Microalgae for Fish-Oil Enriched Chicken Meat

Xin Gen Lei
Professor, Department of Animal Science
Cornell College of Agriculture and Life Sciences

Introduction

- Western diets have an unhealthy ratio of pro-inflammatory (omega-6) and anti-inflammatory (omega-3) fatty acids (FA)
  - Current ratio: 20-30:1; Healthy ratio: 1:2:1

<table>
<thead>
<tr>
<th>Omega-6 Fatty Acids</th>
<th>Omega-3 Fatty Acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linoleic acid (LA)</td>
<td>A-Linolenic acid (ALA)</td>
</tr>
<tr>
<td>Arachidonic acid (AA)</td>
<td>Eicosapentaenoic acid (EPA)</td>
</tr>
<tr>
<td></td>
<td>Docosahexaenoic acid (DHA)</td>
</tr>
</tbody>
</table>

“Plant-based Oil”

- Fish oil & fish meal have been shown to enhance omega-3 FAs in poultry meat
  - Cost, demand & supply for fish oil and fish meal have created the need for alternate sources of omega-3 FAs

Market

- US alone: 40 kg of chicken meat consumed annually per person
- Price premium for omega-3 enriched chicken eggs
  - 1-2X greater than ordinary eggs
- Not all eggs enriched for Fish Oil – many enriched for ALA; low conversion to fish oil in the body

Fish Oil Food Chain

- Source of Fish Oil that is:
  - Vegetarian
  - Low-cost
  - Sustainable
  - Absent mercury, dioxins & PCBs from large carnivorous fish (e.g. salmon or tuna)

Design

- Hatching Ross broiler chicks (n = 6 pens, 6 chicks/pen)
- Inclusion defatted microalgae (DFA):
  - 0 (Control), 2, 4, 8 or 16%
- 6 wk trial
- Food and water provided ad libitum
- Tissues collected at wks 3 & 6
- Fatty acid analysis

Week 6 Liver

- No dietary effect on:
  - Total fat
  - Saturated fatty acids (SFA)
  - Monounsaturated fatty acids (MUFA)
  - Polyunsaturated fatty acids (PUFA)
  - n6 or n9 fatty acids

Reduction in SFA (P=0.01, R²=0.20)

- No dietary effect on:
  - Total fat
  - Monounsaturated fatty acids (MUFA)
  - Polyunsaturated fatty acids (PUFA)
  - n6 or n9 fatty acids

Contact: Phillip Owh, Technology Licensing Officer, 607.254.4508, po62@cornell.edu

Omega-3 Enrichment with DFA

<table>
<thead>
<tr>
<th>Week 6 Liver</th>
<th>Control</th>
<th>15% DGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n6:n3</td>
<td>21.6</td>
<td>7.20</td>
</tr>
<tr>
<td>mg EPA+DHA/100 g</td>
<td>21.0</td>
<td>101</td>
</tr>
<tr>
<td>Week 6 Breast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thigh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n6:n3</td>
<td>76.1</td>
<td>13.8</td>
</tr>
<tr>
<td>mg EPA+DHA/100 g</td>
<td>1.09</td>
<td>16.0</td>
</tr>
</tbody>
</table>

- Omega-3 content & ratios improved at all levels of microalgal inclusion
- Consuming 200g of chicken breast/day would supplement up to 35 mg of EPA/DHA to the average American diet

Microalgae in Feed

- No dietary effect on:
  - Reduction in saturated fatty acids (SFA) (P=0.01, R²=0.20)
  - Linolenic acid (ALA) (P=0.0001, R²=0.44)
  - Docosahexaenoic acid (DHA) (P=0.0001, R²=0.74)
  - Eicosapentaenoic acid (EPA) (P=0.0001, R²=0.33)

- Carnivorous fish
  - Not enrich<br/>- Inclusion<br/>- Fish Oil<br/>- Defatted microalgae

- Fish Oil Food Chain
  - Marine microalgae
  - Zooplankton
  - Planktivorous fish
  - Carnivorous fish
  - Large carnivorous fish

Week 6 Thigh

- No dietary effect on:
  - Total fat
  - Saturated fatty acids (SFA)
  - Monounsaturated fatty acids (MUFA)
  - Polyunsaturated fatty acids (PUFA)
  - n6 or n9 fatty acids

- Reduction in SFA (P=0.01, R²=0.20)

- Carnivorous fish
  - Not enrich<br/>- Inclusion<br/>- Fish Oil<br/>- Defatted microalgae

- Fish Oil Food Chain
  - Marine microalgae
  - Zooplankton
  - Planktivorous fish
  - Carnivorous fish
  - Large carnivorous fish