

How Egg Quality Impacts the Health of Day-One-Chicks?

Teresa M Agulles*

PlusVet Animal Health, Zh engwang Road 2, Environment Protect Industry Park, Jimo City, Qingdao, China

Abstract

The main goal of every breeder farm is to get the maximum number of qualified eggs and live chicks per hen and the highest proportion of top quality day-one-chicks.

In order to obtain the maximum number of healthy, highly productive chicks, we need to consider not only the variables related to the breeders but also the factors related to eggs quality. Physical characteristics of fertile eggs are key not only to embryonic development and hatchability, but also to the health of chicks during the first week of life. Eggs with low shell quality or low specific gravity are more likely to be penetrated by pathogenic bacteria. The most obvious consequence of such infection is the development of omphalitis, also called yolk sac infection, major cause of disease and mortality in broilers during the first week, as well as a loss of productivity throughout the life of broilers.

Keywords: Egg quality; Fertile egg; Salmonella; *E.coli*; Omphalitis; Chicken

Introduction

The supply of day-old chicks is very important for the success of the poultry production chain. The goal of the breeding industry is the production of healthy chicks, which are able to unfold their full genetic capacity. Chick quality can be influenced by many factors, including egg selection, transportation, storage, the whole incubation process, processing in the hatchery and transport to the farms.

Infectious agents can be introduced into the fertile egg management chain in breeder farms or in the hatchery, and affect not only the fertility and hatchability, but also the health of the broilers during the first week and their productivity throughout life.

Physical factors of the fertile egg are directly related to the susceptibility to internal contamination by bacteria and, ultimately, to the health and quality of young chicks.

Egg Quality Factors

Physical characteristics of fertile eggs play an important role in embryonic development, hatchability and status of the chicks. The quality attributes can be divided in two groups:

Internal quality factors

Internal quality factors will indicate the freshness of the egg.

The quality decline begins immediately after the egg is laid, mainly because of the loss of water and CO₂. Losing carbon dioxide leads to an increase in the pH of the egg, that produces changes in the three-dimensional structure of the proteins.

The quality of the albumen is one of the main indicators related to freshness. The height of the albumen and the weight of the intact egg are used to calculate the Haugh Unit value. A Haugh Unit value of 70-80 is ideal for the fertile eggs and it will fall quickly after 3-5 days if the egg is not stored properly [1].

Internal quality is optimal immediately after being laid; however, in practice, the best results are obtained by incubating eggs that have been stored for one to two days [2].

External factors

The eggshell is about 0.3 mm thick and consists of more than 95% of calcium carbonate stabilized by a protein matrix. The cuticle atop and the membranes below the shell operate as barriers. It is covered by up to 20,000 pores that allow the exchange of gases and water between the developing embryo and the environment [3].

There are many factors that determine the quality (thickness and strength) of the shell, among others:

1. Diseases and stress.
2. Nutritional factors, generally related to minerals and vitamins.
3. The length of time that the egg remains in the uterus and the rate of calcium deposition during its formation.
4. Some breeds are able to deposit calcium at a faster rate than other breeds.
5. As the hen ages, the thickness declines.

The presence of visible cracks or micro-cracks due to deficient formation inside a hen or mishandling is quite common. While the eggs with visible cracks are discarded, detecting small cracks is not easy and very often eggs with star-crack and hairline-cracks are sent to the hatchery (Table 1).

Bacterial Penetration inside the Egg

A thin-egg shell, abnormally big pores or the presence of micro-cracks may lead to the penetration of pathogenic bacteria inside the egg. The porous shell is not a significant obstacle to bacterial penetration,

*Corresponding author: Teresa M Agulles, PlusVet Animal Health, Zh engwang Road 2, Environment Protect Industry Park, Jimo City, Qingdao, China 266201, Tel: + 86 532 8752 2311; E-mail: info@plusvet.eu

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| | Weight loss during incubation % | % Fertile eggs | % hatchability of fertile eggs | Average chick weight at day 1 (g) | Culled chicks % |
|----------------|---------------------------------|----------------|--------------------------------|-----------------------------------|-----------------|
| Normal | 11.4 | 97.76 | 85.78 | 48.9 | 1.12 |
| Star crack | 20.7 | 89.44 | 55.64 | 48.2 | 1.69 |
| Hairline crack | 24.0 | 83.31 | 35.78 | 45.6 | 2.24 |

Table 1: Micro-cracked eggs lose more moisture than normal eggs during incubation and show higher embryo dehydration and mortality, as well as worse quality of day-one-chicks [18].

although the underlying shell membranes and the cuticle are a more effective barrier.

There are two main routes for bacterial infection of the fertile egg [4]:

Vertical transmission

During the egg formation, the albumen or the egg membranes (rarely the yolk itself) are contaminated as a result of an existing infectious disease of the ovaries or the oviduct while the egg is being formed.

The existing infectious disease of the reproductive organs may originate from systemic infections or it can be an ascending infection from a contaminated cloaca to the vagina and then to the oviduct.

Some bacteria that produce systemic infections (*E.coli*, *Salmonella*) are introduced to the hens via the gastrointestinal tract. After oral ingestion, these bacteria colonize several regions of the tract, particularly the crop and caeca in the case of *Salmonella*, are able to disrupt intestinal epithelium, enter the bloodstream and spread through the body of the bird to many organs including the reproductive system.

Horizontal transmission

In the horizontal infection, pathogens arrive inside the egg from the outside by penetrating the eggshell.

Although huge microbial contamination of shell is not common at the time of oviposition, avian faecal material and other environmental sources in the laying house, during transport, storage or incubation can rapidly introduce bacteria onto eggs [5,6].

Main contaminant species in the fertile egg

The major contaminants found inside the fertile egg are Gram-negative bacteria such as *Escherichia coli*, *Salmonella*, *Pseudomonas*, *Aeromonas*, *Proteus* and *Alcaligenes* sp; Gram-positive bacteria like *Staphylococcus* and *Bacillus*. It has been found that most contaminated eggs contain a mixed colonization by several species [7-9].

Salmonella and *E.coli*

Salmonella species and *E.coli* are the maybe best studied egg bacterial contaminants that impact DOC quality. These bacteria may arrive to breeding flock and fertile eggs through several potential sources:

1. The replacement pullets, which are carriers of pathogenic bacteria.
2. Laying house environment: Environmental contamination of *Salmonella* and *E.coli* has been found to persist in the houses even after cleaning and disinfection.
3. Vectors: insects, reptiles, wild birds, rodents, livestock, pets and humans.
4. Feed and water

5. Hatcheries: chicks acquire the infection in two ways: either during incubation, by penetration of the bacteria through the egg shell; or at hatch, by ingestion of contaminated dust and aerosols [10].

Health Consequences in Day-One-Chicks

Omphalitis, also called yolk sac infection, is the most obvious consequence of bacterial contamination of the egg and a major cause of mortality in broilers during the first week [11].

Specific signs are:

1. Birds with distended abdomen.
2. Navel inflammation and swelling, that be observed in approximately in 30% of the affected chicks.
3. Unabsorbed yolk sac, that appears enlarged because the yolk has not been utilized by the chick. If the yolk sac contains inflammatory waste products, it is abnormally colored and has fetid odor.
4. Unabsorbed yolk sac is very often accompanied by pericarditis and perihepatitis.

According Kahn et al., unspecific signs found during yolk sac infection are the following [12]:

1. Diarrhea and pasted vents.
2. Dehydration, loss of weight.
3. Depression, drooping of the head and tendency to aggregate near the heat source.
4. Low maternal antibodies, poor immunity.
5. Poorer intestinal absorption of nutrients.
6. Mortality (5-10%) usually begins within 24 hours of birth and peaks by 5-7 days [13,14].

Several bacteria such as *E coli*, *Salmonella* spp., *Proteus* spp., *Enterobacter* spp., *Pseudomonas* spp., *Klebsiella* spp., *Staphylococcus* spp., *Streptococcus* spp., *Clostridium* spp., *Bacillus cereus* and *Enterococcus* have been isolated from the yolk sac of infected birds.

Consequences that last a life time

If chicks survive more than a few days, they show lower weight and poor growth. On necropsy, usually an infected yolk sac remnant can be found, even in birds older than 10 days. Quality of the carcass will be deficient and these animals are very often condemned in the slaughterhouse [15].

Several authors [16,17] proved that pathogenic bacteria are likely to remain in the intestine and yolk sac remnant of the surviving birds during all the life of the animals, may spread to other organs and ultimately result in death.

Affected birds are more likely to develop infectious diseases, especially chronic respiratory diseases.

Holistic Prevention Plan

There is no specific treatment for yolk sac infection in young birds. The use of antibiotics to treat the pathogenic bacteria may be useful in some cases in accordance with susceptibility testing, but generally speaking is of little value.

Prevention is the only possible solution and involves the identification of the causative bacteria and a comprehensive and multilevel plan to eliminate the sources of pathogens in the breeder farm and the hatchery.

Conclusion

Physical characteristics of fertile eggs are directly related to their susceptibility to internal contamination by pathogenic microorganisms that lead to poor health of day one chicks and impaired productivity during all the life of the broiler. Omphalitis is one of the main diseases associated with internal bacterial contamination.

In order to improve the microbiological quality of the egg, it is necessary to set up a holistic prevention plan that includes all the steps involved in fertile egg management. Poor eggshell quality is a factor that is often overlooked but necessary to take into account in order to improve chick quality.

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