Advancing Food Safety in the Frozen Food Industry
Intersection of Science and Policy

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Outline

1) *Listeria* in frozen food facilities and frozen foods
   - *Listeria monocytogenes* (*Lm*)
   - *Lm* persistence in the frozen food supply chain
   - Regulatory policy implications

2) Ensuring safe consumption of frozen foods
   - Developing best food manufacturing practices
   - Training and evaluating industry efforts
   - Targeting vulnerable populations

3) Developing science and assessing *Lm* associated risks

4) Broad Objective: Preventing listeriosis incidence
   - Evaluating alternate risk-based approaches to address public health objectives
Themes to Consider

1) \textit{Lm} Persistence

2) Protecting vulnerable populations will have a significant impact
   - Consumption of NRTE foods without cooking

3) Public health outcomes – current policies and goals

4) Science and risk-based approaches present practical alternatives
Mission: Member-Driven National Trade Association that Advances the Interests of all Segments of the Frozen Food and Beverage Industry

Advance Food Safety
Advocate for Frozen
Increase Consumption
Grow Resources

2017-2020 Strategic Plan
Vision: Our Foods and Beverages are Proudly Chosen to Meet the Needs of a Changing World
Listeria monocytogenes

1) A foodborne pathogen - Listeriosis

2) Diarrhea, fever, vomiting, muscle and headaches, general malaise and weakness

3) 1800 illnesses and 250 deaths/yr. in the United States

4) >15% mortality rate

5) At-risk groups: immuno-compromised, young children and elderly, pregnant women and neonates
Listeria monocytogenes

1) Grows at refrigeration temperatures – Deli/processed meats, soft cheeses, unpasteurized milk, seafood, fruits and vegetables, ice cream, frozen foods

2) Ubiquitous in occurrence
   - Soil, vegetations, water, food processing facilities
   - Processing environments, raw ingredients, human and equipment traffic, water
   - Survives freezing and frozen storage

3) Food processing facilities - comprehensive food safety program

4) Lm persistence
Significant *Lm*-Related Foodborne Outbreaks

- 2008 Deli Meat (Canada) – 57 cases, 24 deaths
- 2010 Pre-cut Celery (US) – 10 cases, 3 deaths
- 2011 Cantaloupe (US) – 147 cases, 33 deaths
- 2014 Caramel Apple (US, Canada) – 5 cases, 2 deaths
- 2014 Stone Fruit (US) – 4 cases
- 1998-2014 Soft Cheese (US) 180 cases, 17 deaths
- 2015 Ice Cream (US) – 10 cases, 4 deaths
- 2016 Frozen Vegetables (US) – 9 cases, 1 death
- 2017-18 RTE Processed Meat (SA) – 1060 cases, 216 deaths
- 2018 Frozen Corn (EU) – 45 cases, 9 deaths
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**Listeria monocytogenes**

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4) *Lm* persistence
**Lm Persistence**

**Harborage, Growth Niches, and Transfer Points**

1) Floors and Drains
2) Cracks in the walls and equipment
3) Wet and rusting hollow framework
4) Walls and crevices of spiral freezers
5) Ceilings, overhead structures and cat-walks
6) Fibrous or porous conveyor belts and hollow rollers
7) Damp insulation and rubber seals around doors
8) Cracked hoses
9) Cleaning tools - mops and sponges, buckets
10) Personnel and vehicular traffic in the facility
**Listeria and Lm Persistence in Processing Facilities**

1) Persistence over years and even decades
   - May lead to repeat contamination that can lead to multiple human cases resulting from the same subtype
   - Outbreaks can be detected by WGS

2) Repeated findings of the same *Listeria* subtype
   - Most common interpretation – indication of unhygienic production conditions
   - Product withdrawals and recalls
   - Scope of action – expanded to large volumes of products produced over a large period of time
Lm in Frozen Foods – Recalls

1) Frozen cut green beans and mixed vegetable
   - Recall initiated by 3rd party test result by a downstream customer
   - NRTE frozen food with validated cooking instructions

2) Frozen biscuits
   - Product sampling by an outside co-manufacturer/packer
   - NRTE frozen food with baking instructions

3) Frozen biscuit dough
   - Regulatory disposition – potential to be contaminated with Lm
   - NRTE frozen food with baking instructions

4) Frozen kernel corn
   - Regulatory disposition – potential to be contaminated with Lm
   - NRTE frozen food with validated cooking instructions

5) Frozen organic whole green beans
   - Routine state sampling program: Dept. of consumer protection (CT)
   - One positive Lm finding in one retail product sample
   - NRTE frozen food with validated cooking instructions
A Watershed Event

1) Multi-state *Lm* outbreak in May 2016 – frozen vegetables

2) IQF corn and peas

3) Nine illnesses and one death

4) Recalls
   - More than 350 consumer food products
   - At least 50 separate food product brands
   - >100 million lbs. of frozen vegetables, pasta salads, appetizers, fried rice, etc., (All frozen NRTE foods)
Frozen Food Industry’s Primary Goals

Minimize presence of *Listeria monocytogenes* in frozen foods and lower incidence of Listeriosis
Frozen Food Industry – Holistic Approach

Science

Policy

Best Food Safety Practices

Consumer & Customer Education
Best Food Safety Manufacturing Practices

Listeria Control Program

- > 100 Best Manufacturing Practices and Recommendations
- > 100 Food Safety Resources
- Online access
- Advanced search function
- Publicly available and Downloadable

AFFI Food Safety Zone

http://www.affifoodsafety.org/
Key Food Safety Initiatives

**Industry Training and Tools**

- **Lm TrendTracker** for data analysis and trending
  - Merieux Nutrisciences

- Equipment certification
  - NSF International

- Google Glass for real-time monitoring and training
  - EyeSucceed

- Frozen food industry education and training
  - Alchemy Systems

[www.listeriastopshere.com](http://www.listeriastopshere.com)

**Projects and New Technologies**

- Antimicrobial agents
  - Phage treatment

- Antimicrobial processes
  - UV-C technology

- Novel sanitation strategies

- Process validation projects
  - Pilot scale/IFSH
There is no *uniform, industry-wide practice* for informing consumers on package.

Inconsistent language:
- “Cook thoroughly”
- “RAW”
- “Not ready to eat”
- “Cook fully”

“I never understood why they can’t just be direct and say, ‘Cook for Safety.’” – Older consumer
Including a symbol can effectively shift behavior, but is most effective for frozen vegetables.
Consumer & Customer Education

Next steps:

- Audience Mapping
- Online Application
- Brand guidelines
- USDA and FDA regulatory recognition
A food safety education campaign:

**GOAL:** Raise awareness of the “Cook for Safety” symbol to shift attitudes to recognize the importance of proper frozen food handling and cooking that prime behavior change.

**PRIMARY AUDIENCE:** Young moms, pregnant women, older consumers and caregivers (individuals particularly susceptible to listeriosis).

**THE APPROACH:**
- **TIER 1:** Regulatory agencies and trade media
- **TIER 2:** Consumers (specifically target vulnerable subpopulations)
- **TIER 3:** Support organizations, like AARP, RDs
Science and Research

1) AFFI *Lm* quantitative risk assessment and modeling research

2) Understanding consumer exposure to *Lm* and public health consequences of listeriosis

3) International scientific advisory panel on *Lm* science and policy

4) Center of excellence for food safety research
**Lm Quantitative Risk Assessment**

**Objective 1:**
Evaluate prevalence of *Lm* in raw ingredients
- Sampling design and protocols
- Sampling ingredients/products
- Data analysis

**Objective 2:**
Evaluate prevalence of *Lm* in frozen food facilities
- Collection of data
- Data Analysis
- Statistical sampling schemes

Outcome: Publish research develop tools for industry implementation and training

Accepted in Journal of Food Protection (Sept. 2019): Evaluating environmental monitoring for *Listeria* spp. and *Lm* in frozen food manufacturing environments
**Lm Quantitative Risk Assessment and Modeling**

Objective 1: Modeling *Lm* transmission in frozen food facilities
- Environmental testing in frozen food environments
- Modeling of public health consequences
  

Objective 2: Validation of models in frozen food facilities
- Application in a frozen food facility
- Development of sampling plans
- Validation sampling and analysis
  

  Zoellner et al., Comprehensive Reviews in Food Science and Food Safety. v. 17, p. 1156
Environmental Monitoring is Complex

1) Challenging to design and develop

2) Can be extremely expensive (High # samples and significant proportion of food safety costs)

3) Scientific basis for program – Validation?

4) New modeling tools can help – as they can simplify complex phenomena
Modeling of \textit{Lm} Transmission

1) Listeria contamination: Heterogeneity and complexity of a food processing facility’s environment and equipment

- Prevalence on surfaces
- Concentration on surfaces
- Time on surfaces
- Formation of niches
- Other events – introduction and transfer

\textbf{EnABLe: An agent-based model to understand \textit{Listeria} dynamics in food processing facilities.} 2019
Zoellner et al., Scientific Reports. v. 9, p. 495
Estimating Risk of Consumption and Illness

1) Risk assessment tool
   ▪ Probability of listeriosis from a dose consumed
   ▪ Listeriosis risk per serving
   ▪ Number of illnesses predicted from a lot of product

2) “Estimating the public health risk associated with low level $Lm$ contamination of a product batch under various consumer handling scenarios”
   ▪ A risk assessment for frozen food manufacturers to assess listeriosis risk
   ▪ Low level $Lm$ in a production lot of frozen vegetables did not typically cause illness
   ▪ Variety of risk management benefits

3) Accepted in the Journal of Food Protection (Sept. 2019)
Key Parameters

• Risk assessment inputs:
  o Lot size: 1,000,000
  o Servings per package and serving size (g): 10 servings of 140 g each
  o Number of finished products tested: 5
    o Results of testing (number positive for Lm): 1
  o Percent of consumers susceptible to Lm: 20%
  o Probability a serving is properly cooked according to package instructions
    o If not cooked, probability thawed at room temperature
  o Distribution of contamination
Research: *Lm* – Public Health Consequences

**Objective : Update risk assessment models and develop a risk categorization matrix**
- Develop dietary profiles of foods consumed by Listeriosis patients
- Determine prevalence of Lm-related dietary profiles
- Assess role of repeated exposures to food contaminated with *Lm*
  - *Jul. 2019 – Mar. 2020*

**Objective : Examine food exposure data and evaluate patterns of acquiring Listeriosis**
- Risk Assessment Models for *Lm* infection that evaluate low levels of contamination
- Risk matrix to identify processing and consumer use characteristics – to develop *Lm* prevention strategies

Outcome: Publish research that will provide a realistic assessment of the public health consequences of low level *Lm* contamination in foods, product processing and formulation, and consumer-use characteristics and inform targeted *Lm* prevention strategies and regulatory policy.
Healthy People Goals
Global *Lm* Scientific Advisory Panel

1) Formed in 2018

2) Past FDA and USDA food safety advisors

3) World renowned authors on *Lm* research

4) Members of Codex, IAFP, and IFT panels

5) Lead roles with Health Canada, FAO, and WHO

6) Experts globally recognized for *Listeria* science and research
Global *Lm* Expert Panel White Paper

1) Develop scientific basis and rationale for a more realistic *Lm* performance standard than “zero”

2) Strategies to meet and exceed CDC 2020 Listeriosis Goals

3) A framework to facilitate further reduction of public health impact relative to *Lm*

4) Provide tangible case study to reflect these aspirations
Performance Standard (C)

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1) Zero tolerance for pathogen: Two-class attributes plan

2) An allowable number of the pathogen: Three-class attributes plan

3) Choosing an appropriate sampling plan – Practical Approach

Arithmetic mean concentration above which a sampling plan would reject a batch with more than 95% confidence
Key Takeaways

1) *Lm* Persistence

2) Protecting vulnerable populations will have a significant impact
   - Consumption of NRTE foods without cooking

3) Implications of ‘zero’ on public health objectives and the industry?

4) Science and risk-based approaches present practical alternatives

Thank you
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