Long-lasting effects of thermal manipulations during embryogenesis in broiler chicken

Context

Poultry: efficient protein source
Huge global development
Climate change

- Avian selection in temperate conditions
- Industrial egg incubation in controlled conditions

Efficient in controlled conditions but… Sensitive to temperature variations

C. Nyuiadzi, Togo

Cressensac. La Dépêche du Midi 2003, France
Strategy to improve robustness?

Control Incubation

- Initial conditions: E0, 37.8°C, 56% RH
- Final conditions: E21=j0

Thermal manipulation during embryogenesis (TM)

- Initial conditions: E0, 37.8°C, 56% RH
- Intermediate conditions: E7, E16
- Final conditions: 39.5°C, 65% RH 12h/d

Piestun et al., Poult. Sci., 2008

- Lower body temperature from hatching to slaughter age
- 50% lower mortality in males submitted to 35°C during 5h at slaughter age

Physiological and metabolic mechanisms involved in the acquisition of embryo acclimation?
Material and methods

Control Incubation C

E0 37.8°C, 56% RH  E21=j0  D34  21°C C
32°C/5h CCh

Thermal manipulation during embryogenesis (TM)

E0  E7  E16  E21=j0
39.5°C, 65% RH 12h/d
37.8°C, 56% RH

Piestun et al., Poult. Sci., 2008

Performance
Meat quality

Physiology
Metabolism
Gene expression

Physiological and metabolic mechanisms involved in the acquisition of embryo acclimation?
Performance and physiological parameters

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>TM</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Hatching rate (% fertile eggs)</td>
<td>86.13</td>
<td>83.19</td>
<td>NS</td>
</tr>
<tr>
<td>Body weight 28d</td>
<td>1525 ± 14</td>
<td>1534 ± 14</td>
<td>NS</td>
</tr>
<tr>
<td>Feed conversion ratio d0-d28 (g/g)</td>
<td>1.49 ± 0.02</td>
<td>1.47 ± 0.02</td>
<td>NS</td>
</tr>
<tr>
<td>Body weight 35d (g)</td>
<td>2185 ± 19</td>
<td>2156 ± 19</td>
<td>P &lt; 0.05</td>
</tr>
</tbody>
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Loyau et al., 2013

**Performance:** No modification in hatchability, slightly lighter (-1.4%) but less fat. No alteration in meat processing quality by TM.
**Body temperature (Tb):**

- **C**
- **TM**

<table>
<thead>
<tr>
<th>Day</th>
<th><strong>C</strong></th>
<th><strong>TM</strong></th>
</tr>
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<tbody>
<tr>
<td><strong>d0</strong></td>
<td>39.5°C</td>
<td>38.5°C</td>
</tr>
<tr>
<td><strong>d28</strong></td>
<td>42.5°C</td>
<td>41.5°C</td>
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</tbody>
</table>

**Stress: Heterophil/Lymphocyte ratio:**

- **C**
- **CCh**
- **TM**
- **TMCh**

<table>
<thead>
<tr>
<th>Treatment</th>
<th><strong>d34</strong></th>
</tr>
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<tbody>
<tr>
<td><strong>C</strong></td>
<td>0.5</td>
</tr>
<tr>
<td><strong>CCh</strong></td>
<td>0.6</td>
</tr>
<tr>
<td><strong>TM</strong></td>
<td>0.3</td>
</tr>
<tr>
<td><strong>TMCh</strong></td>
<td>0.2</td>
</tr>
</tbody>
</table>

**T₃ (nmol/L):**

- **C (170)**
- **TM (150)**

<table>
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<tr>
<th><strong>d28</strong></th>
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<tr>
<td><strong>C (170)</strong></td>
</tr>
<tr>
<td><strong>TM (150)</strong></td>
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</tbody>
</table>

Loyau et al., J. Anim. Sci., 2013
Respiratory physiology

Modification of respiratory physiology by TM during embryogenesis?
Candidate markers of thermotolerance?

**Thermal Manipulation during Embryogenesis Has Long-Term Effects on Muscle and Liver Metabolism in Fast-Growing Chickens**

Thomas Loyau¹, Sonia Métayer-Coustard¹, Cécile Berri¹, Sabine Crochet¹, Estelle Cailleau-Audouin¹, Mélanie Sannier¹, Pascal Chartron¹, Christophe Praud¹, Christelle Hennequet-Antier¹, Nicole Rideau¹,

→ Long-lasting effects of TM during embryogenesis on genes expression
→ Regulation of metabolic heat production?

**Example:**

![Graph showing gene expression levels](image_url)

- PGC-1α (Mitochondrial biogenesis)

- J34
New markers of thermotolerance?

Gene expression analysis on microarray in breast muscle at d34

- Metabolic regulations
- Chromatine modifications
- Vascularization
- Stress response

Limitation of mitochondrial energy metabolism and heat production
Take home message

Physiological and metabolic mechanisms involved in the acquisition of embryo acclimation?

- Modification of respiratory physiology
- Stress in hot conditions (H/L)
- Oxidative stress
- Modification of plasmatic thyroid hormone concentration (J28)
- Energy metabolism regulation
- Internal temperature regulation (+/- long term)
- Modification of vascularisation?
- Régulation metabolic heat?
- Acclimation to heat
Thank you for your attention and thanks to

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