Casing Technologies for Processed Meat Products

Overview

- Casing Selection
- Sausage Anatomy/Assembly
- Thermal Processing
- Common Failures
- Value Added Opportunities
  - Skinless
  - Skin On
    - Natural/Gut
    - Collagen
      - New Generation

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

Proper Selection

- Meat batter formulation
- Type of processing methods employed
- Merchandising conditions for finished product

<table>
<thead>
<tr>
<th>Property</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Strength</td>
<td>Withstands all sausage processing operations;</td>
</tr>
<tr>
<td></td>
<td>Storability</td>
</tr>
<tr>
<td>Water Vapor and Gas</td>
<td>Indispensable for raw sausages;</td>
</tr>
<tr>
<td>Permeability</td>
<td>Allows for suitable rate of desiccation;</td>
</tr>
<tr>
<td></td>
<td>Not advantageous for cooked sausages.</td>
</tr>
<tr>
<td>Other Basic Properties</td>
<td>Chemical inertness;</td>
</tr>
<tr>
<td></td>
<td>Fat impermeability.</td>
</tr>
<tr>
<td>Shrinkability</td>
<td>Expansion and shrinking necessary to accommodate dimensional changes of</td>
</tr>
<tr>
<td></td>
<td>the sausage body.</td>
</tr>
<tr>
<td>Adhesion</td>
<td>This requirement is corollary of shrinkability.</td>
</tr>
<tr>
<td>Other Desirable Properties</td>
<td>Uniform sausage caliber;</td>
</tr>
<tr>
<td></td>
<td>Clippability;</td>
</tr>
<tr>
<td></td>
<td>Printability;</td>
</tr>
<tr>
<td></td>
<td>Temperature resistance;</td>
</tr>
<tr>
<td></td>
<td>Carrier for auxiliary and functional ingredients.</td>
</tr>
</tbody>
</table>

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 elastic
  - 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

Thermal Processing Skinless

- During cooking fat swells/protein shrinks
- Set protein skin early in process

<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–</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>IT &lt;100°F</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Disadvantages of Cellulose

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

- Correct Set Up
- Implications for $L_m$

Storage Considerations

- $> 68^\circ\text{F}$ (Optimum: $60 - 70^\circ\text{F}$)
- Relative Humidity $> 70\%$ (Optimum: $60 - 70\%$)
- If stored in cooler transport prior to use
  - 2 days @ $60 - 70^\circ\text{F}$ 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

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

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

Sheep Casings

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

Sheep Casings

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

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

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Beef Casings

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

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- Vary in size
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 Preparation</td>
<td>45</td>
<td>120°F</td>
<td>6%</td>
<td>Drying, Meat Adhesion</td>
</tr>
<tr>
<td>Smoke / Cook</td>
<td>30</td>
<td>120°F</td>
<td>8%</td>
<td>Color</td>
</tr>
<tr>
<td>Smoke / Cook</td>
<td>20</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>
</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>Smoothing</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>17 – 155°F</td>
<td>167°F</td>
<td>100%</td>
<td>Coagulation</td>
</tr>
<tr>
<td>Shower</td>
<td>Below 100°F</td>
<td></td>
<td></td>
<td>Dry Surface</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

Optimizing Quality

- Meat Block
- Casing Selection
  - Skinless
    - High Volume
    - Cheaper Raw Materials
    - Lower Price
  - Skin On
    - Premium Pricing
    - High Quality
    - Hand Crafted

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
Consumer Acceptance
Bite (Knack/Mouth feel)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>9</td>
<td>36</td>
<td>54</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Gut</td>
<td>-</td>
<td>10</td>
<td>39</td>
<td>35</td>
<td>16</td>
</tr>
</tbody>
</table>

You recognize as being different but consumers don’t!

Pricing Comparison

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
<td>Cost per Pound</td>
<td>Cost per pound</td>
<td>Cost per pound</td>
<td>Cost per pound</td>
<td>Cost per pound</td>
</tr>
<tr>
<td>Hck</td>
<td>$10.97</td>
<td>$10.97</td>
<td>$10.97</td>
<td>$10.97</td>
<td>$10.97</td>
</tr>
<tr>
<td>Caddy</td>
<td>$10.97</td>
<td>$10.97</td>
<td>$10.97</td>
<td>$10.97</td>
<td>$10.97</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>
<tr>
<td>Melting Point</td>
<td>80-95 °F</td>
<td>89-110 °F</td>
<td>86-104 °F</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?