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INCUBATION TECHNOLOGY

Technical Information

Perinatal Development and Nutrient Utilization in Chickens – Effects of Incubation Conditions

Dr. Roos Molenaar M.Sc. – Summary PhD thesis

Suboptimal incubation conditions, such as a high eggshell temperature (EST) or low O_2 availability, can negatively affect the survival and development of chicken embryos. However, the physiological mechanisms that may explain these negative effects are largely unknown.

Furthermore, negative effects of suboptimal incubation conditions may have long-lasting effects on survival and performance of chickens throughout their production cycle, which has not been intensively investigated. Therefore, the first aim of the PhD thesis of Roos Molenaar was to investigate effects of EST and O_2 availability during incubation on the survival, development, physiology, and nutrient utilization of chicken embryos. The second aim was to investigate the long-lasting effects of suboptimal EST on the survival and performance of broiler chickens. In the first study, effects on chick quality, organ development, and nutrient use were investigated in broiler embryos incubated at a high (38.9°C) or normal (37.8°C) EST combined with a low (17%), normal (21%), or high (25%) O_2 concentration from day 7 until 19 of incubation. After day 19 of incubation, the EST difference was maintained, but the O_2 concentration was 21% for all treatments.

What is the effect of different O_2 concentrations during incubation?

Results of the first study showed that body development is related to the O_2 concentration during incubation, a higher O_2 concentration results in a higher yolk-free body mass. Organ weights were proportional to the YFBM at all O_2 concentrations.

However, the shift in O_2 to 21% for all treatments at day 19 of incubation changed the use of nutrients for the embryos in the low (17%) and high (25%) O_2 concentration. Embryos incubated at a low O_2 seemed to use nutrients more efficiently than those incubated at a normal or high O_2. This result suggests that the embryos incubated at 17% adapted to the low O_2 concentration and were better able to use their nutrients, comparable with the positive effect of high altitude training on the performance of sportsmen.

What is the effect of high eggshell temperature (EST) incubation?

Results of the first study showed that a high EST, compared with a normal EST, reduced chick quality expressed by a lower yolk-free body mass (YFBM) at hatch. The reduction in development was possibly a result of

1. the earlier hatching time
2. the lower weight of supply organs (i.e., heart and lung)
3. the reduced amount of proteins that were used for growth

The result that protein use for growth was reduced showed that proteins were lost during high EST incubation. Proteins are the building blocks for the chicken's body and they were not used for growth at high EST incubation. This explains the lower yolk-free body mass that is often found after high EST incubation.

Where remain the proteins that are lost during high eggshell temperature (EST) incubation?

The proteins that are lost in embryos incubated at a high EST are possibly used as an energy source during the hatching process. Why? At normal EST incubation, sugars stored as glycogen in the liver are used for energy during the hatching process. However, embryos incubated at a high EST have a lower amount of glycogen (stored sugars) in their liver before the hatching process starts. To obtain enough energy to emerge from the eggshell, embryos incubated at a high EST probably use valuable proteins as an energy source. It is better to emerge from the egg with some protein loss than not emerge from the egg at all.

Does high eggshell temperature (EST) affect the incidence of ascites?

The first study and several other studies showed that high EST incubation reduce relative heart weights up to 31%. The reduced heart weights may increase the incidence of metabolic disorders related to heart development, such as ascites, in later life. We investigated if broilers incubated at a high EST are more sensitive for ascites. Broiler embryos were incubated at a high (38.9°C) or normal (37.8°C) EST from day 7 of incubation onward and were raised at a normal or cold growout temperature; the latter was used to induce ascites. Results showed that mortality associated with ascites was 3.8% higher in the high EST compared with the normal EST. This result showed that a high EST is a predisposing factor for ascites.

Conclusions

From the thesis of Roos Molenaar, it can be concluded that a high EST or low O_2 availability from the first week of incubation onward negatively affect the survival and development of chickens from hatch until slaughter age.

These negative effects can be partially explained by changes in nutrient use during incubation. High EST incubation decrease valuable sugar stores (hepatic glycogen) that are required for hatching and this may result in embryonic mortality. High compared with normal EST reduced body development of

broiler embryos at hatch which is possible the result of the earlier hatching time, the lower weight of supply organs, and/or the loss of proteins. The lost proteins might be used as an energy source to compensate for the limited sugar stores.

Finally, high EST is a predisposing factor for ascites and this is possibly the result of the reduced heart development at hatch. The PhD thesis of Roos Molenaar showed that preventing high eggshell temperatures is a matter of life and death importance.

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