Incubation temperature – an unknown predisposing factor for ascites

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Ascites is an important cause of mortality in the modern broiler industry. Genetic selection against ascites has been shown to be effective and is nowadays widely used by broiler breeder companies. However, mortality related with ascites still occurs. Modern broiler chickens are prone to develop ascites because of their genetic selection for rapid growth and a high meat yield.

The consequence of this genetic selection is that the development of important cardiovascular organs, such as the heart and the lungs, do not parallel the development in body weight. These organs are essential to supply the chicken with a sufficient amount of oxygen.

Ascites heart (left) and normal heart (right).

Demand for oxygen is good

The demand for oxygen is high in broilers due to their rapid growth. When the bird's demand for oxygen exceeds its capacity, this can result in the development of ascites. To obtain a sufficient amount of oxygen, the chicken will increase its cardiac output and the number of red blood cells, which thickens the blood.

Consequently, the heart needs to pump harder to supply all the tissues with blood. Furthermore, the pressure increases in the lungs and the pulmonary arteries. This leads to a high pressure in the right ventricle of the heart. This high pressure eventually enlarges the right ventricle and this is a typical sign for birds with ascites (see photograph). Moreover, the function of the heart impairs because of this enlargement of the right ventricle and the right heart valve does not close properly.

Finally, this ends up in leakage of fluid in the heart sac, lungs and the abdominal cavity. The fluid accumulation in the abdominal cavity is another typical sign of ascites and the reason why ascites is also called 'waterbelly'. Birds will eventually die from these lesions.

The cause of ascites is often multifactorial and related to an imbalance between oxygen demand and oxygen availability. Factors affecting the oxygen demand (cold temperature or nutritional factors such as feed composition and particle size) or oxygen availability (high altitude or poor ventilation) are predisposing factors for the development of ascites.

Although the incidence of ascites occurs often at the end of the production cycle, the susceptibility for ascites is possibly developed much earlier in life: during the embryonic phase. Incubation temperature is one of the most important factors that influences chick development. The air temperature is usually maintained between 36-38°C throughout incubation.

Embryo temperature

The temperature that the embryo experiences differs from the air temperature inside the incubator as it is related to the heat production of the embryo and the heat transfer between the egg and the surrounding air.

Embryo temperature instead of incubation temperature should be controlled throughout incubation. Because embryo temperature is difficult to measure without killing the embryo, eggshell temperature is often used in practice as an indicator for the actual embryo temperature.

A continuous eggshell temperature of 37.5 -38.0°C has been found to result in the highest hatchability and best chick quality. However, a high eggshell temperature (>38.5°C) in the second half of incubation is commonly found in practice due to the increase in heat production of the developing embryo and problems with cooling capacity and air velocity in some incubators.

A high temperature during the second half of incubation results in a poor chick quality expressed by a pale appearance, small size, and poor navel condition. High temperatures compared with normal eggshell temperatures also reduce the chick's heart weight up to 30% at hatch.

This decrease in heart development may increase the susceptibility of the chicken to develop ascites. The relation between incubation temperature and ascites incidence was never investigated.

Therefore, HatchTech BV, Wageningen University, and Penn State University performed a study to evaluate whether a high eggshell temperature during incubation is indeed a predisposing factor for the development of ascites in broiler chickens.

In the study, two eggshell temperatures (high or normal) during incubation and two growout temperatures (cold or regular) during the growth period were used.

Twenty trays of 132 eggs from a commercial Ross x Cobb (500) flock of 33 weeks of age were used. Eggshell temperature was maintained at 37.8°C in the first week of

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incubation. On day seven of incubation, eggs were divided between two incubators and a high (38.9°C) or normal (37.8°C) eggshell temperature was applied throughout incubation.

At day 21 of incubation, 36 first grade chickens were housed in a pen, with 24 replicates per eggshell temperature treatment. To stimulate the development of ascites, a cold temperature schedule was applied to half of the birds per eggshell temperature treatment. The other birds were grown at a normal temperature schedule. Mortality related with ascites was evaluated daily.

Hatchability and chick quality

Results of the experiment showed that the hatchability of fertile eggs was on average 93.5% and did not differ between the high or normal eggshell temperature treatment.

However, the number of unsaleable chickens was 0.7% higher in the high compared with the normal eggshell temperature treatment.

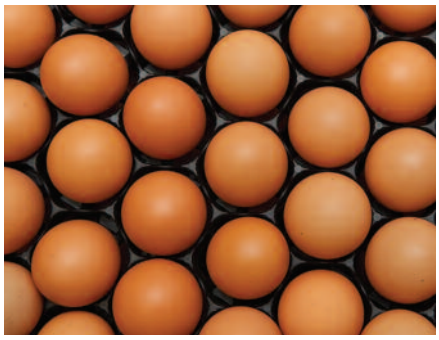
Chick quality of the salable chickens was poorer in the high compared with the normal eggshell temperature, expressed by a smaller size of the bird and a poor navel condition. Subsequent performance was also decreased in the high compared with the normal eggshell temperature treatment: birds weighed on average 41g less at 42 days of age (2,854g vs. 2,895g, respectively).

The negative effects of a high eggshell temperature that were found were consistent with practical experiences and other scientific studies.

Mortality related with ascites

Mortality related with ascites more than doubled in the high eggshell temperature compared with the normal eggshell temperature (Table 1) and this was both in the normal and in the cold growout temperature.

The reason that chickens incubated at a high eggshell temperature are more susceptible for ascites might be the result of the reduction in heart weights at hatch, which was 26% less in the present study.



Treatment	n[1]	Mortality related with ascites (%)
Eggshell temperature		
Normal	24	2.8[b]
High	24	6.6[a]
Growout temperature		
Regular	24	2.8[b]
Cold	24	6.6[a]

[a,b]Means lacking a common letter within a treatment are significantly different ($P \leq 0.05$).
[1]Pen was the experimental unit.

Table 1. Mortality associated with ascites of birds incubated at normal (37.8°C) or high (38.9°C) eggshell temperatures from day seven until 21 days of incubation and grown at a regular or cold temperature treatment until 42 days of age.

A smaller heart at hatch may decrease the ability to supply the body with a sufficient amount of oxygen and can become the first step in the development of ascites.

A high eggshell temperature can therefore be included in the list of predisposing factors for ascites. Preventing a high eggshell temperature during incubation is one of the keys to prevent ascites in later life of broiler chickens. ■