Cheese Safety

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Describe a holistic approach to cheese safety based on risk analysis principles.
Risk = (probability of an adverse event such as falling off a ladder) x the severity of the consequences of the event.
## Cheese borne hazards: prevalence in raw milk

<table>
<thead>
<tr>
<th>Foodborne Pathogen</th>
<th>Number of Studies</th>
<th>Prevalence: Average %</th>
<th>Prevalence: Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter jejuni</td>
<td>9</td>
<td>3.1</td>
<td>0 – 12.3</td>
</tr>
<tr>
<td>Shiga-toxin E. coli</td>
<td>8</td>
<td>2.6</td>
<td>0 – 3.8</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td>16</td>
<td>3.8</td>
<td>1.0 – 12.6</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>12</td>
<td>3.2</td>
<td>0 – 8.9</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>1</td>
<td>34.6</td>
<td></td>
</tr>
<tr>
<td>Yersinia enterocolitica</td>
<td>2</td>
<td>8.2</td>
<td>1.2 – 15.1</td>
</tr>
<tr>
<td>Mycobacterium paratuberculosis</td>
<td>1</td>
<td>68%</td>
<td>(U.S. Study)</td>
</tr>
<tr>
<td>Coxiella burnetii</td>
<td>1 (Kim et al)</td>
<td>&gt;94%</td>
<td>(U.S. Study)</td>
</tr>
</tbody>
</table>

### Take Home Point

Cheese makers must assume that all raw milk received into their plant is contaminated with substantial numbers of one or more pathogenic microorganisms that must be eliminated during the cheese making process.

See also [Milk Facts](#)
Cheese borne hazards: environmental

- *Listeria*: 7 – 28% of non food contact surfaces in cheese plants. Examples:
  - 17% of 243 noncontact surfaces (Menendez);
  - 11% of noncontact surfaces in eight NJ artisan cheese factories; 4% 'niche' sites; D’Amico, 2009.
  - Brazil, two cheese plants, 13 & 10%, Barancelli, 2011)
  - Chilli, 22%, Garces-Aviles, 2008

- Survival demonstrated in cheese brine (5 days) and rennet extract (Ryser 1989)

**Take Home Point**

Environmental contamination can shut down your plant.
### Some Cheese Borne Illnesses in North America

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>GA, NY, TN, TX</td>
<td>1 dead, 4 cases; Oasis Brand Latin American fresh cheese; <em>Listeria m.</em>; <a href="https://www.cdc.gov">U.S. Centre for Disease Control</a></td>
</tr>
<tr>
<td>2013</td>
<td>BC</td>
<td>No illnesses; Okanagan’s Choice, Chipped Parmesan, <em>Listeria m.</em>; <a href="https://www.canada.ca">CFIA</a></td>
</tr>
<tr>
<td>2011</td>
<td>Quebec</td>
<td>1 case; <em>Listeria m.</em>; several brands and varieties including Latin American fresh cheese; <a href="https://www.canada.ca">CFIA alert</a></td>
</tr>
<tr>
<td>2010</td>
<td>Nevada</td>
<td>1 case; homemade <em>queso fresco</em>; raw milk; <em>Campylobacter</em>, <a href="https://www.rgj.com">RGJ.com</a></td>
</tr>
<tr>
<td>2010</td>
<td>AZ, CA, CO, NM, NV</td>
<td>38 cases; 1 HUS (hemolytic-uremic syndrome); <em>Gouda</em>; new strain of <em>E. coli 0157:H7</em>, <a href="https://www.cdc.gov">U.S. CDC</a></td>
</tr>
<tr>
<td>2007</td>
<td>Kansas</td>
<td>67 cases; fresh cheese; raw milk; <em>Campylobacter jejuni</em>; community fair; <a href="https://www.cdc.gov">U.S. CDC</a></td>
</tr>
<tr>
<td>2008</td>
<td>Quebec</td>
<td>1 death; 87 cases; La Chaudiere brand Cheddar curd; <em>Salmonella</em>; <a href="https://www.canada.ca">CFIA</a></td>
</tr>
<tr>
<td>2007</td>
<td>Ontario</td>
<td>24 cases; raw milk cheese; pathogen unknown; mobile cheese-maker; <a href="https://www.outbreakdata.ca">outbreak data base</a></td>
</tr>
<tr>
<td>2007</td>
<td>Ontario</td>
<td>1 infant HUS; mother ate raw milk cheese</td>
</tr>
<tr>
<td>2006</td>
<td>Ontario</td>
<td>9 year old girl hospitalized; raw milk Gouda cheese; <em>E. coli 0157:H7</em></td>
</tr>
<tr>
<td>2002</td>
<td>Edmonton</td>
<td>13 cases (5 hospitalized, 2 HUS); raw milk gouda cheese</td>
</tr>
</tbody>
</table>

### Take Home Point
Don’t kid yourself. It can happen in any plant.
<table>
<thead>
<tr>
<th>Factors affecting growth and survival of pathogens</th>
<th>pH (acidity)</th>
<th>Water activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most pathogens grow</td>
<td>5.6 – 7.0</td>
<td>0.9 – 1.0</td>
</tr>
<tr>
<td>Few pathogens grow</td>
<td>4.4 – 5.6</td>
<td>0.85 – 0.90</td>
</tr>
<tr>
<td>Some survive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No pathogens grow</td>
<td>Less than 4.4</td>
<td>Less than 0.85</td>
</tr>
<tr>
<td>Some may survive</td>
<td>Less than 5.6</td>
<td>Less than 0.90</td>
</tr>
</tbody>
</table>

**Take Home Point**

Pathogens can be controlled by a combination of ‘hurdles’ such as acidity, lack of accessible moisture, heat stress, salt, and competition from bacterial cultures.

**Temperature history**
- less than 10°C, 10 – 45°C, 45 - 55°C, more than 55°C

**Cultures**
- competition, acidity, inhibitors

**Salt**
- less than 1%, 1 – 3%, more than 3%
<table>
<thead>
<tr>
<th>Organism</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Listeria monocytogenes</em> (30% mortality)</td>
<td>• Infectious, relatively high doses</td>
</tr>
<tr>
<td></td>
<td>• Cold, acid and salt tolerant</td>
</tr>
<tr>
<td></td>
<td>• Requires full pasteurization</td>
</tr>
<tr>
<td></td>
<td>• Ubiquitous in food environments</td>
</tr>
<tr>
<td><em>Enteropathogenic E. Coli</em> (e.g., 0157 H7)</td>
<td>• Infectious, low doses</td>
</tr>
<tr>
<td>“hamburger disease”</td>
<td>• Cold and acid tolerant</td>
</tr>
<tr>
<td></td>
<td>• In cheese, usually comes from milk</td>
</tr>
<tr>
<td><em>Salmonella spp</em></td>
<td>• Infectious at low doses</td>
</tr>
<tr>
<td><em>Campylobacter jejuni</em></td>
<td>• Infectious at low doses</td>
</tr>
<tr>
<td><em>Yersina enterocolistica</em></td>
<td>• Cold tolerant</td>
</tr>
<tr>
<td><em>Staphylococci aureus</em></td>
<td>• In cheese, usually from people contact</td>
</tr>
</tbody>
</table>
Cheese Recall Summary

Number of the CFIA Public Alerts Related to Cheeses: 2012-2015

- **Listeria monocytogenes**: 28
- **Salmonella spp.**: 0
- **Staphylococcus aureus**: 10
- **E. coli O157**: 2

Source: Complete listing of all recalls and allergy alerts: CFIA
## Cheese Recall Summary

### Pathogenic Bacteria vs Recall Incidents

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016*</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Listeria monocytogenes</em></td>
<td>1/19(5%)</td>
<td>9/25(36%)</td>
<td>11/32(34%)</td>
<td>7/35(20%)</td>
<td>1/6(17%)</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>0/0</td>
<td>0/0</td>
<td>7/7(100%)</td>
<td>3/6(50%)</td>
<td>0/0</td>
</tr>
<tr>
<td><em>E. coli O157:H7</em></td>
<td>0/47(22%)</td>
<td>2/9</td>
<td>0/9</td>
<td>0/0</td>
<td>0/0</td>
</tr>
<tr>
<td><em>Salmonella spp.</em></td>
<td>0/52</td>
<td>0/31</td>
<td>0/30</td>
<td>0/30</td>
<td>0/0</td>
</tr>
</tbody>
</table>

x/y: “x”: number of cheese recall, “y”: total food recall
* First four month in 2016

Source: Complete listing of all recalls and allergy alerts: CFIA

<table>
<thead>
<tr>
<th>Policy before 2011</th>
<th>Policy after 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{pH} &lt; 5$, or</td>
<td>$\text{pH} &lt; 5$, or</td>
</tr>
<tr>
<td>$A_w \leq 0.92$, or</td>
<td>$A_w &lt; 0.95$, or</td>
</tr>
<tr>
<td>$\text{pH} &lt; 5.5$ &amp; $A_w &lt; 0.92$, or</td>
<td>$\text{pH} &lt; 5$ &amp; $A_w &lt; 0.94$, or</td>
</tr>
<tr>
<td>Refrigerated for $\leq 10$ days</td>
<td>Refrigerated for $\leq 5$ days</td>
</tr>
</tbody>
</table>

**Take Home Point**

Under the new policy for ready-to-eat foods most cheese varieties are categorized as high risk for survival and growth of *Listeria monocytogenes*. 
<table>
<thead>
<tr>
<th>Pathogenic Hurdles in Cheese Making</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold storage of milk</td>
</tr>
<tr>
<td>Remove/kill bacteria</td>
</tr>
<tr>
<td>Cultures</td>
</tr>
<tr>
<td>Available moisture (a&lt;sub&gt;w&lt;/sub&gt;)</td>
</tr>
<tr>
<td>Temperature history</td>
</tr>
<tr>
<td>Exposure history</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Ripening time</td>
</tr>
</tbody>
</table>

Take Home Point

‘One size doesn’t fit all’. Effective cheese risk assessment and management is variety specific.
**Listeria** presence and survival in cheese

**Take Home Points**

- **329 washed rind cheeses from five European countries:** 6.4% contaminated with *L. monocytogenes.*

- **1991 (Marth) review of survival on cheese surfaces:** Parmesan 10 mo; Cheddar > 14 mo; Feta > 2 mo; washed rind Brick, Blue, and Camembert all supported growth of *Listeria*.

- **1991 (Genigeorgis):** inoculated 24 types and 28 brands; counts declined for all ripened cheese with lactic bacterial cultures and surface pH < 5.5.

- Incidence on cheese appears independent of milk heat treatment (Data and citations in Rudolf, 2001).
<table>
<thead>
<tr>
<th>Storage Time (Days)</th>
<th>S. Enteritidis count (CFU/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000000</td>
</tr>
<tr>
<td>7</td>
<td>100000</td>
</tr>
<tr>
<td>16</td>
<td>10000</td>
</tr>
<tr>
<td>29</td>
<td>1000</td>
</tr>
<tr>
<td>39</td>
<td>100</td>
</tr>
<tr>
<td>79</td>
<td>10</td>
</tr>
<tr>
<td>89</td>
<td>1</td>
</tr>
<tr>
<td>99</td>
<td>0</td>
</tr>
</tbody>
</table>

Survival of *Salmonella* Enteritidis in Cheddar cheese. Hirvi et al., 2001
Health Hazard Alert - Certain Okanagan's Choice Cheese brand Chipped Parmesan Cheese may contain *Listeria monocytogenes*
Recall date: June 20, 2013
Reason: Listeria
Hazard classification: Class 1
Company: Castle Cheese
Distribution: BC, MB
Cheese Risk Management priorities

While emphasizing the need for validation my list of highest to lowest risk management priorities is:

• Varieties with minimum or ripened pH > 5.6
• Intelligent inclusion of heat treatments in risk assessment and mitigation strategies
• Cross contamination in food service and retail stores
• Artisan manufacturers in new world countries
• Some traditional practices in old world countries. E.g. Inoculation via back slopping.
Cases
Safety of Unrefrigerated Cheese Curd

1993 Ontario Ministry of Health changed policy to allow sale of pasteurized Cheddar cheese curd at room temperature. Rationale:

- Culture inhibits more at room temperature, acidity and antimicrobials
- Salt inhibition
- 200 year tradition
- Considered (probably incorrectly) *S aureus* higher risk than LM because LM would be destroyed by pasteurization.
Raw Milk Cheese

1997 attempt to change the 60 day national standard for raw milk cheese in Canada. Full pasteurization (72.5° C, 16 s) unless:

1. Milk 63° C, 16 s; pH < 5.5; a_w <0.95; ripen 60 d at >2° C; retail label indicate date of manufacture;  Or,

2. Inspection at 100% level (including imports)

Proposal withdrawn due to objections by raw milk cheese importers, producers & consumers.
Raw Milk Camembert in Quebec

Exempt from 60 d, 2°C rule subject to:

• Water quality specs for producers and processors

• Special herd health program

• Milk: <24 h post milking; monthly *E. coli* < 500; monthly *Staph aureus* < 1000; tri-monthly *Listeria monocytogenes* and *Salmonella spp.* free;

• Records: herd health, milking and processing dates and times; make temperature and acidity.
August 2008, Quebec

- Listeriosis: 22 cases, 1 death, 6 premature deliveries, 1 stillbirth; *Listeria m.* associated with cut and uncut mixed rind soft cheese from two Québec factories; 300 retailers via one distributor; cross-contamination assumed likely among pasteurized and raw milk cheese.
- **Ombudsman** criticized agencies for inconsistent recalls, for not distinguishing between soft and hard cheese, and for inconsistent risk assessments.