Eggshell: the most important component of egg quality

It is hard to overstate the importance of eggshell quality for successful production of chicks. From the time the egg enters the uterus of the hen during shell formation until the chick is hatched the shell protects the egg contents from physical damage.

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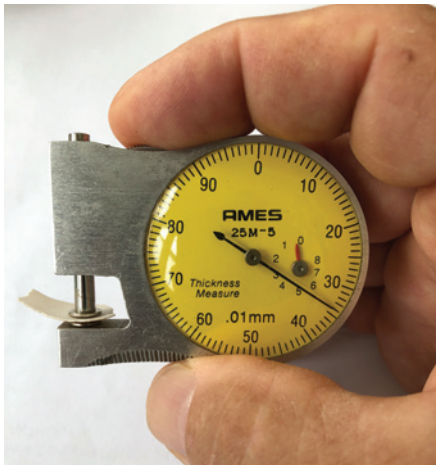
After lay the eggshell provides further protection from entry of pathogens. Eggshell quality affects egg quality which ultimately affects chick quality. This article will review the importance of shell quality and methods to evaluate eggshell quality in parent stock breeders.

The commercial hatching egg has shell strength to survive a lot of handling (oviposition, collection belt, traying, transport to hatchery) before it reaches the incubator. The risk of microbial contamination increases with poor shell quality.

Contamination can lead to bangers, rots, late embryonic mortality and yolk sack infections. The shell protects the embryo from physical damage and the entry of pathogens via the cuticle layer. It also provides a calcium source for the embryo, regulates gas exchange and manages moisture loss.

Measure shell thickness using a thickness gauge micrometer with a curved pin to accommodate the curvature of the shell.



Poor shell quality can lead to cracks, poor hatchability, reduced chick quality and therefore economic losses.

Structure and composition

Eggshells are made almost entirely of calcium carbonate ($CaCO_3$) crystals. The crystals are tightly bound to each other by proteins derived from the uterine fluid. (These proteins indicate that the chicken came first, not the egg). Average eggshell thickness is about 0.30mm.

There are about 10,000 pores on the shell surface each one 0.0017mm in diameter totalling 1.8mm^2 in open space to support gas exchange and moisture loss. Eggshells less than 0.28mm thick rarely hatch viable chicks due to excessive dehydration during incubation.

Breeder age and egg size

The calcium necessary for eggshell formation originates from two sources; diet and medullary bone. The medullary bone, located in the long bones of the hen, serves to buffer dietary deficiencies and is activated during the hen's resting phase at lights out. Dietary calcium should be increased from 0.95 to 1.2% in the developer diet fed from 16 weeks to first egg.

Medullary bone is formed as the pullet matures and is maintained in the hen throughout production if adequate dietary calcium is provided. Typically, 3% dietary calcium in the breeder diet is necessary for maintenance of eggshell quality.

Long term deficiencies in dietary calcium will lead to medullary bone depletion and shell thinning. It is well documented that as the hen ages, the egg weight increases and shell thickness decreases. Eggs from older hens are more susceptible to microbial contamination, cracks and breakage.

Therefore, it is important to support older breeder flocks by providing trace minerals (Zn, Mn), vitamin D3 and oyster shell, particularly in the hot season. Eggshell quality is reduced by heat stress and disease interfering with movement of calcium in the blood.

Cuticle and shell colour

Eggshell colour is a breed trait and, for broiler breeders, a uniform, brown shell colour is a sign of good quality. The cuticle is a thin layer covering the shell consisting primarily of glycoproteins with some carbohydrate and fat constituents. Cuticles are formed just prior to oviposition along with shell colour pigments.

This layer dries and hardens in 20-30 seconds after being laid and is the first mechanism of defence against micro-organisms and controls egg moisture loss. Along with shell thickness, cuticle thickness also decreases as the hen ages.

There is no proven link between pigmentation, cuticle deposition and shell quality, though improved cuticle coverage is often associated with positive hatch results. There is significant variation in cuticle deposition among broiler breeds.

By selecting for improved cuticle deposition, the risk of disease could potentially be reduced. It is easy to visualise cuticle quality with staining. The staining method requires total egg immersion in a 1% solution of cuticle blue stain for five

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minutes. The staining intensity is directly related to the cuticle amount present. Since the cuticle provides a protective advantage for the egg contents, sanding, rubbing, and washing damage the cuticle.

A damaged cuticle will alter gas exchange through the shell, increase the risk of contamination and ultimately poor hatchability and chick quality. Egg cleaning practices in attempt to salvage dirty eggs are not recommended by Cobb.

Shell quality

Almost 50% of discarded eggs are due to shell quality issues. A pale brown or white colour can be the first indication of poor eggshell quality for broiler breeders. In pale eggs, it is likely that cuticle deposition and calcium accumulation are decreasing or not complete which could be a result of nutrition and disease. In some cases, eggshell quality issues are due to premature oviposition.

Shell thickness and strength is a critical factor for commercial broiler breeders and should be monitored over the life of a flock. There are a variety of tests that can evaluate shell quality. Destructive methods include breaking strength, shell weight and thickness. Shell weight and thickness can be readily measured on site.

The ideal egg is clean, uniform in colour and the correct shape.

A sample of 30 eggs per flock is recommended. Use relatively clean floor eggs instead of nest eggs since they are likely lost as hatching eggs.

Follow the procedure below to evaluate eggshell quality.

- Weigh each egg (to the 0.01g) and place in a labelled cup.
- Break each egg, discard the contents and carefully rinse the shell.
- Carefully peel the shell membranes away from the shell and return the shell to the cup. Prevent any shell from becoming lost during this step.
- Allow all eggshells to dry overnight and individually weigh shells (to the 0.01g).
- Using a pinch caliper with a curved pin, measure shell thickness in three locations (top, equator and bottom of egg). The curved tip is necessary to measure the shell curvature.
- Average the three thickness measures to determine overall shell thickness.
- For the 30-eggs sampled, calculate average egg weight, shell weight, and shell thickness. This is calculated as:
shell weight/egg weight x 100.
- Monitor the change in eggshell over time by repeating this procedure at least monthly.

Conclusion

Efforts to hatch good quality chicks from eggs with poor eggshell quality is futile. Shell quality and ultimately chick quality is determined and impacted by breeder age, nutrition, shell thickness and the cuticle formation.

It is important to monitor shell quality for the life of your flock and respond to changes in quality. ■

References are available from the author on request