Poultry Meat Quality Research

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Issues in the Poultry Industry

- Meat Tenderness
- Water Holding Capacity
- Color
- Appearance
- Consumer preferences
- Fillet dimensions
Issues from Various Sources
Research Need Areas

- White striping in broiler breast meat
- Age, strain, size of birds - effects on meat quality, effects on tenders (feathering?)
- Marination – process (e.g., timing, holding, etc.), ingredients, fillet size
- Heat stress/PSE
- Stunning/welfare
- Electrical stimulation - bird size?
- Consumer acceptance of products
Significant Changes in the Poultry Industry

Increased Yield

Increase in large birds for heavy debone market
White Striping Condition

Normal (NORM)  Moderate (MOD)  Severe (SEV)
White Striping: Growth Rate

Incidence

LOW ND
2787 g

HIGH ND
3042 g
White Striping: Genetic Impact

- Related to body weight rather than genetics
- Broilers in big bird programs are likely to have more White Striping; age impact (e.g., 6 vs. 8 wk)

Bauermeister et al., 2009; Kuttappan et al., 2009
## White Striping: Meat Quality

<table>
<thead>
<tr>
<th>Striping score</th>
<th>NORM</th>
<th>MOD</th>
<th>SEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTC wt. (g)</td>
<td>2302&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2528&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2762&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>pH 24h PM</td>
<td>5.77&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.81&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.82&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>L* 24h PM</td>
<td>52.48&lt;sup&gt;a&lt;/sup&gt;</td>
<td>52.54&lt;sup&gt;a&lt;/sup&gt;</td>
<td>52.59&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>a* 24h PM</td>
<td>3.69&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.55&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.59&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>b* 24h PM</td>
<td>2.30&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.52&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.98&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Length (cm)</td>
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<td>19.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19.13&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>9.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.73&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10.08&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Top Height (cm)</td>
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<td>3.10&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.55&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Middle Height (cm)</td>
<td>1.61&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.52&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Bottom Height (cm)</td>
<td>0.95&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.20&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.45&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Cook Loss (%)</td>
<td>24.12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24.31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25.49&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>MORSE (N.mm)</td>
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<td>176.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>169.91&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>n</td>
<td>498</td>
<td>528</td>
<td>86</td>
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</tbody>
</table>

- Most impact on fillet dimensions
- b* value increased with severity

Kuttappan et al., 2009
White Striping Appearance: Consumer Acceptance

Kuttappan et al., 2010

Hedonic Mean

NORM: 6.9a
MOD: 6.1b
SEV: 4.5c
White Striping: Histology

Masson Trichrome
connective tissue

H&E

Oil Red O
Lipid

NORM
MOD
SEV
Recent Research of White Striping in Broiler Breast Meat

- Associated with growth: heavier broilers more affected
- Meat quality (tenderness, water holding capacity) not greatly affected
- Visual appearance: lower acceptability
- Fat content higher (striped areas, increased fat)
- Increased connective tissue in affected areas
- Form of muscular dystrophy
- Occurrence not affected by vitamin E levels in diet
White Striping Condition
Future Research Needs

- Underlying causes
- Occurrence in industry (documented)
- Further meat quality, especially with most severe
Boneless Breast Meat Processing

Yield and Throughput Important

- Slitter
- 6-9+ weeks
- Various Strains
- Time
- And/or Portion (vertical)
- Yield and Throughput Important
- Important
Early Deboning

- Processors are deboning broilers (6-9 wk) as early as 2 h PM

- Early deboning leads to tougher meat due to sarcomere shortening (Stewart et al., 1984; Dawson et al., 1987; Lyon et al., 1989)

- Other effects
  - Age of bird, strain, pre-rigor portioning
Effect of Age and Strain on Broiler Breast Meat Tenderness

Neither tough nor tender

*Mehaffey et al., 2004

Significant of debone hour, age, and strain
Effect of Strain on Tenderness:
Small Bird Market (40 d)

Early deboning (2h) → more variation

MORS Energy (N.mm)

A

B

C

Strain

Brewer et al., 2009a
Effect of Strain on Tenderness: Big Bird Market (60 d)

Variation greater at 4h
MORS Values of Broiler Breast Fillets from 40, 60 and 67 d old Broilers Deboned at 2, 4, and 6 h Postmortem

Age effect?

Neither tough nor tender

a-c comparison within age

Brewer et al., 2009ab
Tenderness (Bird Related)
Future Research Needs

- Mechanism for changes in tenderness associated with bigger/older birds
  - Size or age? “older” birds still “young”
    - Connective tissue?
  - Fiber characteristics? Diameter?
  - Rigor differences?
Effect of Horizontal Portioning

No effect on tenderness. Yield?

Owens et al., 2006
Effect of Vertical Portioning

![Bar chart showing the effect of vertical portioning on total energy (N.mm).](chart)

- For Strain B, there is a significant increase in total energy for both 2 h and 4 h postmortem conditions.
- Owens et al., 2007 noted that early postmortem conditions led to increased toughness.

**Additional Notes:**
- SEM = 1.76
- Early postmortem = increased toughness
Marination: Effect of Deboning Time

Similar pattern as non-marinated, but overall lower
Can vary from shortly after deboning to several days

What is the impact on marination properties and tenderness?

Short time between early deboning and marination?
Deboned at 2 h postmortem, tumble marinated

Kuttappan et al., 2010

Reduced pickup when marinating early. Yield? Functionality?
Time of Marination (Varies)
Total Marinade Retained\(^1\) for Fillets

Less marinade retained.

Based on marinade weight

Kuttappan et al., 2010
MORSE Values of Breast Fillets Deboned at 2 h PM and Marinated at Various Times

Reduced tenderness improvement

Kuttappan et al., 2010
MORSE values and the corresponding levels of tenderness as perceived by consumers

Kuttappan et al., 2010
Consumer Scale: Cavitt et al., 2005
Cook Loss % of Fillets (Normal and Light) Marinated with Non-Meat Ingredients

Effect of phosphate removal?
Marination

Future Research

- Time of cooking/freezing
- Fillet size / Methods
- Novel ingredients to improve WHC, move towards clean labels, phosphate replacement
- Antimicrobial ingredients, effects on quality
- Tenderness assessment for raw product
Overall Poultry Meat Quality Research Need Areas

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