

Total replacement technology with organic minerals for laying hens

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Eggs are an excellent source of minerals and nutrients. However, the nutrients and minerals in the egg, and indeed shell formation, can be greatly influenced by both genetics and the health and nutrition of the bird.

Although genetic improvements in shell quality parameters have been achieved through selection in our modern strains of laying hens, there is still room for improvement under commercial conditions.

Adequate protein, vitamin, mineral, and trace mineral nutrition is essential for best results. Bird strains differ in the ages at which shell quality begins to substantially decline and likely in the rate at which the decline happens. Genetic gains in egg shell quality also have to be taken into consideration for modern strains.

Organic trace minerals

Organic trace minerals such as copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) can be presented in a number of forms, but the chelation of proteins, peptides or amino acids to minerals equates more closely to that of small peptides and amino acids and appears to be an appropriate form for inclusion in diets.

Minerals chelated to proteins are known as proteinates. Alternatively, the mineral Selenium (Se) can be presented as selenium enriched yeast. Organic trace minerals, min-

Fig. 1. The membrane fibres (top left) overlying the ciliated cells (Prof. Sally E. Solomon).

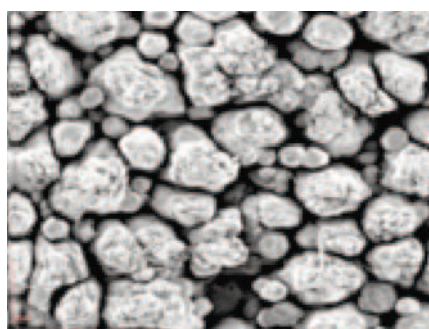
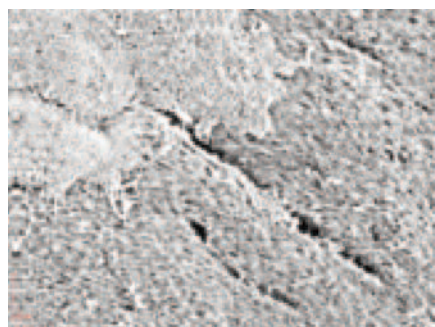


Fig. 2. Spherical calcite between normal mammillae (Prof. Sally E. Solomon).

erals bound to amino acids and short chain peptides or presented in yeast, are more efficiently absorbed by the hen.

Furthermore, having neutral electrochemical charges, organic trace minerals are far less likely to interact with other minerals, vitamins, and pigments in the premix or in the diet and cause losses of these other valuable components.

Consequently, trace mineral proteinates can be used at lower inclusion levels in the diet yet still achieve adequate levels in the bird, while also reducing excretion rates and minimising the quantity of undigested trace minerals in the environment.

Proteinates of Cu, Fe, Mn and Zn comprise the Bioplex range of organic trace minerals while Se incorporated into yeast, *Saccharomyces cerevisiae* CNCM I-3060, is known as Sel-Plex. Bioplex and Sel-Plex (Alltech Inc., Nicholasville, KY) can be added to laying hen diets on top of regular basal diets, as partial replacement or as Total Replacement for trace minerals from inorganic sources to help improve shell quality traits.

There has been considerable research investigating the effects and advantages of mineral proteinates in laying hens. For example, Total Replacement of typically added inorganic trace mineral levels, with minerals proteinates and selenium yeast at up to 93% lower levels than the inorganic minerals, improved shell structure and shell breaking strength (by approximately 4-6%) in caged laying hens from 22-72 weeks of age, as shown by Prof. Sally E. Solomon, Senior Research fellow, University of Glasgow, Scotland (Figs. 1 and 2).

A study in hens 20-60 weeks of age found that the activity of the enzyme associated with generating carbonate for egg shell formation (carbonic anhydrase) decreased over time. There is also a diminishing ability to absorb essential trace minerals with age, but the inclusion of trace mineral proteinates increased the activity of this enzyme. Other trace minerals such as Zn and Mn are necessary for the correct functioning of other enzymes important in egg formation, and for this reason they are known as enzyme activators.

Meta-analysis

Often, when research describing the effects of organic or inorganic minerals is examined, it is difficult to compare individual studies looking at the effects of trace mineral proteinates on egg production, egg quality or mineral utilisation. However, using a statistical meta-analysis to tease out any quantitative benefits of using trace mineral proteinates will allow us to do just that.

Essentially, a meta-analysis combines results from different studies that are sufficiently similar to allow the identification of common effects.

In this case, 23 trials relating to egg shell quality from laying hen trials published worldwide between 1996 and 2008 from Australia, Brazil, Canada, Czech Republic, Hungary, Lebanon, Mexico, Philippines, Romania, Turkey, UK, and the US have been analysed. Five egg shell quality traits were identified across all 23 studies and compared:

- Shell strength.
- Shell thickness.
- Percent shell.
- Percent checks or cracks – fine cracks discovered during the candling phase.
- Specific gravity.

The analysis showed that the inclusion of trace mineral proteinates increased the shell strength and shell thickness and decreased the percentage of checks or cracks (Table 1). The percentage of shell weight and specific gravity also tended to be increased by trace mineral proteinates.

This type of large scale analysis clearly

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Continued from page 21 shows the benefits of using trace mineral proteinates on a global scale on egg shell quality traits.

Total Replacement concept

Total Replacement is a concept and technology that Alltech have been developing over the last 10 years. Organic trace minerals, presented as proteinates or in yeast, typically have increased bioavailability compared to their inorganic counterparts.

Organic trace minerals can be used to boost existing dietary levels (by adding on top) or as a Total Replacement for inorganic minerals to support and sustain egg shell quality in laying hens as they age. It has been observed that these trace mineral proteinates can be included in feed at substantially lower levels than inorganic minerals yet they still provide the bird with correct mineral levels. Table 2 shows the National Research Council (NRC) (1994) recommended levels versus Bioplex and Sel-Plex recommended levels in poultry. A number of studies have demonstrated the increased bioavailability of trace mineral proteinates at low inclusion levels. Pullets fed diets supplemented with Bioplex at 25% NRC level, compared with 100% NRC level of supplementation with inorganic minerals, reduced mineral excretion by up to 20% but had no

	Shell Strength (%)	Shell Thickness (µm)	Shell weight (%)	Check or cracks (%)	Specific gravity or change (%)
Base diet	100	364	8.66	4.03	100.06
Organic trace minerals	103.8 Significant*	379 Significant	8.75 Not significant	2.89 Significant	100.06 Not significant

* Significantly different at P < 0.05

Table 1. Results from meta-analysis on egg-shell parameter from 23 studies (1996-2008).

negative influence on performance and tissue mineral concentration.

In another study, laying hens fed up to 33% Total Replacement with Bioplex demonstrated a 23% improvement in bone strength compared with 100% inorganic trace minerals (Cu, Fe, Mn and Zn), while excretion of each of these four trace miner-

als in the manure was on average 34% lower in trace mineral proteinates treatments.

This meta-analysis from studies performed all over the world demonstrates that significant benefits from adding trace mineral proteinates may be expected, including increased egg shell strength and shell thickness, and decreased numbers of checks and/or cracks at processing. Egg shell weight also tends to be increased. In addition to the performance benefits of trace mineral proteinates, there is the benefit of lower levels of trace minerals in bird manure, reducing environmental pollution.

Total Replacement using trace mineral proteinates and organic selenium yeast is an exciting proposition for layers, and all the evidence indicates it is beneficial for both the bird and the environment. ■

Table 2. NRC recommended levels and recommended Total Replacement levels with Bioplex and Sel-Plex.

Trace mineral	NRC level (ppm)	Total replacement levels with Bioplex and Sel-Plex (ppm)
Iron	80	5
Copper	8	5
Zinc	40	30
Manganese	60	30
Selenium	0.15	0.3

References are available from the author on request