Listeria monocytogenes in Food Plants
with emphasis on
Cold-Smoked Salmon Plants & Dairies

Presented by
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January 19, 2009
Introduction
Why are we so concerned with *Listeria monocytogenes*?

- Epidemiological information indicates that the fatality rate for people that contract listeriosis is **20%**.
Comparison of Fatality Rates for Foodborne Illnesses*
(United States 1983-1992)

<table>
<thead>
<tr>
<th>Organism</th>
<th>Illnesses</th>
<th>Deaths</th>
<th>Fatality Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter</td>
<td>2,453,926</td>
<td>124</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Salmonella</td>
<td>1,413,322</td>
<td>585</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Escherichia coli 0175:H7</td>
<td>73,480</td>
<td>61</td>
<td>0.1</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td>2,518</td>
<td>504</td>
<td>20</td>
</tr>
</tbody>
</table>

(*Mead et al. 1999)
Who is Susceptible to Listeriosis?

- Pregnant Women
- Fetuses
- Newborns
- Immuno-suppressed people
- Elderly
# Health Canada Guidelines for high risk individuals:

<table>
<thead>
<tr>
<th>Foods to Avoid:</th>
<th>Safer alternatives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot dogs, especially straight from the package without further heating. The fluid within hot dog packages may contain more <em>Listeria</em> than the hot dogs. Avoid spreading fluid from packages onto other foods, cutting boards, utensils, dishes and food preparation surfaces. Wash your hands after handling hot dogs.</td>
<td>Hot dogs reheated until steaming hot</td>
</tr>
<tr>
<td>Non-dried deli-meats</td>
<td>Dried and salted deli-meats such as salami and pepperoni, as they generally do not support the growth of <em>Listeria</em>. In addition, you can reduce your risk by reheating deli-meats until steaming hot.</td>
</tr>
<tr>
<td>Soft and semi-soft cheeses such as feta, Brie, Camembert and blue-veined cheese if they are made from unpasteurized milk</td>
<td>Pasteurized milk and milk products including cheeses made from pasteurized milk</td>
</tr>
<tr>
<td>Refrigerated pâté and meat spreads</td>
<td>Canned or shelf-stable pâté and meat spreads</td>
</tr>
<tr>
<td>Refrigerated smoked seafood and fish</td>
<td>Cooked refrigerated smoked seafood and fish. Canned or shelf-stable smoked seafood and fish.</td>
</tr>
<tr>
<td>Raw or undercooked meat, poultry and fish</td>
<td>Thoroughly cooked meat, poultry and fish</td>
</tr>
</tbody>
</table>
What impact does this have on a HACCP Plan or a Food Safety Plan?

You must determine two items in these plans:

Are you making a food that supports the growth of Listeria or other contaminating pathogens?

Who are your customers? Are you selling to high risk individuals?
What do you do if the answer to both questions is yes?

You can set up additional barriers to growth:

• Acidification
• Water activity reduction
• Preservative addition
• Shelf-life reduction
• Frozen distribution
What do you do if the answer to both questions is yes?

You can kill or remove the organisms:

- Reduce the initial microbial load on inputs
- In-pack pasteurization
- Irradiation (follow regulations)
- Filtration
What do you do if the answer to both questions is yes?

You can change your marketing program:

• Change product preparation instructions
• Educate customers through promotional materials, website, trained sales staff
• Develop products specifically for a set of high-risk customers
What Foods are at Risk of Pathogen Growth?
Determine the Risk of Pathogen Growth in Food

If you answer YES to any question, your risk is LOW

- No Pathogens Allowed
- Is the product frozen?
- Is the product safely distributed at room temperature?
- pH ≤ 4.6?
- aw ≤ 0.85?
- Is the shelf-life ≤ 10 days?
- Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?
Determine the Risk of Pathogen Growth in Food

What is the risk of pathogen growth in:

Tomato-based soup?

Is the product frozen?

Is the product safely distributed at room temperature?

pH ≤ 4.6?

aw ≤ 0.85?

Is the shelf-life < 10 days?

Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?
Determine the Risk of Pathogen Growth in Food

What is the risk of pathogen growth in:

Cream-based soup?

- Is the product frozen?
- Is the product safely distributed at room temperature?
- pH ≤ 4.6?
- aw ≤ 0.85?
- Is the shelf-life < 10 days?
- Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?
Determine the Risk of Pathogen Growth in Food

What is the risk of pathogen growth in: Orange Juice?

- Is the product frozen?
- Is the product safely distributed at room temperature?
- pH \( \leq 4.6 \)?
- aw \( \leq 0.85 \)?
- Is the shelf-life \( \leq 10 \) days?
- Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?
Determine the Risk of Pathogen Growth in Food

What is the risk of pathogen growth in:

Carrot Juice?

- Is the product frozen?
- Is the product safely distributed at room temperature?
- pH ≤ 4.6?
- aw ≤ 0.85?
- Is the shelf-life ≤ 10 days?
- Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?
Determine the Risk of Pathogen Growth in Food

What is the risk of pathogen growth in:

Hot dogs?

Is the product frozen?
Is the product safely distributed at room temperature?
$\text{pH} \leq 4.6$?
$aw \leq 0.85$?
Is the shelf-life $\leq 10$ days?
Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?
Determine the Risk of Pathogen Growth in Food

What is the risk of pathogen growth in:

Old Cheddar cheese?

Is the product frozen?

Is the product safely distributed at room temperature?

pH ≤ 4.6?

aw ≤ 0.85?

Is the shelf-life ≤ 10 days?

Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?
Determine the Risk of Pathogen Growth in Food

What is the risk of pathogen growth in:

Hot Smoked Salmon?

Is the product frozen?
Is the product safely distributed at room temperature?
$pH \leq 4.6$?
$aw \leq 0.85$?
Is the shelf-life $\leq 10$ days?
Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?
Determine the Risk of Pathogen Growth in Food

What is the risk of pathogen growth in:

Frozen cold-smoked Salmon?

- Is the product frozen?
- Is the product safely distributed at room temperature?
- pH ≤ 4.6?
- aw ≤ 0.85?
- Is the shelf-life ≤ 10 days?
- Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?
Determine the Risk of Pathogen Growth in Food

What is the risk of pathogen growth in:

Refrigerated cold-smoked salmon?

- Is the product frozen?
- Is the product safely distributed at room temperature?
- pH ≤ 4.6?
- aw ≤ 0.85?
- Is the shelf-life ≤ 10 days?
- Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?
Determining the Risk of Pathogen Growth in Food

- No Pathogens Allowed
- Is the product frozen?
- Is the product safely distributed at room temperature?
- pH < 4.6?
- aw ≤ 0.85?
- Is the shelf-life ≤ 10 days?
- Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?

What barriers are there in soft cheese and cold-smoked salmon?
What makes *Listeria monocytogenes* a problem for food processors?
The organism:

• Resists the effect of freezing, drying, and heat well for an organism that does not form spores

• Grows at refrigeration temperatures

• Can form biofilms and become established in niches
Listeria monocytogenes can grow in many conditions:

- Facultative anaerobe
- Temperature Range: -0.4 to 45°C
- pH 4.39 – 9.4
- Water activity ≥ 0.92
- Salt concentration ≤ 10%
### Associated Foods

<table>
<thead>
<tr>
<th>Raw milk</th>
<th>Soft Mold Ripened Cheese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>Raw &amp; cooked poultry</td>
</tr>
<tr>
<td>Raw vegetables</td>
<td>Raw meats</td>
</tr>
<tr>
<td>Raw fermented sausage</td>
<td>Raw &amp; smoked fish</td>
</tr>
<tr>
<td>Liver Pate</td>
<td></td>
</tr>
</tbody>
</table>

**Listeria monocytogenes**
What should we consider in a Cold-Smoked Salmon Plant?

- *Listeria monocytogenes* is naturally found on the surfaces of salmon
- *Listeria monocytogenes* can be reduced but not eliminated during cold-smoking
- Brine can be a reservoir of *Listeria monocytogenes*
Major risk factors leading to the occurrence of *Listeria monocytogenes* in smoked salmon*

- Rotation of employees
- Poorly-maintained facilities
- Salting filets in vats (rather than small vats, trays or grates in stacks)

Important Processing Conditions for Cold-Smoked Salmon

- Environmental Monitoring program
- Minimize job rotation
- Well maintained facility
- Dry salting
- Separate areas for dressing and smoking
- Adequate post-production sanitation procedures
What should we consider in a Dairy?

- Soft mold-ripened cheeses are susceptible because they are conducive to the growth of *Listeria monocytogenes* during ripening and refrigerated storage.
- *Listeria monocytogenes* may be found in raw milk.
- The optimum time to sample susceptible cheese is after 21 days for surface ripened (cheese surface) and after 50 days for mold-ripened.
Important Processing Conditions for Dairies

- Environmental Monitoring program
- Minimize job rotation
- Well maintained facility
- Separate raw and pasteurized milk areas
- Slow vat records
- Brine Control
Environmental Monitoring Programs for *Listeria monocytogenes*
Environmental Monitoring is used to:

- Assess the risk of product contamination
- Determine in-control baseline measurement
- Assess if the environment is under control
- Investigate sources of contamination so corrective actions can be implemented.
Environmental Monitoring Program Design

• Establish baseline measurements using **biased**, investigative sampling techniques.

• Sample where Listeria is likely to be found

*Data from this phase is used to select sampling sites, times, frequencies, and types of samples*
Environmental Monitoring Program Design

Where should you sample for Listeria in your food plant?
Environmental Monitoring Program Design

A Zone concept may be useful:

- **Zone 1**: Product Contact Surfaces
- **Zone 2**: Nonproduct contact surfaces in close proximity
- **Zone 3**: Nonproduct contact surfaces – further away
- **Zone 4**: Significantly distant from processing area
Environmental Monitoring Program Design

What zones are your problem areas located in?

- **Zone 1**
  - Product Contact Surfaces

- **Zone 2**
  - Nonproduct contact surfaces in close proximity

- **Zone 3**
  - Nonproduct contact surfaces – further away

- **Zone 4**
  - Significantly distant from processing area
Environmental Monitoring Program Design - Recommendations

1. Swab and visually inspect areas where *Listeria* is likely to reside:
   - Drains
   - Damaged floors and walls, particularly in refrigerated areas
   - Product accumulation points
   - Potential niches and hard-to-clean areas within equipment

2. Test for *Listeria spp.* - investigate if swabs are positive
Environmental Monitoring Program Design - Recommendations

3. Consider swabbing of equipment during production –

Biofilms and niches are of greatest concern when located after a kill step (e.g., cooking) in a process. In both cases the environment appears visually clean and will pass inspection. Traditional sampling for indicators before start of operation to verify the equipment is clean will not detect the presence of a biofilm or niche. During production movement or vibrations of the equipment and/or flow of food through the system causes some of the microorganisms in biofilms and niches to become dislodged and contaminate the food. It is only through microbiological sampling of the equipment or food during production that biofilms and niches are revealed and corrective actions can be taken. (Tompkin, 2004)
4. Sampling finished products is needed to verify that the environmental program is functioning properly –

*Experience also indicates that sampling the food occasionally can detect contamination that is missed by the routine environmental sampling program. The reason for this discrepancy is not always apparent but such experiences suggest that sampling the food at some frequency should be included to supplement the environmental samples and verify the environmental program is sufficiently sensitive and functioning as expected.* (Tompkin, 2004)
Performing the Environmental Monitoring Program – Example Standard Operating Procedure
The Environmental Monitoring Program Design is an important part of monitoring and verifying your HACCP and Food Safety Plan.

HACCP Principle #4: Establish Monitoring Procedures

HACCP Principle #6: Establish Verification Procedures
References
Monitoring of Zone 1 – example

Monitor (Swabs and visual inspection)

Positive

Troubleshoot (review/observe sanitation and physical conditions)

Negative

Continue monitoring

Preventive/Corrective Action (dismantle equipment, intensify cleaning, repair physical damage)

Positive

Verification Swabs

Negative

Continue monitoring

Additional Actions, Test & Hold Finished Product Testing

Positive

Negative

Continue monitoring
Monitoring of Zone 2 - example

Monitoring

Negative: Continue Monitoring

Positive:

Troubleshoot (review/observe sanitation and physical conditions)

Preventive/Corrective Action (intensify cleaning, repair physical damage)

Verify Action (reswab)
Monitoring of Zones 3 and 4 - example

Monitoring

- **Negative**
  - Continue Monitoring

- **Positive**
  - Troubleshoot (review/observe sanitation and physical conditions)

  - Preventive/Corrective Action (intensify cleaning, repair physical damage)
• Establish baseline measurements
• Identify sampling sites and frequency
• Establish swabbing and analysis method
• Establish Deviation Procedures
Important Reference


www.codexalimentarius.net/web/index_en.jsp
Determine the Risk of Pathogen Growth in Food

Is the product frozen?

Is the product safely distributed at room temperature?

pH ≤ 4.6?

aw < 0.85?

Is the shelf-life < 10 days?

Has product been specifically formulated and/or processed in some other manner to prevent the growth of pathogens?

What is the risk of pathogen growth in:

Hot dogs?
Food Safety Objectives for *Listeria monocytogenes*

**Category 1 Food (Foods that have been implicated in foodborne outbreaks)**

No *Listeria monocytogenes* detected in 50 grams of food

**Category 2 Food (Foods that support the growth of Lm)**

No *Listeria monocytogenes* detected in 25 grams of food

**Category 3 Food (Foods that do not support the growth of Lm)**

≤ 100 cfu/g
HACCP Principle #4

Establish Monitoring Procedures

- Planned sequence of observations
- Assess control of CCP
- Acceptability based on Critical Limit

HACCP Principle #6

Establish Verification Procedures

Is the HACCP Plan working?

Is the Critical Limit adequate?