Variations in egg incubation temperature enable chicken acclimation through long-lasting changes in energy metabolism


INRA Val-de-Loire, France ; ITRA Lomé, Togo; KU Leuven, Belgium; Virginia Polytechnic Institute, USA; Ege University, Turkey; ARO The Volcani Center, Israel

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Context

Poultry: efficient protein source
Huge global development

Up scaling to integrated production systems
Broiler chickens

Breeding companies → Hatcheries → Farmers → Slaughter House / Processing

Suppliers (feed, vet. products...)
Climate change

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

Efficient in controlled conditions but...
Susceptibility to temperature variations

C. Nyuiadzi, Togo

Cressensac. La Dépêche du Midi 2003, France
Strategies?

At the farmer level:

- Alerts and management strategies (feed withdrawal…)
  Control of feed quality
- Building improvements (insulation, ventilation, climatization…)

*BUT* cost, sustainability…?
To improve farm animal robustness and adaptive capacities
ReColAd network, INRA ACCAF, Poster #151 session L2.4

- Search for markers of thermotolerance or disease resistance/tolerance, selection strategies
  ex: use of major genes controlling feathering crossbreeding

- Conception of innovative and sustainable rearing practices and production systems
Strategies to improve poultry robustness

To reconcile thermotolerance and growth performance: *embryo acclimation*

Thermal manipulation during embryogenesis (TM)

Heat/Cold

Better tolerance to extreme thermal exposure

Incubator: easy treatment on a large number of eggs
Embryo heat acclimation

Heat manipulation during embryogenesis (TM)

- E0
- E7
- E16
- TM
- Control C
- 39.5°C 12h/d
- 37.8°C

Heat challenge (Ch) or not at 34d

- 5h at 32°C
- TMCh
- CCh
- TM
- 21°C

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

What are the physiological and metabolic mechanisms involved in the acquisition of embryo acclimation?

THERMOCHICK project
Performance and physiological parameters

Performance: No modification in hatchability, slightly lighter but leaner chickens
No alteration in meat processing quality by TM

Body temperature (Tb):

- d0: 37.5°C
- d28: 38.5°C

T3 (nmol/L)

- C (170): 2.8 nmol/L
- TM (150): 2.4 nmol/L

Stress: Heterophil/Lymphocyte ratio:

- C: 0.5
- CCh: 0.6
- TM: 0.3
- TMCh: 0.4

Loyau et al., J. Anim. Sci., 2013
Regulation of energy metabolism

Muscle PGC-1α mRNA expression

Liver citrate synthase activity

Loyau et al., Plos One, 2014

Limitation of mitochondrial energy metabolism and heat production
New markers of thermotolerance?

Gene expression analysis on microarray in breast muscle at d34

- Metabolic regulations
- Chromatine modifications
- Vascularization
- Stress response

= earlier or more responsive!

TM vs C n=28

TMCh vs TM n = 759

CCh vs C n = 128
Cold incubation temperature

Cold manipulation during embryogenesis (TM)

Control

TM

E0

E10

E18

37.6°C

36.6°C 6h/d

E21=j0

Yalçın et al., Poult. Sci., 2012

Better tolerance to cold

- anti-oxidant defense

- Tb at hatch and long term effects on the regulation of energy metabolism and heat production

PGC-1α/β-actin

Muscle

Loyau et al., Poult. Sci., 2014

a

b
Variations in egg incubation temperature

Long-Lasting effects

Slight effect on performance, body composition, meat quality

Tb : Cold ↗, Heat ↘

Stress markers

Metabolic adaptations

Changes in heat production?

Better adaptability of chickens to changes in ambient temperature

Can it be applied in the field?

Loyau et al., Animal, 2015
Multicriteria analysis and evaluation of such strategies

Three dimensions of sustainability:

<table>
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<tr>
<th>Economical</th>
<th>Social</th>
<th>Environmental</th>
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<td>Meat quality</td>
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<td>Production costs…</td>
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Incubation temperature × Rearing conditions

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POSTER #11 session L2.1
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Thank you for your attention!