

# Glucose oxidation in chicken embryos incubated at a normal or high eggshell temperature - preliminary results of a tracer study

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**In practice, eggshell temperature (EST) often increases at the end of incubation due to heat production of the developing embryos and a poor cooling capacity or air velocity in the incubator. High ( $\geq 38.9^{\circ}\text{C}$ ) compared to normal ( $37.8^{\circ}\text{C}$ ) EST negatively affects survival and hatchling development (Lourens et al., 2005), and this may be related to changes in nutrient utilization or more specific changes in glucose metabolism. This study was performed to measure in ovo glucose metabolism using [U- $^{13}\text{C}$ ] glucose at a normal or high EST.**

Two studies were conducted to develop the technique. Broiler eggs incubated for 13 days were used (Ross flock 59 weeks;  $n = 300$ ). Eggs were divided between two identical open-circuit climate respiration chambers (CRC) and incubated at a normal ( $37.8^{\circ}\text{C}$ ) or high ( $38.9^{\circ}\text{C}$ ) EST. In study I, a solution containing [U- $^{13}\text{C}$ ]glucose (1.05 mg in 250 ml sterile water) was injected as a single bolus

in the allantoic fluid at day 14.5 of incubation. In study II, a solution containing [U- $^{13}\text{C}$ ] glucose (0.73 mg in 250 ml sterile water) was repeatedly injected as a daily bolus in the chorio-allantoic fluid for 4 consecutive days from day 14.5 of incubation onward. From day 14 until 19 of incubation, the  $^{12}\text{CO}_2$  and  $^{13}\text{CO}_2$  production were measured every six minutes.  $^{13}\text{C}$  enrichment in  $\text{CO}_2$  was corrected for the

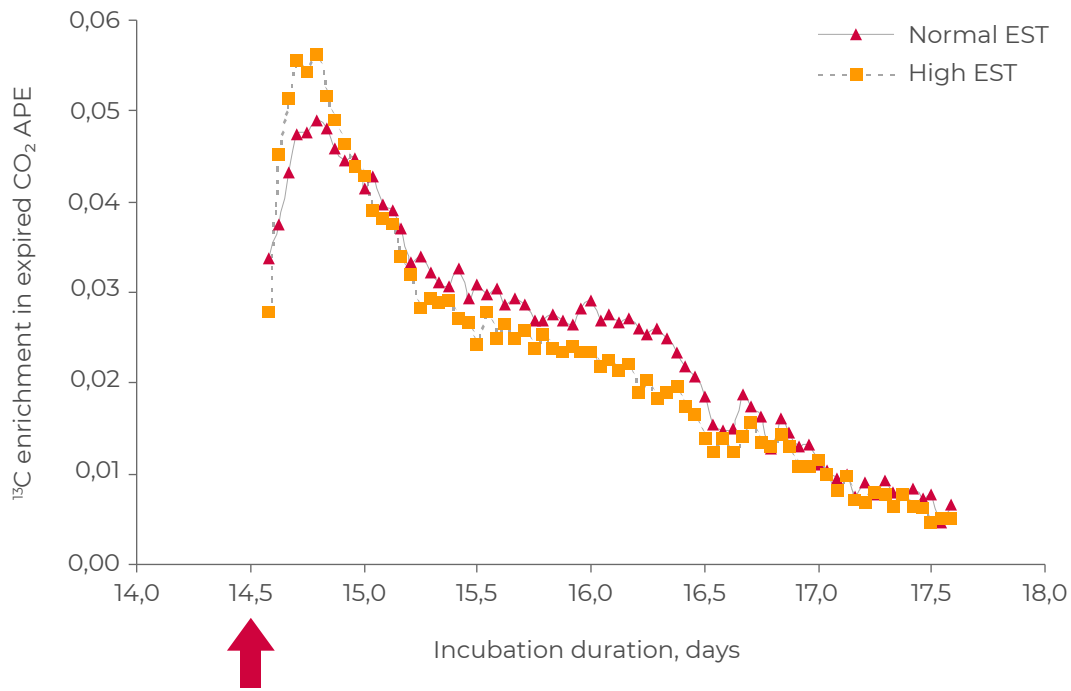
natural background of  $^{13}\text{C}$  enrichment during the two days prior to the  $[\text{U-}^{13}\text{C}]$ glucose injection for each treatment.  $^{13}\text{C}$  enrichment was expressed as atom percentage excess (APE).  $^{13}\text{C}$  enrichment in expired  $\text{CO}_2$  in both studies was calculated per hour and not analyzed statistically, because the studies were not repeated.

In study I,  $^{13}\text{C}$  enrichment in expired  $\text{CO}_2$  showed a peak in both EST treatments within 8 h after  $[\text{U-}^{13}\text{C}]$ glucose injection (Figure 1). This indicates that the injected glucose was partially oxidized and that this technique can be used to measure glucose oxidation in chicken embryos. In study II, the same pattern of  $^{13}\text{C}$  enrichment was observed as in study I (Figure 2). However, with each subsequent injection  $^{13}\text{C}$  enrichment started higher and declined faster (i.e. narrower oxidation peak). This indicates that glucose oxidation increased during embryonic development and supports findings that glycolytic activity in muscle tissue and liver increase during incubation (Pearce, 1977). Such increased oxidation may

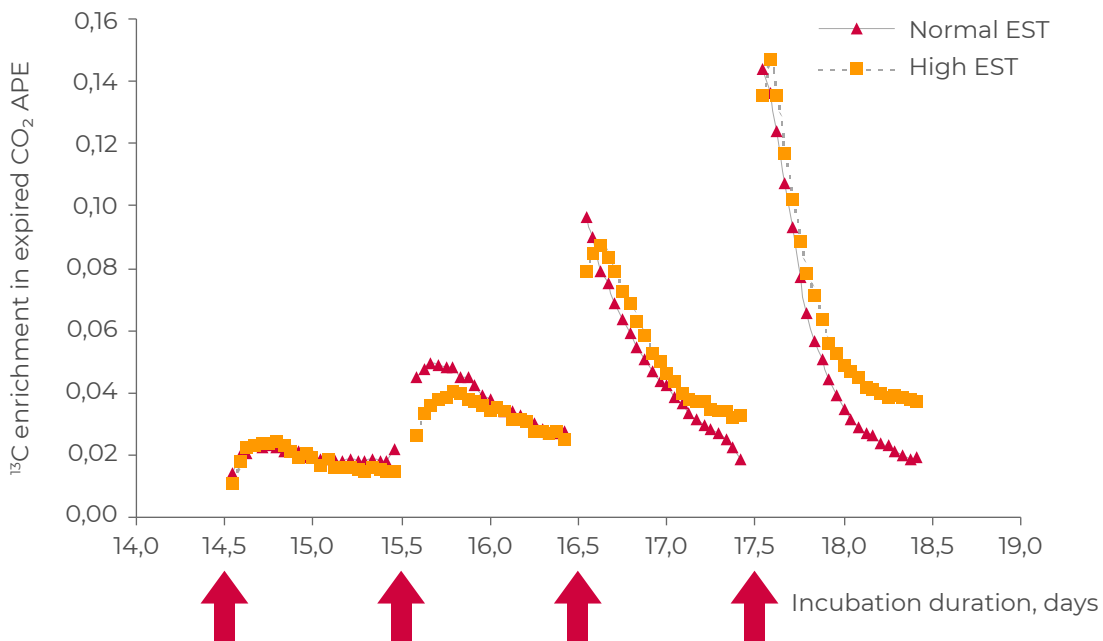
suggest higher glucose requirements in the developing chicken embryo towards the end of incubation. Because differences in  $^{13}\text{C}$  enrichment between EST treatments tended to increase during incubation, we started a larger study to evaluate the effect of EST on glucose oxidation. During that experiment,  $^{13}\text{C}$  enrichment in expired  $\text{CO}_2$ , plasma glucose, and hepatic glycogen was measured. Furthermore, yolk free body mass, residual yolk weight, plasma glucose and plasma lactate concentrations, and hepatic glycogen concentrations were evaluated. Results of this larger study are currently processed.

### References

- Lourens, A., H. van den Brand, R. Meijerhof, and B. Kemp. 2005. *Effect of eggshell temperature during incubation on embryo development, hatchability, and posthatch development*. *Poult. Sci.* 84:914-920.
- Pearce, J. 1977. *Some differences between avian and mammalian biochemistry*. *Int. J. Biochem.* 8:269-275.



**Figure 1.** Study I: <sup>13</sup>C enrichment in expired CO<sub>2</sub> after injecting a solution of [U-<sup>13</sup>C]glucose in the chorio-allantoic fluid at day 14.5 of incubation of embryos incubated at a normal (37.8°C) or high (38.9°C) eggshell temperature (EST) from day 13 of incubation onward (n = 1). The arrow on the X-axis indicates the time of injection.



**Figure 2.** Study II: <sup>13</sup>C enrichment in expired CO<sub>2</sub>, after injecting for 4 consecutive days, from day 14.5 of incubation onward, a solution of [U-<sup>13</sup>C]glucose in the chorio-allantoic fluid of embryos incubated at a normal (37.8°C) or high (38.9°C) eggshell temperature (EST) from day 13 of incubation onward (n = 1). The arrows on the X-axis indicate the times of injection.