Controlling Factors that Influence Pork Quality

“Variation in Fat Tissue”

Iowa Pork Congress

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Iowa State University Pork Quality

Aroma Evaluation          Flavor/Texture

[Images of people smelling and tasting samples]
Factors Influencing Pork Quality

- Factors we can (somewhat) control
  - Genetics
  - Rations
  - Management styles
  - Delivery, animal handling
  - Slaughter factors
  - Cold-side management

- Factors out of our control
  - Weather
  - Biological variation
Issues Related to Variation in Fat Quality

- Soft pork fat is nothing new…
- Research paper –
- Soft Pork Studies – The Influence of the Character of the Ration Upon the Composition of the Body Fat of Hogs
- The Journal of Biological Chemistry
- 1926
“Rations low in fat have produced firm body fats while those high in unsaturated oils have produced fats with the characteristics of the ingested fats.”

“The evidence indicates that the animal body tends to deposit ingested fat in preference to synthesizing new fat…”

“The iodine value was an excellent measure of firmness of the adipose tissue.”

Of course…oil was $1.88 per barrel and pigs were slaughtered at 190 pounds.
Challenges with Ration Management

- Standard corn/soy rations are a thing of the past
- Major alternative ingredients
  - Dried Distillers Grains with Solubles (DDGS)
  - Animal/Vegetable blends
  - Bakery meal
  - Glycerol
  - Pet food
- Future corn byproducts
DDGS – Variable Quality

Dark, Heat Damaged Low Quality
- poor amino acid digestibility
- burnt smell (poor palatability)

Yellow-Golden
High Quality DDGS
Used Frying Oil – Restaurant Grease
Bakery Products - Twinkies, etc…
Are turned into bakery meal...
# Bakery Meal – Endres Processing

<table>
<thead>
<tr>
<th>Component</th>
<th>Rosemount, MN</th>
<th>Battle Creek, MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Sugar (%)</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>Starch (%)</td>
<td>20</td>
<td>28</td>
</tr>
</tbody>
</table>
Iowa, eggs and old chickens…
Turned into “Spent Hen Meal”
Pet Food/Pet Food Meal
Increasing Dietary Polyunsaturated Fat

Composition of Ingredient

↓

Fat Concentration

↓

Corn Oil Concentration

↓

Unsaturated Fatty Acid Concentration

↓

Linoleic Acid Concentration
Fatty Acids

Stearic Acid – Saturated

Linoleic Acid – Polyunsaturated
Diet and Iodine Value (Kellner, 2011)

Carcass Fat (IV) Iodine Value

<table>
<thead>
<tr>
<th>Iodine Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>65.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Tallow (IV = 41.9)</td>
</tr>
<tr>
<td>66.3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>CWG (IV = 66.5)</td>
</tr>
<tr>
<td>67.2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Corn Oil (IV = 123.1)</td>
</tr>
<tr>
<td>70.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>70.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>72.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>80.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

Iodine Value Range:

- 40 to 45
- 50 to 55
- 60 to 65
- 70 to 75
- 80 to 85
Iodine Value by Sample Site

(Kellner, 2011)

Iodine Value by Sample Site

Iodine Value

Control | Tallow | CWG | Corn Oil
---|---|---|---
0 | 63.3 | 64.3 | 67.9 | 72.0 | 79.1 | 81.4
3 | 63.9 | 64.4 | 70.3 | 72.6 | 75.6 | 79.6
6 | 69.6 | 69.1 | 70.0 | 70.9 | 79.6 | 79.6

Belly Fat IV | Back Fat IV | Jowl Fat IV
Soft Pork Fat - Guidelines

• Denmark – Danish Meat Research Institute
  • Maximum Iodine Value of 70
  • Maximum Linoleic Acid Content of 1.6%

• United States - Recommendations not clearly established - Boyd in 1997 recommended:
  • Maximum Iodine Value of 74
  • Maximum Linoleic Acid Content of 2.1%
Potential Soft-Fat Issues

- Pork Bellies Into Bacon
  - Spareribs are more difficult to remove
  - Skinning becomes more difficult
  - Soft bellies lead to increase in down-graded product
  - Top quality bellies are reduced to trim value
  - On average up to $25/head loss
  - Dimensional issues – out-of-spec product
  - Increased manipulation to produce bacon
Potential Soft-Fat Issues

• Fresh and Cured Hams
  • Skinning more difficult
  • Less muscle integrity
Potential Soft-Fat Issues

- **Specialty Hams**
  - Textural issues with dry-cured hams
  - Fat is softer with oily texture
  - Flavor issues with more unsaturated fat
  - Rancidity may increase during processing
  - Parma ham specifications require iodine value less than 70
  - Processing times are from 9 to 12 months
Aging Parma Hams
Potential Soft Fat Issues

- Butts and Blade End Loins
  - Lack of integrity causes issues with slicing
  - Slicing yields reduced - especially critical on thin-sliced products in the Japanese market
Potential Soft Fat Issues

- Sausage Manufacture
  - Fat softness may lead to textural issues
  - Potential for increased rancidity – flavor issues related polyunsaturated fatty acids
  - Non-vacuum packaged processed products that contain salt and exposed to light...

- Indirect Issues
  - Choice white grease composition may affect firmness of soaps and crayons
Measurement of Fat Quality

- Subjective firmness
  - Rated on a 1-3 or 1-5 point scale
  - Temperature dependent
- “Flop” Test
  - Most measured skin on
  - Belly is draped over a rod
  - Flop angle and distance between ends
  - Temperature dependent
Belly Flop Test

Pomerenke and Shurson, University of Minnesota
Is Iodine Value the Best Measure?

Iodine
### Iodine Values of Fats and Oils

<table>
<thead>
<tr>
<th>Fats and Oils</th>
<th>Iodine Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut oil</td>
<td>8-10</td>
</tr>
<tr>
<td>Beef Tallow</td>
<td>38-55</td>
</tr>
<tr>
<td>Lard</td>
<td>46-70</td>
</tr>
<tr>
<td>Choice White</td>
<td>68-70</td>
</tr>
<tr>
<td>Corn Oil</td>
<td>111-130</td>
</tr>
<tr>
<td>Soybean Oil</td>
<td>137-143</td>
</tr>
<tr>
<td>Menhaden Oil</td>
<td>139-173</td>
</tr>
</tbody>
</table>
Measurement of Fat Quality

- **Direct Iodine Value (IV)**
  - Fat removed from belly, back fat or jowl
  - Pure fat submitted to titration
  - More double bonds = greater iodine values
- **Calculated Iodine Value (IV)**
  - Determine fatty acid profile of fat
  - Calculate iodine value from:
    - \[ IV = (0.95 \times [16:1]) + (0.86 \times [18:1]) + (1.732 \times [18:2]) + (2.616 \times [18:3]) + (0.785 \times [20:1]) \]
Measurement of Fat Quality

- Estimated IV by Near Infrared (NIR)
  - Laboratory applications
    - Fat removed from carcass
    - Rapid estimate of IV
  - On-line applications
    - Probe carcasses on the slaughter floor
    - Cold side to sort bellies into product streams
    - Bacon processors may use to spec raw material
Variation in Iodine Value

- Not only variation within pigs fed same rations – variation within individual bellies (Trusell et al., 2010)

<table>
<thead>
<tr>
<th></th>
<th>D</th>
<th>C</th>
<th>V</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>71.9</td>
<td>71.0</td>
<td>70.1</td>
<td>70.3</td>
<td>70.6</td>
<td>70.8</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>70.4</td>
<td>69.9</td>
<td>69.5</td>
<td>68.7</td>
<td>67.8</td>
<td>69.2</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>69.9</td>
<td>69.8</td>
<td>69.0</td>
<td>67.4</td>
<td>67.2</td>
<td>68.7</td>
<td></td>
</tr>
</tbody>
</table>

|   | 70.7  | 70.2  | 69.5  | 68.8  | 68.5  |

Iowa State University

Food Science and Human Nutrition
Variation Within Tissue (Apple, 2010)

Primary lean (latissimus dorsi)
61.9D

Secondary lean (cutaneous trunci)
63.4C

Intermuscular fat layer
66.0B

Subcutaneous fat layer
69.7A
## Percent Lean and Belly Attributes

<table>
<thead>
<tr>
<th>Percent Lean (%)</th>
<th>Carcass Wt. (lbs)</th>
<th>Belly Wt. (lbs)</th>
<th>Center Thickness</th>
<th>Edge Thickness</th>
<th>Iodine Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.1</td>
<td>226</td>
<td>18.85</td>
<td>1.0</td>
<td>1.3</td>
<td>65.6</td>
</tr>
<tr>
<td>52.6</td>
<td>225</td>
<td>15.25</td>
<td>1.0</td>
<td>1.2</td>
<td>66.4</td>
</tr>
<tr>
<td>51.4</td>
<td>216</td>
<td>21.10</td>
<td>1.1</td>
<td>1.4</td>
<td>67.3</td>
</tr>
<tr>
<td>52.8</td>
<td>217</td>
<td>15.25</td>
<td>1.1</td>
<td>1.1</td>
<td>68.4</td>
</tr>
<tr>
<td>49.2</td>
<td>223</td>
<td>19.45</td>
<td>1.0</td>
<td>1.4</td>
<td>68.8</td>
</tr>
<tr>
<td>AVE 51.4</td>
<td>221</td>
<td>17.98</td>
<td>1.0 inch</td>
<td>1.3 inch</td>
<td>67.3</td>
</tr>
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</tr>
</thead>
<tbody>
<tr>
<td>58.5</td>
<td>206</td>
<td>15.75</td>
<td>0.9</td>
<td>1.1</td>
<td>71.3</td>
</tr>
<tr>
<td>61.4</td>
<td>226</td>
<td>15.45</td>
<td>1.0</td>
<td>1.0</td>
<td>73.8</td>
</tr>
<tr>
<td>58.6</td>
<td>215</td>
<td>15.35</td>
<td>0.9</td>
<td>1.0</td>
<td>74.3</td>
</tr>
<tr>
<td>59.4</td>
<td>221</td>
<td>16.55</td>
<td>0.9</td>
<td>1.0</td>
<td>74.4</td>
</tr>
<tr>
<td>60.0</td>
<td>212</td>
<td>14.85</td>
<td>0.9</td>
<td>0.9</td>
<td>80.3</td>
</tr>
<tr>
<td>AVE 59.6</td>
<td>216</td>
<td>15.59</td>
<td>0.9 inch</td>
<td>1.0 inch</td>
<td>74.8</td>
</tr>
</tbody>
</table>
General Trends in Iodine Value

- Increase of 0.33 units for every 1% increase in DDGS in the diet
- Belly IV = Jowl IV x 0.98236
- Gilts usually 2 to 3 points greater than barrows
- Paylean increases 1.5 to 2.0 points
- Not all pigs respond the same to step-down rations
- Belly softness may be related to moisture content of lipid tissue
In Summary…

• Must consider all fat-containing feed ingredients in ration formulation
• Consider implications of ration decisions downstream - all the way to crayon firmness
• Various packers may have different concerns related to iodine value based on domestic markets, exports or further processing
• Technology for rapid on-line estimate of iodine value is in the developmental stages