Contrasting metabolic indicators of energy and stress status in slaughter lambs and beef cattle

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8.45am Session 33 Elafiti 3: Improving carcass and meat quality
Overview

- Blood Energy/Stress indicators at slaughter
- Beef contrasted to lamb
- What are the consequences - if any?
Energy/stress measures in blood at point of slaughter (exsanguination)

- Glucose
- Lactate
- Non esterified fatty acids (NEFA)
Energy/stress measures in blood

- **Glucose**
  - ↓ [glucose] pre slaughter fasting
  - ↑ [glucose] acute pre slaughter stress (hepatic glycogenolysis)

- **Lactate**
  - ↑ [lactate] muscle excursion and acute pre slaughter stress (muscle glycogenolysis)

- **Non esterified fatty acids (NEFA)**
  - ↑ [NEFA] pre-slaughter fasting
  - ↑ [NEFA] acute pre slaughter stress
General Aim

- The Meat Standards Australia eating quality cut x cook prediction model
- Could a panel of energy/stress markers at slaughter be possible to help improve the prediction of consumer sensory scores?
Hypothesis (s)

- Blood response of energy/stress markers to commercial slaughter in lambs and beef cattle will be similar

- Stress response will relate to meat quality parameters (work in progress !)
Animals - Lamb

- $n = 2,877$, 7-10mo old, HCW 23kg, 2 years
- Extensively raised outdoors on 2 research farms
- 2 different abattoirs - electrical stunning then immediate exsanguination
- 24-36 hours of total feed deprivation
- Wide range of sire genetics

Stewart et al. 2018, Meat Science; Stewart et al. 2018, Meat & Muscle Biology
Animals – Beef cattle

**Beef 1**
- Bos Indicus cross steers, 4 farms, abattoir ‘A’ (n=343) [Nth Aust]
- Slaughtered 24-48 hours after dispatch

**Beef 2**
- Bos Taurus steers/heifers from King Island farms, abattoir ’B’ (n=240) [Sth Aust]
- Slaughtered 24 hours after dispatch

**Beef 3**
- Bos Taurus steers/heifers from Tasmanian farms abattoir ’B’ (n=244) [Sth Aust]
- Slaughtered 48-72 hours after dispatch

- HCW = 290±40kg, extensively raised outdoors on pasture
- Head percussion stunning then immediate exsanguination

1 Polkinghorne et al 2018 Meat Science; 2 & 3 publication in progress
Results – carbohydrate metabolism
(plasma mM)

<table>
<thead>
<tr>
<th>Normal range</th>
<th>Glucose (2-4)</th>
<th>Lactate (0.5-1)</th>
<th>NEFA (0.5-0.15)</th>
<th>D-3-OH Butyrate (0.3-0.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lambs</td>
<td>4.7 ±0.9</td>
<td>3.5 ±2.3</td>
<td>1.2 ±0.5</td>
<td>0.4 ±0.1</td>
</tr>
<tr>
<td>Beef 1</td>
<td>6.9 ±0.9</td>
<td>9.4 ±3.2</td>
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<tr>
<td>Beef 2</td>
<td>7.4 ±1.2</td>
<td>14.5 ±3.3</td>
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<tr>
<td>Beef 3</td>
<td>6.2 ±0.9</td>
<td>12.0 ±2.5</td>
<td>0.6 ±0.3</td>
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<tr>
<td>Beef/Lamb</td>
<td>x 1.45</td>
<td>x 3.42</td>
<td>x 0.36</td>
<td>x 0.58</td>
</tr>
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Conclusion

- ↑ [glucose] and [lactate] in plasma at sticking
- MORE so in beef cattle
- Heightened adrenergic response
  - Hepatic glycogenolysis (glucose)
  - Muscle glycogenolysis (lactate)
- Muscle exertion
  - Muscle glycogenolysis (lactate)
## Results – fat metabolism
(plasma mM)

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Conclusion

- ↑ [NEFA] in plasma at exsanguination
- MORE so in lamb than beef cattle
- So for lamb
  - Greater response to time off feed ??
  - Or heightened lipid adrenergic/stress response ??
Lamb – fasted in pen versus fasted then slaughtered (Stewart et al 2018)
Beef fasting expt (van der Walt et al. 1993)

[NEFA]

Slaughter Pen Beef fasting

0h 24h 48h

NEFA F NEFA K
Conclusion

- ↑ [NEFA] due mainly to pre-slaughter fasting response
- This response is greater in lamb compared to beef
- Why?
  - Rumen fill / retention?
  - Metabolic scaling?
  - Increase metabolic rate beyond scaling?
Possible Consequences - some examples

Markers for meat quality issues ????
(i) Eating quality - beef

Beef 1 - weak negative effect with $\uparrow$ [glucose]

(Polkinghorne et al. (2018), 25mm grilled striploin, 7-10 days aging)
(i) Eating quality - beef

Beef 2 and 3 studies – effects on MSA score in 5 muscles (/100)

- Glucose –ve effect 4 muscles = -2.5 points (*not sign*)
- Lactate –ve effect 5 muscles = -3 points (*2 sign*)
- NEFA +ve effect 5 muscles = +3 points (*2 sign*)

Loudon et al. Unpublished, 25mm grill, 10 and 20 days aging
5 muscles = eye round, outside, oyster, striploin, tenderloin
(i) Eating quality - beef

Another Previous beef study using ± electric goads negative effect associated with $\uparrow$ [lactate] = -4 points

(i) Eating quality - beef

Beef cattle

- So a possible association of \( \uparrow \) [glucose] and \( \uparrow \) [lactate] with small reduction in eating quality
- Clearly fat mobilization is modest and not associated with any reduction in eating quality
(ii) Carcase shrink - lamb

Carcase shrink due to fasting in lamb is very significant (Thompson et al, 1897)

- 0.1%/hr weight loss after about 12 hours
- Beef more like 0.03%/hour
- Strong NEFA response matches this difference
Thank you