# Investing in a stronger shell

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**Eggshells that are cracked or broken account for between 80 and 90% of the eggs that are downgraded. This can be a problem, especially in older laying hens. Therefore, the quality of eggshells plays a key role in the economics of a layer farming operation.**

Eggs for the table egg market need to be strong enough to prevent cracks from occurring during packaging and transportation in order to withstand pathogenic challenges and maintain a healthy and clean product for consumers. Cracked eggs need to be sent to the liquid egg market or they can be sold into a market that uses large quantities over a short period of time, which will result in a lower price for the eggs.

There are several factors that can have an influence on shell quality, such as genotype, age, oviposition time, housing system and a balanced diet that contains sufficient calcium, phosphorus and trace minerals.

## Eggshell formation

The eggshell is formed in the uterus, which is also known as the shell gland. The shell consists of several layers: the mammillary layer, palisade layer, vertical or surface crystal layer, and the cuticle. The palisade layer is the thickest layer of the eggshell. The vertical or surface crystal layer lies under the cuticle.

Traditionally, the focus has been more on the effect of macro-minerals (calcium and phosphorus) and vitamin D3 and its importance on eggshell quality. However, the enzymes that play a role in shell mineralisation and formation in the shell gland also need consideration, and these are often dependent on micro-minerals.

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## Microminerals and the shell

The organic matrix of the eggshell is influenced by zinc (Zn), manganese (Mn) and copper (Cu), and therefore these trace minerals also have an influence on the mechanical eggshell properties. Copper improves the integrity of the shell membrane, while zinc and manganese have an effect in both the organic and inorganic chemistry of eggshells.

Zinc is a component of the carbonic anhydrase enzyme that is essential for eggshell development. Inefficient activity or inhibition of this enzyme can result in reduced eggshell weight due to lowered bicarbonate ion secretion.

Manganese activates enzymes such as glycosyl transferase that contribute to the formation of the organic matrix of the shell. Glycosyl transferase is involved in the formation of mucopolysaccharides, which are components of proteoglycans. Proteoglycans are present in the shell matrix and play an integral part in the control of the structure and texture of the shell. Diets that are deficient in manganese could lead to eggs with thinner shells.

Copper is part of the enzyme lysyl oxidase that is critical for collagen formation in the eggshell membrane. This enzyme plays a role in converting lysine to cross-linked desmosine and isodesmosine, which create the lysine-derived crosslinks in the eggshell membrane fibres that are responsible for the shape of the egg. Therefore, a deficiency in copper could lead to an abnormally shaped egg.

## Research and recommendations

The recommended supplementation levels to increase eggshell strength and reduce egg loss for manganese, zinc and copper, respectively, are in the region of 60 ppm, 60 ppm, and 10 ppm. However, supplementation levels should consider certain factors such as genetics, hen age, climate and production systems or market. In fact, supplementing hens between the ages of 60 weeks and 73 weeks at these levels resulted in an average increase in eggshell breaking strength of between 8.5 and 9.1% compared to diets that were not supplemented. In the same study, these supplementation levels were also shown to improve fracture toughness by between 10.9 and 12.8%, especially in older hens. Another research study focusing on manganese supplementation alone, without any other trace minerals, suggested a supplementation level of 100 ppm of manganese to improve eggshell quality, especially in aged laying hens.

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A further study reported improved eggshell breaking strength when supplementing 80 ppm and 120 ppm Zn in the organic form, compared to the same level of inorganic Zn. Research on trace mineral supplementation has often found that the organic trace minerals are better utilised than the inorganic forms. Using organic minerals efficaciously from an economic perspective would tend to suggest a strategy where inorganic and organic mineral sources are used in the same diet.

Layer diets should consider micro-mineral supplementation in addition to macro-mineral supplementation for optimal eggshell quality.

**References available on request.*