Listeria in the Dairy Industry

Dr. Margaret “Peggy” Poole
Listeria in the Dairy Industry

1. What is Listeria?
2. What is its impact on Consumers & our Companies?
3. What can and is being done to make food safe?
Listeria in the Dairy Industry

1. What is Listeria?
Microbial Impact on life

**Beneficial**
- Food Fermentation
- Probiotics, Antimicrobials
- Energy production
- Pollution abatement
- Flavors

**Pathogens are disease causing microorganisms**

**Economic losses**
- Spoilage
- Starter culture inhibition
- Plant diseases

**The Good**

**The Bad**

**The Ugly**
Common groups of microorganisms

**PROTOZOA**
- Pellicle
- Contractile vacuole
- Radiating canal
- Cilia
- Trichocyst
- Oral groove
- Macronucleus
- Micronucleus
- Cell mouth
- Gullet
- Anal pore
- Food vacuole forming
- Food vacuole circulatnig
- Endoplasm
- Enocoplasm
- Cytoplasm

**MOLDS & YEASTS**
- **Yeast Cell**
  - Cell Wall
  - Mitochondria
  - Vacuoles
  - Membrane
  - Nucleus
  - Bud Scar
  - Lipid Granule
  - Phosphat Granules

**BACTERIA**
- **Cell Wall**
  - Membrane
  - Nuclear Material
  - Cell Inclusions
  - Cytoplasm
  - Cell wall
  - Slime layer (capsule)

**VIRUSES**
- **Cell structure**
  - Protein coat
  - Nucleic material (envelope)
  - Sheath
Looking for something this big...or small!!!!!!

Salt (120µm, 4724 µ-inch)

<table>
<thead>
<tr>
<th>Micron (µm)</th>
<th>Micro-inch(µ-inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1,000,000 meter</td>
<td>1/1,000,000 inch</td>
</tr>
<tr>
<td>39.37 µ-inch</td>
<td>0.0254 micron</td>
</tr>
</tbody>
</table>

- Yeast (5 µm, 197 µ-inch)
- Mold (3 µm, 118 µ-inch)
- Listeria (0.5 µm, 19.7 µ-inch)
Factors Affecting Microbial Growth in Foods

- Food: Nutrients/carbon/energy sources
- Acid: Microorganisms grow best at pH near 7
  - Most pathogens do not grow at pH < 4.6
- Temperature: 40°F to 140°F Danger Zone
  - Psychrotrophic - will grow at low temperatures—refrigerated temp (14°F - 68°F)
  - Mesophile - will grow in warm temperatures room and body temp (50°F - 122°F)
  - Thermophile - will grow in hot temperatures- (104°F to 167°F)
- Time: Microorganisms can double every 20 minutes
- Oxygen: Some grow with oxygen (aerobic), some without (anaerobic), some either way (facultative anaerobes)
- Moisture: as available water; $A_w$ range from 0.00-1.00. Most pathogens do not grow below $A_w$ of 0.86
- Competition from other microorganisms
- Antimicrobials/inhibitors/preservatives
## Pathogens of Concern for Dairy

<table>
<thead>
<tr>
<th>Pathogens of Concern</th>
<th>Cause of Illness</th>
<th>General Dairy</th>
<th>Low Aw Dairy Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bacillus cereus</em></td>
<td>Toxin</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><em>Cronobacter sakazakii</em></td>
<td>Infection</td>
<td>Rare</td>
<td>Yes</td>
</tr>
<tr>
<td><em>Listeria monocytogenes</em></td>
<td>Infection</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><em>Pathogenic E. Coli</em></td>
<td>Infection followed by Toxin</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td>Infection</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>Toxin</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
# Pathogen Limits of Growth

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Minimal water activity (Aw)</th>
<th>pH Range</th>
<th>Temperature Range (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bacillus cereus</em></td>
<td>0.92</td>
<td>4.3-9.0</td>
<td>39-131</td>
</tr>
<tr>
<td><em>Cronobacter sakazakii</em></td>
<td>Unknown growth limit.</td>
<td>4.0-9.0</td>
<td>42-113</td>
</tr>
<tr>
<td></td>
<td>Survives 0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Listeria monocytogenes</em></td>
<td>0.90</td>
<td>4.4-9.4</td>
<td><strong>35-113</strong></td>
</tr>
<tr>
<td><em>Pathogenic E. Coli</em></td>
<td>0.95</td>
<td>4.0-9.0</td>
<td>44-115</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td>0.94</td>
<td>3.7-9.5</td>
<td>40-115</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>0.83</td>
<td>4.0-10</td>
<td>45-118</td>
</tr>
</tbody>
</table>
Listeria monocytogenes

- Gram-positive rod
- Only pathogenic species of genus Listeria
  - ivanovii, innocua, welshimeri, seeligeri, grayi/murrayi, cornellensis
- Ubiquitous: soil, sewage, decaying plant material, 10% of humans, wild and domestic animals.
- Slow grower. Poor competitor compared with other Listeria species
- Wide Growth Conditions:
  - 35°F to 113°F (Optimal 98.6°F)
  - pH 4.4-9.4 (Optimal 7)
  - $a_w$ 0.9 min.
  - 10% salt and can survive higher levels.
  - Aerobic, microaerophilic, facultative anaerobic
- **Will grow in refrigeration**
- Can persist in plant environment
- At Risk areas---Wet, Cool, Salty
- Protective survival mechanisms
- Readily destroyed by pasteurization and cooking
- Zero Tolerance US standard
Virulence of *Listeria monocytogenes* (2012 data)*

<table>
<thead>
<tr>
<th>Pathogen</th>
<th># Illnesses Per 100,000</th>
<th>% Hospitalizations</th>
<th>% Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Salmonella</em></td>
<td>16.42</td>
<td>29</td>
<td>0.42</td>
</tr>
<tr>
<td><em>Campylobacter</em></td>
<td>14.30</td>
<td>15</td>
<td>0.1</td>
</tr>
<tr>
<td><em>STEC Non-O157</em></td>
<td>1.16</td>
<td>16</td>
<td>0.18</td>
</tr>
<tr>
<td><em>STEC 0157</em></td>
<td>1.12</td>
<td>35</td>
<td>0.19</td>
</tr>
<tr>
<td><em>C. sakazakii</em></td>
<td>1**</td>
<td>100</td>
<td>40-80</td>
</tr>
<tr>
<td><em>Listeria monocytogenes</em></td>
<td>0.25</td>
<td>96</td>
<td>10.74</td>
</tr>
</tbody>
</table>

*Centers for Disease Control & Prevention. 2013
**Incidence is 9.4 per 100,000 in low birth weight infants
Listeria in the Dairy Industry

1. What is Listeria?
2. What is its impact on Consumers & our Companies?
3. What can and is being done to make food safe?
Pathogens are enemies that are invisible, silent and deadly to people, companies and jobs.
Foodborne Illness—The human toll

- CDC estimates every year, roughly 1 out of every 6 Americans gets some type of food poisoning—48 million folks.
- 128,000 are hospitalized
- 3000 die
- Overall, there are more foodborne illnesses but fewer deaths than previously estimated
Approximately 1,600 cases of Listeriosis are reported in the US every year!

260 of these cases results in DEATH !!

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Illness</th>
</tr>
</thead>
<tbody>
<tr>
<td>dairy</td>
<td>656951</td>
</tr>
<tr>
<td>meat</td>
<td>844006</td>
</tr>
<tr>
<td>Poultry</td>
<td>653622</td>
</tr>
<tr>
<td>Produce</td>
<td>985807</td>
</tr>
<tr>
<td>Fruits/Nuts</td>
<td>230636</td>
</tr>
<tr>
<td>Vegetables</td>
<td>755171</td>
</tr>
<tr>
<td>Leafy Greens</td>
<td>188327</td>
</tr>
<tr>
<td>Vine stalk</td>
<td>436546</td>
</tr>
</tbody>
</table>
Food Safety Issues are also very CO$TLY!

Recent Recall Financial Impact

2012 – Sunland Peanut $100 Million
2011 – Cantaloupe $150 Million
2010 – Egg Industry $400 Million
2008 – P.C.A Peanut Butter Industry $1 Billion
2008 – Chinese Milk with Melamine $1 Billion
2007 – Chinese Pet Food with Melamine $3 Billion
2006 – Spinach Industry / Leafy Veg $100 Million

Market Share Erosion
Reputation/Brand Damage
Liability Insurance Lockout or Increased Premiums
Criminal Charges
Loss of Consumer CONFIDENCE ??

• Chipotle

• Blue Bell
Chipotle

• Salmonella, E.Coli, & Norovirus outbreaks

• **350 people** across **10 states** were sickened (no deaths)

• December same-store sales down **30%** (37% in Nov)

• Reporting a **14.6%** decline in 4Q revenue

• Stock price dropped >**40%** in past 3 months

• **$16 million** expenses to cover replacement food costs, lab analysis, food safety experts, and preparing for legal costs
Chipotle

• Salmonella, E.Coli, & Norovirus outbreaks

• 350 people across 10 states were sickened (no deaths)

• Lawsuits from customers sickened after eating at Chipotle

• Federal Criminal Investigation initiated

• Lawsuit filed on behalf of investors alleging the chain misled stockholders about its food-safety protocols
Blue Bell

- **Listeria** outbreak
- CDC reported **10 people** across **4 states** were sickened. (Arizona, Kansas, Oklahoma, & Texas)
- **3 deaths**

  - April 2015 – Recalled **ALL** products sold in **23 states**
  - Temp ceased production in 4 facilities in 3 states (TX, OK, AL)
  - May 2015 – **1400** EE furloughed (3900 total); 750 Full time/700 Part time jobs cut; Reduced pay for EE remaining
  - Limited sales resumed Aug 2015; Fla restocking Jan 2016 (**9 months**)
Blue Bell

- **Listeria** outbreak

- CDC reported **10 people** across **4 states** were sickened. (Arizona, Kansas, Oklahoma, & Texas)

- **3 deaths**

- US Justice Department has launched a criminal investigation

- Government lawyers looking into what BB executives knew about Listeria in its plants & what they did in response
# Dairy “Ice Cream” recalls 2010-2013

<table>
<thead>
<tr>
<th>Date</th>
<th>Reason</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/5/2010</td>
<td>Allergen</td>
<td>Turkey Hill Dairy</td>
</tr>
<tr>
<td>7/23/2010</td>
<td>Undeclared peanuts</td>
<td>Oregon Ice Cream Company LLC</td>
</tr>
<tr>
<td>9/22/2010</td>
<td>Undeclared peanuts</td>
<td>Deluxe Ice Cream</td>
</tr>
<tr>
<td>10/6/2010</td>
<td>Salmonella</td>
<td>Montalvan's Sales</td>
</tr>
<tr>
<td>12/10/2010</td>
<td>Undeclared Milk</td>
<td>Toffuti Brands, Inc.</td>
</tr>
<tr>
<td>12/17/2010</td>
<td>Undeclared milk</td>
<td>Tofutti Brands, Inc.</td>
</tr>
<tr>
<td>1/28/2011</td>
<td>Undeclared almonds</td>
<td>Publix Super Markets</td>
</tr>
<tr>
<td>3/23/2011</td>
<td>Undeclared allergens</td>
<td>Sassy Cow Creamery, LLC</td>
</tr>
<tr>
<td>5/10/2011</td>
<td>Undeclared Egg</td>
<td>Oberweis Dairy, Inc.</td>
</tr>
<tr>
<td>8/18/2011</td>
<td>Undeclared walnuts, milk and coconut</td>
<td>Paleteria La Super</td>
</tr>
<tr>
<td>10/12/2011</td>
<td>Undeclared peanuts</td>
<td>The Kroger Co.</td>
</tr>
<tr>
<td>10/27/2011</td>
<td>Undeclared wheat</td>
<td>Wells Enterprises, Inc.</td>
</tr>
<tr>
<td>5/22/2012</td>
<td>Undeclared Milk Protein</td>
<td>Harris Teeter</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Fudge covered wafer pieces have been manufactured on shared equipment that processes peanuts and tree nuts.</td>
<td>Unilever</td>
</tr>
<tr>
<td>7/3/2012</td>
<td>Undeclared eggs</td>
<td>Fruiti Pops Inc.</td>
</tr>
<tr>
<td>7/6/2012</td>
<td>Undeclared Milk</td>
<td>Arctic Zero Inc.</td>
</tr>
<tr>
<td>7/19/2012</td>
<td>Undeclared Brazil Nuts</td>
<td>Cass-Clay Creamery</td>
</tr>
<tr>
<td>9/13/2012</td>
<td>May contain small plastic objects</td>
<td>University Creamery dba Berkey Creamery</td>
</tr>
</tbody>
</table>
# Dairy “Ice Cream” recalls 2010-2013 (con’t)

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<tr>
<th>Date</th>
<th>Reason</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/27/2012</td>
<td>Salmonella</td>
<td>Oregon Ice Cream Company</td>
</tr>
<tr>
<td>10/9/2012</td>
<td>Salmonella</td>
<td>Belfonte Ice Cream &amp; Dairy Foods Company</td>
</tr>
<tr>
<td>10/9/2012</td>
<td>Salmonella</td>
<td>Clemmy’s Ice Cream</td>
</tr>
<tr>
<td>10/9/2012</td>
<td>Salmonella</td>
<td>Toft Dairy</td>
</tr>
<tr>
<td>10/9/2012</td>
<td>Salmonella</td>
<td>BGC Manufacturing</td>
</tr>
<tr>
<td>10/9/2012</td>
<td>Salmonella</td>
<td>Smith Dairy Products Company</td>
</tr>
<tr>
<td>10/10/2012</td>
<td>Salmonella</td>
<td>Dean Foods Company, Meadow Gold Dairy</td>
</tr>
<tr>
<td>10/10/2012</td>
<td>Salmonella</td>
<td>Meadow Gold Dairy</td>
</tr>
<tr>
<td>10/11/2012</td>
<td>Salmonella</td>
<td>Oregon Ice Cream Company</td>
</tr>
<tr>
<td>10/11/2012</td>
<td>Salmonella</td>
<td>Velvet Ice Cream</td>
</tr>
<tr>
<td>10/11/2012</td>
<td>Salmonella</td>
<td>Super Store Industries</td>
</tr>
<tr>
<td>10/17/2012</td>
<td>Salmonella</td>
<td>Buck’s Ice Cream</td>
</tr>
<tr>
<td>10/26/2012</td>
<td>Undeclared pecans</td>
<td>Schoep's Ice Cream Company</td>
</tr>
<tr>
<td>11/6/2012</td>
<td>Undeclared pecans</td>
<td>The Kroger Co.</td>
</tr>
<tr>
<td>11/12/2012</td>
<td>Salmonella</td>
<td>Boulder Ice Cream</td>
</tr>
<tr>
<td>1/7/2013</td>
<td>Undeclared soy, pecan, and wheat</td>
<td>Southwest Ice Cream Specialties</td>
</tr>
<tr>
<td>4/26/2013</td>
<td>Undeclared wheat, soy, almonds, and peanuts</td>
<td>Maple View Farm</td>
</tr>
<tr>
<td>5/9/2013</td>
<td>Undeclared almonds, coconut and soy</td>
<td>Dairy Fresh</td>
</tr>
<tr>
<td>6/28/2013</td>
<td>Undeclared Pecans</td>
<td>Talenti® Gelato &amp; Sorbetto</td>
</tr>
<tr>
<td>9/9/2013</td>
<td>Undeclared Almonds</td>
<td>Talenti® Gelato &amp; Sorbetto</td>
</tr>
<tr>
<td>10/7/2013</td>
<td>Metal shavings</td>
<td>Turkey Hill Dairy</td>
</tr>
</tbody>
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1. What is Listeria?
2. What is its impact on Consumers & our Companies?
3. What can and is being done to make food safe?
A Culture of Food Safety

• **Senior Management Commitment**
  • Part of the Company SOP
  • Resources

• **Objective is Food Safety**
  • Go beyond Regulation
  • Go beyond the minimum

• **Personnel alignment**
  • Right individuals, mindset, attitude
  • Willingness to share responsibility

• **Total company involvement**
Innovation Center - 7 PreCompetitive Committees

- Animal Care
  - Mission: A unified vision and shared industry strategy on animal care
- Consumer Confidence
  - Mission: Maintain/increase consumer confidence and trust
- Food Safety
  - Mission: Strengthen food safety practices to protect trust in dairy
- Globalization
  - Mission: Increase global competitiveness
- Health & Wellness
  - Mission: Promote and protect dairy’s growth within the broader health and wellness category of foods and beverages
- Research & Insights
  - Mission: To drive innovation through knowledge and tools
- Sustainability
  - Mission: Position dairy as environmentally sound, economically viable and socially responsible
IC Food Safety Committee Objective

Strengthen manufacturing practices in all dairy processing facilities and advance science-based tools to diminish food safety risks that could compromise the reputation of the U.S. dairy industry.
Innovation Center Food Safety Team

- Jack Jeffers - Dean Foods
- Jeff Acker - DFA
- Brian Cords - Foremost Farms
- Jeremy Travis - Hilmar Cheese Company
- Danny Tyndell - HP Hood
- Clay Hough - IDFA
- Sara Mortimore - Land O’Lakes
- Edith Wilkin - Leprino
- Joe Delaney - Prairie Farms
- Greg Desautels - Saputo
- Janet Raddatz – Sargento
- Tom Hedge - Schreiber Foods
- Mark Wustenberg - Tillamook
- Steve Baxley - United Dairymen of AZ
- Bill Graves, Tom Suber, Tim Stubbs - DMI
- Joseph Stout, Jim Mueller, Tom O’Connell – Facilitators
- +40 additional Subject Matter Experts
Food Safety Action Platforms

1) **Pathogen Control - *Dairy Plant Food Safety workshops***
   - Best practices, uniform approach to in-plant pathogen control programs

2) **Supplier Food Safety Management**
   - Risk control tools and training to mitigate risk from materials / services

3) **Artisan / Farmstead Cheese Food Safety**
   - Mitigate pathogen risks in small operations

4) **Verification via Auditing**
   - Strengthen audit standards. Dairy input to GFSI, BRC, & SQF

5) **Regulatory Roundtable**
   - Engagement strategy to enhance relationships and dialogue with regulators

6) **Listeria Control Guidance Document**
   - Comprehensive written guide to controlling Listeria

7) **Listeria Research Platform**
   - IC collaboration and consortium funding model for Listeria research
Listeria Research Consortium

- Established January 2015 with funding from
  - Core companies
    - Darigold, Foremost Farms, Glanbia, Great Lakes Cheese, Hilmar Cheese, Land O'Lakes, Leprino, Saputo, Sargento Foods, Schreiber Foods
  - All IC board companies (greater good contribution)
  - Dairy Management Inc.

- Target areas
  - Listeria controls, product and plant environment
  - Listeria virulence research
  - Critical risk mitigation - surface ripened & fresh cheeses

- Four projects initiated, 2016 RFP planned.
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wiedmann Martin - Cornell U</td>
<td>Understanding regulation of Listeria monocytogenes cell envelope composition to facilitate development and discovery of improved control strategies</td>
</tr>
<tr>
<td>Glass Kathleen - U. of Wisc</td>
<td>Combinations of acid type, pH, and commercial clean label antimicrobial ingredients on the growth of Listeria monocytogenes in high-moisture cheese</td>
</tr>
<tr>
<td>Keener Kevin - Purdue U.</td>
<td>Controlling Listeria monocytogenes in High Risk Cheeses by Treatment with High Voltage Atmospheric Cold Plasma (HVACP)</td>
</tr>
<tr>
<td>Begley Máire - Cork Inst of Tech</td>
<td>Identification of microbially-derived anti-listerial compounds using high-throughput robotics.</td>
</tr>
</tbody>
</table>
Listeria Control Guidance Document

- Comprehensive guide to controlling *Listeria*
- Dairy industry specific
- Built on “Pathogen Equation” & DPFS
- Industry wide effort
  - 13 primary authors
  - Industry, Academic, Government reviewers
- Expands activities beyond workshops
- Published October 15, 2015
Dairy Plant Food Safety Workshop

- Two day workshops
- Volunteer industry expert trainers
- Lectures, hands-on exercises, peer learning, expert Q&A
- Started 2011, 24 sessions, ~1300 trained
- Traditional and “Dry / Powders” versions
- Online tools
The Pathogen Control Equation: A Food Safety/Quality Principles Approach

1. Separate Raw From RTE
2. GMP’s Followed
3. Controlled Floor Conditions
4. Sanitary Design Equipment and Building
5. Effective Sanitation Procedures and Controls
6. Environmental Monitoring

= Pathogen Control
CONTACT: Tim Stubbs
(847.627.3241)

WWW.usdairy.com/foodsafty
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2. What is its impact on Consumers & our Companies?
3. What can and is being done to make food safe?
The face of foodborne illness

http://bcove.me/pailrnygh
Thank You!