The Importance of Microbiological Testing in Food Safety Management

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EXPERT GROUP: History-Based Performance of the HACCP Control Systems to Verify the Effectiveness of Food Safety Management

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Relevance of microbial testing for verification in the production of chocolate

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Agenda

General Considerations

Chocolate production – A Microbiologist View

Verification (and Controls)

Summary
## General Considerations

Examples of *Salmonella* outbreaks related to chocolate (products):

<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Country</th>
<th>Product</th>
<th>CFU/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970/71</td>
<td>Sweden</td>
<td>cocoa powder</td>
<td>?</td>
</tr>
<tr>
<td>1982</td>
<td>Italy</td>
<td>chocolate</td>
<td>low number</td>
</tr>
<tr>
<td>1985/86</td>
<td>Canada</td>
<td>chocolate</td>
<td>0.043-0.24 cfu/g</td>
</tr>
<tr>
<td>2001</td>
<td>USA</td>
<td>(raw) almonds</td>
<td>0.012-0.029 cfu/g</td>
</tr>
<tr>
<td>2001</td>
<td>Germany</td>
<td>chocolate</td>
<td>1.1-2.8 cfu/g</td>
</tr>
<tr>
<td>2002</td>
<td>Australia</td>
<td>Tahini</td>
<td>?</td>
</tr>
<tr>
<td>2006</td>
<td>UK</td>
<td>chocolate</td>
<td>0.03 cfu/g</td>
</tr>
<tr>
<td>2009</td>
<td>USA</td>
<td>pistachios</td>
<td>?</td>
</tr>
</tbody>
</table>

Data refer to a very low amount of microorganisms that could cause illness!!
General Considerations

Since the Beginning of the 1970ies statistical considerations have been made towards the risk to accept a contaminated material \(\Leftrightarrow\) applied sampling plans

Table 2. Acceptance plan for 25 g test units

<table>
<thead>
<tr>
<th>Product Category</th>
<th>No. of Units Tested(^a)</th>
<th>Significance: 95% Probability No More Than 1 Organism In(^b), g</th>
</tr>
</thead>
<tbody>
<tr>
<td>I, II, IV, V</td>
<td>60 (1500) 95 (2375)</td>
<td>500</td>
</tr>
<tr>
<td>I, II</td>
<td>30 (750) 48 (1200)</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>15 (375) 24 (600)</td>
<td>125</td>
</tr>
</tbody>
</table>

\(^a\) Numbers in parentheses indicate total grams of sample tested.

\(^b\) Confidence limits in Attribute Sampling Tables are commonly expressed in terms of the proportion of samples defective. However, at very low levels of contamination it may be more meaningful to speak in terms of concentration per unit. Thus, an average proportion of 0.05, 0.1, and 0.2 defective (positive) 25 g test units corresponds respectively to one organism in 500, 250, and 125 g product.
General Considerations

Foster Plan (1971)!!

- Official recognition/acceptance that “it is impossible to be 100% certain that salmonellae are absent”

- Recommendation of sampling plans:
  - “designed to assure that the Salmonella contamination level would be below an arbitrarily defined figure and aimed towards balancing safety against practicability”
Although *Salmonella* doesn’t grow in dry (low water activity) products, it will **survive** for long time periods.

Examples of prolonged detection at ambient storage:

- **S. Typhimurium, S. Enteritidis:** 15-18 months
- **S. Typhi & S. Paratyphi B:** 4-8 months

**S. Anatum:**
- Initial inoculum: 50cfu/100g
- After 15 months storage: 14cfu/100g
General Considerations

Heat resistance of *Salmonella* also depends on water activity / moisture and composition (e.g. fat, sugar) of the materials to be heat-treated.

Examples:

*Salmonella* Senftenberg in raw milk  
D-value at 67.5°C: 0.046min

*Salmonella* Senftenberg in chocolate  
D-value at 70°C: min. 440 min
General Considerations

- Chocolate Products caused illness / outbreaks where very low amount of cells was found in products (left overs)
- *Salmonella* survives for a long time in chocolate
- Heat resistance of *Salmonella* depends on food matrix (increased in high fat, high sugar / salt, low water activity matrixes)

Adequate **Process Controls** are required!

BUT: Originally, processes had been designed for product quality, not safety!
Chocolate production
– A Microbiologist View
Cocoa processing - A Microbiologist View

Raw Cocoa Beans → Pre-cleaning → Bean Dry Roasting → Pre-heating

Debacterization (Steam) → Bean Dry Roasting → Pre-heating

Drying → Bean Dry Roasting

Grinding → Breaking / Winnowing

Cocoa liquor → Nib Roasting / alcalization

Cocoa butter → Grinding → Pressing

Cocoa powder
Nut processing - A Microbiologist View

1. Harvest (Raw Nuts)
2. De-Shelling
3. Cleaning & Sorting
4. Roasting / Pasteurization
5. Packing
6. Sorting
7. Storage
8. Pre-cleaning
9. Storage
10. Storage
Verification (and Controls)
# Microbiological analyses in Food Processing

<table>
<thead>
<tr>
<th>Microbiological Testing</th>
<th>Process Controls (HACCP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low number of sample compared to batch</td>
<td>Control is applied to all the product – not limited to sample</td>
</tr>
<tr>
<td>Indicate control at the sampling interval</td>
<td>Continuous validated operational controls</td>
</tr>
<tr>
<td>After the fact – find out too late</td>
<td>Timely response to out of control process</td>
</tr>
</tbody>
</table>

Product quality/food safety is manufactured, not tested.
Process Controls - Validation

Role of microbiological analyses in Food Processing

뜨 Validation of microbiological critical control points:

➤ target organism(s)
➤ behavior of target organism(s) in products / processes
➤ method(s) of detection & enumeration
➤ required level of reduction / change
➤ available indicator organisms?

➤ Verification activities once the CCP is validated
Role of Verification Testing

- **Finished Product testing** is a verification of process controls.

*Note: Adequate lot management is important, and the frequency of verification should be based on best knowledge of the process.*
Supplier Selection & Management

Proactive means of identifying and controlling microbiological and other food safety risks at supplier level:

Supplier Control programs based on risk ranking of materials

- Adequate Food Safety management in place
- Validation of Critical Control Points
- Zoning (adequate separation between raw and RTE) / Pathogen Environmental Monitoring
- Environmental Monitoring (non-pathogen)
Role of Verification Testing

- Raw Materials (Ingredient) testing is a verification of supplier’s process controls.

*Note: Testing ingredients without a robust supplier quality program does not ensure safety / quality of ingredients.*
Environmental Controls

_Zone:_
An area or a region distinguished from adjacent parts by a _distinctive feature or characteristic._
Environmental Controls

Prolonged survival in processing environment

Salmonella Agona 1998

Salmonella Agona 2008
Use of appropriate hygiene indicators

- Enterobacteriaceae
- Coliforms
- Salmonella
- STEC
- E. coli
- Listeria spp.
- Listeria monocytogenes
Role of Verification Testing

- **Environmental monitoring** is a verification of segregation (Hygienic Zoning) and GMPs
Chocolate Confectionery production

- Raw Cocoa Beans
- Raw Nuts
- Supply of Sensitive Ingredients
- CCP monitoring (verification)
- Biological control step
- Biological control step
- Incoming Control (verification) Measures
- Hygienic Zoning (Verification by Environmental Monitoring)
- Hygiene monitoring (Cleaning Verification)

Finished Product
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