P<0.05)

Khajareem et al., 2002. Poultry Sci 81(In press)

- D. **Maternal Immunity** - Immunity in the hen will be passed on to the progeny in poultry. A common vaccination strategy is to obtain a high level of maternal immunity so it passes on to the chick and improves survival rate. Feeding complexed zinc to broiler breeders increased the yolk zinc content of the eggs (28) and increased embryonic bone zinc content (27). Researchers also found a significant increase in the immunity (toe web swelling) of progeny when complexed zinc was fed to the broiler breeders (27; Table 2). Researchers at Mississippi State University showed a similar response in improved cellular immunity of progeny when feeding the broiler breeder hen zinc and manganese complexes (34).

Table 2. Effect of Trace Mineral Complexes on Progeny

**EFFECT OF TRACE MINERAL COMPLEXES ON PROGENY
WHEN FEEDING BREEDER HEN**

Treatments	Bone Dry Weight (g) ^a	Zinc Content (µg/g Dry Bone) ^a	Toe Web Swelling PHAP-P (mm) ^b
Control	0.075 ^x	191.31	0.813 ^z
ZnO	0.075 ^x	191.13	0.758 ^z
Zinc complex ^c	0.078 ^w	210.50	1.067 ^y

^a Control = 72 ppm Zn from ZnO, ZnO = Control + 80 ppm Zn from ZnO, Zinc complex = Control + 80 ppm Zn from zinc complex

^b Control = 78 ppm Zn from ZnO, ZnO = Control + 40 ppm Zn from ZnO, Zinc complex = Control + 40 ppm Zn from zinc complex

^c ZINPRO[®] zinc methionine

^{wx} Within a column, means lacking a common superscript letter differ (P<0.05)

^{yz} Within a column, means lacking a common superscript letter differ (P<0.0001)

Kidd et al. 1992 Poultry Sci.71:1201-1206; 1993 Poultry Sci. 72:1492-1499.

3. Mortality Feeding complexed zinc and manganese to broilers has consistently shown a reduction in mortality. By enhancing the immune system through increased zinc status, the birds stay healthier, grow faster and are better able to cope with disease challenges. Fourteen research projects were summarized showing the effects of feeding complexed zinc and manganese to broilers. The results show a consistent (P<0.001) reduction in mortality (5.98 vs. 7.68%) in broilers when compared to broilers fed control diets containing inorganic trace minerals (30). Additional research conducted in Mexico looked at the effects of feeding complexed zinc and manganese to broilers in conditions conducive to inducing ascites. The addition of complexed zinc and manganese reduced (P<0.05) total mortality (10.4 vs. 12.9%) and mortality from ascites (5.8 vs. 7.8%) compared to broilers fed the sulfate control diet (31). The above research was conducted using broilers that have a relatively short lifespan. However, birds with a longer productive lifespan also have shown decreased mortality when fed diets supplemented with trace mineral amino acid complexes. Research conducted in laying hens showed decreased mortality (12.1 vs. 13.7%) when feeding zinc amino acid complex from one-day of age through sixty-four weeks of age (18). Additionally, broiler breeders fed complexed zinc and manganese from one-day of age through sixty-five weeks of age had lower mortality (6.51 vs. 8.43%) than the control group fed inorganic zinc and manganese (21).

4. Fertility Two research trials looked at the effects of supplemental complexed zinc and manganese in broiler breeder diets (21, 32). A numerical trend for improved fertility was seen in both trials (83.5% vs. 83.8%; 78% vs. 85%). Male broiler breeders may also benefit from the use of complexed zinc in the diet. Zinc is a necessary component of sperm and semen production. Feeding zinc to male breeders of other species has increased sperm concentration and sperm motility (4, 5, 9).

5. Hatching Eggs Egg size and eggshell quality are two factors that affect the number of hatching eggs available for setting. Research has demonstrated that feeding complexed trace minerals will improve the number of quality eggs.

- A. Setting Eggs - Research on feeding complexed zinc and manganese to broiler breeders demonstrated a statistical increase in the percent of setting eggs (88.60% vs. 87.27%) compared to breeders fed inorganic zinc and manganese (21).
- B. Specific Gravity - Eggs from layers fed complexed zinc and manganese had higher ($P < 0.05$) specific gravity than eggs from hens fed inorganic trace minerals (19).
- C. Egg Weight - Egg weight increased when complexed zinc and manganese were added to the diet of layers (19).

6. Hatchability Two research trials looked at the effects on hatchability when supplementing complexed zinc and manganese in broiler breeder diets (21, 32). There was a numerical trend for improved hatchability in both trials (68% vs. 73%, 83.5% vs. 84.2%).

7. Chick Production and Chick Quality

When all aspects of the broiler breeder production system are functioning properly, the producer will see improved flock performance. Improved performance means increased profitability. Feeding complexed trace minerals will improve immunity, decrease mortality, and increase fertility and hatchability. These benefits all pay off in the production of a higher quality day-old-chick. A trial using broiler breeders demonstrated the positive results of feeding complexed trace minerals on the production of day-old-chicks. Broiler breeders fed complexed trace minerals produced more chicks per hen (Figure 7) compared to hens fed the control diet containing only inorganic trace minerals (21). Additional research found that broiler chicks from hens fed zinc and manganese amino acid complexes had increased livability through 17 days of age (35; Figure 8). These data suggest that feeding the hen trace mineral amino acid complexes improves chick quality.



USDA-ARS Image # K3627-16.
Photo by Keith Weller

Figure 7. Chicks Per Hen

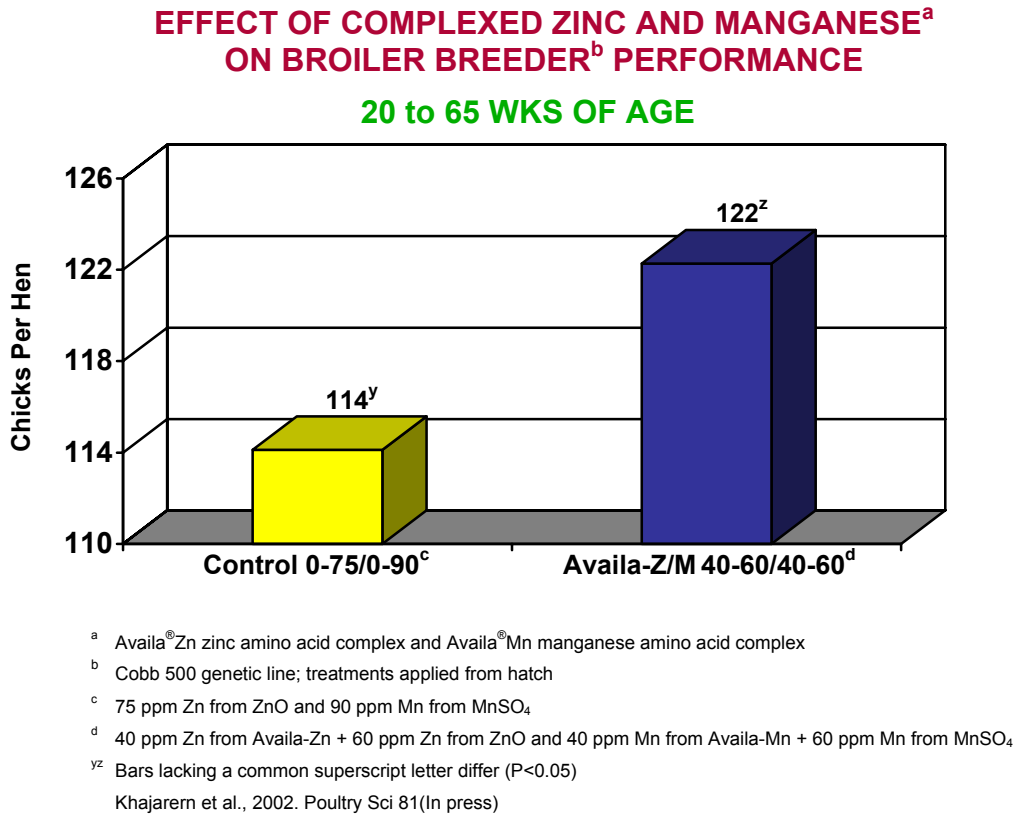
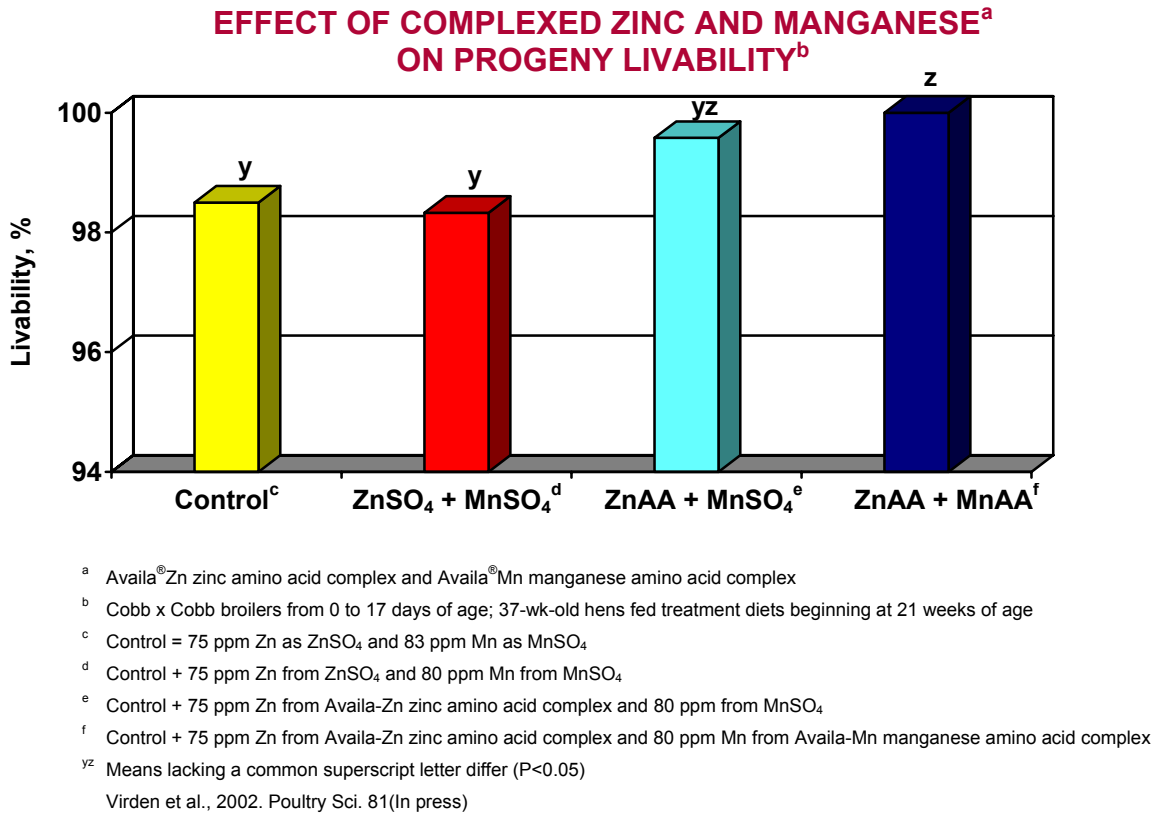


Figure 8. Amino Acid Complexes Increase Livability of Broiler Breeder Progeny

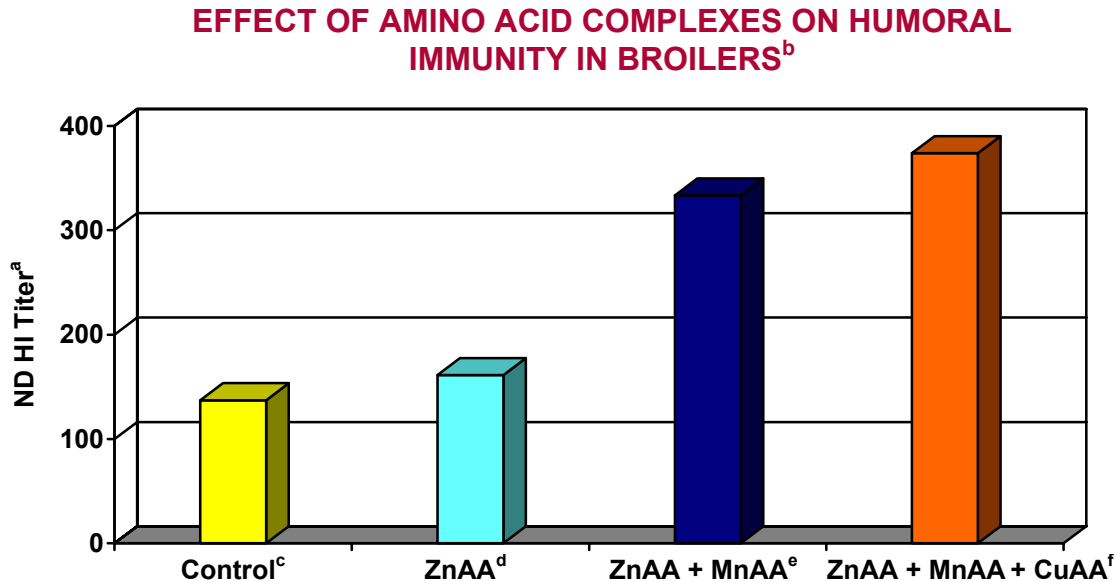


The Case for Complexed Copper

As has been mentioned previously, the nutritional requirement of broiler breeders for copper is unknown. Typically copper is supplemented at 8 to 25 ppm in broiler breeder diets. However, it is important to know that zinc, calcium and iron can reduce copper availability. Broiler breeder diets contain high levels of calcium, which acts as an antagonist to copper (16). Providing a bioavailable form of copper in the breeder diet will be beneficial and assure proper copper status in the bird.

Many of the copper dependent enzymes play a role in the immune system. Research conducted in broilers showed that feeding diets supplemented with zinc, manganese and copper complexes increased ND titers above titers of broilers fed inorganic trace minerals or diets supplemented with zinc and manganese complexes (Figure 9). Copper also is necessary for enzymes that are necessary to increase structural strength and elasticity of connective tissue such as the eggshell membrane and blood vessels, and increase bone strength. These components are critical to maximize broiler breeder egg production. Providing copper in highly bioavailable amino acid complex form is an excellent way of ensuring maximum broiler breeder performance.

Figure 9. Zinc, Manganese and Copper Amino Acid Complexes Improve Broiler ND Titer^a



41102001

^a ND = Newcastle disease; HI = hemagglutination inhibition

^b 42 days of age

^c Control = 100 ppm Zn as ZnSO₄, 120 ppm Mn as MnO, 15 ppm Cu as CuSO₄, all treatments iso-mineral

^d ZnAA was 40 ppm Zn from Availa[®]Zn zinc amino acid complex

^e MnAA was 40 ppm Mn from Availa[®]Mn manganese amino acid complex

^f CuAA was 10 ppm Cu from Availa[®]Cu copper amino acid complex

Personal Communication, Dr. H. Shieh, National Chung-Hsing University, Taiwan

Developing Trace Mineral Status

Developing and maintaining trace mineral status in broiler breeders is a difficult task. Typical diets contain antagonists that tie up essential trace minerals and make them unavailable for absorption. Feeding complexed trace minerals is a way to assure adequate mineral status and top performance from your flock.

Feeding recommendations for Availa[®]ZMC complexed zinc, manganese and copper are explained below. It is important to note that the effects of feeding complexed trace minerals are a factor of both feeding level and time. Several of the research trials cited in this paper fed complexed trace minerals for only a few months in the middle of the production cycle and found variable results. Other trials used lower than recommended feeding rates and also received variable results. Trials where complexed trace minerals were fed from day-old chick to the end of the production cycle at recommended levels have generated consistent performance responses and economic returns. It is important to feed Availa-ZMC starting with day-old chicks and continuously through the production cycle to achieve the results stated in this paper. Feeding for shorter periods of time will not be as effective.

Conclusions

Research on feeding complexed trace minerals to broilers breeders and other poultry has proven it to be an effective and economical way to improve performance. Feeding complexed zinc, manganese and copper to broiler breeders has been shown to increase egg production, egg size and improve eggshell quality, improve hatchability and fertility, increase cellular, humoral and maternal immunity, reduce footpad lesions, increase the total number of chicks produced per hen and improve chick quality. Availa-ZMC is a profitable tool for broiler breeder flocks.

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