High pH in lamb meat accelerates browning

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Outline

• Background
• Hypothesis
• Materials & Methods
• Results
• Conclusions
Lamb browning

- Lamb meat browns rapidly
- Consumers prefer red meat

$\downarrow$ shelf life

$\downarrow$ $\$5.53$
Lamb browning

- Lamb meat browns rapidly
- Consumers prefer red meat

↓ shelf life

↓ $
Lamb browning

Oxymyoglobin
Fe²⁺

Deoxymyoglobin
Fe²⁺

Metmyoglobin
Fe³⁺

Auto-oxidation

O₂
Lamb browning

Factors governing meat browning:

- $O_2$ penetration & consumption
- Rate of myoglobin auto-oxidation
- Extent of metmyoglobin reducing activity
pH$_{24}$ & Lamb browning

- Oxymyoglobin (Fe$^{2+}$)
- Deoxymyoglobin (Fe$^{2+}$)
- Metmyoglobin (Fe$^{3+}$)

O$_2$ → Oxymyoglobin (Fe$^{2+}$)
Oxygen (O$_2$) consumption increases with pH$_{24}$

Deoxymyoglobin (Fe$^{2+}$) → Metmyoglobin (Fe$^{3+}$)

Auto-oxidation process:
- pH$_{24}$ increases
- Water holding capacity increases
- Mitochondrial O$_2$ consumption increases
Factors governing meat browning:

- $O_2$ penetration & consumption $\rightarrow$ depth of bloom
- Rate of myoglobin auto-oxidation
- Extent of metmyoglobin reducing activity
**pH\textsubscript{24} & Breed type**

Corbett, S., pers. comm. 2013

![Bar chart showing pH at 24 hours for different siretypes: Maternal, Merino, and Terminal. The chart compares LL and ST breed types.](image-url)
pH$_{24}$ & Breed type

Corbett, S., pers. comm. 2013

Merinos?

O$_2$
Hypothesis

Merinos

$\text{pH}_{24}$
Materials & Methods

4953 lambs:
- 5 years (2007-2011)
- 5 sites

<table>
<thead>
<tr>
<th>Sire type</th>
<th>Dam breed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal</td>
<td>Merino</td>
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<tr>
<td>Merino</td>
<td>Merino</td>
</tr>
<tr>
<td>Terminal</td>
<td>Merino</td>
</tr>
<tr>
<td>Terminal</td>
<td>Border-Leicester Merino</td>
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</tbody>
</table>

- Extensive pasture grazing
Materials & Methods

- Loin muscle @ 24 hrs
- Vacuum packaged & aged 5 days
- Re-packaged with oxygen-permeable wrap
- Simulated retail display for 3 days
Materials & Methods

- Ratio of reflectance:
  
  \[
  \frac{R_{630 \text{ nm}}}{R_{580 \text{ nm}}}
  \]

- \( R_{630}/R_{580} \) represents meat redness
Materials & Methods

R630/R580:
Materials & Methods

R630/R580

3.3 needed for consumer acceptance
Materials & Methods

Statistical Analysis

• Linear mixed effects model (SAS)

• Fixed Effects ➔ Year of birth
  ➔ Site reared
  ➔ Kill group (within site by year)
  ➔ Sire type
  ➔ Dam breed (within sire type)
  ➔ Sex

• Random Effects ➔ Sire
  ➔ Dam * year

• Covariable ➔ pH_{24}
pH_{24} & Retail Colour

Muscle pH at 24 hours

R630/R580

Consumer acceptance level
pH$_{24}$ & Retail Colour

Muscle pH at 24 hours

Consumer acceptance level
Sire type

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<th>Type</th>
<th>Value</th>
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<tr>
<td>Merino</td>
<td>2.7</td>
</tr>
<tr>
<td>Terminal</td>
<td>3.1</td>
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Sire type & Dam breed

Dams

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</tr>
<tr>
<td>Merino</td>
<td>2.7</td>
</tr>
<tr>
<td>Terminal Merino</td>
<td>3.0</td>
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<tr>
<td>Terminal Border-Leicester Merino</td>
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Sire type & Dam breed

No change with pH24 correction!

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<th>Dams</th>
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Hypothesis

Merinos

\[ \text{pH}_{24} \]
Hypothesis

Merinos pH24
Hypothesis
Hypothesis
Conclusion

Low lamb meat $\text{pH}_{24}$ will improve colour during display.

Merino produce worse meat colour, though this cannot be accounted for by their higher pH.

Further work

- measure depth of oxygen penetration & $\text{pH}_{24}$
- metmyoglobin reductase activity?
- Further investigation into breed effects on colour