Regulations and packaging solutions for meat

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Spring 2017

PACKAGING Technology & Research

GlobalMeat news.com

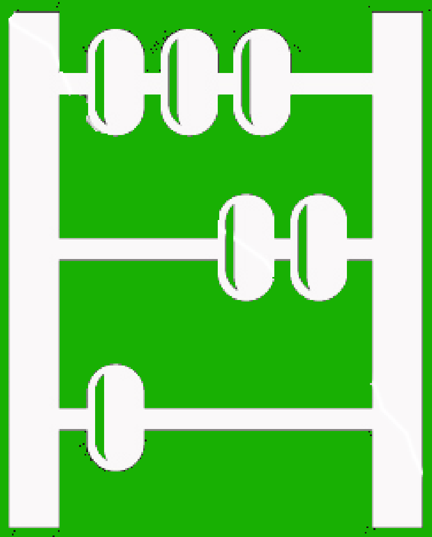
Overview

Food safety regulations

Microbiology threats

Packaging strategies

Packaging solutions



Food safety regulations

Regulations-USA

- FSMA
    - cGMPs
    - Hazard analysis
    - Preventative Controls for Human Food – PCHF

- Role of packaging

Reality

- Global operations mean compliance with numerous regulations
- EU's comprehensive regulations
- China's new regulations
  - CFDA
  - Mimic EU
  - Shift toward self-regulating
  - Increased post-market reviews

Microbiology threats

Major threats–processed meat

Microbes of concern are

- Anaerobes
  - *Clostridium Botulinum*
- Facultative anaerobes or microaerophillic
  - *Campylobacter*
  - *Escherichia coli 0157:H7*
  - *Listeria (30)*
  - *Salmonella*
  - *Aeromonas hyrophila*

Packaging strategies

Packaging challenges in meat-microbial growth

MANUFACTURER

- Reduce contamination during product fill
- Assess initial microbial load
- Reduce initial microbial load
- Enable HACCP, etc
- Address chilled worker conditions

DISTRIBUTOR/ RETAILER

- Enable stock rotation
- Time &Temp monitoring system
- Oxygen level monitoring system
- Control temperature
- Reduce microbial load at POS

CONSUMER

- Refrigerate to freezer
- Heat/Cook in Package
- Enable safe package reuse
- Reduce consumer contamin from repeat use
- Expand time for safe product use
- Enable freezer storage

Packaging strategies-microbial growth

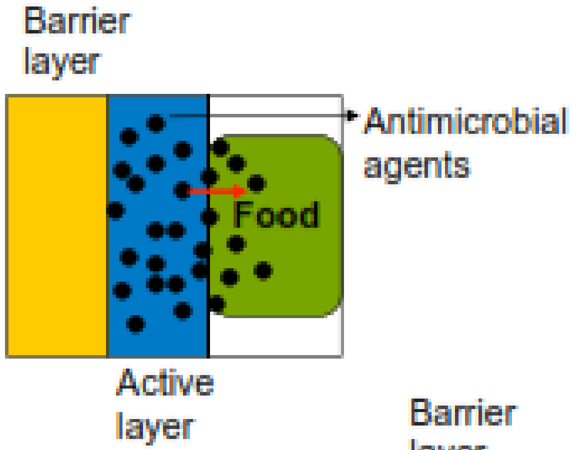
- Edible & Antimicrobial packaging
- MAP & Vacuum packaging
- Barriers & Intelligent packaging
- Technologies that align with processing

1. Edible & Antimicrobial packaging

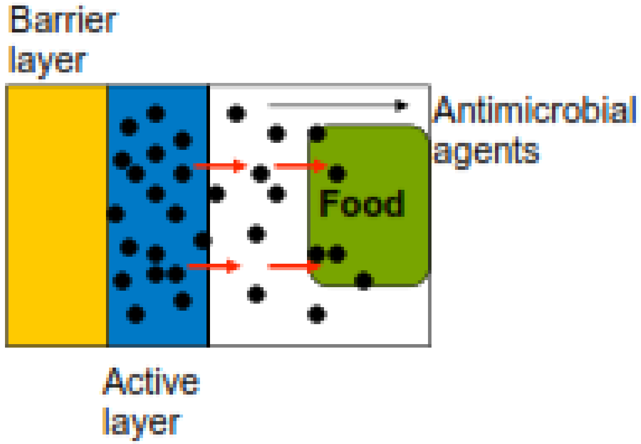
- Edible and antimicrobial are combined

3 ways to convey antimicrobial activity

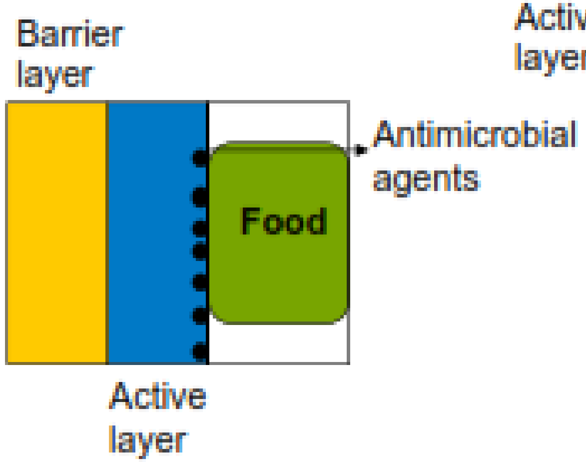
within a structure



through headspace



as a coating



Antimicrobial Options

Regulatory

- FDA
  - Most are GRAS
- EU
  - Defined amounts allowed

Table 6—List of permitted food additives that could be used as antimicrobial agents in packaging materials.

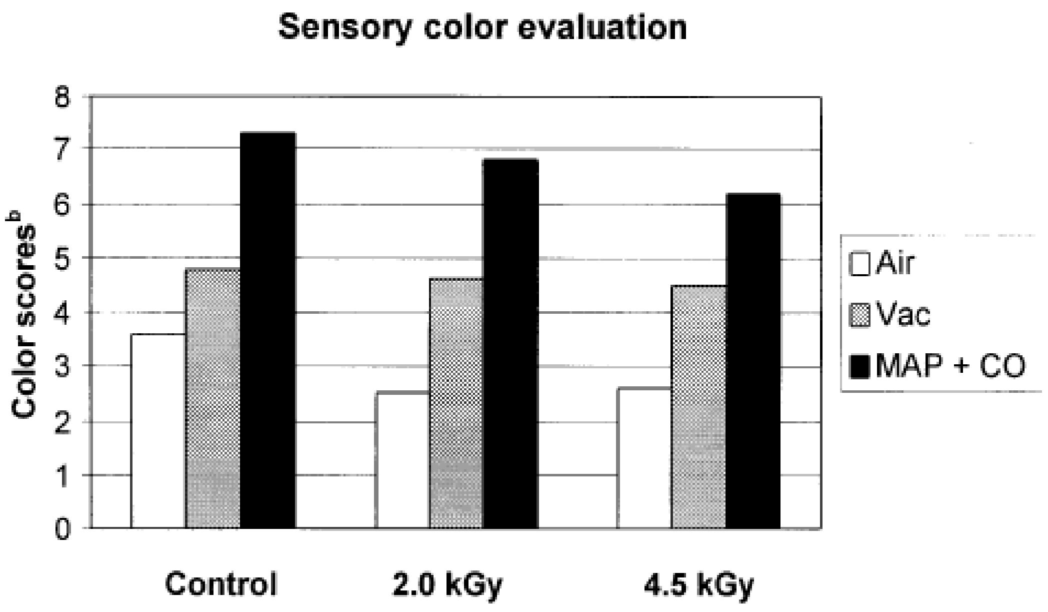
Additive	Code Assigned by Legislative Authority		
	Australia/New Zealand[1]	Europe[2]	U.S.A.[3]
Acetic acid	260	E260	GRAS
Benzoic acid	210	E210	GRAS
Butylated hydroxyanisole (BHA)	320	E320	GRAS
Butylated hydroxytoluene (BHT)	321	E321	GRAS
Carvarcol			FA
Citral			GRAS
Citric acid	330	E330	GRAS
p-Cresol			FA
EDTA			FA
Estragole (methyl chavicol)			GRAS
Ethanol		E1510	GRAS
Ethyl paraben		E214	GRAS
Eugenol			GRAS
Geraniol			GRAS
Glucose oxidase	1102		GRAS
Hexamethylenetetramine (HMT)		E239	
Konjac glucomannan		E425	GRAS
Lactic acid	270	E270	GRAS
Lauric acid			FA
Linalool			GRAS
Lysozyme	1105	E1105	GRAS
Malic acid	296	E296	GRAS
Methyl paraben	218	E218	
Natamycin	235	E235	FA
Nisin	234	E234	GRAS
Phosphoric acid	338	E338	GRAS
Polyphosphate		E452	GRAS
Potassium sorbate	202	E202	GRAS
Propionic acid	280	E280	GRAS
Propyl paraben	216	E216	GRAS
Sodium benzoate	211	E211	GRAS
Sorbic acid	200	E200	GRAS
Succinic acid		E363	GRAS
Sulfur dioxide	220	E220	GRAS
Tartaric acid	334	E334	GRAS
Tertiary butylhydroquinone (TBHQ)	319		FA
α-Terpineol			FA
Thymol			FA

Antimicrobial	Food Safety Microbes	Food Quality Microbes	Categories Tested	Packaging Materials Tested	FDA	EU	FAO/WHO	Manufacturers	Economic	Social Issues	Technology	Innovation
Nisin	Listeria (with Lysozyme); E. coli (with EDTA); Salmonella	Not assessed	Meat, cheese, seafood, perishable processed food	Cellulose and SPI, zein, WPI, LDPE, cellophane, paper, chitosan	GRAS	E234; Restrictions to cheese, eggs, puddings	Approved	Numerous	Costs are not standard and are based on desired result; concern with resistance promotoes use of other bacteriocins in tandem	Increased resistance possible; considered natural	Abundance of studies due to nisin's commercial availability	Use bacteriociins synergistically; bioengineering for increased efficacy; refine coating distribution
Pediocin	Listeria	S. aureus and B. cereus	Processed meat (ham, bologna, smoked fish)	WPI coated PP, Cellulose	GRAS	Not approved		Minimal	Concern with resistance promotoes use of other bacteriocins in tandem	Increased resistance possible; considered natural	Limited studies	Use bacteriociins synergistically; bioengineering for increased efficacy; refine coating distribution
Lacticin	Clostridia and Listeria	S. aureus, Bacillus, Lactococcus, Lactobacillus	Cottage cheese, cheese, milk, orange juice, egg, water, ham, turkey breast, smoked salmon	Zein, WPI, Paper board with AP; PE, Pectin/PLA composite Cellophane	GRAS	Not approved	Approved by 50+ countries	Laboratories	Concern with resistance promotoes use of other bacteriocins in tandem	Increased resistance possible; considered natural	Limited understanding beyond use as additive	Use bacteriociins synergistically; bioengineering for increased efficacy; refine coating distribution
Chitosan	E. coli	S. Aureus, P. fragi, B. subtilis	Seafood	PVA, PE, carrier of other antimicrobials	GRAS	Not approved		Multiple	Innovations and use in water quality and fuel cells may lower prices or increase demand to increase prices	Non-toxic, biodegradable, and biocompatible	Abundance of research; variability of results due to natural origin	Combining with other antimicrobials to increase spectrum; identify optimum molecular weight and polymerization
Lysozyme	Listeria; E.coli (with lactoferrin or EDTA)	S. Aureus, P. fragi, B. subtilis, L. plastarum	Tuna; sushi, raw and processed meat	Cellulose, paper, zein, SPI, PVOH, surface immobilization	GRAS	E1105; approved for cheese and beer		Numerous chemical companies	Need to combine with lactorferrin or EDTA to inhibit E.coli	Considered natural	Abundance of research; variability of results due to natural origin	To attain both Listeria and E. coli inactivity, determine optimum EDTA or lactoferrin concentration
Lactoperoxidase	Listeria; E. coli	Yeasts, Molds	Salmon and roasted turkey, milk, cheese, vegetables	•WPI, alginate	GRAS	No approved	Recommended when adequate cooling unavailable in dairy	Numerous chemical companies	Whey derivation lowers cost	Advocacy by FAO has increased awareness	Efficacy a function of LPS, thiocyanate, and H_2O_2	Activation by H_2O_2
Plant Extracts	E. coli (Oregano); Listeria (Neem)	S. aureus (Grapefruit seed, green teat)		SPI, WPI, chitosan, casein	GRAS	Approved	Approved	Numerous	Costly due to extraction	Taste preferences inhibit use; no labeling issues	Not applied beyond laboratory stages	Natural/organic platform; improving efficacy
Metal ions	E.coli , Listeria (Titanium), Ziinc, Silver, Copper); Salmonella (Zinc and nisin)	S. aureus	Meat, sliced fruit, eggs, orange juice	Glass, metal, polymers, chitosan, zein, cellulose	Defined amounts	Defined amounts	Defined amounts	Numerous	Silver most costly	Consumer familiarity; Environmental and increased resistance; Limit migration into food is paramount	Nanoparticles most effectives due to shigh surface area	Medical research applicable to food packaging
Surface Treatments	E. coli	Antifungal	Meat, produce	Paperboard, polymers	by-products would need approval	by-products would need approval	by-products would need approval	Internal	Variable	resultant additives require acceptance	Skill set within converters	Adapt processes from medical packaging; plasma activation; GRAS by-products
Acids, Salts, Anhydrides	Listeria and E.coli (Sorbic Acid); Listeria (Lauric acid and EDTA)	Yeasts, Molds	Meat, produce	Coatings on various substrates	Most are GRAS	Defined amounts allowed	Defined amounts allowed	Numerous	Variable	Consumer familiarity	Processes of inactivation are well known	Refined efficacy
Chlorine Dioxide	Listeria, Salmonella	Not Evaluated	Produce	Known permeability to ClO_2	Considered a treatment	E926 under consideration		Numerous	Systems in place lowers cost	Color issues; Connected to household disinfectant	Technology well known	Explore ability to recharge system

2. MAP & Vacuum packaging

- MAP
  - Replacing O_2 with inert gases (N_2, CO, CO_2)
  - O_2 scavengers

- Vacuum packaging
  - Removing O_2
  - O_2 scavengers



MAP & Vacuum packaging

- Hffs
- Vffs

3. Barriers & Intelligent packaging

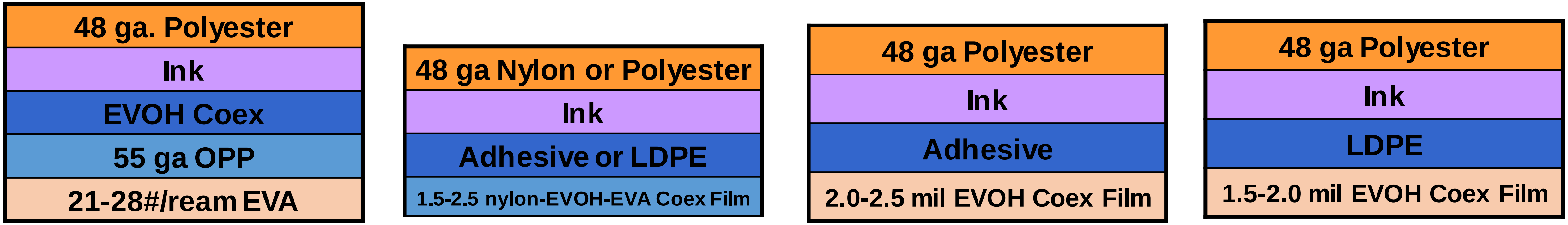
- Multilayer packaging
- Intelligent packaging

Barrier packaging

- Multilayer packaging
  - Barrier
  - Seals
  - Resealable
  - Peelable

Barrier packaging

- Key barrier elements
  - EVOH
  - PVC
  - Nanofillers/technology



Gieser, 2017

Intelligent packaging-TTIs

- *FreshCode,* Varcode and *Tempix*, Tempix
  - fading barcodes

- *CoolVu*
  - aluminum layer thins causing a reaction

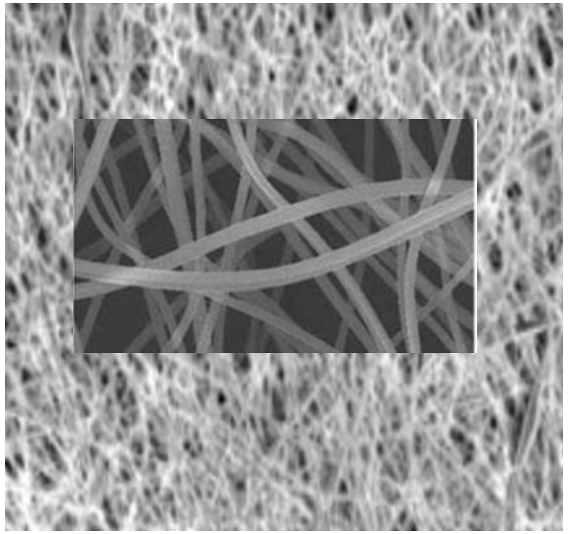
- *FreshMeter*
  - turns from blue to gray via benzopyridine photoactivation

- *L5-8 Smart Seafood*
  - irreversible color change from the hydrolysis of triglycerides

Intelligent packaging-degradation sensors

Degradation sensors are advancing rapidly

- Direct connection to food deterioration
- More sophisticated sensors that convert biochemical signals to electrical responses that show remaining shelf life from manufacturer to consumer



Authenticity sensors

Authenticity Sensors

Intelligent packaging expands brand image potential

<u>Current solutions</u>

- Thermochromatic inks change color and reveal images when the product is at the proper temperature
- NFC *OpenSense* package sensor is physically tapped with a smartphone
- Polymark fluorescence based detection for sorting food-contact PET

4. Technologies that align with processing

- Retort
- HPP
- MATS and MAPS
- Freezing and refrigeration

Packaging strategies-microbial growth

- Edible & Antimicrobial packaging
- MAP & Vacuum packaging
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Packaging Solutions

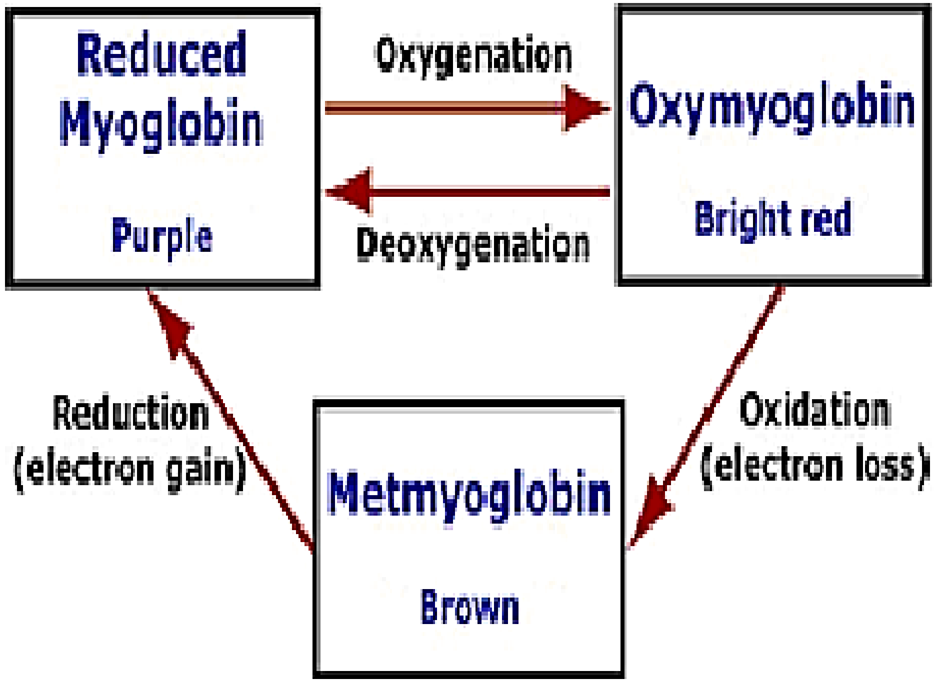
Focus on refrigerated and frozen

- Fresh
- Prepared

Packaging for refrigerated fresh meat

Degradation is due to:

- Microbial
- Oxidation
- Weeping



Packaging for refrigerated fresh meat

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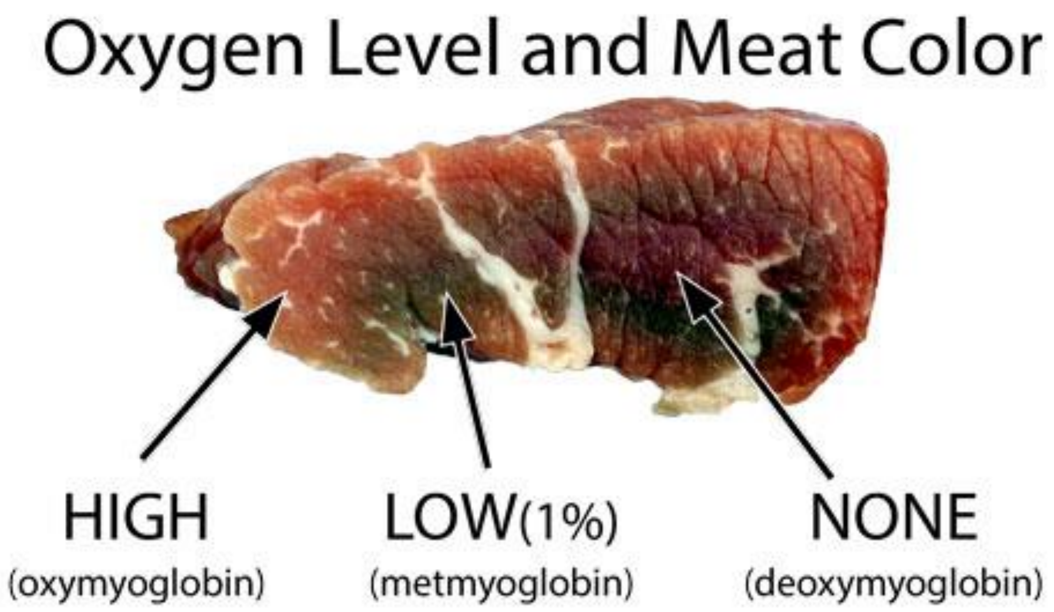


Packaging for refrigerated fresh meat

- Meats vary in their susceptibility to oxidation based on their fatty acid profiles

Meat	Unsaturated Fat	Polyunsaturated Fat	Oxidative Potential
Lamb	0.00	0.84	1.26
Bison	0.96	0.22	1.29
Beef	1.55	0.15	1.78
Pork	1.54	0.30	1.99
Chicken (white meat)	1.21	0.70	2.26
Turkey (white meat)	3.91	1.69	6.45

Packaging for refrigerated fresh meat

Control Oxygen and moisture

1. Chub Pack
2. Vacuum
3. Master Pack
    - Tray with overwrap
    - Tray with skin pack
4. Antimicrobial edible barriers
5. Oxygen scavenging films & sachets
6. Barrier technology
7. Phages

Packaging for refrigerated prepared meat

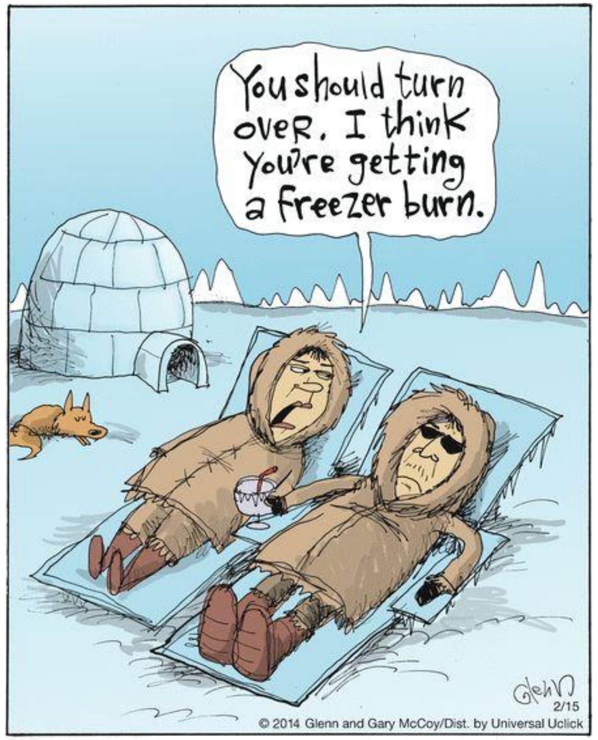
- MAP or vacuum packaging

- Packaging enables processing
  - High Pressure Processing (HPP)
  - Sausage/Link Process
    1. Product is partially cooked
    2. Product is vacuum sealed
    3. Packaged product cooking is completed in the package
- MATS
- PL, etc

Packaging for frozen fresh meat

Degradation is due to:

- Freezer burn
  - Interfacial water freezes and thaws and ice crystals grow crushing cells
  - Increased degradation within cells before they burst
  - Texture loss
- Water loss
  - Loss from product
  - Loss from package is economic loss



Packaging for frozen & prepared meat

- Control moisture
  - Eliminate package headspace
  - Protect meat with edible barriers

Package Strategies-frozen prepared meals w meat

Control moisture & enable venting

1 Perforations
2 Laser scored
3 Channels that vent air/steam through fin seal area
4 Tray in colander

Packaging for shelf stable prepared meat

- Degradation is due to:
  - Mold
  - Moisture loss
  - Oxidation

Packaging for shelf stable prepared meat

- Barrier
- MAP
- Scavengers

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