Peanut-Related Food Safety Issues

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Hot Topics on Peanuts

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Center for Food Safety at UGA’s Griffin Campus
Risks in Foods

Foodborne Diseases

Intoxications
- Chemical Poisoning
- Poisonous Plants and Animals
- Microbial Intoxication
  - Mycotoxins
  - Algal Toxins
  - Bacterial Toxins

Infections
- Toxicoinfections
- Invasive Infections

Sensitivities
- Allergies
Peanut’s Food Safety Risks

1. Allergies
2. Mycotoxins
3. *Salmonella*
Peanuts as Allergens

- One of the top 8 food allergens
- Food allergens top reason for food recalls
  - 2016 – **44 recalls due to undeclared peanuts out of 470**
- 3.3 million people suffer peanut or tree nut allergies
- 0.6 to 1.5% of children suffer peanut allergy
Peanuts as Allergens

- Allergy incidence is lower in Asia
- Symptoms: mild to severe (including life-threatening anaphylactic shock)
- Affect skin, GI tract, respiratory tract
- Occur within minutes or few hours after ingestion
Peanut Allergy Origins

Sequential rises in three different allergic diseases

PRE-HYGIENE

Seasonal Allergic Rhinitis

Pediatric Asthma

Peanut Allergy

Alpha-gal

1870: Blackley (UK) and Wyman (USA) define hay fever
1911: Noon starts immunotherapy for hay fever
1946: New York initiates ragweed eradication
1969: Increased asthma in Birmingham (UK) schools
1995: First recognition of rise in peanut allergy
1995-2000: Peak of asthma prevalence and severity

Copied from Platts-Mills et al. 2015
Peanuts as Allergens

- Early oral exposure to peanuts reduces peanut allergy
- 18 allergenic peanut proteins
- Resistant to digestion, heat denaturation and any type of hydrolysis
- Main types: cupin, conglutin, conarachin, Ara h 1, Ara h 2, Ara h 3
Prevention of Undeclared Peanuts

- Based on the 2004 FALCPA
  - GMP’s
  - Ingredient labelling
  - Informed consent statements on packaging
- FSMA
  - GMP revisions
  - Formally recognized as hazard – HARPC
  - Introduced the concept of cross-contact
Peanut’s Food Safety Risks

1. Allergies
2. Mycotoxins
3. Salmonella
Mycotoxins in Peanuts

- Aflatoxins (produced by *Aspergillus flavus*)
- Became evident in 1960s
  - Turkey X disease (100,000 poults died from peanut meal)
- Major risk in many developing countries
- US tolerance level < 15 ppb
**Salmonella**

- *Salmonella* are Gram-negative facultative anaerobic bacteria
- Cause serious gastroenteritis diseases
  - Typhoid fever and non-typhoid infections
- Zoonotic pathogenic bacteria
- Associated with poultry and eggs
# Estimates of Burden of Bacterial Foodborne Pathogens in the U. S. A.

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Cases</th>
<th>Hospitalizations</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Salmonella</em> (non-typhoidal)</td>
<td>1,028,000</td>
<td>19,336</td>
<td>378</td>
</tr>
<tr>
<td><em>Clostridium perfringens</em></td>
<td>966,000</td>
<td>438</td>
<td>26</td>
</tr>
<tr>
<td><em>Campylobacter (jejuni, coli)</em></td>
<td>845,000</td>
<td>8,463</td>
<td>76</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>241,000</td>
<td>1,064</td>
<td>6</td>
</tr>
<tr>
<td><em>Shigella</em></td>
<td>131,000</td>
<td>1,456</td>
<td>10</td>
</tr>
<tr>
<td>STEC non-O157</td>
<td>113,000</td>
<td>271</td>
<td>0</td>
</tr>
<tr>
<td><em>Yersinia enterocolitica</em></td>
<td>98,000</td>
<td>533</td>
<td>29</td>
</tr>
<tr>
<td><em>Bacillus cereus</em></td>
<td>63,400</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td><em>E. coli</em> O157:H7 (STEC O157)</td>
<td>63,100</td>
<td>2,138</td>
<td>20</td>
</tr>
<tr>
<td><em>Vibrio parahemolyticus</em></td>
<td>34,700</td>
<td>100</td>
<td>12</td>
</tr>
<tr>
<td><em>Streptococcus</em></td>
<td>11,200</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><em>Listeria monocytogenes</em></td>
<td>1,590</td>
<td>1,455</td>
<td>255</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>3.6 million</strong></td>
<td><strong>35,796</strong></td>
<td><strong>861</strong></td>
</tr>
</tbody>
</table>

(Scallan et al, 2011)
Incidence of *Salmonella* Foodborne Outbreaks

https://wwwn.cdc.gov/foodborneoutbreaks/
### Salmonella Outbreaks Associated with Peanuts

<table>
<thead>
<tr>
<th>Year</th>
<th>Serovar implicated</th>
<th>Source</th>
<th>Number of cases</th>
<th>Country</th>
<th>Route of contamination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994/1995</td>
<td>Agona PT 15</td>
<td>Peanut-flavored savory snack</td>
<td>71</td>
<td>Israel, UK, USA</td>
<td>Unidentified</td>
</tr>
<tr>
<td>1996</td>
<td>Mbandaka</td>
<td>Peanut butter</td>
<td>15</td>
<td>Australia</td>
<td>Roasted peanuts</td>
</tr>
<tr>
<td>2001</td>
<td>Stanley and Newport</td>
<td>In-shell peanuts</td>
<td>109</td>
<td>Australia, Canada, UK</td>
<td>Imported peanuts</td>
</tr>
<tr>
<td>2006</td>
<td>Thompson</td>
<td>Boiled peanuts</td>
<td>100</td>
<td>USA</td>
<td>Peanuts</td>
</tr>
<tr>
<td>2006/2007</td>
<td>Tennessee</td>
<td>Peanut butter</td>
<td>715</td>
<td>USA</td>
<td>Unidentified</td>
</tr>
<tr>
<td>2008/2009</td>
<td>Typhimurium</td>
<td>Peanut butter</td>
<td>714</td>
<td>USA, Canada</td>
<td>Numerous sources identified</td>
</tr>
<tr>
<td>2010</td>
<td>Typhimurium PT170</td>
<td>Peanut/cashew mix</td>
<td>19</td>
<td>Australia</td>
<td>Unidentified</td>
</tr>
<tr>
<td>2012</td>
<td>Bredeney</td>
<td>Peanut butter</td>
<td>42</td>
<td>USA</td>
<td>Cross-contamination between raw and finished product</td>
</tr>
</tbody>
</table>
## Notable *Salmonella* outbreaks due to low water activity ($a_w$) foods

<table>
<thead>
<tr>
<th>Food</th>
<th>Year</th>
<th>Serovar</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw almonds</td>
<td>2004</td>
<td>Enteritidis</td>
<td>29</td>
</tr>
<tr>
<td>Peanut butter</td>
<td>2007</td>
<td>Tennessee</td>
<td>425</td>
</tr>
<tr>
<td>Dry pet food</td>
<td>2007</td>
<td>Schwarzengrund</td>
<td>62</td>
</tr>
<tr>
<td>Puffed rice/wheat cereals</td>
<td>2008</td>
<td>Agona</td>
<td>28</td>
</tr>
<tr>
<td>Peanut products/butter</td>
<td>2009</td>
<td>Typhimurium</td>
<td>714</td>
</tr>
<tr>
<td>Black and red pepper</td>
<td>2009</td>
<td>Montevideo</td>
<td>272</td>
</tr>
<tr>
<td>Turkish pine nuts</td>
<td>2011</td>
<td>Enteritidis</td>
<td>43</td>
</tr>
<tr>
<td>Peanut products/butter</td>
<td>2012</td>
<td>Bredeney</td>
<td>42</td>
</tr>
<tr>
<td>Chia sprout powder</td>
<td>2014</td>
<td>Newport, Hartford, Oranienburg</td>
<td>31</td>
</tr>
</tbody>
</table>
Food recalls due to *Salmonella* detection

2014

- Produce: 13, 27%
- Nuts: 5, 10%
- Spices: 1, 2%
- Snacks: 6, 12%
- Pet food: 1, 2%
- Dairy: 1, 2%
- DS: 5, 10%
- Flour: 6, 12%
- Poultry: 8, 17%
- Total: 49 recalls

2016

- Produce: 9, 12%
- Nuts: 12%
- Spices: 5%
- Snacks: 3%
- Pet food: 12%
- Bakery: 12%
- Pasta: 7%
- Tea: 7%
- Other: 3%
- Dairy: 30%
- Eggs: 7%
- Total: 67 recalls
**Salmonella** in Dry Foods: Origins of this Problem

- *Salmonella* is a pervasive organism in nature
- Increased used of dry ingredients
- *Salmonella’s* ability to remain viable at low moisture levels
- *Salmonella’s* unique tolerance to heat at low water activity
- Improved surveillance and detection systems
Salmonella in Peanuts: Research Needs

- Sources of contamination
- Prevalence in low $a_w$ foods
- Long term-survival
- Thermal resistance
- Use of surrogates
- Methods of inactivation

Control and Prevention
Salmonella and Peanuts Research Publications

Number of peer-reviewed papers

(Pubmed, 2017)
Prevalence of *Salmonella* in Peanuts

- 2.33% of samples (22/944) tested positive (2008-2010)
  - 10 different serovars
  - Included 3 regions (SW, SE, Va/NC)
  - Only 3 samples had > 0.03 MPN/g
    (Calhoun et al., 2013, J. Food Prot. 76:575)

- 0.67% in 10,162 samples (2009-2011)
  - Included 2 states: Texas (Western) and Georgia (Eastern)
  - Prevalence in 2009 was 1.35%
  - Only 12 out of 68 samples were quantifiable (0.7-1.1 MPN)
    (Miksch et al., 2013, J. Food Prot. 76:1668)
Survival of *Salmonella* in Peanuts

- In peanut butter (PB), from 5.7 Log CFU/g – 1.0 Log CFU/g survived after 5.5 months at 21°C with multiple serovars (Burnett et al., 2000, J. Appl. Microbiol. 89:472)

- Three *S. Tennessee* strains only survived 2 weeks at 22°C in PB (Miksch et al., 2013, J. Food Prot. 76:1668)

- On peanut kernels, 4 serovars survived 12 months at 22°C (Brar et al., 2015, J. Food Prot. 78:323)
Control of *Salmonella* in Peanuts

- Heating is limited because of increased thermal tolerance, D-values at 90°C of 9 to 13 min in PB
  
  (Ma et al., 2009, J. Food Prot. 72:1596)

- Roasting of kernels in combination with microwaving reduced 4 Log CFU/g *E. faecium*  
  
  (Smith et al., 2014, J. Food Sci. 29:1584)

- High pressure processing (HPP) only reduced 1.7 Log CFU/g  
  
  (D’Sousa et al., 2014, J. Food Prot. 77:1664)

- Gamma-irradiation has been tested with promising results  
  
Specific Research Projects

- Kinetics of thermal inactivation in TOC
- Internalization of *Salmonella* into peanut plants
- Identification of GRAS-status bacteria surrogates
- *Salmonella* genes involved in desiccation tolerance
Internalization of *Salmonella* into Peanut Plants

Detected in more than 80% of stems at ≥3 log CFU/g when soil had ≥6 log CFU/g
Summary

- Three main risks are associated with peanuts: allergens, aflatoxins and *Salmonella*
- Allergy prevention is a major focus of FSMA
- *Salmonella* in low $a_w$ foods is a recently recognized risk
- *Salmonella* prevalence in peanuts is relatively low, but poses a risk
Summary

- *Salmonella* pervasiveness and survival fitness allow it to remain viable in peanuts
- Increased heat tolerance is an additional challenge
- Needs for validation of roasting processing and development of alternative technologies
Questions?
Thanks!!!

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