HMTBa chelates play role in trace mineral nutrition

Highly bioavailable sources of trace minerals help young chicks achieve their full genetic potential when fed to breeder hens at lower dietary concentrations.

By MEGHARAJA K. MANANGI*

GENETIC selection has increased the overall demands for supplemental nutrients in broiler and layer breeders.

Trace minerals such as zinc, copper and manganese are required to ensure the health and productivity of the animal. They function both as enzyme cofactors and as constituents of metalloenzymes.

Zinc, copper and manganese play a role either individually or in combination to maintain the structural integrity of tissues (Underwood and Suttle, 2001; Opshal et al., 1982; Rath et al., 1999; Guenther et al., 1978; O’Dell et al., 1961; Strause et al., 1986; Manangi et al., 2012b).

Laying hens fed chelated zinc, copper and manganese have shown improvements in bone strength, immune response, eggshell quality (shell thickness and breaking strength or broken eggs) and embryonic bone development (Padhye et al., 2011; Torres and Korver, 2011; Manangi et al., 2012a).

Evidence that these trace minerals play a key role in eggshell and bone formation suggests that supplementing hens with chelated trace minerals will support not only the quality of eggs from breeder hens but also the hatching rate and progeny quality.

A number of trials with layer/broiler breeders have been carried out in which the zinc, copper and manganese chelates of methionine hydroxy analogue (HMTBa) replaced inorganic trace minerals (ITMs) in the diet.

Studies with broilers clearly identified the increased bioavailability (Richards et al., 2010) of the chelated trace minerals, which was linked to their possible resistance to antagonists from the feed or the drinking water, such as iron or calcium. These studies provided a framework for study designs in which the commercial levels of ITM use can be challenged in a “reduce and replace” strategy (Manangi et al., 2012).

Layer breeders

Research with breeder producers in commercial conditions supports this approach.

In the first study, two groups of 9,500 female line layer breeders received identical diets except for the source of key trace minerals. For the control group, trace minerals consisted of 100 mg of zinc oxide, 10 mg of copper sulfate and 100 mg of manganese oxide per kilogram of diet, and the test group had the corresponding HMTBa chelates included at 50:10:65 mg/kg of the diet. Performance was measured until week 80.

The production data per housed hen are summarized in Figure 1.

During the 80 weeks, a 4.1% increase in total egg production per housed hen (326 versus 339) and a 4.9% increase in hatchable eggs per housed hen (306.5 versus 321.5) resulted with the use of the HMTBa chelates in the diet.

Eggshell breaking strength also was measured to indirectly assess the

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**1. Impact of ITMs versus HMTBa chelated zinc, copper and manganese (MINTREX) on hatching rate**

<table>
<thead>
<tr>
<th>ITM</th>
<th>HMTBa chelate</th>
<th>Improvement, %</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embryos alive at 18 days, %</td>
<td>82.0</td>
<td>83.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Embryo survival from day 18 to 21, %</td>
<td>88.8</td>
<td>89.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Total hatchability, %</td>
<td>72.7</td>
<td>74.1</td>
<td>1.8</td>
</tr>
</tbody>
</table>

*8,300 eggs in each treatment were monitored to evaluate hatching rate at week 36.

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**2. Impact of using ITMs versus HMTBa chelated zinc, copper and manganese on egg trace mineral content (source effect)**

<table>
<thead>
<tr>
<th>Mineral</th>
<th>ITM*</th>
<th>HMTBa**</th>
<th>Difference, %</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc, mg/kg</td>
<td>40</td>
<td>42</td>
<td>+5%</td>
<td>0.036</td>
</tr>
<tr>
<td>Copper, mg/kg</td>
<td>2.6</td>
<td>3.2</td>
<td>+23%</td>
<td>0.060</td>
</tr>
<tr>
<td>Manganese, mg/kg</td>
<td>0.85</td>
<td>0.91</td>
<td>+7%</td>
<td>NS</td>
</tr>
</tbody>
</table>

*30:10:30 zinc/copper/manganese.
**20:10:20 zinc/copper/manganese.

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effect of the mineral source on eggshell structure. The results for the two groups during the 80-week period showed a consistent improvement in eggshell strength with the HMTBa chelates (Figure 2).

Replacing the standard ITM source with the HMTBa chelates at a lower inclusion rate promoted improved performance and stronger eggshell structure over the period of lay. In particular, after 60 weeks of age, when production starts to decrease, chelate use improved overall performance. The results support the premise that chelated trace minerals have a higher bioavailability and increase the supply of essential nutrients to the animal’s tissues.

Broiler breeders
In a second trial (Manangi et al., 2013) with heavy breeders producing a male line, the HMTBa chelates were included in the diets of two flocks, each with two groups of 3,800 birds, from 21 to 36 weeks. The control diet contained 100 mg of zinc oxide, 10 mg of copper sulfate and 100 mg of manganese oxide per kilogram of diet. The HMTBa chelate diet included 56 mg of zinc, 14 mg of copper and 56 mg of manganese per kilogram. Inclusion of the chelated minerals resulted in an average increase in egg production of 5.8% and significant improvements in hatchery results at 36 weeks. These included an increase in the number of embryos alive at 18 days and percent hatchability (Table 1).

Bone development
Abnormalities in bone development have been reported to be initiated early in life, with manifestation later as a result of an environmental or infectious challenge. Ensuring the supply of key nutrients for early development of tissues, such as bone and collagen, is essential.

Skeletal development depends on the production of a collagen structure that undergoes ossification between day 11 and day 19. The enzymes catalyzing these processes are dependent upon zinc, copper and manganese for their biological activity. The importance of this process encourages use of the most bioavailable source of trace minerals fed to breeders to improve progeny development.

Several trials with both layers and breeders have shown that yolk mineral status is sensitive to the trace mineral source in the diet.

Yolk mineral status
In a recent controlled research trial, the ITM source of either zinc, copper or manganese was replaced with the corresponding HMTBa chelates at a reduced level, and the mineral content of the egg yolks was measured (Sun et al., 2012). Fifteen eggs from each treatment were sampled at weeks 43, 48 and 52. Results are shown in Table 2.

The results of the Sun et al. study were confirmed in a commercial trial with breeders in which 100 mg of inorganic zinc, 10 mg of inorganic copper and 100 mg of inorganic manganese per kilogram of diet were replaced with 50 mg of zinc, 10 mg of copper and 65 mg of manganese as HMTBa chelates. Eggs were sampled at weeks 42, 57 and 77, and the trace mineral content of the yolk was measured.

Pooled data showed that the use of the HMTBa chelates resulted in an increase in the yolk’s zinc content from 33.5 mg/kg to 38.8 mg/kg, or a 16% improvement. Copper content showed a numerical increase, but no change occurred in the yolk’s manganese content.

These trials demonstrate that producers can improve tissue trace mineral supply to embryos, in this case through manipulating yolk content, while reducing the diet’s mineral content. Given the physiological impact of trace minerals, this may favor the chick’s early immunity development and livability.

Embryo development
The relationship between an increased supply of trace minerals and embryo development can be assessed by measuring the extent of bone mineralization in the one-day-old chick. In the heavy breeder trial (Table 1), tibia bones were analyzed from day-old chicks hatched from eggs laid at 36 weeks from both the control and chelate groups. These results (Figure 3) show...
that despite reducing the zinc, copper and manganese content of the diet from 100 mg/10 mg/100 mg, respectively, to 56 mg/14 mg/56 mg when using the chelate, tibia ash content was significantly increased in the day-old chick ($P = 0.02$). Tibia zinc content also increased 3%, from 84 to 87 mg/kg dry matter (Manangi et al., 2013).

These data are supported by another trial (Torres and Korver, 2011) in which four different mineral treatments were fed to broiler breeders. Bone measurements were made on day-old chicks hatched from 33-week-old hens after 11 weeks on the diets. The dietary treatments (zinc/copper/manganese amounts in mg/kg) were: control ITM 100/10/120, high ITM 140/30/160, control ITM plus HMTBa chelate (total 140/30/160) and HMTBa chelate 50/10/60. Tibia and femur bone thickness was measured (Figure 4).

Increasing the supply of the three trace minerals in the ITM form had no effect on chick bone development. Adding a low concentration of the HMTBa chelated trace mineral source to the control ITM provided a trace mineral content equivalent to the high ITM treatment. This resulted in a numerical improvement in femur thickness. However, when the chelates were used alone at a lower concentration than in the other diets, there was a significant ($P < 0.05$) increase in both tibia and femur thickness.

These data in breeders are supported by a similar study in laying hens (Manangi et al., 2012a).

Summary

The trace minerals zinc, copper and manganese play an essential role in the maintenance of the health and productivity of the breeder bird. Providing a more bioavailable source of these elements in the diet improves egg production and hatchability until after 80 weeks of age.

Inclusion of the stable HMTBa chelates in breeder diets results in increased mineral levels in the egg yolk, from which they become available to the developing chick. As a result, the formation of key structural tissues, such as collagen and bone, is enhanced, as is the survival of the day-old chick. This helps the chick more fully express its full genetic potential.

Highly bioavailable sources of the trace minerals achieve these effects at lower dietary concentrations, thus reducing the environmental impact from the breeder operations.

References


Manangi, M.K., P. Buttin, J. Richard, M. Vazquez-Anon and M. Decoux. 2013. Feeding broiler breeder hens with diets containing reduced levels of Zn, Cu and Mn as chelates compared to industry levels as sulfates/oxides improve hatching rate and progeny quality. Poult. Sci. 92 (E-suppl. 1):P446 (abstr.).


