Egg quality: optimising hatchling performance from inside the shell

Viable hatching eggs and healthy chicks are the end goal when it comes to hatchery management, and while many incubation factors can be controlled within the hatchery, a great deal can be done at breeder flock level to improve these production parameters.

by Emily Marshall, Alltech.
www.alltech.com

Improved shell strength leads to an improvement in hatchability.

Embryonic development is a complex process and, as such, many things can go wrong. Therefore, egg and embryo quality is of paramount importance to ensure the economic success of hatchery and breeding operations. When discussing quality parameters, multiple factors should be considered – from the external egg surface, shell structure and function, to ensuring that the fertilised yolk has the essential nutrients required for effective embryogenesis.

Shell structure and function

The avian egg is considered to be the most complex amniotic egg in oviparous vertebrates. It is well known that the shell has an essential function in providing a sealed, protected environment for the embryo to grow within while allowing the transfer of gases and water, which are vital to development. The shell is a complex structure, composed primarily of calcium carbonate ($CaCO_3$), made up of multiple layers.

The shell has an essential function in providing a sealed, protected environment for the embryo to grow.

The base layer (mammillary body) is formed first, which then provides a platform on which other components can grow. The palisade layer forms on top of this, followed by the transitional vertical crystal layer and the cuticle. Each layer consists of a highly specific structure, which provides high resistance to compressive stress.

These structures have $CaCO_3$ components, but their structural integrity is withheld in the organic matrix by glycoproteins and glycosaminoglycans. Ensuring optimal shell structure will help to prevent breakages and hairline cracks, as shell strength will be improved. This impacts the developing embryo, as it helps to prevent bacterial translocation across the shell.

Critical to ensuring shell structure and strength is providing the correct amount of minerals from the right source, enabling the breeder bird to utilise them efficiently. Organic chelated minerals have superior bioavailability and have been shown in multiple field studies to improve shell strength.

Fieldwork conducted on breeder operations also reveals that through substituting inorganic minerals with BioPlex minerals, shell strength was improved, which leads to an improvement in hatchability. This work was done in a commercial setting, and, as a result, potential extraneous factors cannot be excluded. However, the importance of shell structure on offspring function should not be overlooked.

The cuticle is another crucial component in ensuring the best quality eggs. It is a glycosylated protein layer formed prior to oviposition. Cuticle proteins have antimicrobial properties, and increasing cuticle deposition enhances the defensive abilities of the egg against bacteria.

Recent work shows that cuticle deposition does not decrease over the age of the breeder flock, at least up to 50 weeks, and it is vital in preventing pathogenic microbial penetration of the shell, which could lead to early embryo mortality. Improving cuticle thickness, as well as shell thickness and structure, are important factors in preventing contamination.

Research shows that even clean eggs, which have been set, contain 10^3-10^5CFU/g bacteria on the shell surface. This contamination comes from the breeder flocks, and while some will be beneficial microflora, it is highly likely that there will be aberrant bacteria present. Therefore, with multiple microbial populations on the shell surface, any interventions added to improve the protective measures from within the shell can be significant.

Continued on page 10

Continued from page 9

The importance of microbiota

As mentioned above, there are several micro-organisms found on the surface of incubating eggs. Micro-organisms play a major role in the health and gastrointestinal function of adult birds, as part of the microbiota. There is evidence to show that from 16 days of incubation, there is flora present in the gut of developing embryos.

This changes prior to hatch and then continues to develop until reaching climax flora in the adult. The microbial population has been heavily researched over recent years, and it is now understood that it helps to maintain healthy gastrointestinal function, as well as helping to modulate the immune system.

Both of these factors have huge economic impacts through the benefits shown in improvements in feed efficiencies and growth rate, and the vast amount of energy that would be converted away from growth or egg production during an acute phase immune response. The vast number of organisms found on the shell surface will be present once the chick has hatched and will become the primary coloniser of its gut, alongside what comes from within the egg. This vertical transmission means that the flora of the breeder can have huge consequences on the flora of the offspring.

Many studies have shown that improving the microbial diversity of breeders and putting them onto a gut health programme significantly benefits the performance of offspring. Maternal antibodies are a critical factor that transfer from parent to chick, and in a similar way to that of the microbiota, it has been shown that improving antibody titres in parents leads to better quality hatchlings through transovarial transfer.

Higher amounts of maternal antibodies in the offspring allow them to better respond to any challenges which may arise before their immune system has fully matured. Antibody titres in parent flocks were increased by improving gut health and immune function via dietary supplementation with Actigen.

Embryogenesis

The yolk is an essential part of the egg and provides the developing embryo with the nutrients required for sustenance and growth. Embryogenesis is an amazing process, taking single cells through multiple division cycles to produce a viable chick to hatch. Cell division and replication is a metabolically and cellularly stressful process and, as such, the yolk must provide the best forms and the right amount of nutrients to support this.

As cells divide and respire, they produce oxygen free radicals, which cause cellular stress. If not controlled effectively, they can cause cellular damage, leading to potential genetic mutations, which could impact development. As a result, ensuring the breeder birds are being fed correctly is important.

While supplementation with vitamin E is commonplace in breeder diets, the benefit of the addition of organic selenium is often overlooked. Not only does it have an impact on spermatogenesis, leading to higher fertility rates, but it is also a key part of the glutathione peroxidase enzyme, reducing oxygen free radicals in the cytosol. The addition of both additives in diets affords higher levels of protection, as vitamin E works to protect cell walls, whereas selenium works via the cytosol, protecting from inside the cell.

Egg and chick quality can cover a plethora of factors, as discussed above, and all intervention strategies used to help improve quality have to be economically viable. It becomes crucial to consider, not what interventions cost, but the benefit to the bottom line that they could bring back.

As the demand for poultry meat and eggs continues to grow in Europe, we are going to need to produce more viable chicks in order to keep up with demand.

Perhaps, looking at our breeder flocks could be a good place to start. ■