

Technical Information

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Storage of hatching eggs

Effects of storage and early incubation conditions on egg characteristics, embryonic development, hatchability, and chick quality.

Summary PhD thesis Inge Reijrink

Introduction

After oviposition, hatching eggs are first stored at the breeder farm and then transported to the hatchery and stored again before they are finally placed in an incubator. The storage duration depends on the supply of hatching eggs, the hatchery capacity, and the market demand for day-old chicks. Normally, commercial hatcheries set their eggs after 3 to 5 days of storage to minimize the negative effects of egg storage on hatchability and chick quality. However, hatcheries may need to increase the storage duration in some situations.

It is well known that an increase in the storage duration increases the incubation duration, decreases hatchability, decreases chick quality on the day of hatching, decreases subsequent growth performance, and increases post-hatch mortality. Although the negative effects of prolonged egg storage are well known, the reasons for the negative effects of extended storage on hatchability and chick quality are not completely understood.

Why does prolonged egg storage have a negative effect on hatchability and chick quality?

During storage, eggs are stored at temperatures below those necessary for morphological development. However, some cellular activity, such as cell death, still occurs in the embryo. In addition to changes in the embryo, changes in the egg characteristics (micro-environment of the embryo) occur during storage. After oviposition, CO₂ and H₂O are lost from the egg, and the albumen pH increases from about 7.6 to about 9.0, the yolk pH increases from about 6.0 to about 6.5, the albumen height decreases, and the strength of the yolk membrane decreases as well. Because these changes in the

embryo and the egg characteristics both occur during egg storage, it is difficult to determine which of these changes causes the negative effects of prolonged egg storage on hatchability and chick quality. The first aim of the PhD thesis of Inge Reijrink was to determine which physiological mechanisms are responsible for the negative effects of prolonged egg storage on hatchability and chick quality. The second aim was to investigate how the negative effects of prolonged egg storage can be reduced by making changes in the storage or early incubation conditions.

Prestorage incubation can have positive and negative effects on hatchability

The results from the PhD thesis of Inge Reijrink and the results from other studies indicate that the negative effects of prolonged egg storage on hatchability depend on the stage of embryonic development during storage. At oviposition, the stage of embryonic development often ranges from EG10 to EG13 (formation of the hypoblast). These stages are the optimal stages to survive prolonged egg storage and to continue embryonic development successfully at the onset of incubation. When embryos are developed beyond stage EG13 (primitive streak starts to develop) due to prestorage incubation, frequent warming during storage, or high environmental temperatures, hatchability can decline by more than 50%. Embryos of a young breeder flock (<30 weeks of age) may be below developmental stage EG10 at oviposition (area pellucida is not distinct). When embryos are less developed than stage EG10, prestorage incubation or frequent warming during storage lasting 3 to 6 hours can improve hatchability when the storage duration is prolonged, but the embryos must not be allowed to develop further than developmental stage EG13 because then the risk of a decline in hatchability is high.

The gaseous environment in the storage room has a minor effect on hatchability and chick quality

The conditions in the micro-environment of the embryo during storage may also be responsible for the negative effects of prolonged egg storage on hatchability and chick quality. To change the micro-environment of the embryos, eggs were stored in normal air, 0.74% CO₂, 1.5% CO₂, or 3.0% O₂. The effect of these treatments on albumen quality, embryonic development, hatchability, and chick quality were investigated. The results demonstrated that the 0.74 and 1.5% CO₂ treatments prevented some of the changes in albumen height and albumen pH during storage, but the treatments did not affect embryonic development, hatchability, or chick quality. These data suggest that the changes in albumen quality (pH and height) that occurred during storage were not detrimental to the embryos used in the current research. The embryos also survived storage at a low O₂ concentrations.

Preincubation warming after prolonged egg storage affects hatchability

The start of incubation may be crucial for the survival rate of the sensitive long-term stored embryos. To investigate whether the warming profile at the onset of incubation affects embryo viability, two experiments were conducted in which the effects of 4 hours and 24 hours preincubation warming profiles on embryonic development, hatchability, and chick quality were investigated when eggs were stored for short and prolonged times. The results demonstrated that the 24 hours preincubation

warming profile decreased embryonic mortality during the first 9 days of incubation by 4.4% and, consequently, increased hatchability when the storage duration was 13 or 14 days in comparison to the 4 hours preincubation warming profile. The preincubation warming profile did not affect hatchability when the storage duration was 4 days and did not affect chick quality. In conclusion, a slow preincubation warming profile can improve hatchability when egg storage is prolonged.

Hypercapnic incubation after prolonged egg storage does not improve hatchability and chick quality

During early incubation, the optimal pH for embryonic development seems to be between 7.9 and 8.4. However, the albumen pH is around 9.0 during the first 2 days of incubation and slowly declines thereafter due to the CO₂ production of the embryo. Although the change in albumen quality during storage did not affect embryo viability in the current research, it was hypothesized that an albumen pH around 9.0 during the first few days of incubation can be detrimental to embryonic development, especially when embryo viability is reduced due to prolonged egg storage. To investigate the effect of albumen pH during early incubation on hatchability and chick quality when egg storage was prolonged, eggs were exposed to CO₂ concentrations between 0.70 and 0.80% during the first 5 days of incubation (hypercapnic incubation) to reduce the albumen pH during early incubation. Hypercapnic incubation decreased the total albumen pH but retarded embryonic development and decreased the hatchability of fertile eggs by 1.3%. Chick quality was not affected. It can be concluded that an albumen pH around 9.0 during early incubation was not detrimental for embryonic development in the current research.

Conclusions

Which physiological mechanisms are responsible for the negative effects of prolonged egg storage on hatchability and chick quality?

Embryo characteristics seem to have a more important role in the negative effects of prolonged egg storage on hatchability than the changes in the egg characteristics, such as changes in albumen pH and height.

None of the treatments used in the PhD thesis of Inge Reijrink had an effect on chick quality; therefore, the reason for the decline in chick quality due to prolonged egg storage is still unclear.

How to overcome the negative effects of prolonged egg storage on hatchability?

- Start incubation with a slow preincubation warming profile.
- Prestorage incubation can be used to prevent part of the decline in hatchability that is caused by prolonged egg storage, but attention must be paid to the prestorage incubation duration because embryos can develop too far, which will have a negative effect on hatchability.