Carcass Grading: Today and Tomorrow

Dale R. Woerner, Ph.D.
Cargill Endowed Professor in Sustainable Meat Science
Texas Tech University, Lubbock, TX
Dale.Woerner@TTU.edu
Beef Grading

- The meat grading program is administered by the U.S. Department of Agriculture (USDA). Beef quality grades indicate palatability characteristics such as tenderness, juiciness and flavor.
- Inspection
  - By law, all meat must be inspected and passed for wholesomeness by the USDA.
- Grading
  - Quality grading is voluntary. Prime, Choice and Select are the most common quality grades consumers see.
Beef Grading

- Beef carcass, not individual cuts are graded
- Grade carries forward to all wholesale/primal and portion cuts derived from graded carcass
- Roughly 95% of all federally inspected slaughter gets a grade
USDA Quality Grades for Beef*

Grades for Youthful Cattle
- Prime
- Choice
  - Premium Choice (CH+/CH+)
  - Commodity Choice (CH-)
- Select
- Standard

Grades for Mature cattle
- Commercial
- Utility
  - Breaking (< 80% lean)
  - Boning (≥ 80% lean)
- Cutter
- Canner

*Mature bulls are not eligible for quality grading.
USDA Quality Grade Factors

- **Maturity**
  - Skeletal Ossification (evaluated in split vertebrae)
  - Shape and Color of Ribs
  - Lean Color (longissimus)
  - Lean Texture (longissimus)

- **Degree of Marbling**
  - Amount and Distribution of Intramuscular Fat (longissimus)
<table>
<thead>
<tr>
<th>Maturity Group</th>
<th>Approximate Chronological Age</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9 to 30 months</td>
<td>Youthful</td>
</tr>
<tr>
<td>B</td>
<td>30 to 42 months</td>
<td>Youthful</td>
</tr>
<tr>
<td>C</td>
<td>42 to 72 months</td>
<td>Mature</td>
</tr>
<tr>
<td>D</td>
<td>72 to 96 months</td>
<td>Mature</td>
</tr>
<tr>
<td>E</td>
<td>More than 96 months</td>
<td></td>
</tr>
</tbody>
</table>
Carcass Maturity

- Physiological Indicators
- Skeletal Ossification
- Lean Color and Texture
Skeletal Ossification

Hind Quarter

↓
↓
↓

Cartilage Ossification

↓
↓
↓

Forequarter

Sacral

Lumbar

Thoracic
Lean maturity is based on the color of the lean in the Ribeye.
# Combining Marbling with Carcass Maturity to Determine Quality Grade

<table>
<thead>
<tr>
<th>Marbling Score</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abundant</td>
<td>Prime</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderately Abundant</td>
<td>Prime</td>
<td>Commercial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly Abundant</td>
<td></td>
<td>Commercial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>Choice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modest</td>
<td>Choice</td>
<td></td>
<td></td>
<td>Utility</td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>Select</td>
<td></td>
<td></td>
<td>Utility</td>
<td></td>
</tr>
<tr>
<td>Slight</td>
<td>Select</td>
<td></td>
<td></td>
<td></td>
<td>Utility</td>
</tr>
<tr>
<td>Traces</td>
<td>Standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practically Devoid</td>
<td>Standard</td>
<td></td>
<td></td>
<td>Cutter</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Canner</td>
<td></td>
</tr>
</tbody>
</table>
As of December of 2017, USDA Grade Standards ensure that:
Cattle 30 months old, or less, are included in the youngest maturity group recognized as “beef” (A maturity).
Skeletal and muscular evidence will still be used to determine maturity for those animals over 30 months of age.
USDA Marbling Scores

- Moderately Abundant - Prime
- Slightly Abundant - Prime
- Moderate – High Choice
- Modest – Average Choice
- Small – Low Choice
- Slight - Select
Prime Beef - 1960 to 2016

Choice Beef - 1960 to 2016
Beef Grades - 1980 to 2016

Calendar Year

Choice, Select Percentage %

Prime Percentage %
USDA Yield Grades

**Yield Grades:**
Reflect differences in yield of closely trimmed, boneless retail cuts from the round, loin, rib, and chuck.

YG-1  more than 52.3%
YG-2  50.1 to 52.3%
YG-3  47.8 to 50.0%
YG-4  45.5 to 47.7%
YG-5  45.4% or less
USDA Yield Grade Factors

- Thickness of Fat over the ribeye (adjusted)
- Ribeye area
- Estimated % kidney, pelvic and heart (KPH) fat
- Hot carcass weight

\[ YG = 2.5 + (2.5 \times FT) - (0.32 \times REA) + (0.2 \times KPH) + (0.0038 \times HCW) \]
Camera Grading Systems
Augmentation of USDA Grade Application
Variation in Beef Sensory Attributes Explained by Differences in Marbling

TAMU “1005-Head Study”
Smith et al. (1980)

Camera study

% Variation Explained by Marbling

*Juiciness* 24 45
*Tenderness* 27 40
*Flavor Desirability* 30 32
*Overall Palatability* 34 71
*Sensory Experience* 61
Effect of Marbling Degree on Probability of a Positive Sensory Experience

Colorado State University M.S. Thesis: M. R. Emerson (2011)
“This is one of the food business’s biggest new battlefields, as meat packers make a bold bid to turn their anonymous product into coveted national brand names.”
Branded Beef Demand

U.S. Comprehensive Beef Cutout: Branded Sales Volume as a Percent of Total Sales Volume

![Graph showing branded beef sales volume as a percent of total sales volume over time.](image-url)
The History of Instrument Assessment of Beef

A Focus on the Last Ten Years

Prepared for the National Cattleman’s Beef Association
Dale R. Woerner
Keith E. Belk
Department of Animal Sciences
Colorado State University

All photos provided courtesy of Colorado State University’s Department of Animal Science

www.beefresearch.org
Hot Camera Systems
Cold Camera Systems
Beef Carcass Instrumentation

• Australian VIAScan™
• Computer Vision System™ (CVS™)
  ➢ RMS Research Management Systems (Canada/USA)
• Beef Carcass Classification Center II™ (BCC-II™)
  ➢ SFK (Denmark)
• VBS-2000 & VBG-2000
  ➢ E+V (Germany)
• QualitySpec BT Spectrometer
  ➢ Analytical Spectral Devices, Inc.
Dual Component VIA Systems & Output

Hot System Camera

Chilled Carcass System
“The world’s first online CT scanner for food”
X-Ray Technologies

• Past technologies have been imaged based, but new technologies are x-ray based technologies
  • CT Scans
    • Danish Meat Institute
    • Dexa
      • Australian x-ray system
  • X-ray technologies show the most promise for advancing accuracy of yield prediction
    • Use to predict % fat-free lean
    • Use to estimate trim/grind lean points in addition to %BCTRC
Rapid Evaporative Ionization Mass Spectrometry (REIMS)

• New technique allowing for characterization of biological tissues
• Provides molecular fingerprint
  • Real-time analysis (seconds)
  • No sample preparation
  • Hand-held sampling device
• Histological-based tissue identification with 90-98% accuracy (Balog et al., 2013)

Source: Balog et al. (2016)
Rapid Evaporative Ionization (REIMS) Mass Spectrometry

- Fatty acids
- DGs
- TGs
- PGs
- PIs
- Cardiolipins/Lipid dimers

MILD (-)

BOLD (-)
Beef Type Classification

Linear Discriminants
Calculated from Partial Least Squares

Beef Type
- Select/Low Choice
- Top Choice/Prime
- Dark Cutter
- Grassfed
- Wagyu
### Sensory Prediction with REIMS

#### Overall

<table>
<thead>
<tr>
<th>Reference Class</th>
<th>Predicted Class</th>
<th>Total</th>
<th>Sensitivity</th>
<th>Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>18</td>
<td>61.1%</td>
<td>73.3%</td>
</tr>
<tr>
<td>Positive</td>
<td>Negative</td>
<td>18</td>
<td>61.1%</td>
<td>73.3%</td>
</tr>
<tr>
<td>Negative</td>
<td>4</td>
<td>35</td>
<td>89.7%</td>
<td>83.3%</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>42</td>
<td>57</td>
<td></td>
</tr>
</tbody>
</table>

Overall Prediction Accuracy: **80.7%**

Balanced Prediction Accuracy: **75.4%**

#### Linear Discriminants

- Calculated from Partial Least Squares

#### Trained Sensory Rating Factor Scores

- Comprised of Tenderness, Juiciness, and Descriptive Flavor Attributes

- Overall Category: Positive, Neutral, Negative
SSF Tenderness Classification

<table>
<thead>
<tr>
<th>Predicted Class</th>
<th>Reference Class</th>
<th>Tender</th>
<th>Tough</th>
<th>Total</th>
<th>Sensitivity</th>
<th>Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tender</td>
<td>18</td>
<td>9</td>
<td>27</td>
<td></td>
<td>66.7%</td>
<td>78.3%</td>
</tr>
<tr>
<td>Tough</td>
<td>5</td>
<td>25</td>
<td>30</td>
<td></td>
<td>83.3%</td>
<td>73.5%</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>34</td>
<td>57</td>
<td></td>
<td>75.44%</td>
<td>75.00%</td>
</tr>
</tbody>
</table>

Overall Prediction Accuracy 75.44%
Balanced Prediction Accuracy 75.00%
Questions, please.
Thank you!

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