Computed Tomography and Magnetic Resonance Imaging to phenotype fertilized eggs during incubation

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Introduction: Egg storage prior to incubation is widely used to coordinate hatcheries activities and synchronize hatchings. However, the conditions of egg storage (temperature and duration) can have adverse effects on the viability of embryos and their subsequent development. By combining non-invasive approaches (Computed Tomography (CT), Magnetic Resonance Imaging (MRI)) and classical measurements on internal egg components (after egg opening), we explored the effect of egg storage duration prior to incubation (0, 3 and 10 days) , on egg quality and the development of the embryo.

Material and methods

We first explored the **effect of storage** duration (0, 3 or 10 days) on **egg quality** and then, evaluated the impact of 3 (D3) or 10 (D10) days of egg storage on **embryonic development**. The various steps of the protocol are summarized in Figure 1.

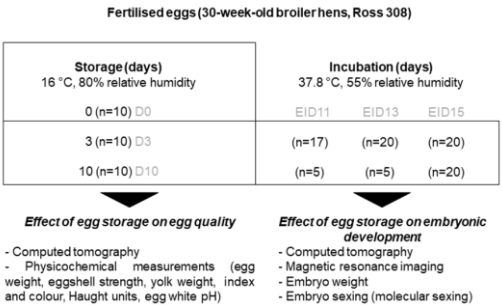

Figure 1. Experimental protocol

Results (1)

Storage up to 10 days negatively affects some egg quality traits (physicochemical parameters: yolk index and volume, egg white pH; CT-scan data: volumes of the air chamber and a "grey" area containing the blastoderm).
The three groups are distinct (D0, D3, D10, Figure 2).

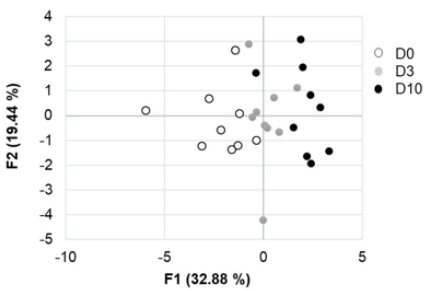

Figure 2. Principal components analysis of egg storage effect (D0, D3, D10) on egg quality

Results (2)

Storage of eggs for ten days (D10) versus 3 days (D3) does not affect **fertility (98.5% vs 98.1%)** but does affect embryonic viability (**4.8% mortality for D10 eggs *versus* 1% for D3 eggs**). It does not affect the sex ratio. **D10 eggs are associated with a decrease in embryo growth**, visible by MRI from day 11 of incubation (EID11) (decrease in brain and embryo volumes). Figure 3 illustrates the images obtained by CT scan and MRI.

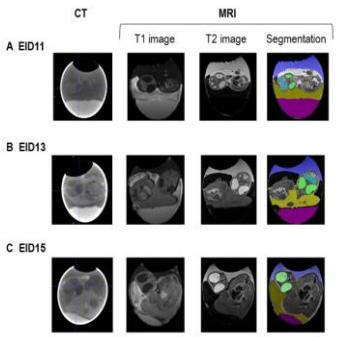

Figure 3. CT-scan and MRI analysis (T1 sequence, anatomical data; T2 sequence, visualisation of aqueous structures) of eggs after 11, 13 and 15 days of incubation (EID11, EID13 and EID15). On the right, segmentation of the various egg compartments for the measurement of their volume (dark blue: allantoic fluid; green, eye volume; light blue: brain volume; yellowish: yolk; pink, egg white)

The weight of the embryo is also affected but not the developmental kinetics (Figure 4).

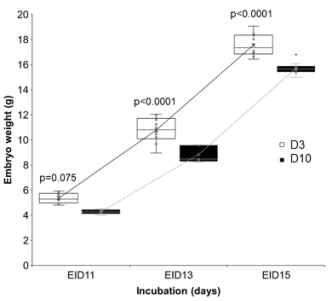

Figure 4. Effect of egg storage time (D3 vs D10) on embryo weight after 11, 13 and 15 days of incubation. (EID11, EID13 and EID15). Statistical analysis: ANOVA (p<0.05).

Conclusions: According to these results, egg storage time has a negative impact on egg quality before incubation (Figure 2), and on embryonic viability and growth (Figure 4). CT and MRI imaging technologies seem to be relevant non-invasive tools to assess egg quality and to study the impact of storage (and incubation) conditions on the embryo (development and positioning), and on the modifications of internal egg structures (volumetry, localisation).

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