Casings – Why are they important?

- Governing force in the conversion of meat batter into final sausage product
- Walls that work for and with the proteins
- Integral part of the sausage
  – Separates from surrounding environment
  – Development of independent meat systems

Property | Function
--- | ---
Mechanical Strength | Withstands all sausage processing operations; storability
Water Vapor and Gas Permeability | indispensable for raw sausages; allows for suitable rate of desiccation; not advantageous for cooked sausages.

Other Basic Properties | Chemical inertness; fat impermeability.
Shrinkability | Expansion and shrinking necessary to accommodate dimensional changes of the sausage body.
Adhesion | This requirement is corollary of shrinkability.
Other Desirable Properties | Uniform sausage caliber; clippability; printability; temperature resistance; carrier for auxiliary and functional ingredients.

What is the ideal casing?

- Fresh Sausage
- Liver and Blood Sausage
- Cooked Sausage
- Dry Sausage
- Semi-Dry Sausage
Fresh Sausage

• Analysis
  – Coarse or fine particle size
  – Stuffed into permeable casings
  – High cooking temperatures – 395°F
  – Grilling, pan fry or deep fat frying
• Casing Requirements
  – Permeability
  – Expansion/shrink capabilities
  – Tender bite
  – Frying performance

Cooked Sausage

• Analysis
  – Fine or coarse particle size
  – Emulsification/protein extraction
  – Fresh or frozen meats
  – Thermal processed (175°F with 100% RH)
  – Expansion during thermal process
  – Tightly stuffed
  – Impermeable and permeable casings used
• Casing Requirements
  – Shrink capacity
  – Permeable or impermeable
  – Peelability

Liver and Blood Sausage

• Analysis
  – Precooked meats
  – Non-meat proteins/binders used
  – Process temperatures between 176 - 212°F
  – Cold smoke may be applied
• Casing Requirements
  – Permeability or barrier casing
  – Shrinkability
  – Peelability
  – Good cookability

Semi-Dry Sausage

• Analysis
  – Coarse or fine particle size
  – Fresh or frozen meats
  – Fast fermentation (pH below 4.9)
  – Thermal processing to IT of 160°F
  – Processing temperatures with 75% RH and smoke
  – Stuffed into permeable casings
• Casing Requirements
  – Permeability
  – Shrink capacity
  – Tender bite (if consumed)
  – Sufficient adhesion
  – Peelability

Dry Sausage

• Analysis
  – Coarse or fine particle size
  – Fresh or frozen meats
  – Slowly fermented product (pH 5.3 – 4.7)
  – Long ripening and aging
    • MPR
    • Temps below 59°F
    • 75% RH
• Casing Requirements
  – Permeability
  – Shrinkability
  – Sufficient Adhesion
  – Peelability

Large Diameter Casings

• Collagen
• Cellulose Casings
  – Highly elasticity
  – Low elasticity
• Fibrous Casings
  – Permeable
  – Impermeable
  – Coated
  – Prestuck
• Plastic Casings
  – Permeable
  – Impermeable
• Cook-In Bags
• Nettings
**Large Diameter Collagen**
- Inedible collagen
- Straight or curved
- Shirred or Flat Film
- Good Machinability and stuffing capacity
- Ideal for dry and semi-dry sausage applications
- Natural look
- High permeability
- Soaked 10-15% brine solution

**Large Diameter Cellulose**
- Mostly replaced by fibrous
- Soaked prior to stuffing
- Permeable
- Printing available
- Caliber range 38 – 250mm
- Low Elasticity
  - Cylindrical/uniform shaped products
- High Elasticity
  - Oval/pear shaped products

**Fibrous Casings**
- Most versatile product
  - Strength
  - Uniformity
  - Machinability
  - Technological performance
- Formed from paper with viscose coating
- Inedible
- Permeable or Impermeable (barrier coating)
- Comes in various forms/varieties
- Caliber range 34 – 200mm
- Soaked prior to use (some RTU)

**Fibrous Coatings**
- Standard performance
- Peeling agent (Zip or Easy Peel)
- Adhesion agent (Securex)
  - Care not to mix with other casings!

**Plastic Casings**
- Mostly used for cooked sausages
- Highly advanced thermoplastics
- High barrier functions
- 35 – 150mm
- Requirements
  - Less taper
  - Good shrink characteristics
  - Barrier functions
    - Allow for smoke penetration
    - Sufficient meat adhesion

**Plastic Casings**
- High End Products
  - Multi layer casings
  - High barrier
  - Good shrink
  - Size
  - Final package
- Low End Products
  - Mostly single layer
  - Reduced barrier
  - Large sizes
  - Stack packs
  - Used for low end sausage
Cook In Bags

- Plastic/Polyester
  - Withstand High Temperature
- Vacuum Seal
- Keeps Moisture In
- Faster Cooking Times
- Uses
  - Roast Beef
  - Turkey Breast

Nettings

- Standard
- Pre-Smoked/Flavors
- Correct Sizing is Important
- Release Agents

Skinless Casings

- Cellulose source formed into a casing
- Inedible and peeled prior to sausage consumption
- Caliber ranges 14 – 40mm
- Strand Length 55 – 225ft
- Coatings
- Colors/Printing

Advantages of Cellulose

- Ease of Use
- Variety of Sizes
- Uniformity
- Mechanical Strength
  - Automated Processes
  - Permeable

Disadvantages of Cellulose

- Peeling
  - Release Agents
- Proper Skin Formation
  - Humidity
  - Air Velocity
- Knack/Snap

Thermal Processing Skinless

<table>
<thead>
<tr>
<th>Step</th>
<th>Minutes</th>
<th>Temperature</th>
<th>RH</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drying</td>
<td>20</td>
<td>140°F</td>
<td>35%</td>
<td>Reddening Skin formation</td>
</tr>
<tr>
<td>Smoking</td>
<td>25 – 40</td>
<td>145°F</td>
<td>50 - 60%</td>
<td>Reddening Smoke Color Coagulation</td>
</tr>
<tr>
<td>Cooking</td>
<td>5 min</td>
<td>145°F</td>
<td>0%</td>
<td>Color Set</td>
</tr>
<tr>
<td>Cooking</td>
<td>20</td>
<td>167°F</td>
<td>100</td>
<td>Coagulation</td>
</tr>
<tr>
<td>Showering</td>
<td></td>
<td>IT &lt;100°F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Peeling of Skinless Sausage

- Correct Set Up
- Implications for *Lm*

Storage Considerations

- > 68°F (Optimum: 60 – 70°F)
- Relative Humidity > 70% (Optimum: 60 – 70%)
- If stored in cooler transport prior to use
  – 2 days @ 60 – 70°F before stuffing

Natural Casings

- Pork
- Sheep
- Beef
- Standardized
  – Salted
  – Pre-soaked
  – Pre-tubed
  – Colored

Casing Structure

Natural Casing Process
Hog Casings

- Used for small diameter (28 – 40mm)
- Fresh or fully cooked smoked sausage

Sheep Casings

- Smallest of natural casings (16 – 28mm)
- Most tender – desirable “knack”

Sheep Quality Grades

- A, AA or FQ – highest quality
- AB, B or PQ – some pinholes, coarse sausage
- BC or C – contains more sprinkler holes
  - Very coarse emulsions

Beef Casings

- Beef bungs, caps and rounds middles most common
- Used for bologna, salami, ring bologna, polish sausage, head cheese
- Vary in size

Hog Casings

- Hog bungs available
  - Individual pieces
  - Sewn
    - Double walled
    - Single walled
- Calibers range 50 – 90mm
- Production of liver sausages and salami

Hog Casings

- Sold in bundles or hanks
  - 91 meters
- Shorts
  - 1 – 2 meters length
  - 35mm and up/down
- Hand cut
- Knife cut

Hog Casings

- Available in individual pieces
- Double walled
- Single walled
- Calibers range 50 – 90mm
- Production of liver sausages and salami
Sizes/Bundles

- **Rounds**
  - 9, 18, 30 meters
- **Middles**
  - 9 or 18 meters
  - Sewn for uniformity
- **Bladders**
  - Hold 5 – 14 lbs of sausage

Labeling of Natural Casings

- **FSIS Notice 6-02**
  - Species dependent
  - Ingredient statement
  - Colorants?

Thermal Processing of Natural Casings

<table>
<thead>
<tr>
<th>Step</th>
<th>Minutes</th>
<th>Temperature</th>
<th>RH</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Prep.</td>
<td>45</td>
<td>120°F</td>
<td>0%</td>
<td>Drying</td>
</tr>
<tr>
<td>Smoke / Cook</td>
<td>30</td>
<td>120°F</td>
<td>0%</td>
<td>Meat Adhesion</td>
</tr>
<tr>
<td>Smoke / Cook</td>
<td>30</td>
<td>145°F</td>
<td>47%</td>
<td>Flavor</td>
</tr>
<tr>
<td>Smoke / Cook</td>
<td>30</td>
<td>165°F</td>
<td>50%</td>
<td>Coagulation</td>
</tr>
<tr>
<td>Cook</td>
<td>20</td>
<td>165°F</td>
<td>0%</td>
<td>Color Set</td>
</tr>
<tr>
<td>Cook</td>
<td>IT</td>
<td>170°F</td>
<td>78%</td>
<td>Coagulation</td>
</tr>
<tr>
<td>Shower</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Advantages to Sheep Gut

- “Natural” Marketing
  - Labeling
  - Old World Appearance
- Knack/Snap
- Curve

Disadvantages to Sheep Gut

- Machinability
- Product Uniformity
- Ease of Use
  - Not RTU
    - Require soaking prior to use
- Consistency in Quality
- Pricing/Availability

Pricing Pressures
Collagen Casings
The “Natural” Alternative

• Natural Protein Found in Animals
  – 35% of Total Protein
• Originates From Inner Layer of Beef Hide
  – Solubilized, extruded and hardened
  – Dried, shirred and humidified
• Ready to stuff
• Differ based on processing requirements of the sausage

Collagen – Fresh Sausage (FSC)

• Less cross linking
• Better clarity
• Used for fresh or dry sausage
• Caliber range 16 – 32mm
• Requirements
  – Machinability
  – Transparency
  – Uniformity
  – Frying-Grilling Performance
  – Good Bite

Collagen – Processed Meat (PMC)

• Medium cross linking
• Used for frankfurters, smoked sausage
• Caliber ranges 13 – 43mm
• Requirements
  – Machinability
  – Uniformity
  – Good smoking and cooking performance
  – Good bite

Collagen – Beef Stick Casing (BSC)

• Strong cross linking
• Used for beef sticks and dry sausage
• Caliber ranges 13 – 23mm
• Requirements
  – Machinability (especially at cold temperatures)
  – Good bite

General Recommendations

• Stuff dry
• Clean casing contact areas
• Use largest possible stuffing tube
• Load the casing correctly (stuffing direction)
• Stuff to RSD
• Don’t under stuff
• At least 1mm difference between inner bore of casing and horn size
• Exchange break rings as needed
• Consider stuffing temperatures

Thermal Processing of Collagen Casings

• Bite strongly influenced by:
  – Drying
  – Smoking
• Excessive will result in toughness
• Correct addition of humidity is critical to produce a tender bite or “knack”
### Cook Cycle Collagen

<table>
<thead>
<tr>
<th>Step</th>
<th>Minutes</th>
<th>Temperature</th>
<th>RH%</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drying</td>
<td>15 – 20</td>
<td>140°F</td>
<td></td>
<td>Reddening Moist Adhesion</td>
</tr>
<tr>
<td>Cooking</td>
<td>3</td>
<td>140°F</td>
<td>100%</td>
<td>Shrink Softening</td>
</tr>
<tr>
<td>Exhaust</td>
<td>2</td>
<td>140°F</td>
<td></td>
<td>Reduce Steam</td>
</tr>
<tr>
<td>Drying</td>
<td>5-10</td>
<td>140°F</td>
<td></td>
<td>Prepare Surface</td>
</tr>
<tr>
<td>Smoking</td>
<td>15 – 30</td>
<td>140°F</td>
<td>50-60%</td>
<td>Color Taste</td>
</tr>
<tr>
<td>Cooking</td>
<td>5-10</td>
<td>145°F</td>
<td>0%</td>
<td>Evacuation/ Color Set</td>
</tr>
<tr>
<td>Cooking</td>
<td>IT – 158°F</td>
<td>167°F</td>
<td>100%</td>
<td>Coagulation</td>
</tr>
<tr>
<td>Cooking</td>
<td>3</td>
<td>167°F</td>
<td></td>
<td>Color Set Dry Surface</td>
</tr>
<tr>
<td>Shower</td>
<td>Below 100°F</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Labeling of Collagen Casings

- FSIS Notice 6-02
- Species Dependent
- Clear versus colored
  - Carmine
  - Yellow #5

### Co-Extrusion

- **Casing material:**
  - Beef and pork based collagen
  - Hybrid (collagen/Alginate)
  - Alginate gel
- **Brine:**
  - Sodium-Chloride (NaCl)
  - Di-Potassium Phosphate(K2HPO4)
  - Calcium-Chloride (CaCl2)
- **Casing development:**
  - Crosswise fiber orientation
  - Collagen fibers collapse
  - Brining time: 2 – 40 seconds

### Co-Extrusion Casing Development

- **Chemical cross-linking:**
  - Bridge between fibers
  - Network of fibers
  - Aldehydes
  - Liquid smoke
- **Result:**
  - Permanent skin
  - Color, taste and flavor
  - Bite

### New Generation of Collagen Casings

- **1920’s Utilizing Manufacturing Techniques for Cellulose**
  - Didn’t gain popularity in U.S. until 1960’s
  - Casings we relatively thick, chewy
- **Dramatic Improvements**
  - Strong and easy to use but tender to bite
  - Helps processors manufacture efficiently
  - Developed with consumer in mind

### Optimizing Quality

- **Meat Block**
- **Casing Selection**
  - Skinless
    - High Volume
    - Cheaper Raw Materials
    - Lower Price
  - Skin On
    - Premium Pricing
    - High Quality
    - Hand Crafted
**Consumer Acceptance Bite (Knack/Mouth feel)**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much too weak</td>
<td>A little too weak</td>
<td>Just about right</td>
<td>A little too intensive</td>
<td>Much too intensive</td>
</tr>
<tr>
<td>Select</td>
<td>9</td>
<td>36</td>
<td>54</td>
<td>1</td>
</tr>
<tr>
<td>Gut</td>
<td>-</td>
<td>10</td>
<td>39</td>
<td>35</td>
</tr>
</tbody>
</table>

You recognize as being different but consumers don’t!

---

**Pricing Comparison**

<table>
<thead>
<tr>
<th>Natural Sheep</th>
<th>Elk</th>
<th>Deer</th>
<th>SELECT</th>
<th>Natural Sheep</th>
<th>Elk</th>
<th>Deer</th>
<th>SELECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per Unit</td>
<td>Cost per Unit</td>
<td>Cost per Unit</td>
<td>Cost per Unit</td>
<td>Cost per Unit</td>
<td>Cost per Unit</td>
<td>Cost per Unit</td>
<td>Cost per Unit</td>
</tr>
<tr>
<td>$8.41</td>
<td>$5.90</td>
<td>$10.95</td>
<td>$5.90</td>
<td>$8.41</td>
<td>$5.90</td>
<td>$10.95</td>
<td>$5.90</td>
</tr>
</tbody>
</table>

---

**Importance of Fat Sources**

<table>
<thead>
<tr>
<th></th>
<th>Chicken</th>
<th>Beef</th>
<th>Pork</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated</td>
<td>32.7 %</td>
<td>53.7 %</td>
<td>41.5 %</td>
</tr>
<tr>
<td>Monosaturated</td>
<td>27.4 %</td>
<td>43.6 %</td>
<td>50.2 %</td>
</tr>
<tr>
<td>Polyunsaturated</td>
<td>21.9 %</td>
<td>2.3 %</td>
<td>6.0 %</td>
</tr>
</tbody>
</table>

**Melting Point**

- Chopping Temperatures *(Initial)*
  - Lean protein source: 40-45 °F

- Chopping Temperatures *(Final)*
  - Pork: 55-60 °F
  - Beef: 44-46 °F or 68-72 °F
  - Poultry 34 °F or less

**Unstable Emulsions**

- Over chopping
- Heating
- Amount of collagen
Raw Material Considerations

- WATER...
  - Protein
  - Fat
  - Added Water
  - Consider all sources when formulating blends!
- Final Particle Size
  - Impacts on thermal processing and drying

Stuffing Considerations

Equipment Impacts

- Set Up
  - Twist Linker
  - FAM/Flex Linker
  - AL System
- Horn Size
- Follower Pressure
- Break Ring/Chucks

Correct Horn Set Up

Stuffing Failures

Stuffing Swirl – Horn Size
“Cork Screwing”

RSD Implications

- MEASURE!
  - Uniformity
  - Peelability
  - Machinability
  - Shrinkability
  - Packaging performance

Importance of RSD

Improper Stuffing Implications

- Over
  - Peeling problems
  - Stuffing breakage
  - Casing deformation
  - Reduced appeal

- Under
  - Peeling problems
  - Wrinkles
  - Gel separations
  - Undersize
  - Casing liftoff
  - Length variations
  - Uncontrolled shrink

Summary

- Casing selection is critical
- Dependent upon the type of sausage produced
- Variety of options regardless of sausage type
- Proper selection increase value and demand for your products

Questions?