



# **In vitro effects of triiodothyronine and insulin on the metabolism of muscle cells from chickens submitted or not to heat manipulation during embryogenesis**

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**ABSTRACTS**

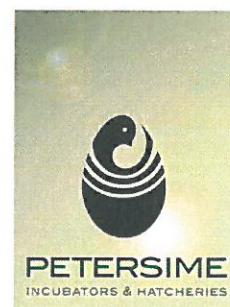
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### **In vitro effects of triiodothyronine and insulin on the metabolism of muscle cells from chickens submitted or not to heat manipulation during embryogenesis**

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Broiler chickens are particularly sensitive to heat exposure during growth, with socio-economic consequences for poultry industry. An embryonic heat acclimation technique was developed to improve chicken long-term heat tolerance (Piestun *et al.*, 2008). This thermal manipulation (TM) consists of a rise in temperature during the incubation of eggs 12 h/d from day 7 to 16 of incubation. TM was notably shown to change the thyroid axis regulation in the long term. Chickens resistance to an acute heat challenge was improved at slaughter age. The glucose-insulin balance of birds was also modified (Loyau *et al.*, 2013). The aim of this work was to better understand *in vitro* the involvement of the thyroid hormone triiodothyronine (T<sub>3</sub>) and of insulin in the regulation of metabolic pathways affecting *in vivo* energy and protein utilization as well as muscle growth in TM *Pectoralis major* (Loyau *et al.*, 2014). To identify T<sub>3</sub> and insulin effects in interaction to incubation condition, we measured by qRT-PCR the expression of candidate genes involved in metabolism and muscle growth, in the regulation of muscle thyroid hormone concentrations and of oxidative stress. Signaling pathways regulating protein synthesis were also studied by biochemical method. The study was carried out both at proliferative (myoblasts) and differentiation (myotubes) cell stages in cells derived from muscle *Pectoralis major* of chicks submitted to the embryonic treatment TM or not.

In our study, TM stimulated pathways that promote proteosynthesis and modified a signaling pathway controlling cellular stress (P38 mitogen activated protein kinase). The TM also affected the regulation of energy metabolism. Indeed, the expression of Peroxisome proliferator activated receptor coactivator 1 $\alpha$  (PGC-1 $\alpha$ ) gene involved in muscle cell energy metabolism was increased in TM as compared to control myoblasts. Apart from the observed effects of incubation conditions, direct effects of hormones were observed. T<sub>3</sub> hormone had contrasting effects on the AKT/S6K1 (S6 kinase 1)/S6 (ribosomal protein) pathway, likely stimulating proteosynthesis in myotubes. It also increased the expression of deiodinase 3 promoting T<sub>3</sub> conversion to T<sub>2</sub> (diiodothyronine). Insulin activated the AKT/S6K1/S6 pathway in both cell types and stimulated the expression of genes involved in the use of energy nutrient such as Citrate Synthase, key enzyme of the Krebs cycle, and  $\beta$  hydroxyacyl-CoA dehydrogenase controlling fatty acid oxidation. Furthermore, insulin interacted with incubation condition to stimulate mitochondrial metabolism via greater PGC-1 $\alpha$  expression in TM myotubes only.

In conclusion, the *in vitro* study of TM-derived muscle cells revealed physiological and metabolic modifications promoting protein synthesis and energy use consecutive to embryo heat acclimation treatment in birds that were maintained through cell mitosis. Our results suggest programming mechanisms controlling gene expression under the effect of environment. We speculate that epigenetic alterations could be involved.

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#### References

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