Emerging Foodborne Pathogens with Potential Significance to the Middle East

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INTERNATIONAL FOOD SAFETY EVENTS
WITH MIDDLE EASTERN CONNECTIONS
2011
Enterohemorrhagic *Escherichia coli* O104:H4 caused a large and deadly disease outbreak in Europe

- 3,950 people were affected, from 16 countries, but the majority were Germans
- 800 people suffered hemolytic uremic syndrome (HUS)
- 53 died (mainly adults)
- Cucumber from Spain was the believed to be culprit, but this assessment was proven false
- Epidemiological analysis: Sprouts made from seed imported from **Egypt in 2009** was the source.

References:
CDC. 2013. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6250a3.htm
Fenugreek Seeds → Incubation for days → Water → Sprouts
Microbiological characterisation of EHEC O104:H4
Enterohemorrhagic *Escherichia coli*

- Hemorrhagic colitis
- Hemolytic uremic syndrome (acute renal failure in children)

This disease outbreak is caused by a different virotype of *E. coli* but:

- Exhibit the same symptoms as EHEC
- Affect all age groups, not just children
What did we learn?

Persistence

That pathogenic *E. coli* strain survived for > 2 years in the dry seeds

Microbiological analysis

• Tracking the source was unsuccessful initially
• Outcome: Costly to Spain ($200M/week), Egypt, Germany, and other European countries

A new pathogen seems to be evolving

• Deadly to adults
• Looks like a hybrid between two dangerous groups: EHEC and EAEC
Proposed scheme of the origin of the new *E. coli* pathotype

For Pathogen Identification and Tracking: What to search for?

**E. coli**

Enterohemorrhagic *Escherichia coli* O104:H4 XXXXX

**Virotype:**
Communicates information about disease and sequelae

**Species:**
Communicates genotypic and phenotypic similarity at species level

**Serotype:**
Information about somatic and flagellar antigens

**Strain:**
Name of a specific culture originating from a single isolate
What can be done?

Better science in identifying and tracking pathogens

Serotyping doesn’t correlate with pathogenicity

Current finger-printing techniques have shortcomings

Whole-genome sequencing seems to be the answer
How about **survival** in the **dry** state?

**Moisture and pH; importance in food regulations**
Most vegetables, Milk, Meat, Egg (>0.97)
Cheese (Cheddar 0.95)

Italian Cheeses (Parmesan: 0.88)

Dry sausages (e.g., Salami)

Dry Milk (8% H₂O)
Peanut Butter (15% H₂O)
Tahini
Halawa

Spices
Dry seeds

C. botulinum growth
C. botulinum no growth
Microbial growth
No growth
pH

3
Pomegranate
Citrus juices
Apples
Tomatoes
Mayonnaise
Grapes

4

4.6
Several cheeses
Dry sausages

5
Bread
Fish
Meat
Milk
Beans
Most vegetables

6

7

8
Egg white

**Acid Foods**

C. botulinum no growth
C. botulinum growth

**Low Acid Foods**
High Moisture Foods

Intermediate Moisture

Low Acid

Water Activity ($a_w$)

pH
Water Activity ($a_w$)

pH

3  4  5  6  7  8

High moisture Foods

Intermediate moisture

Low Acid

Hardly regulated

No growth

Risky

Highly regulated

Intermediate moisture

Less regulated

Clostridium

Cl. botulinum

Cl. butyricum

Cl. perfringens

Cl. baratii

Cl. freudenreichii

CL. sordellii

CL. difficile

CL. tetani

CL. saccharogenes

CL. botulinum spores

CL. butyricum spores

CL. perfringens spores

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Behavior of microorganisms in various environments (including food)

1. Growth
   - High moisture
   - Nutritionally supportive
   - Non-hostile environment

2. Death (Inactivation, lethality)
   - Hostile environment

3. Survival (or dormancy)
   - Intermediate or low moisture
   - Non-supportive media
   - Hostile environment
### Infectious microbes
- Enterohemorrhagic *Escherichia coli*
- *Salmonella* serovars
- *Listeria monocytogenes*
- *Yersinia enterocolitica*
- etc.

<table>
<thead>
<tr>
<th>Survival</th>
<th>Growth</th>
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<tbody>
<tr>
<td>Health hazard</td>
<td>Greater hazard</td>
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### Toxins-producing microorganisms
- *Clostridium botulinum* toxin
- *Staphylococcus aureus* toxin
- *Bacillus cereus* toxin

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Salmonellosis outbreaks linked to sesame products from middle east (INFOSAN, 2004)

2001: *Salmonella* Typhimurium DT 104 in imported Halawa, in Europe

2003: *Salmonella* Montevideo in imported Tahini, in Australia

Sesame seeds → Tahini → Halva
Are non-spore-forming pathogens adapting to low $a_w$ food?

- Peanut butter
- Spices
- Milk Powder
- Cholate products

Are new dry-resistant strains evolving?

- Selective pressure of low $a_w$
- Adaptive mutation
- Horizontal gene transfer
Conclusions

• As new pathogens emerge, our detection and tracking methods need to cope.

• Contrary to long-standing convention, attention need to be directed to the safety of low water activity food.

• Middle eastern foods with low $a_w$ have been implicated in a number of high-profile disease outbreaks.

• Solutions are ideal at the preharvest stage (prevention), but post-harvest decontamination should only be used as the last resort.
Questions?