Physiological Responses to Heat Stress in Three Chicken Lines

Animal Genomics and Adaptation to Climate Change

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Overall Objectives

• Genetic factors on thermal tolerance to heat stress

Heat Stress

Gene and/or genetic markers with NDV and Heat Stress in US population

Gene and/or genetic markers with NDV and Heat Stress in African indigenous ecotypes

Overall Objectives

1. Gene and/or genetic markers with NDV and Heat Stress in US population

2. Gene and/or genetic markers with NDV and Heat Stress in African indigenous ecotypes

3. New breeding stock in Africa

4. SNP Panel Validation

5. Identifying genes, genetic markers and genetic pathways associated with heat stress in three unique chicken populations in the US

6. Identifying genes and/or genetic markers associated with heat stress in African indigenous chicken ecotypes using whole genome SNP panel.

Experimental Populations

- Leghorn-GB2
- Fayoumi-M13
- Hy-Line Brown

Leghorns: more susceptible to stress.

Fayoumi: a hardy breed, and particularly well suited to hot climates.

Hy-Line Brown: widely distributed in African countries.

Physiological Responses to Heat Stress

Plasma pH rise

K+ lost

Panting

Urine Excretion increase

Stop Drinking and Eating

Shunts Blood

Respiratory Rate Rise

Acid/Base Balance lost

Na+ and K+ Balance lost

Day 13 Pre-heat (Baseline for BT and iSTAT)

Acute Heat 4 hrs post heat stress

Chronic Heat 1 6 days post heat stress

Chronic Heat & NDV 9 days post heat stress

Sudden stress

Adaption

Distinct Highly Inbred Lines

Body Temperature

Fayoumi

Leghorn

Day 53 Pre-heat
(Base line for BT and iSTAT)

35°C and 50% humidity on Day 14

Acute Heat 4 hrs post heat stress

Chronic Heat 1 6 days post heat stress

Chronic Heat & NDV 9 days post heat stress

** AH: Acute Heat

** CH1: Chronic Heat 1

** CH2: Chronic Heat 2

Non-treated

Heat Stress
**Physiological Response Parameters in Blood**

**Chemistries/Electrolytes**
- Sodium (Na); Potassium (K); Ionized Calcium (iCa); Glucose (Glu)

**Blood Gases**
- pH; PCO₂; PO₂; TCO₂; HCO₃; Base Excess (BE); sO₂

**Hematology**
- Hematocrit (Hct); Hemoglobin (Hb)

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**Heat Stress Response in Leghorn and Fayoumi Lines**

- **Heat Stressed Birds Between Genetic Lines (Acute Heat)**

- **Heat Stressed Birds Between Genetic Lines (Chronic Heat 1)**

- **Heat Stressed Birds Between Genetic Lines (Chronic Heat 2)**

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**Sodium Between Leghorn and Fayoumi lines**

- Na⁺

- **Heat Stress**

- Non-treated vs Heat Stress

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**Glucose Between Leghorn and Fayoumi lines**

- Glu

- **Heat Stress**

- Non-treated vs Heat Stress
**pH (37) Between Leghorn and Fayoumi lines**

**HCT Between Leghorn and Fayoumi lines**

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### Inbred Line Result Summary

<table>
<thead>
<tr>
<th>iSTAT Parameters</th>
<th>Leghorn Acute</th>
<th>Leghorn Chronic1</th>
<th>Leghorn Chronic2</th>
<th>Fayoumi Acute</th>
<th>Fayoumi Chronic1</th>
<th>Fayoumi Chronic2</th>
<th>Heat resistant</th>
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<tbody>
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<tr>
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**In summary**

1. **Fayoumi** birds had more physiological changes during heat stress than **Leghorn** birds, which allowed them to easily adapt to high temperature exposure.

2. Increase of Na⁺ and decrease of Glucose, Hct, and Hb could be potentially important parameters, contributing to Fayoumi’s heat stress resistance. These four parameters may be used physiological indicators of heat tolerance.

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### Hy-Line Brown Experimental Procedures

- **Day 13 Pre-heat** (Base line for BW, BT and iSTAT)
- 35°C and 50% humidity on Day 14
- Acute Heat 4 hrs post heat stress
- Chronic Heat 1 6 days post heat stress
- Chronic Heat & NDV 9 days post heat stress

### Hy-Line Brown Results

- **Hy-Line Brown Body Weight Gain**
- **Hy-Line Brown Body Temperature Changes**
Distributions of Physiological Responses in Hy-Line Brown

In summary

1. Physiological measurements of Hy-Line Brown were more variable with a high dynamic range that will be useful for further Genome-wide associated studies.

2. Hy-Line Brown birds had more physiological changes during Heat stress than compared to Leghorn birds. The changes were not always consistent with Fayoumi birds.

Hy-Line Brown Result Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Fayoumi</th>
<th>Hy-Line Brown</th>
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<tbody>
<tr>
<td>Na⁺</td>
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<td>K⁺</td>
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<td>iCa²⁺</td>
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<td>Hct</td>
<td>NS</td>
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<tr>
<td>Hb</td>
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Overall

Future Plan

1. Transcriptome analysis of inbred lines to identify genes and genetic markers associated with heat stress responses.

2. GWAS to identify SNPs and genomic regions associated with heat stress.

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