For Good Beef, Sex is More Important than Breed


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Outline

• Marbling and collagen differs between breeds and sexes

• Modelling breed and sex

• Need to take sex and breed into account when predicting eating quality
Which is better?
Outline

- Marbling and collagen differs between breeds and sexes
- Modelling breed and sex
- Need to take sex and breed into account when predicting eating quality
Dairy

High IMF
Garcia-de-Siles et al., 1997
Thompson, 2001

Beef

Low IMF
Dairy  

High IMF  

More Collagen  

Boccard et al. 1979

Beef  

Low IMF  

Less Collagen
Dairy & Females

High IMF
Venkata Reddy et al., 2015

More Collagen

Beef & Bulls

Low IMF

Less Collagen
Hypothesis

Breeds and sexes will differ in quality

Differences in quality will be explained by maturity and IMF
Outline

• Marbling and collagen differs between breeds and sexes

• Modelling breed and sex

• Need to take sex and breed into account when predicting eating quality
482 carcasses

- Bull: 94
- Female: 173
- Steer: 215

- 5 countries
- Aged between 5-28 days
- Two hanging methods
- 4 cooking methods
- 18 muscle types
- All graded by MSA trained graders
482 carcasses

- Bull: 94
- Female: 173
- Steer: 215

482 carcasses

- Beef: 207
- Dairy: 151
- Cross: 124

- 5 countries
- Aged between 5-28 days
- Two hanging methods
- 4 cooking methods
- 18 muscle types
- All graded by MSA trained graders
Taste Panels

482 Carcasses
18 Muscles

482 Carcasses
18 Muscles

Taste Panels

X 10 samples

482 Carcasses
Taste Panels

18 Muscles

X 10 samples

482 Carcasses

112688 Consumers
18 Muscles

482 Carcasses

Taste Panels

Untrained

$11268 \times 10$ samples

11268 Consumers
18 Muscles

482 Carcasses

Taste Panels

X 10 samples

Untrained

11268 Consumers

X 6 Samples
Taste Panels

• Scored for
  – Tenderness 0 - 100
  – Juiciness 0 - 100
  – Flavour 0 - 100
  – Overall Liking 0 - 100

• Scores then weighted and combined into a single MQ4 value

\[
\text{Tenderness} \times 0.3 + \text{Juiciness} \times 0.1 + \text{Flavour} \times 0.3 + \text{Overall Liking} \times 0.3 = \text{MQ4}
\]
The Meat Standards Australia System

**Predictors**
- Breed (2-10) restricted to
  - Bosindicus content
- Sex (2)
- Growth path (10)
  - carcass wt
  - **ossification score**
  - Milk fed veal
- Hanging (0-10)
- **Marble score** (2-10)
- Ageing: 5d min (0-6)
- Cooking method (0-12)
- Muscle (30)
- **pHu**
- Rib fat

**Basic criteria**
- Stress minimization
- Optimal processing

**Thresholds (requirement)**
- Ultimate pH<5.7/colour
- Rib fat > 3mm
The Meat Standards Australia System

### Predictors
- Breed (2-10) restricted to
  - Bosindicus content
- Sex (2)
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  - carcass wt
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  - Milk fed veal
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- Rib fat

### Basic criteria
- Stress minimization
- Optimal processing

### Thresholds (requirement)
- Ultimate pH<5.7/colour
- Rib fat > 3mm

= Predicted MQ4
The Meat Standards Australia System

- **Predictors**
  - **Breed** (2-10) restricted to
    - Bosindicus content
  - **Sex** (2)
  - Growth path (10)
    - Carcass wt
    - Ossification score
    - Milk fed veal
  - Hanging (0-10)
  - Marble score (2-10)
  - Ageing: 5d min (0-6)
  - Cooking method (0-12)
  - Muscle (30)
  - pHu
  - Rib fat

- **Thresholds (Requirement)**
  - Ultimate pH<5.7/colour
  - Rib fat > 3mm

- Mostly Beef Breeds
- No Bulls
Statistical Analysis

Linear mixed effects model

- **Fixed Effects**
  - Source country
  - Hang method
  - Muscle
  - Cook method
  - Sex
  - Breed

- **Random Terms**
  - Animal I.D.
  - Taste panel country
  - Kill Group

- **Covariates**
  - Days aged
Statistical Analysis

Linear mixed effects model

- **Fixed Effects**
  - Source country
  - Hang method
  - Muscle
  - Cook method
  - Sex
  - Breed

- **Random Terms**
  - Animal I.D.
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Statistical Analysis

Linear mixed effects model

- Fixed Effects
  - Source country
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  - Muscle
  - Cook method
  - Sex
  - Breed

- Random Terms
  - Animal I.D.
  - Taste panel country
  - Kill Group

- Covariates
  - Days aged

Two Models:

1) MQ4
2) Prediction accuracy
Outline

• Marbling and collagen differs between breeds and sexes

• Modelling breed and sex

• Need to take sex and breed into account when predicting eating quality
Bulls
Steers
Females

Lower scores

MQ4

MSA accuracy

Lower scores

MQ4

Bulls
Steers
Females
Lower scores

Not fully explained by MSA

MQ4

MSA accuracy

Bulls
Steers
Females

MQ4

Prediction error

Bulls
Females
Steers
Lower scores - Needs adjustment for: Bulls

MQ4

MSA accuracy

Lower scores

Needs adjustment for: Bulls

Lower scores

Needs adjustment for: Bulls

Lower scores

Needs adjustment for: Bulls
Lower scores

MQ4

MSA accuracy

Needs adjustment for:

Bulls

Not explained by:

Age
Ultimate pH
Marbling score

Needs adjustment for: Bulls
Not explained by: Age
Ultimate pH
Marbling score

Prediction error

Bulls
Steers
Females

MQ4

Lower scores

Bulls
Steers
Females

Needs adjustment for: Bulls
Not explained by: Age
Ultimate pH
Marbling score
Blade
Chuck
Chuck Tender
Cube roll a
Cube roll b
Silverside a
Knuckle a
Knuckle b
Silverside b
Blade
Rump cap
Rump tail
Eye of rump centre
Eye of rump side
Shortloin
Tenderloin
Topside a
Topside b
MQ4

MSA accuracy

Higher scores

Blade
Chuck
Chuck Tender
Cube roll a
Cube roll b
Silverside a
Knuckle a
Knuckle b
Silverside b
Blade
Rump cap
Rump tail
Eye of rump centre
Eye of rump side
Shortloin
Tenderloin
Topside a
Topside b

Beef
Cross
Dairy
MQ4

MSA accuracy

Higher scores
MQ4

Higher scores

Blade
Chuck
Chuck Tender
Cube roll a
Cube roll b
Silverside a
Knuckle a
Knuckle b
Silverside b
Blade
Rump cap
Rump tail
Eye of rump centre
Eye of rump side
Shortloin
Tenderloin
Topside a
Topside b

Blade
Chuck
Chuck Tender
cube roll a
cube roll b
Silverside a
knuckle a
knuckle b
Silverside b
Blade
rump cap
rump tail
eye of rump centre
eye of rump side
Shortloin
Tenderloin
topside a
topside b
MQ4

Higher scores

Blade
Chuck
Chuck Tender
Cube roll a
Cube roll b
Silverside a
Knuckle a
Knuckle b
Silverside b
Blade
Rump cap
Rump tail
Eye of rump centre
Eye of rump side
Short loin
Tenderloin
Topside a
Topside b

Blade
Chuck
Chuck Tender
cube roll a
cube roll b
Silverside a
knuckle a
knuckle b
Silverside b
Blade
rump cap
rump tail
eye of rump centre
eye of rump side
Short loin
Tenderloin
topside a
topside b

Beef
Cross
Dairy

MQ
MSA accuracy

Higher scores
Higher scores

MQ4

MSA accuracy

Blade
Chuck
Chuck Tender
Cube roll a
Cube roll b
Silverside a
Knuckle a
Knuckle b
Silverside b
Blade
Rump cap
Rump tail
Eye of rump centre
Eye of rump side
Shortloin
Tenderloin
Topside a
Topside b

Blade
Chuck
Chuck Tender
cube roll a
cube roll b
Silverside a
knuckle a
knuckle b
Silverside b
Blade
rump cap
rump tail
eye of rump centre
eye of rump side
Shortloin
Tenderloin
topside a
topside b

Green: Beef
Red: Cross
Yellow: Dairy

Lower Values
MQ4

Higher scores

Blade
Chuck
Chuck Tender
Cube roll a
Cube roll b
Silverside a
Knuckle a
Knuckle b
Silverside b
Blade
Rump cap
Rump tail
Eye of rump centre
Eye of rump side
Shortloin
Tenderloin
Topside a
Topside b

MSA accuracy

Needs additional adjustment for:

**Muscle type**
**AND**
**Breed**

Lower Values
MQ4
Higher scores

MSA accuracy

Needs additional adjustment for:

Muscle type
AND
Breed

Not explained by:

Age
Ultimate pH
Marbling score

Higher scores

Blade
Chuck
Chuck Tender
Cube roll a
Cube roll b
Silverside a
Knuckle a
Knuckle b
Silverside b
Blade
Rump cap
Rump tail
Eye of rump centre
Eye of rump side
Shortloin
Tenderloin
Topside a
Topside b

Lower Values

Beef
Cross
Dairy

Beef
Cross
Dairy

Beef
Cross
Dairy

Beef
Cross
Dairy
Conclusion

Breeds and sexes differ in quality
Conclusion

Breeds and sexes differ in quality

Differences are explained by carcass traits
Conclusion

Breeds and sexes differ in quality

Need sex and breed adjustments to guarantee and predict quality
Contributors

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<table>
<thead>
<tr>
<th>Muscle Name</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. triceps brachii caput longum</td>
<td>Blade</td>
</tr>
<tr>
<td>M. serratus ventralis cervicis</td>
<td>Chuck</td>
</tr>
<tr>
<td>M. supraspinatus</td>
<td>Chuck Tender</td>
</tr>
<tr>
<td>M. longissimus dorsi</td>
<td>Cube Roll a</td>
</tr>
<tr>
<td>M. spinalis dorsi</td>
<td>Cube Roll b</td>
</tr>
<tr>
<td>M. semitendinosus</td>
<td>Silverside a</td>
</tr>
<tr>
<td>M. rectus femoris</td>
<td>Knuckle a</td>
</tr>
<tr>
<td>M. vastus lateralis</td>
<td>Knuckle b</td>
</tr>
<tr>
<td>M. biceps femoris (syn. gluteobiceps)</td>
<td>Silverside b</td>
</tr>
<tr>
<td>M. infraspinatus</td>
<td>Blade</td>
</tr>
<tr>
<td>M. biceps femoris (syn. gluteobiceps)</td>
<td>rump cap</td>
</tr>
<tr>
<td>M. tensor fasciae latae</td>
<td>rump tail</td>
</tr>
<tr>
<td>M. gluteus medius</td>
<td>eye of rump centre</td>
</tr>
<tr>
<td>M. gluteus medius</td>
<td>eye of rump side</td>
</tr>
<tr>
<td>M. longissimus dorsi</td>
<td>Shortloin</td>
</tr>
<tr>
<td>M. psoas major</td>
<td>Tenderloin</td>
</tr>
<tr>
<td>M. adductor femoris</td>
<td>Topside a</td>
</tr>
<tr>
<td>M. semimembranosus</td>
<td>Topside b</td>
</tr>
</tbody>
</table>