Casing Technologies for Processed Meat Products

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DEVRO

Overview

- Casing Selection
- Sausage Anatomy/Assembly
- Thermal Processing
- Common Failures
- Value Added Opportinities
  - 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

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

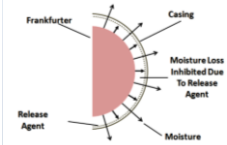
Thermal Processing Skinless

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

Step	Minutes	Temperature	RH	Effects
Drying	20	140°F	35%	Reddening Skin formation
Smoking	25 – 40	145°F	50-60%	Reddening Smoke Color Coagulation
Cooking	5 min	145°F	0%	Color Set
Cooking	20	167°F	100	Coagulation
Showering		IT <100°F		

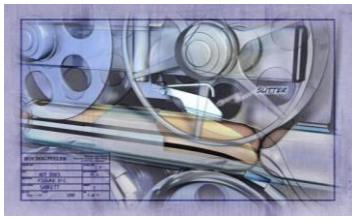
Disadvantages of Cellulose

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



Peeling of Skinless Sausage

- Correct Set Up
- Implications for *Lm*



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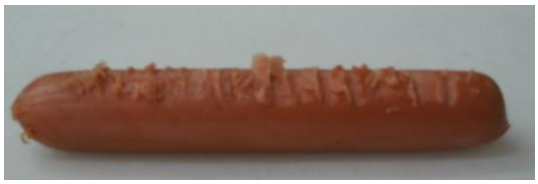
Peeling Defects



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

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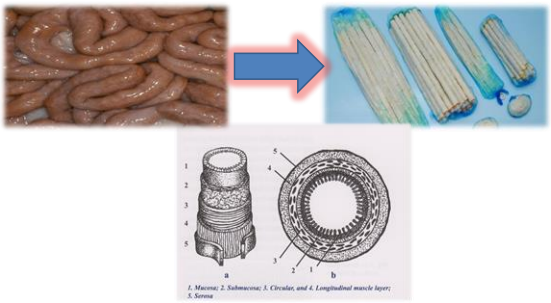
Natural Casings

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

Casing Structure



Natural Casing Process

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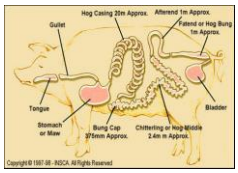
Hog Casings

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



Hog Casings

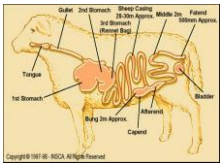
- Hog bungs available
  - Individual pieces
  - Sewn
    - Double walled
    - Single walled
- Calibers range 50 – 90mm
- Production of liver sausages and salami

Hog Casings

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

Sheep Casings

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

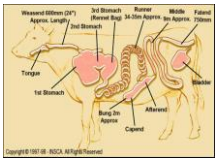


Sheep Quality Grades

- 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



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

Step	Minutes	Temperature	RH	Impacts
Surface Preparation	45	120°F	0%	Drying Meat Adhesion
Smoke / Cook	30	120°F	0%	Color
Smoke / Cook	30	145°F	47%	Flavor
Smoke / Cook	30	165°F	50%	Coagulation
Cook	20	165°F	0%	Color Set
Cook	IT	170°F	78%	Coagulation
Shower				

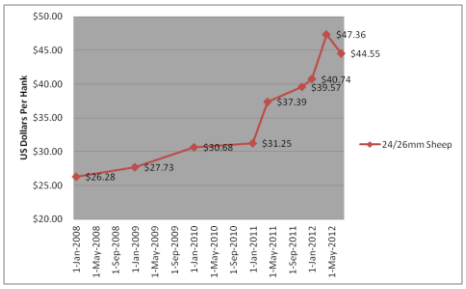
Advantages to Sheep Gut

- "Natural" Marketing
  - Labeling
  - Old World Appearance
- Knack/Snap
- Curve

Disadvantages to Sheep Gut

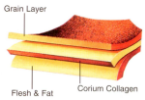
- Machinability
- Product Uniformity
- Ease of Use
  - Not RTU
    - Require soaking prior to use
- Consistency in Quality
- Pricing/Availability

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

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

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)

	1 Much too weak	2 A little too weak	3 Just about right	4 A little too intensive	5 Much too intensive
Select	9	36	**54**	1	-
Gut	-	10	**39**	35	16

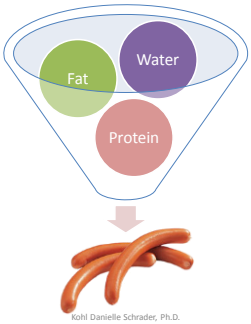
You recognize as being different but consumers don't!

ISI tests December 2009

Pricing Comparison

22/24 Natural Sheep Casings (based on 25 hank pail rate)	22mm Devro SELECT Collagen (based on Case rate)	24/26 Natural Sheep Casings (based on 25 hank pail rate)	24mm Devro SELECT Collagen (based on Case rate)	24/70 Peelable Cellulose (Skinless) (based on 1 caddy rate)
Cost per Hank $42.41	Cost per Caddy $110.89	Cost per Hank $44.55	Cost per Caddy $79.84	Cost per caddy $106.37
Feet per Hank 300	Feet per Caddy 1750	Feet per hank 300	Feet per Caddy 1260	Feet per caddy 3500
Cost per Foot $0.141	Cost per Foot $0.063	Cost per Foot $0.149	Cost per Foot $0.063	Cost per Foot $0.030
Pounds per Hank 65	Pounds per Caddy 380	Pounds per hank 68	Pounds per Caddy 285	Pounds per caddy 700
Cost per Pound $0.652	**Cost per Pound $0.292**	**Cost per Pound $0.655**	**Cost per Pound $0.280**	**Cost per pound $0.152**

Processing Considerations



Importance of Fat Sources

	Chicken	Beef	Pork
Saturated	32.7 %	53.7 %	41.5 %
Monosaturated	27.4 %	43.6 %	50.2 %
Polyunsaturated	21.9 %	2.3 %	6.0 %
Melting Point	80-95 °F	89-110 °F	86-104 °F

Melting Point

- Chopping Temperatures (*Initial*)
  - Lean protein source: 40-45 ºF
- Chopping Temperatures (*Final*)
  - Pork: 55-60 ºF
  - Beef: 44-46 ºF or 68-72 ºF
  - Poultry 34 ºF or less

Unstable Emulsions

- Over chopping
- Heating
- Amount of collagen

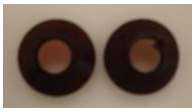
Raw Material Considerations

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

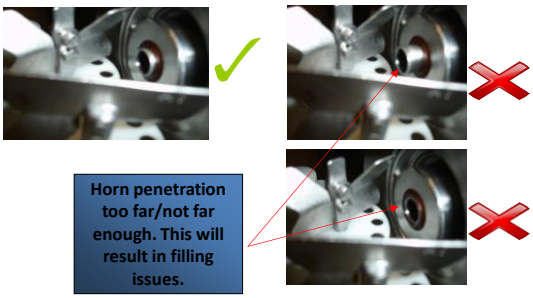
Stuffing Considerations

Equipment Impacts

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



Correct Horn Set Up



Stuffing Failures

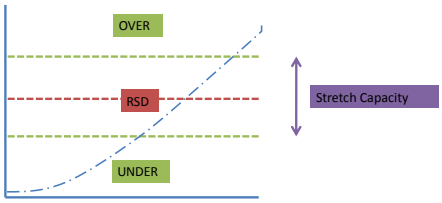
Stuffing Swirl – Horn Size

"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?